IPO Pricing with Bookbuilding and a When-Issued Market

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Abstract

This paper examines the IPO pricing process in a market which employs bookbuilding and also has a liquid when-issued market for IPOs. We find that when-issued trading reveals information of relevance for IPO pricing, but does not supplant bookbuilding as a source of information. Underwriters conduct bookbuilding to gather information before they post price ranges. When-issued trading commences after ranges have been posted. This trading indicates to underwriters where IPOs should be priced relative to the ranges. We find no evidence of a partial adjustment phenomenon, and hence no evidence for informative bookbuilding after price ranges are set and when-issued trading begins.

Key words: Initial public offerings; bookbuilding; when-issued trading
JEL classification: G32

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 active forward trading may even occur before the primary market offer price is set. 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 reguation 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 of IPOs. Germany, in particular, stands out as a country with a very active when-issued market for IPO shares. This market operates concurrently with a bookbuilding process in which the underwriters collect indications of interest directly from investors. While bookbuilding is well-recognized as a potential source of information for IPO pricing, practitioners also view the when-issued market as an indicator for how IPOs should be priced. To quote one of the

[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.

largest market makers in the German when-issued market, this market affects IPO pricing in that: "By observing when-issued trading, the underwriter can gauge the market's interest in an IPO."[3] Thus, in pricing IPOs, the underwriters can draw on two sources of information: (i) direct communication with investors who participate in the bookbuilding process and (ii) the prices of IPO shares in when-issued trading.

The objective of this paper is to examine the pricing of IPOs that are listed on the German Neuer Markt, in order to understand how the existence of a liquid when-issued market affects IPO pricing.[4] We find that the prices of when-issued trading are indeed very good indicators for how IPO shares are priced by the underwriters. However, they are not unbiased indicators! We find instead that, in their pricing decisions, the underwriters systematically underreact to information contained in the prices of recent trades in the when-issued market. Hence, investments in IPO shares yield rents commensurate to some information revealed by these prices. According to the theory by Benveniste and Spindt (1989), this finding could be interpreted as evidence of IPO pricing through bookbuilding: the rents may be received by investors who post orders for IPO shares, in exchange for the information contained in these orders. However, this theory applies only to private information contained in investors' orders. By contrast, the prices of when-issued trading are publicly available. This raises the question of why informational rents should be paid for information that is available for free. We suggest a simple answer: the underwriters may need the information before the when-issued market opens and, hence, before the information becomes freely available. Consistent with this argument, underwriters on the Neuer Markt indeed make important pricing decisions before the opening of when-issued trading. They set price ranges that effectively constrain the subsequent pricing of IPOs by imposing price ceilings above which IPOs are not priced.[5]

We argue that it is not merely a coincidence that when-issued trading never starts be-

[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."

[4]On September 26, 2002 the Frankfurt stock exchange announced that the Neuer Markt will close, at the latest by the end of 2003. As discussed in more detail in the following section, this does not affect our analysis.

[5]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 price ranges. Derrien and Womack (2003) also point this out for French IPOs. None of the IPOs in our study are priced above the posted range.

fore the price range has been posted. Instead, the timing of when-issued trading may be a consequence of an important externality of the bookbuilding process. This externality arises since the price range may reveal some information that the underwriter has obtained directly from investors through bookbuilding.[6] The market microstructure literature suggests a reason why when-issued trading may fail to open without such information revelation. For example, Glosten and Milgrom (1985) model how a market may fail to open in the presence of severe informational asymmetries across traders. The posting of the price range can effectively mitigate such asymmetries and thus facilitate when-issued trading.

Thus, while our results show that the when-issued market does reveal information that can be of use for setting IPO offer prices, we do not believe that when-issued trading fully supplants bookbuilding as a means for obtaining information. For the reasons stated above, this would not happen even if the when-issued market were fully efficient. Instead, stylized facts (discussed below) suggest that the opening of when-issued trading hinges on the posting of price ranges that reveal information underwriters obtain through bookbuilding. However, once the market for when-issued trading opens, it may dominate bookbuilding as a source of information for IPO pricing. In fact, we find no evidence of informational rents being paid to investors for providing information after the opening of when-issued trading.[7]

To summarize, we provide evidence for the coexistence of two rather different sources of information for determining IPO prices for firms listing on the Neuer Markt. Underwriters gather information through bookbuilding before they post price ranges. When-issued trading commences after these ranges have been posted. This trading indicates to the underwriters where IPOs should be priced relative to the price ranges.

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

[6]That these ranges are not just "cheap talk" is suggested by the fact that the underwriters do not price above the ranges.

[7]This is in contrast to evidence for U.S. markets that there is an informational role of bookbuilding even very close in time to the pricing date. See, for example, Bradley and Jordan (2002) and Lowry and Schwert (2001). See also Aussenegg, Pichler and Stomper (2002) for evidence that underwriters on Nasdaq gather information even after range amendments that occur very close to the pricing date.

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 findings 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. Furthermore, they show that if informative bookbuilding is a prerequisite for the when-issued market to function, then the existence of a liquid when-issued market does not interfere with information gathering through bookbuilding.

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 Neuer Markt 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.

The paper is organized as follows. The following section provides a description of key institutional aspects of the Neuer Markt IPO market. In the third section we develop our hypotheses. It is in this section that we also present a methodology to test for a partial adjustment phenomenon (as defined by Hanley (1993)), in the presence of binding price ranges. In the fourth section we describe the data. The fifth section provides summary statistics and a discussion of our empirical results. The final section concludes.

2 Institutional Characteristics of the Neuer Markt IPO Market

The Neuer Markt was created in March 1997 as a market segment of the Frankfurt Stock Exchange 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 the year 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. Instead, we regard the Neuer Markt IPO market as one example of a generic institutional framework for IPOs that will continue to exist in Germany and other European countries even after the closure of the Neuer Markt.

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 differs 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. By doing this, we do not want to suggest that the Neuer Markt is unique. It is rather the prime

[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".

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]

Listing and disclosure requirements: Table 2 states important 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: As on Nasdaq, bookbuilding is the dominant method for selling IPO shares on the Neuer Markt. Also, underwriters on both markets post price ranges some time before the final pricing of issues. However, apart from these basic similarities, there are a number of differences: 1) On Nasdaq, there is significant variation in when price ranges are first filed with the Securities and Exchange Commission (SEC).[12] On the Neuer Markt, the ranges are typically posted in a filing one week prior to pricing. (The mean (median) time between this filing and the pricing date is 7.02 (7.00) calendar days; the minimum (maximum) is 2 (18) calendar days). While bookbuilding "officially" occurs only after the filing of the ranges, during the so-called "subscription period", underwriters may also 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 on Nasdaq such range amendments are quite common. 3) While Nasdaq issues are frequently priced outside the final price ranges, this is rare for

[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.

[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]Aussenegg, Pichler and Stomper (2002) examine a sample of Nasdaq IPOs for the same time period as this study. In their data set 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.

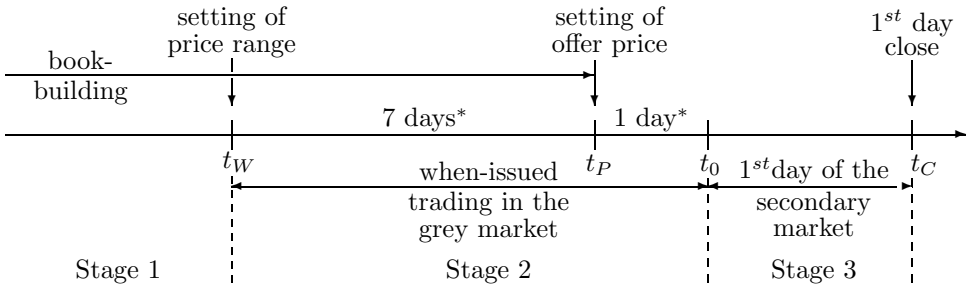
Neuer Markt IPOs. In our study, some Neuer Markt issues are priced below the ranges, but none are priced above. While no explicit legal restriction keeps underwriters from pricing IPOs above the ranges, bankers told us that this is never done due to concerns of legal action. Thus, an effective ceiling is placed on the IPO offer price prior to the onset of official bookbuilding during the subscription period.

When-issued trading: German IPOs differ from U.S. IPOs in that there is an active when-issued, forward market for IPO shares, also known as "Handel per Erscheinen" but more commonly called the "grey market". Grey market trading starts after the filing of the price range, but before the pricing of the IPO shares. 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.[14] 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 89 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.[15]

Timeline: In order to help understand the timing of bookbuilding and when-issued trading on the Neuer Markt, we present a stylized timeline in Figure 1. This timeline 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,

[14] 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.

[15] 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

the period of when-issued trading in the grey market. Grey market trading starts after price ranges are set and continues beyond time t_P, which is when the underwriters set prices at which IPO shares are offered in the primary market. 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, bookbuilding does not start until after time t_W.[16] 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 IPO Pricing with Bookbuilding and When-Issued Trading

In pricing IPOs on the Neuer Markt, underwriters can draw on two qualitatively different sources of information. The first of these, bookbuilding, is based on relationships between underwriters and investors who may provide the underwriters with relevant information. The second, when-issued trading in the grey market, can enable aggregation of investors' information, without relying on relationships between them and the underwriters. We discuss

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

in this section why underwriters may draw on either, or on both, sources of information for IPO pricing.

Relationship-based information gathering through bookbuilding: During the bookbuilding process, underwriters gather information from investors who regularly submit orders to buy shares in IPOs led by the underwriters. According to Benveniste and Spindt (1989), such information gathering is costly. They model bookbuilding as a mechanism by which underwriters obtain information directly from investors. To provide incentives for investors to truthfully reveal positive information about an issue, underwriters only partially adjust the IPO prices to such information and then allocate underpriced shares to those investors who provided the positive information. These investors realize initial returns commensurate to the price adjustment. Hanley (1993) documents that there is indeed a significant positive relation between initial returns of U.S. IPOs and the revision of IPO prices from preliminary price ranges set some time before pricing. Ljungqvist and Wilhelm (2002) show that this relation is robust with respect to cross-country differences in underwriters' discretion in the allocation of IPO shares.

Market-based information aggregation in the grey market: Bookbuilding has an inherent disadvantage in that building and maintaining relationships is costly. Thus, the number of relationships is limited, and underwriters may miss important pieces of information that reside with investors who do not participate in bookbuilding. If such investors trade in the grey market, then their information can be revealed through the prices of transactions in this market. These prices can serve as freely and publicly observable indicators for how underwriters should price IPOs. However, as we will argue below, this market may not be able to supplant bookbuilding as a source of information for IPO pricing. This is because the informativeness of the grey market may hinge on the success of the underwriters' information gathering activities *prior to* the opening of the grey market.

Bookbuilding and information aggregation in the grey market: For effective information aggregation in the grey market, this 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 a number of reasons why such liquidity cannot be taken for granted. First, there may not be enough sell-signed volume since sellers in the when-issued market may be concerned about 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.[17] Bookbuilding, however, differs from Treasury auctions in its method of allocating securities in the primary market. In bookbuilding, underwriters exercise discretion in the allocation of IPO shares. If bookbuilding precedes when-issued trading, then some traders in the grey market may already be confident that they will be allocated IPO shares. By selling these shares in the grey market, the investors can raise the liquidity of this market, thus rendering the grey market more informative as an indicator for how underwriters should price IPOs.[18]

Second, traders in the when-issued market may hope to receive securities in the primary market, making them loath to trade too aggressively, and to thus release information that could push up the primary market 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. Bookbuilding differs from Treasury auctions in that underwriters have discretion in pricing securities in the primary market: IPO shares need not be priced in a way that fully incorporates all information into the price. In fact, the observed implicit commitments by underwriters in Germany to not price IPO shares above publicly posted price ceilings can alleviate traders' concerns about pushing up the offer price through aggressive when-issued trading.

A further important reason why grey market liquidity cannot be taken for granted can be found in the literature on market microstructure. As modeled by Glosten and Milgrom

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

[18] We are not the first to point out that the efficiency of IPO pricing may be enhanced by underwriters' discretion in allocating IPO shares. Instead, we provide a further argument for why this may be the case, thus extending the empirical analysis by Ljungqvist and Wilhelm (2002) and the theoretical analysis by Maksimovic and Pichler (2002). Our views are also shared by practitioners. For example, consider the following quote 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.

(1985), a market may fail to open in the presence of severe informational asymmetries across traders. This happens because agents who would normally supply liquidity (market makers) respond to the possibility of trading with better informed traders by quoting spreads that are so wide that no trading occurs. This problem is potentially much more severe in when-issued trading of IPO shares, as compared to when-issued trading of Treasury securities. 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.[19] When-issued trading may fail to open unless these informational asymmetries can be mitigated.

Indeed, mitigation of such informational asymmetries across traders seems to be the case for Neuer Markt IPOs. For example, grey market trading never opens before the underwriter announces a range for the offer price of the IPO shares.[20] This announcement can reveal information that the underwriter has gathered from informed investors before setting the price range.[21] Thus, these investors' informational advantage is reduced, enabling grey market trading to start.

To summarize, we argue that when-issued trading in the grey market may not supplant bookbuilding as a source of information for IPO pricing, even if the grey market fully reveals all information that underwriters can obtain before pricing. For the reasons stated above, bookbuilding may be essential for grey market trading to open. We are not suggesting 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.

The empirical analysis: In our empirical analysis, we will investigate whether underwriters conduct bookbuilding to obtain costly information for IPO pricing even in the presence of a

[19] 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.

[20] This timing convention is not restricted only to IPOs in Germany. According to Gary Beechener of Tullett & Tokyo Liberty (securities) Ltd., one of the biggest brokers in the when-issued market of IPOs in Europe: "I have never come across an issue that traded prior to the range indication."

[21] 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. Further, as discussed above, the posted ranges are effectively binding. Thus, we would argue that these ranges are not just "cheap talk".

liquid when-issued market. We will regard bookbuilding as a source of relevant information if we find that investors earn rents that are significantly related to the information.[22] No informational rents should be paid, if all necessary information can be obtained for free by observing prices in the grey market, without any information gathering taking place through bookbuilding.

In order to answer the question of whether investors receive informational rents we begin by examining the relation between grey market trading and IPO pricing. We will test the following hypothesis.[23]

> **H_{GREY}**: No informational rents are being paid for any information contained in the prices of grey market trading. Thus, underwriters fully adjust the pricing of IPOs for any information contained in the prices of grey market transactions before the pricing date, t_P.[24]

The alternative is that underwriters adjust the pricing of IPO shares only partially for some information contained in the prices of grey market transactions. Then, investors earn initial returns commensurate to the value of this information. This suggests that the initial returns really are informational rents. By paying investors such rents, underwriters can obtain information even *before* the grey market opens, perhaps to set price ranges at time t_W. This implies that underwriters draw on a different source of information, other than just the grey market.

If grey market trading does not *fully* supplant bookbuilding as a source of information, it may still drive out informative bookbuilding *after* the grey market opens (and thus after the price ranges are set). The posting of the price ranges enables us to investigate this possibility by using an analysis that resembles that of the "partial adjustment phenomenon" by Hanley (1993). We will look for evidence that investors receive initial returns commensurate to any information that determines the pricing of IPOs *relative to the price ranges*. If no such evidence can be found, then it must be costless for the underwriters to obtain the information, perhaps because it is freely available after the grey market opens.

[22] This is consistent with the model by Benveniste and Spindt (1989).

[23] This hypothesis is stated informally here. Later in this section we will restate the hypothesis more formally.

[24] We emphasize the word *before*, because the last grey market price is typically posted *after* the offer price is set. For this reason, we cannot use the closing prices of the final day of grey market trading in our analysis of IPO pricing.

$\mathbf{H_{REV}}$: No informational rents are paid for information of relevance for the pricing of IPOs relative to the price ranges set at time t_W. As such, initial returns are not positively related to price revisions from the midpoints of the price ranges to the offer prices, in any way that cannot be explained with public information.

This hypothesis differs from $\mathbf{H_{GREY}}$ in that we are now focusing on the *relative* pricing of IPOs with respect to the price ranges. Hence, we investigate the relation between the initial returns of IPOs and information that determines how underwriters set offer prices relative to price ranges. This change in focus enables us to address the question of whether underwriters conduct bookbuilding to obtain information after the setting of the ranges, and thus after grey market trading begins.

We have so far stated the hypotheses in a very informal manner. In the remainder of this section, we will develop a simple model and derive formalized versions of these hypotheses that we can bring to the data.

3.1 The Hypotheses

An implication of the Benveniste and Spindt (1989) theory is that IPO prices should only partially adjust to positive information that is provided by investors during bookbuilding. Hanley (1993) documented such a partial adjustment phenomenon. A number of researchers, however, have provided evidence that IPO offer prices also partially adjust to publicly available information.[25] We begin our analysis by modeling the partial adjustment phenomenon, but we will do this in a way so as to differentiate between partial adjustment that may be due to underwriters' information gathering and partial adjustment that is explained by public information.

3.1.1 Price revisions with a pricing "constraint"

As discussed above, IPOs in this market are not priced above the posted ranges. This is a common characteristic of IPO pricing in Europe. We thus first develop a methodology that can be used to test for a partial adjustment effect when prices are constrained.

[25] See for example, Bradley and Jordan (2002), Benveniste, Ljungqvist, Wilhelm, and Yu (2003), Ljungqvist and Wilhelm (2002), Loughran and Ritter (2002a), and Lowry and Schwert (2002).

The price revision can be expressed as follows:

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

where $PREV$ denotes the actual price revision from the midpoint of the range to the offer price (in Euros), $MAXREV$ is the maximum possible price revision (i.e., 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. This latent price revision reflects both public information, and private information that the underwriter obtains in the course of bookbuilding after setting the price range:

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

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 (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 difference between the first day closing price and the offer price of an IPO. IR_0 is the initial return if $i = 0$ (that is, 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.[26] If rents are paid for information, in the form of partial adjustment, then $\beta < 1$, so that $\gamma_U > 0$ and $\gamma_C > 1$.

In the following subsections, we will make use of equation (4) in order to formalize the hypotheses stated earlier. From this point onward we will refer to IPOs subject to constrained pricing as "constrained" IPOs (C), and all others as "unconstrained" IPOs (U). Consistent with equation (4), we will at times need to form different hypotheses for IPOs that are constrained and those that are unconstrained.

3.1.2 IPO pricing and grey market trading

In formalizing the hypothesis $\mathbf{H_{GREY}}$, we will first address the question of whether grey market trading reveals information of relevance for IPO pricing. We will then test whether the offer prices of IPOs are fully adjusted to reflect this information. We will thus separate the hypothesis into two formal hypotheses: $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$.

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.[27] If grey market trading releases pricing-relevant information, 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, $PREV^*$.

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

[27] We define the grey market return similar to the price revision $PREV^*$ in order to obtain a one-to-one relation between the two variables under hypothesis $\mathbf{H_{GREY}}$.

A necessary condition for the grey market return to provide information is that the coefficient is greater than zero. This is the alternative hypothesis.

In testing the hypothesis $\mathbf{H^{Inf}_{GREY}}$ we will test whether grey market trading provides underwriters with information that is relevant for pricing IPOs. If so, then we can also test whether underwriters fully adjust the pricing of IPOs to this information. This test provides an indirect answer to the question concerning the informational role of bookbuilding prior to the opening of grey market trading. To see this, note that such trading can reveal information that underwriters need in order to set price ranges *before* grey market trading commences. However, as such revelation does not occur until *after* the setting of the ranges, underwriters cannot wait for the information to become freely available. Instead, they must engage in bookbuilding in order to obtain the information directly from investors. As a consequence, rents may be paid for information that is later revealed through grey market trading. If such informational rents are indeed paid, then we should find partial adjustment of the pricing of IPOs for information revealed through grey market trading. That is, we should reject the following hypothesis:[28]

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

As stated below hypothesis $\mathbf{H_{GREY}}$, the alternative is that underwriters adjust the pricing of IPO shares only partially to the grey market return. Under this alternative hypothesis, the coefficient of the grey market return is less than one.

3.1.3 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 at time t_W. Since the opening coincides with the setting of the price ranges, we can focus on information that determines how underwriters set the offer prices *relative to* these ranges. If no informational rents are paid to investors who participate in bookbuilding after time t_W, then the under-

[28] We want to emphasize that this hypothesis regards the *latent* price revision, that is the price revision that would occur if the offer price were not constrained by the range maximum. Thus, if we reject this hypothesis it is not due to the pricing constraint.

writers 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. Therefore, hypothesis $\mathbf{H_{REV}}$ can be stated more formally in terms of 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 time t_W, then the theory of Benveniste and Spindt (1989) suggests that $\beta < 1$: underwriters only partially adjust the pricing of IPOs for information i of relevance for the pricing of IPOs relative to the price ranges. 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.[29]

3.2 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, the term $PREV_0 - MAXREV$ measures the extent to which price ranges constrain the price revision that is induced by public information. According to equation (4), initial returns should be directly related to this amount. Therefore, we test whether in a regression of initial returns of constrained IPOs on the extent to which the offer price is constrained ($PREV_0 - MAXREV$),

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

the coefficient (δ) is equal to one.

Initial returns represent money left on the table by the issuer. The extent to which the offer price is constrained, $PREV_0 - MAXREV$, 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.[30]

4 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. We are aware that some of our results may be affected by this, but do not expect that it affects our qualitative results.

Exclusions: Six of the Neuer Markt IPOs were dual listings that went public simultaneously on the Neuer Markt and another exchange. These observations are excluded from our sample because the pricing of these IPOs may involve information gathering in markets for which we have no data. We include in our regressions only firms that went public between February 1999 and December 2000: we use the January 1999 data to measure the market conditions prior to the IPOs in Febuary. After exclusion of four IPOs in January 1999, we obtain a final sample of 253 IPOs.

[30] Thus, we check if the shadow price on the pricing constraint is significantly positive.

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 about when-issued trading, we use the price of the last transaction before the pricing date t_P of each IPO. For 14 IPOs we could not obtain such prices; instead, we use the last mid-quotes (mean of the bid and ask quotes) posted before the pricing date.[31]

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 split our sample into groups of IPOs by high-technology and non-high-technology issuers, as well as internet and non-internet issuers.[32] 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: In the remainder of this section, we present descriptive statistics. To put these statistics into perspective, once again we compare IPOs on the Neuer Markt with Nasdaq IPOs. The results are stated in Table 3.[33] In the years 1999 and 2000, high-technology issuers account for 68% (60%) of IPO volume on the Neuer Markt (Nasdaq). In absolute numbers of IPOs, 72% (62%) of IPOs on the Neuer Markt (Nasdaq) were high-technology firms. The two markets differ in the prevalence of internet IPOs: only 21% of IPOs on the Neuer Markt versus approximately 50% on Nasdaq.

[31] As discussed in Section 2, when-issued trading usually continues for at least one day *after* the pricing of IPOs. For this reason, we cannot use the closing prices of the final day of when-issued trading in our analysis of IPO pricing.

[32] Note that these industry groups "overlap", in that each IPO is assigned to two groups. For example, IPOs of internet retailers are classified as "non-high-technology" and "internet".

[33] Data for the Nasdaq IPOs were obtained directly from the U.S. Securities and Exchange Commission's (SEC) Edgar database. To obtain our final Nasdaq data set of 774 firms, we exclude unit offerings, REITs (real estate investment trusts), closed-end funds, banks and savings and loans, ADRs (American Depository Receipts) and preferred stock offerings. We identify high-technology issuers 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. This list can be downloaded from http://bear.cba.ufl.edu/ritter/ipodata.htm. We would like to thank Jay Ritter for providing these data.

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 non-internet IPOs.[34] In terms of the fraction of issuers' stock sold in IPOs, firms listing on the Neuer Markt on average sold significantly more than those on Nasdaq. While this is true across all industry groups, the fraction sold is significantly smaller for internet IPOs on both markets.

5 Empirical Analysis

5.1 Descriptive Statistics on IPO pricing

From this point forward our study focuses entirely on the Neuer Markt IPO market. Table 4 provides descriptive statistics on the price ranges posted at time t_W (Panel A) and the pricing of IPOs relative to these ranges at time t_P (Panel B). Panel A shows that the range center (i.e. the midpoint between the minimum and maximum of the price range) as well as the range size (defined as 100(%)x(range maximum – range minimum)/range center) do not differ significantly across the industry groups (high-technology, non-high-technology, internet and non-internet). Price ranges in this market exhibit much variation in their centers and in their widths. Panel B shows the distribution of prices at which IPO shares were offered, relative to the price ranges. While pricing IPOs above posted ranges is common on Nasdaq, we do not observe this on the Neuer Markt. More than two-thirds of all Neuer Markt IPOs are priced exactly at the top of the range, and none are priced above the range. In contrast, Ljungqvist and Wilhelm (2003) document for the year 1999 (2000) that 47% (39%) of U.S. IPOs were priced above the bookbuilding range.

Table 5 provides summary statistics for three further variables that characterize IPO pricing. The first of these, given in Panel A, is the price revision. This is the percentage by which underwriters price IPOs above or below the midpoints of the price ranges: 100%×(offer price – range center)/range center. We find no significant difference in the mean price revision across the industry groups. The mean price revision of 3.6% for the total sample is less than

[34]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.

one-fourth as large as the mean price revision of 15% for U.S. IPOs reported by Ljungqvist and Wilhelm (2003) for the years 1999 to 2000. This difference is consistent with the fact that IPOs on the Neuer Markt are not priced above the price range.

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. We find no significant difference in means between the high-technology and non-high-technology groups, but internet IPOs do have a significantly higher mean initial return than non-internet IPOs (the difference is significant at the 6% level). Moreover, the mean initial return of Neuer Markt IPOs is smaller than for U.S. IPOs. Loughran and Ritter (2002b) report for the years 1999 and 2000 a mean (median) initial return of 65.0% (32.3%) compared to 45.3% (19.4%) for our total sample of 253 Neuer Markt IPOs.[35]

Finally, we look at how IPOs are priced relative to the prices of recent transactions in the grey market. Panel C of Table 5 presents statistics on the percentage by which underwriters deviate in IPO pricing from the last grey market prices available just before setting the offer prices. On average, IPOs in our sample were priced about 22% below the last available grey market price. Given underwriters' policy of not pricing above posted price ranges, it is not surprising that IPOs are on average priced below the grey market prices. 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, these prices were on average 4.5% below the grey market prices. A t-test reveals that this deviation is statistically significant at the 1% level ($t = -4.1006$).

5.2 IPO Pricing

In this section, we analyze the pricing of IPOs on the Neuer Markt. The purpose of this is both to set the stage for the analysis in the next section, and to test hypotheses $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$. We run regressions explaining the percentage latent price revision:

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

[35] 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%).

where *offer price** is the offer price that would be set if the underwriter were able to price above the top of the price range. As discussed in Section 3.1, we will differentiate between those parts of the price revision that we can explain with publicly available information and those that we cannot explain. In developing a model to do this we build on results of previous studies of IPO (under-)pricing, discussed below.

5.2.1 Explanatory variables for IPO pricing

Table 6 lists the notation and the exact definitions of the explanatory variables of our model for IPO pricing. We denote indicator variables as "I" with a subscript stating the criterion that must be satisfied for such a variable to equal one: for example, the indicator variable $I_{INTERNET}$ equals one for IPOs with the industry classification "internet". Further, we use a "hat" ($\hat{\cdot}$) to denote explanatory variables that we treat as endogenous.

Our model of IPO pricing is influenced by a number of other papers both on IPO pricing and IPO underpricing. 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 the Appendix and stated in Table 6, Panel A.

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.[36] 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.[37] 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 likely to be 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.

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

[37] We found only three range amendments in 1999 and 2000.

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 ($FSOLD$). While we seek to control for such an effect, 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 interpreted as an unrestricted reduced form of a structural model simultaneously explaining the range center and the fraction sold.[38]

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).

[38] 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.

In the Appendix 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.[39]

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.[40] 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 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 ($N^{NM}_{t_W - 2m}$).

To summarize, we estimate the following model for how underwriters revise the offer price from the center of the price range:[41]

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

where the dependent variable $PREV^*$ is the (latent) price revision from the center of the price range to the (latent) offer price, as a percentage of the range center. Panel B of Table 6 presents the exact definitions of all the explanatory variables included in each of the broad categories in equation (6). Panel A of Table 6 summarizes the structure of the first stage regressions for instrumenting endogenous explanatory variables. The instruments that are denoted in bold face are identifying variables that are included in only one of these regressions.[42]

[39] 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 $\bar{IR}^{NQ+}_{t_W \to t_P}$.

[40] 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.

[41] Note that 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.

[42] Since the model is overidentified, we can test the validity of these variables as instruments by testing the restriction that none are (directly) used elsewhere as explanatory variables. There are three endogenous variables $UMSHARE$, $RCENTER$,

5.2.2 Estimation issues

In estimating model (6), we must take into account the fact that IPOs on the Neuer Markt are not priced above the upper bounds of the price ranges. As a further complication, the sizes of these price ranges differ across IPOs. Thus, the price revision is a right-censored variable, but censoring occurs at different levels of the latent price revision $PREV^*$. Hence, an ordinary TOBIT model is not suited to estimate model (6). 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.[43] 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.

Two criteria are used 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 IPOs fail to meet the second one. We categorize these three IPOs as unconstrained.[44]

5.2.3 Results

Table 7 presents the results. Panel A reports the models used for instrumenting the endogenous variables. Panel B presents the results from estimating the model (6): column (1) reports the base model, and column (2) adds an explanatory variable, $GREYMKT$, required to test the hypotheses $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$. This variable is defined as the percentage by which the price of the last transaction in the grey market before the time of IPO pricing

and $FSOLD$, and six instruments that serve to identify these variables. Thus, the model satisfies the "order condition" for identification, stated for example in Davidson and MacKinnon (1993), page 633.

[43] 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).

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

(t_P) differs from the center of the price range:[45]

$$GREYMKT = \frac{last\ grey\ market\ price\ before\ t_P - range\ center}{range\ center}. \tag{7}$$

For both models, the test discussed by Smith and Blundell (1986) rejects exogeneity of the three variables treated as endogenous ($UMSHARE$, $RCENTER$, and $FSOLD$) with a p-value of 0.018 for column (1) and a p-value of 0.036 for column (2).[46] 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 results in Panel A column (1) indicate that, as suggested by Habib and Ljungqvist (2001) and Beatty and Welch (1996), the choice of underwriter depends on the size of the issue and the issuer: we obtain positive coefficients for the variables $I_{EPROC>MEDIAN}$ and $I_{EMCAP>MEDIAN}$ indicating IPOs with above-median expected proceeds/market capitalization. Also, the coefficient of the log of issuers' sales and that of the issuers' total assets is significantly positive.

Columns (2) and (3) present the results of our model for the determination of the price range and the fraction of an issuer's equity that is sold at the IPO. As we anticipated, these variables seem to be interdependent: our model explains them up to significantly negatively correlated residuals (correlation of -0.152). The range center is positively related to recent primary market returns ($\bar{IR}^{NM}_{t_W-2m}$), IPO activity ($N^{NM}_{t_W-2m}$), and the issuer's earnings per share (EPS), but negatively related to an indicator of whether earnings are positive ($I_{EPS>0}$). The range center is also set lower for IPOs of firms with non-German headquarters ($I_{FOREIGN}$). The issuer's size ($I_{EMCAP>MEDIAN}$) is significant in explaining both the range center and the fraction of equity sold, but with opposite signs. Larger firms post higher range centers and sell smaller fractions of their equity at the IPO. In addition, the fraction sold is positively related to the issuer's age ($Log(AGE)$).

[45] The grey market return is defined similarly to the variable $PREV^*$ (defined in equation (5)). Thus, under hypothesis $\mathbf{H_{GREY}}$, we should find a one-to-one relation between $PREV^*$ and $GREYMKT$.

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

Panel B of Table 7 reports estimates for our model of IPO pricing. Of the endogenous variables, only the range center has a coefficient that is significantly different from zero in column (1). The sign of this coefficient is intuitively plausible: 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).

We find that market conditions and IPO activity are significant in explaining price revisions. Price revisions are positively related to both secondary and primary market returns, and to the number of recent IPOs. The positive relation to market conditions is not surprising in the light of the results of the empirical studies cited above, although most of those studies investigate IPO underpricing. As a novel result, we show that there are significant cross-market effects, in that IPO pricing on the Neuer Markt is positively related to initial returns of recent Nasdaq IPOs. This is true both for Nasdaq IPOs that occurred during the two months prior to range setting, and for those that occurred after the range setting. However, this cross-market effect is significant only for those Nasdaq IPOs by 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.

The explanatory variables of column (1) all cease to have any significant effects once we include the variable $GREYMKT$ in column (2). This suggests that the other variables contain no significant additional information beyond what is impounded in the prices of grey market trading.[47]

Testing the hypotheses $\mathbf{H^{Inf}_{GREY}}$ and $\mathbf{H^{Adj}_{GREY}}$: We now test our hypotheses on whether when-issued trading reveals information of relevance for IPO pricing ($\mathbf{H^{Inf}_{GREY}}$) and on how underwriters respond to such information in setting the prices at which IPO shares are offered ($\mathbf{H^{Adj}_{GREY}}$). Contrary to 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 grey market return ($GREYMKT$) substantially contributes to the explanatory

[47] However, the coefficients of the variables in column (1) do not differ significantly from those in column (2).

power of our model. We thus reject the hypothesis $\mathbf{H^{Inf}_{GREY}}$. This suggests that when-issued trading can serve as a freely and publicly observable indicator for how underwriters should price IPO shares.

However, 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. We thus reject the hypothesis $\mathbf{H^{Adj}_{GREY}}$ that underwriters fully adjust the pricing of IPO shares for information revealed through when-issued trading. (Our tests and hypotheses are for the *latent* price revision. Hence, this result is *not* due to constrained IPO pricing.) What we find instead is partial adjustment, as if underwriters cede informational rents for information that is revealed through grey market trading. On the surface this partial adjustment appears to be 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, perhaps to set the price ranges at time t_W. Thus, such information may *not* be freely available when it is needed. If so, then underwriters may resort to bookbuilding in order to obtain the information directly from investors in exchange for informational rents. Our findings suggest that such informational rents are indeed paid. This explanation is made more plausible by the fact that the setting of the price ranges is important, in that the ranges may subsequently constrain the pricing of IPOs. Therefore, we conclude that, in rejecting the hypothesis $\mathbf{H^{Adj}_{GREY}}$, we find evidence consistent with informational rents being paid for information that helps underwriters to set price ranges.

5.3 IPO Pricing Relative to the Price Ranges

In this section, we test the hypotheses $\mathbf{H^{U}_{REV}}$ and $\mathbf{H^{C}_{REV}}$. In these hypotheses the focus is on *deliberate* IPO underpricing, borne out by a positive relation between initial returns and that part of the latent price revision $PREV^*$ that cannot be explained by public information. To test whether there is such a relation, we draw on results of the last section. We assume that model (6) determines $PREV_0$, i.e. the price revision that would result if underwriters

received no information beyond what is publicly available. Then, any difference between the latent price revision and the predicted revision, $PREV^* - PREV_0$, captures IPO pricing in response to non-public information i.

Equation (4) states how such information affects initial returns. To convert this equation into an econometric model, we need to address the problem that we can directly observe the latent price revision $PREV^*$ only for IPOs priced within or below their price ranges. For the other IPOs we need to draw on information impounded in prices of when-issued trading 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.[48] We denote this price revision by $PREV_G$. Using this variable, equation (4) corresponds to the following model:

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

where $PREV_0$ is the latent price revision, if underwriters receive no private information ($i = 0$), and ϵ_U and ϵ_C denote econometric disturbances. I_{CON} is a dummy variable that is equal to one for constrained IPOs and zero for unconstrained. (The criteria for categorizing IPOs is described in Section 5.2.2.) For all IPOs we calculate $PREV_0$ using the model of column (1) of Table 7, Panel B. $PREV$ is the actual price revision ((offer price−range center)/range center). $PREV_G$ is calculated using the model of column (2) of Table 7, Panel B, and conditioning on the fact that the latent price revision $PREV^*$ exceeds the maximum possible price revision, $MAXREV$ = (upper bound of price range − range center)/range center.

[48] 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.

5.3.1 Estimation of IPO underpricing

We will estimate model (8) under three different specifications. The first specification is the most restrictive one. In this specification we use no control variables and we substitute the following variables for various terms of the model (8), thus imposing some constraints:

- $SURP = PREV - PREV_0$ 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 $i = 0$.

We thus obtain the following specification for model (8):

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

The second specification is less restrictive. We include a large set of control variables to capture that part of initial returns, IR_0, that can be predicted using publicly available information. This set includes all of the variables defined in Panel B of Table 6 as well as a standard 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 we can now regard these variables as exogenous.[49]

The third specification is the least restrictive. We relax the constraints that are imposed by substituting the variables $SURP$ and $SURP_G$ into model (8). Instead, we regress initial returns directly on the variables $PREV$ and $PREV_G$, as well as on a large set of control variables. This regression will reveal whether there is a partial adjustment phenomenon of the form defined by Hanley (1993).

[49] 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 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 $FSOLD$.

Estimation issues: 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 estimate model (8) not only by means of OLS but also by means of two staged least squares estimation. Thereby, 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 it has been suggested by Ljungqvist and Wilhelm (2003). The second instrument exploits higher moment information to improve the 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 $PREV_G$.

Alternatively, we could also 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.[50] In order to be conservative, we abstain from such an adjustment: instead, we report "naive" robust standard errors, merely adjusted for heteroscedasticity.

5.3.2 Results

Table 8 presents the results. Panel A reports descriptive statistics for the central explanatory variables of the regressions stated in Panel B. For the IPOs with constrained offer prices, the price ranges represent substantial pricing constraints: $CEXTENT$ 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, 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!

[50] See Murphy and Topel (1985). With increased standard errors, we would obtain wider confidence intervals, making it harder to reject the hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$.

Panel B of Table 8 contains the results from estimating model (8). In 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. Column (1) reports estimates for the set of variables that we use as control variables. Column (2) states the results from estimating model (8′) without control variables. In column (3), we add the control variables in order to show the robustness of the coefficients of the variables $SURP$, $SURP_G$, and $CEXTENT$. In column (4), we relax the constraints that are imposed implicitly by substituting the variables $SURP$, $SURP_G$, and $CEXTENT$ into model (8). In this column we estimate a more standard "partial adjustment" regression, similar to that proposed by Hanley (1993).[51] The coefficients of the price revision variables $PREV$ and $PREV_G$ do not differ significantly from those of the surprise variables $SURP$ and $SURP_G$ in column (3). 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 coefficients of the price revision variables are not significantly different from those in column (4). In column (6), we report the results of the robustness check discussed above, in the paragraph labeled "estimation issues". To check whether attenuation bias or simultaneity bias affects our results, we instrument the price revision variables $PREV$ and $PREV_G$ as described in that paragraph. Column (6) shows that the coefficient of $PREV$ remains insignificant, as in columns (4) and (5); the point estimate of the coefficient of $PREV_G$ increases, but not significantly so.[52]

The estimates in Panel B of Table 8 confirm a number of our expectations, as well as the results of several empirical studies cited above. We find that there is a positive relation between initial returns and the price ranges of IPOs on the Neuer Markt ($RCENTER$). Similar to results of Habib and Ljungqvist (2001), Loughran and Ritter (2002a,b), and Bradley and Jordan (2002), we find evidence of a negative relation between initial returns

[51] To see why this is a test of the constraints imposed by the definitions of the surprise variables $SURP$ and $SURP_G$, note that in columns (4)-(6) control variables capture any effect of $PREV_0$ on initial returns (since $PREV_0$ is a linear combination of a subset of these control variables).

[52] We checked that our results are also robust to omitting the two higher moment instruments and also to using other higher moment instruments.

and the fraction of an issuer's outstanding shares that are sold in the IPO ($FSOLD$). 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)). Finally, we obtain results that confirm a feature of our model: the one-to-one correspondence between initial returns and the per-share amount of money left on the table due to constrained IPO pricing. As indicated by the p-values stated at the bottoms of columns (2) and (3) of Table 8 Panel B, we cannot reject that the extent to which IPO pricing is constrained, $CEXTENT$, affects initial returns with a coefficient $\delta = 1$.

Testing the hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$: As discussed in Section 3, rejecting hypotheses $\mathbf{H^U_{REV}}$ and $\mathbf{H^C_{REV}}$, against the alternatives of $\gamma_U > 0$ and $\gamma_C > 1$ would be 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, for Neuer Markt IPOs we find no evidence of an informational role of bookbuilding after the opening of the grey market. This is the case both for IPOs priced inside their price ranges, for which we can directly observe the latent price revision ($PREV^* = PREV$), and for IPOs where we estimate what the price revision would be if pricing were not constrained by the price ranges ($PREV^* = PREV_G$). 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). This suggests that, after the grey market opens, investors receive no informational rents for providing underwriters with information by posting informative orders for IPO shares.

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 instead 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 should not receive rents for providing the information. To summarize, 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 ($\beta = 1$).[53] 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 for our findings: We are not the first to point out that underwriters do not always add value when they build a book. Ljungqvist, Jenkinson and Wilhelm (2001) point out that bookbuilding only leads to lower IPO underpricing when conducted by competent banks and/or targeted at informed investors. They provide evidence that underwriters outside the U.S. may lack both competence and informed investors to talk to. The lack of evidence for a partial adjustment phenomenon in Panel B of Table 8 is not inconsistent with these views. However, we point out an additional reason for why bookbuilding may not add value, at least after the opening of when-issued trading of IPO shares. In the presence of the when-issued market, it may simply not be efficient for underwriters to gather information through bookbuilding.

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.[54] The main results of our analysis were unchanged. (We do

[53] 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.

[54] 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

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 opening of when-issued trading.

6 Conclusion

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 IPO shares in the when-issued market, and the results on IPO pricing relative to price ranges set before this market opens. In combination, these results show how the existence of a liquid when-issued market affects IPO pricing. We find that underwriters adjust IPO prices only partially with respect to some information impounded in the prices of IPO shares in the when-issued market. However, this partial adjustment is *not* associated with information that underwriters obtain *after* the opening of when-issued trading. Instead, the partial adjustment must be associated with information that the underwriters obtain before the opening of when-issued trading.

According to the theory of Benveniste and Spindt (1989), our findings can be interpreted as evidence for rents that investors receive for providing underwriters with information. Hence, it seems that even a liquid when-issued market does not supplant the process of bookbuilding by which underwriters obtain information directly from investors before when-issued trading opens. Underwriters seem unable to wait for information to be revealed through trading in the when-issued market. We argue that this is due to externalities of the bookbuilding process, in the absence of which when-issued trading could not open. This argument is consistent with three stylized facts. First, when-issued trading never opens before underwriters set price ranges. Second, the price ranges vary across IPOs, perhaps due to information that underwriters obtain through bookbuilding before they set the ranges. If so, then this revelation of information can mitigate informational asymmetries across traders in the when-issued market that perhaps keep this market from opening any sooner. Third, the setting of price ranges is not just "cheap talk" by underwriters since the ranges impose

investors. In addition, icluding these 31 observations allowed us to repeat our analysis without convergence problems in the maximum likelihood estimation of model (6).

costly constraints on the subsequent pricing of IPOs. Hence, the ranges are credible signals of information held by underwriters.

Our results are also of relevance for our understanding of IPO pricing on markets without when-issued trading. Specifically, we provide an indirect validation for the common interpretation of bookbuilding as a mechanism by which underwriters obtain information directly from investors. This interpretation relies on a well-documented empirical regularity: the partial adjustment phenomenon (Hanley (1993)), that is consistent with an IPO pricing policy by which underwriters pay informational rents to investors who post informative orders for IPO shares. The institutional framework of the Neuer Markt allows us to test and confirm this interpretation of the partial adjustment phenomenon. 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 for information revealed after when-issued trading commences. Because when-issued trading commences immediately after the posting of ranges, this means that there should be no rationale for a partial adjustment phenomenon. Indeed, we find no evidence of a partial adjustment phenomenon on the Neuer Markt. This contrast between the Neuer Markt and IPO markets without when-issued trading bolsters the interpretation that the partial adjustment phenomenon found in these other markets is indeed due to informational rents.

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 grey market. To obtain information from the investors in spite of this, underwriters may have to offer them higher informational rents. As discussed in the introduction, recent theoretical work

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 Neuer Markt, average underpricing on the Neuer Markt was lower than on Nasdaq for the years 1999 and 2000. However, this could 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

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.

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.[55] 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.[56] However, the *significance* of the coefficient is lowered by the fact that a number of the observations take on identical values.[57]

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

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

[57] We did attempt to test whether the coefficient on $\bar{IR}^{NM}_{t_W \to t_P}$ in column (1) of Table 7 Panel B would be significant just for those 144 IPOs for which there were similar IPOs on the Neuer Markt during this time. But, due to the nature of the regression methodology that we employ to handle the pricing constraints, this sample size is too small.

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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 Nasdaq and the Neuer Markt 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 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). 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.

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

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 (in million US$ for Nasdaq IPOs and million Euros for Neuer Markt IPOs, respectively). Fraction sold is the number of shares sold at the IPO divided by the number of shares outstanding (in %).

Panel A: Issue Size

		Total	Hightech	Non-Hightech	Internet	Non-Internet
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
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

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

			Total	Hightech	Non-Hightech	Internet	Non-Internet
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
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

Table 4
Summary Statistics for Neuer Markt IPOs: Ranges and Pricing

In both panels, 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 (2003) is used. Neuer Markt IPOs are defined as internet firms if the NEMAX industry classification is internet.

Panel A. The range center, RCENTER, is the midpoint between the minimum and maximum of the price range. The range size, RSIZE, is defined as 100(%)x(range maximum – range minimum)/range center.

Panel B. IPOs are split into five groups: the offer price is (i)strictly above the range, (ii) at the upper bound of the range, (iii) within the range, (iv) at the lower bound of the range, and (v) strictly below the range.

Panel A: Range Center and Size

		Total	Hightech	Non-Hightech	Internet	Non-Internet
RCENTER	Mean	22.1	22.4	21.3	21.8	22.2
(Euro)	Std.Dev.	11.6	11.5	12.1	12.3	11.5
	Median	20.0	20.0	19.5	19.3	20.0
RSIZE	Mean	17.4	17.2	17.8	17.7	17.3
(%)	Std.Dev.	5.6	5.5	5.6	6.5	5.3
	Median	16.4	16.2	17.3	16.0	16.7
No. of IPOs		253	181	72	54	199

Panel B: Distribution of Offer Prices around the Ranges

	Total	Hightech	Non-Hightech	Internet	Non-Internet
OFFER	% of sample	% of sample	% of sample	% of sample	% of sample
strictly above the range	0.0	0.0	0.0	0.0	0.0
at upper end of the range	70.0	69.6	70.8	74.1	68.8
strictly within the range	16.6	16.0	18.1	13.0	17.6
at lower end of the range	9.9	10.5	8.4	11.1	9.6
strictly below the range	3.5	3.9	2.8	1.8	4.0
No. of IPOs	253	181	72	54	199

Table 5

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

In Panels A and B, 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 (2003) is used. Neuer Markt IPOs are defined as internet firms if the NEMAX industry classification is internet.

Panel A. The price revision, PREV, is defined as 100(%)x(offer price – range center)/range center.

Panel B. Initial returns are defined as 100(%)x(1st day close at time t_C – offer price)/offer price.

Panel C. This panel summarizes the pricing 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.
In this panel, 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 as high or higher than this upper bound must have been paid for shares in the last grey market transaction prior to the pricing date

Panel A: Price Revision (%)

PREV=100(%)x(OFFER – RCENTER)/RCENTER

	Total	Hightech	Non-Hightech	Internet	Non-Internet
Mean	3.6	3.5	3.9	4.6	3.3
Std.Dev.	8.5	8.6	8.4	7.6	8.8
Median	7.0	7.1	6.9	7.3	7.0
Minimum	-28.9	-28.9	-26.2	-18.2	-28.9
Maximum	14.3	14.3	13.6	14.3	13.6
No. of IPOs	253	181	72	54	199

Panel B: Initial Returns (%)

IR=100(%)x(1stCLOSE – OFFER)/OFFER

	Total	Hightech	Non-Hightech	Internet	Non-Internet
Mean	45.3	47.7	39.2	60.7	41.1
Std.Dev.	69.1	74.0	55.2	84.1	64.1
Median	19.4	19.9	18.3	29.4	17.5
Minimum	-30.0	-30.0	-21.5	-16.6	-30.0
Maximum	444.4	444.4	228.0	352.2	444.4
No. of IPOs	253	181	72	54	199

Table 5 (continued)

Panel C: 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

Table 6
Variables for IPO Pricing Model

Panel A: 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 6, Panel B: Explanatory Variables IPO Pricing

Underwriter reputation:

$\hat{UMSHARE}$	Underwriter market share, instrumented as stated in Panel A of Table 6.

IPO pricing process up to t_W:

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

Issue(r) characteristics:

$\hat{FSOLD}$	Fraction of issuer's stock sold in the IPO, instrumented as stated in Panel A of Table 6
$I_{INTERNET}$	Dummy variable indicating internet IPOs
$I_{HIGHTECH}$	Dummy variable indicating hightech IPOs

Primary and secondary market conditions:

$IX_{t_W \to t_P}$	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:

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

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. All explanatory variables are defined in Panel A 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 B 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. For IPOs that are unconstrained ($I_{CON} = 0$) these 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 IPOs with $OFFER <$Top of Range ($I_{CON} = 0$)			
	$SURP$	$PREV$	$PREV_0$	
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 IPOs with $OFFER =$Top of Range ($I_{CON} = 1$)			
	$SURP_G$	$PREV_G$	$PREV_0$	$CEXTENT$
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.