Pre-IPO Markets*

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Abstract. We take advantage of the grey market, a when-issued market for shares to be issued in an IPO, to look at how behavioral biases affect prices in the post-IPO market. We develop a model in which bookbuilding and a grey market take place simultaneously. While bookbuilding extracts information from large institutions about the fundamental value of the securities, the grey market reflects the opinion of (possibly biased) retail and other small investors. When the publicly observable grey market price is high relative to fundamental value, bookbuilding investors resell shares to these smaller investors in the aftermarket, so the offer price and the aftermarket price will be close to the grey market price, but will revert to the fundamental value in the long run. In contrast, when the grey market price is low, the offer and aftermarket prices will be close to fundamental value. Empirical results confirm this asymmetry in the issue price and aftermarket prices.

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1. Introduction

The performance of initial public offerings, both in the short and long run, has long shown numerous anomalies. Some studies have argued that high prices in the short run followed by abnormally low returns in the long run are due to overenthusiasm among retail investors who may be less than perfectly rational.[1] One difficulty in testing this hypothesis is that it is difficult to disentangle the expectations of different types of investors when we only observe a single price in the aftermarket. Thus, more evidence is needed to determine what type of investors are driving prices in the aftermarket and whether these prices are consistent with rational behavior.

In this paper we take advantage of the existence in many countries of a pre-IPO "grey market" to distinguish between the valuations of different types of investors. The grey market is a when-issued market (which takes place at the same time as bookbuilding) in which smaller investors speculate on the post-IPO share price.[2] The publicly observable grey market price reflects the valuation of these smaller investors. Thus, the grey market provides a unique opportunity to observe the opinion of a subset of investors before the shares start trading. Using the grey market price we can study the relation between the valuation of smaller investors and the aftermarket share price, and to assess its consistency with rationality.

In order to conduct this analysis, we first build a model that gives us empirical implications that we then take to data. In the model, small investors trade in the grey market, while the underwriter collects bids during bookbuilding from large institutional investors before pricing the issue.[3] Thus, there are two separate markets with two separate sets of investors.

Bookbuilding investors are endowed with information about the fundamental value of the shares. Grey market investors also have information which may or may not be relevant to the fundamental value. In addition, the grey market investors may overweight the relevance of their information.

To the extent that grey market investors are representative of smaller investors in general, their valuation is indicative of the reservation price for smaller investors in the aftermarket. If that reservation price is higher than the fundamental value of the shares, bookbuilding investors know that they can resell their shares in the immediate aftermarket at a price above the fundamental

[1] See Ritter and Welch (2002) for a discussion.
[2] Section 3 describes the grey market in more detail.
[3] For a description of bookbuilding see Cornelli and Goldreich (2001) and Ljungqvist and Wilhelm (2002).

value. If instead the reservation price of smaller investors is low, bookbuilding investors will hold on to the shares that they are allocated, valuing them at the fundamental value. Thus, the bookbuilding investors value the shares at the maximum of the fundamental value and the reservation price of the smaller investors. Since the underwriter can also observe the grey market price, when the grey market price is high he will anticipate that the shares will be sold in the aftermarket at a profit and will set a higher offer price to extract this additional surplus. When the grey market price is low, the underwriter will disregard the valuation of smaller investors.

Empirically, we test the predictions of the model by looking at the relation between the grey market price and both the issue price and the aftermarket price. The influence of the grey market price should depend on the degree to which it contains information about the fundamental value.

First, consider the extreme case in which the grey market information is completely unrelated to the fundamental value. If grey market investors mistakenly use this information in their reservation price, it will still affect the aftermarket price when these (or similar) investors purchase the shares in the aftermarket. Thus, we should expect a relation between the grey market price and the aftermarket price, but only when the reservation price is above the fundamental value. There should be no relation when the reservation price is below the fundamental value because then the bookbuilding investors will not resell the shares to the grey market investors. To the extent that a high reservation price is anticipated by the underwriter, there will be a similar relation between the grey market price and the issue price.

On the other hand, if the grey market price does contain fundamental information, then there will be a positive relation between the grey market price and the aftermarket price (and also the issue price) even when the grey market price is low. However, to the extent that grey market investors overweight their information, there will still be an asymmetry, i.e., a stronger relation when the grey market price is high.

Note that the model predicts asymmetry only when the grey market investors show conservatism.[4] In other words, although they receive new information about the fundamental value when the issue price is set, they overweight their own information when updating their reservation price. Whether or not grey market investors overweight their information is thus an empirical question which can be answered in the context of the model.

We test the predictions of the model using grey market price data for a large set of European

[4]See Barberis, Shleifer, and Vishny (1998).

IPOs completed between 1995 and 2002. We find that the grey market price is more correlated with the issue price and the aftermarket price when the grey market price is high, although there is a positive correlation even when the grey market price is low. This suggests that the grey market contains information about the fundamental value, but also that the grey market investors overweight their information in a way that is reflected in the aftermarket price and exploited by the underwriter when setting the issue price. We find higher levels of aftermarket volume when the grey market price is high, consistent with bookbuilding investors reselling their shares to grey market investors only when the grey market investors have higher valuations. We use the bid-ask spread in the grey market to proxy for a lack of depth which should be reflected in a lower aftermarket price. The results are consistent.

The model also has implications for long-run returns. When the grey market price is high, demand from smaller investors will cause the shares to trade in the short run at a high price relative to fundamentals. However, in the long run, as the true value is revealed through time, prices will revert to the fundamental value and we expect negative returns. On the other hand, when the grey market price is low, the aftermarket price is based on fundamentals and we do not expect a reversal pattern. Our empirical results are consistent with this prediction.

We should point out one thing this paper does not do. Although the optimal mechanism in our model has underpricing to facilitate information extraction in bookbuilding (as in Benveniste and Spindt (1989)), it is not our goal to explain the magnitude of observed underpricing. The point of this paper is to show how high valuations among grey market investors can lead to a high aftermarket price, but not why the issue price is often set well below this. However, a number of explanations given in the literature (for example, agency conflicts) could be added to our model to explain underpricing.

A notable feature of our model is that prices are sometimes biased upwards, but never downwards, even though the potentially irrational investors could be both excessively optimistic or pessimistic. In the presence of short sale constraints, excessively pessimistic investors are priced out of the market.

We stress that our results are also relevant for countries that do not have a grey market (such as the United States). As long as the underwriter and the major institutional investors have some sense of what smaller investors are willing to pay, the same phenomena would occur. The significance of the grey market is that it allows us to observe smaller investors' valuation easily and directly, enabling us to test for these effects.

Related literature

Several papers on IPOs have documented empirical patterns that motivate our study. Ritter (1991) presents evidence that abnormally high prices immediately after the IPO are followed by abnormally low returns in the long-run and Ritter and Welch (2002) show that this is particularly strong in certain period of times. Purnanandam and Swaminathan (2003) compare the offer price in several IPOs with their "fair value" computed using several price multiples of non-IPO industry peers. They find that issues which are overpriced relative to their fair value also have higher returns on the first day of trading but lower returns in the long run. These patterns are consistent with our results. If some investors are excessively enthusiastic about an issue, the underwriter sets the offer price above the fundamental value, expecting these investors to buy the shares in the aftermarket. This leads to a high short run price, and, as the price converges to the fundamental value, long returns will be low.

A large literature, both theoretical and empirical, has explained IPO patterns with the presence of small, unsophisticated investors. Lee, Shleifer, and Thaler (1991) show that the annual number of IPOs is negatively related to the closed-end fund discount which they argue is a measure of retail investor sentiment. Rajan and Servaes (2003) model two different types of irrational agents, feedback traders and sentiment investors. The latter are similar to our grey market investors. They proxy for investor sentiment using the market-to-book ratio and find that it is positively correlated to first-day returns and negatively correlated to long term returns. In contrast, we use the grey market price to measure the valuation of sentiment investors. Ljungqvist, Nanda, and Singh (2003) argue that an initial price run-up may be due to the existence of "exuberant" investors and may lead to long-term underperformance. Their explanation is similar to ours, but their model addresses the issue of underpricing, which is needed to compensate regular investors for losses in case the hot market ends abruptly. Our model is mainly aimed at introducing the grey market, in order to generate testable implications and does not address the issue of underpricing. It is interesting to note that the grey market price constitutes an ex-ante signal that the issue will be hot. Therefore, when the grey market price is high the investors know that that there is a low probability that the hot market will end. This constitutes an additional reason why the grey market would ultimately benefit the issuer. Aggarwal, Krigman and Womack (2002) also relate the price path in the aftermarket to momentum traders, focussing on the role of research analyst and media in creating this momentum. We do not investigate why the grey market investors are particularly enthusiastic about a certain issue, and simply look at

what happens when they are enthusiastic.

Testing these theories means investigating the role of retail or small investors. While we use the grey market price as an indication of smaller investors' opinion, other papers have looked at who owns the shares in the aftermarket. Ofek and Richardson (2003) show that high initial returns occur when institutions sell IPO shares to retail investors on the first day. Similarly, Ben Dor (2003) looks at the level of institutional ownership shortly after the IPO and find that high institutional ownership forecasts higher returns in hot markets. These findings are consistent with our paper, since we predict that bookbuilding investors sell the shares to smaller investors when they are overvalued. In an empirical study that is complementary to our findings, Dorn (2003) finds that the volume of trade by retail investors in the German grey market is correlated with high initial returns and low long-run returns. This can be viewed as further evidence that participation of smaller investors in the grey market can be interpreted as sentiment.

Besides Dorn (2003), other papers study the grey market in Germany. Löffler, Panther and Theissen (2002) document that pre-issue prices are unbiased estimates of the first-day prices. Aussenegg, Pichler, and Stomper (2003) also find that IPO offer prices are related to prices in the grey market but they show that the coefficient is smaller than one, which they argue is consistent with bookbuilding being used for gathering information, even in the presence of a when-issued market. Finally, Pichler and Stomper (2004) also model the interaction between bookbuilding and the grey market. However, in their model, grey market investors have similar information to bookbuilding investors, and they ask whether the existence of the grey market hinders or helps the aggregation of the information in bookbuilding. In contrast, we introduce a class of investors who have different information from bookbuilding investors, in order to explain certain IPO phenomena and to show how these (possibly biased) investors affect prices in an asymmetric way.

The paper proceeds as follows. In Section 2 we present the model, the optimal mechanism, and the empirical implications. Section 3 describes the data. Section 4 presents the empirical results. In Section 5 we extend the model to allow bookbuilding investors to trade in the grey market. Section 6 concludes.

2. The model

An issuer wants to sell S shares in an IPO. Each share has a fundamental value $v \in [0, \bar{v}]$. Since the underwriter does not know v before setting the issue price P_I, he conducts bookbuilding to collect information from institutional investors about v. Simultaneously with bookbuilding, a publicly observable grey market takes place in which a different group of investors trade the shares on a when-issued basis.[5]

The expected fundamental value of a share is a weighted average of the information arriving from bookbuilding s_B and the information from the grey market s_G:

$$E(v \mid s_B, s_G) = \alpha s_G + (1 - \alpha) s_B, \tag{1}$$

where $0 \leq \alpha < 1$. When $\alpha = 0$, grey market investors' information is irrelevant. We assume that bookbuilding investors' information is always relevant.[6]

The timing is as follows. First the underwriter sets an initial indicative price range, based on his prior beliefs. Then both bookbuilding and grey market trading begin. At the end of bookbuilding, the underwriter observes the bids in the book as well as the grey market price and sets the issue price. When the issue price is set, information about bookbuilding is revealed. Afterwards, aftermarket trading begins.

2.1. Bookbuilding. We model the bookbuilding process as in Biais and Faugeron-Crouzet (2002). Three investors take part in the bookbuilding process: two are informed and one is uninformed. The uninformed investor can buy at most $S(1-k)$ shares, with $0 < k < 1$. The information from bookbuilding, s_B, is the aggregate of the signals s_i observed by the two informed investors, $i = 1, 2$. s_i is i.i.d. and equals H with probability π and L with probability $(1 - \pi)$. The distribution of the signals is such that if both investors observe a signal equal to H then $s_B = H$; if both observe L then $s_B = L$; but if one observes L and the other H then $s_B = M$, where $0 < L < M < H < \bar{v}$. The ex-ante expected value of the bookbuilding information is $E(s_B) = \pi^2 H + 2\pi(1-\pi)M + (1-\pi)^2 L$. For simplicity, we assume that $E(s_B) = M$.

From the point of view of an informed investor who observes s_i (as well as the grey market

[5] In Section 5, we consider the case in which there is an overlap between the two groups of investors.

[6] Cornelli and Goldreich (2003) show that bookbuilding aggregates information that is relevant for both the issue price and the long-run aftermarket price.

information s_G, which, as explained below, can be inferred from the grey market price) the expected fundamental value is

$$E(v \mid s_G, s_i) = \alpha s_G + (1 - \alpha) E(s_B \mid s_i) \tag{2}$$

Each investor submits a bid for shares, after observing his own signal, but not knowing the signal of the other informed investor. The underwriter designs a mechanism (described in Section 2.4) in which he sets the issue price and allocates the shares as a function of the bids. We assume that the underwriter acts in the interest of the issuer, i.e., he maximizes IPO proceeds.

The bookbuilding set-up described so far is similar to the one in Benveniste and Spindt (1989). The main difference here is the existence of a grey market whose price is observed before the issue price is set.

2.2. Grey Market. At the same time as bookbuilding there is a grey market in which investors trade the shares on a when-issued basis. For now, we assume that bookbuilding investors are not allowed to trade in the grey market.

Since in reality the grey market price is continuously and publicly observable, while bookbuilding is a confidential process controlled by the underwriter, we assume that grey market investors do not observe s_B. Instead, they only observe a signal about the value of the shares, $s_G \in [0, \bar{v}]$.[7]

Grey market investors know that the fundamental value is a weighted average of their signal and the bookbuilding information, but we allow for the possibility that they overweight the importance of their signal. In other words, after observing s_G, their expectation of the fundamental value of the shares is

$$E_G(v \mid s_G) = \hat{\alpha} s_G + (1 - \hat{\alpha}) E(s_B) \tag{3}$$

where $\hat{\alpha} \geq \alpha$ and E_G refers to the expectation from the perspective of grey market investors. The difference $(\hat{\alpha} - \alpha)$ represents the extent to which grey market investors overweight their

[7]The assumption that the signal of the grey market investors is continuous, while the signal of the bookbuilding investors is discrete, is made only in order to simplify the analysis.

signal. When $\hat{\alpha} - \alpha = 0$ they are fully rational. Note that only the expectation of s_B appears in equation (3), since grey market investors do not observe the bookbuilding information.

Trading in the grey market results in a price P_{GM}, reflecting investors' beliefs about the fundamental value of the shares. Thus, $P_{GM} = E_G(v \mid s_G)$. After observing P_{GM} the underwriter and the bookbuilding investors, knowing $\hat{\alpha}$, can perfectly infer s_G using the following relation:

$$s_G = \frac{P_{GM} - (1 - \hat{\alpha})M}{\hat{\alpha}} \tag{4}$$

After the underwriter aggregates the bookbuilding information into the issue price (and before the start of aftermarket trading), the bookbuilding information s_B is revealed.[8] Grey market investors then update their valuation, starting from their prior valuation, to

$$\hat{P}_{GM} \equiv \hat{P}_{GM}(s_G, s_B) = \hat{\alpha} s_G + (1 - \hat{\alpha}) s_B = P_{GM} + (1 - \hat{\alpha})(s_B - M). \tag{5}$$

$\hat{P}_{GM}$ differs from P_{GM} because it incorporates the observed s_B rather than its expectation. It differs from the fundamental value if $\hat{\alpha} \neq \alpha$. The difference between $\hat{\alpha}$ and α is motivated by experimental evidence that individuals are slow to change their beliefs in the face of new evidence: they update their priors too little relative to Bayesian updating (see Barberis, Shleifer, and Vishny, 1998).[9]

2.3. Aftermarket. After the shares are allocated to the bookbuilding investors, trading in the aftermarket begins. At this point, both bookbuilding and grey market investors have observed both s_G and s_B. Grey market investors value the shares at $\hat{P}_{GM}$, while bookbuilding investors value the shares at the expected fundamental value, given in equation (1). Again, these two valuations differ if $\hat{\alpha} > \alpha$.

We assume that aftermarket participants include investors who have the same valuation as the grey market investors. They may be the grey investors themselves or other (perhaps retail) investors who did not trade in the grey market. As a result, the grey market price is representative

[8] A more realistic assumption might be that grey market investors infer the information from the offer price. However, we assume s_B is revealed to avoid modelling situations in which the offer price is manipulated by the underwriter to hide information.

[9] An alternative explanation could be the one studied in Harris and Raviv (1993), where individuals receiving common information differ in the way they interpret this information.

of the valuation of a larger set of investors. For simplicity, we continue to refer to this set of investors as grey market investors.[10]

Let us define P_{AM} as the aftermarket price in the short-run, say on the first day of trading. If the fundamental value of the shares exceeds the price $\hat{P}_{GM}$ grey market investors are willing to pay in the aftermarket, then the bookbuilding investors will not sell their shares to them. Thus, there will be no trading involving grey market investors and the aftermarket price will not depend on their valuation. The expected aftermarket price P_{AM} will then equal the expected fundamental value. If instead the price that grey market investors are willing to pay exceeds the fundamental value, the bookbuilding investors can sell their shares to the grey market investors at this higher price.

The price at which bookbuilding investors can resell their shares depends upon the depth in the market. If there are many investors willing to buy shares at the price $\hat{P}_{GM}$, bookbuilding investors will have all the market power and will set the price equal to $\hat{P}_{GM}$, extracting all the surplus from trading. However, if there are not enough investors willing to buy all S shares at $\hat{P}_{GM}$, for example if the demand for these shares is downward sloping, then bookbuilding investors will have to sell some of their shares at a lower price. Assuming a linear demand curve, bookbuilding investors expect to sell their shares in the aftermarket at $\hat{P}_{GM} - \lambda S$, where λS captures the discount necessary to sell all S in the aftermarket. Although more complex functional forms are possible, this simple linear form suffices to capture the idea that the market may not be very deep. If the market is deep enough to sell all the shares at $\hat{P}_{GM}$, then $\lambda = 0$.

In the long run, all uncertainty is resolved and the long-run price equals the fundamental value.

2.4. Optimal Mechanism. We now characterize the optimal bookbuilding mechanism. This mechanism specifies the issue price and the number of shares to be allocated to the various bidders, as a function of their bids and the grey market price P_{GM}.[11]

To find the optimal mechanism, by the Revelation Principle we can restrict attention, without

[10]Dorn (2003) finds a strong positive correlation between the volume of retail trade in the grey market and retail volume in the first-day of aftermarket trade. This supports our assumption that the opinion of grey market investors is indicative of the valuation of small investors in the aftermarket.

[11]By law, the underwriter cannot charge different prices to different investors, so we do not allow the mechanism to price discriminate among investors. Bennouri and Falconieri (2003) show that, if there is no limit to the quantities investors can be allocated, price discrimination is never optimal.

loss of generality, to a direct revelation mechanism where the bookbuilding investors simultaneously announce their signals to the underwriter. The underwriter uses the announced signals $(\tilde{s}_1, \tilde{s}_2)$ (which aggregate to $\tilde{s}_B$) and the grey market information s_G to set the issue price and to allocate the shares. A direct revelation mechanism is described by the outcome functions (P_I, q, q_u), where $P_I(s_G, \tilde{s}_B)$ is the issue price; $q(s_G, \tilde{s}_i, \tilde{s}_j)$ is the allocation to an informed investor who announces signal $\tilde{s}_i$ when the other informed investor announces $\tilde{s}_j$; and $q_u(s_G, \tilde{s}_i, \tilde{s}_j)$ is the allocation to the uninformed investor when one informed investor announces $\tilde{s}_i$ and the other announces $\tilde{s}_j$. We look for an equilibrium of this mechanism in which buyers truthfully reveal their signals.

In order to derive the optimal mechanism, we must first determine the reservation price of the bookbuilding investors. After the issue price has been set, the bookbuilding investors observe both s_B and s_G. They thus know the expected fundamental value of the shares (equation (1)), which is the value they will obtain if they hold the shares in the long run. Additionally, since they observe P_{GM}, they can also compute the price that grey market investors would be willing to pay in the aftermarket $(\hat{P}_{GM} - \lambda S)$.

When $\hat{P}_{GM} - \lambda S$ exceeds the fundamental value, bookbuilding investors will be able to resell their shares in the aftermarket to grey market investors. Thus, the relevant value of the shares, from their point of view, is the short-run aftermarket price. When $\hat{P}_{GM} - \lambda S$ is lower than the fundamental value, bookbuilding investors will not resell the shares in the aftermarket. Therefore, after the end of bookbuilding, when a bookbuilding investor observes s_B, his valuation will be the maximum of the two possible valuations, i.e., $Max\{E(v \mid s_G, s_B), \hat{P}_{GM} - \lambda S\}$.

During bookbuilding, each informed investor will have observed his own signal s_i but not that of the other informed investor. Therefore, an investor with a signal $s_i = H$ will value a share at $\pi * Max\{E(v \mid s_G, H), \hat{P}_{GM} - \lambda S\} + (1 - \pi) * Max\{E(v \mid s_G, M), \hat{P}_{GM} - \lambda S\}$. An investor with a signal L will have a valuation of $\pi * Max\{E(v \mid s_G, M), \hat{P}_{GM} - \lambda S\} + (1 - \pi) * Max\{E(v \mid s_G, L), \hat{P}_{GM} - \lambda S\}$.

The underwriter, who also observes the grey market price, knows that if P_{GM} is high, he can increase the issue price above the fundamental value. That way, he can extract the surplus informed investors expect to gain from trading with the grey market investors in the aftermarket. Yet if P_{GM} is low, the underwriter does not need to lower the issue price, since he knows that the bookbuilding investors are still willing to buy and hold the shares at a price close to the fundamental value. In other words, the issue price (and the subsequent aftermarket price) will

reflect the grey market price when it is high, but will reflect the fundamental value when the grey market price is low.

The following proposition presents the optimal mechanism.

Proposition 1: *Assume that* $\hat{\alpha} \geq \frac{1-\alpha}{2}$ *and that* H *and* L *are equidistant from* M.[12] *In the optimal mechanism the quantities allocated to the bookbuilding investors are:*

$$\begin{aligned} &q(H,H) = S/2, \;\; q_u(H,H) = 0, \\ &q(H,L) = S, \;\; q(L,H) = 0, \;\; q_u(H,L) = 0, \\ &q(L,L) = Sk/2, \;\; q_u(L,L) = S(1-k) \end{aligned} \tag{6}$$

where we have suppressed the argument s_G *since the quantities allocated do not depend on the grey market information.*

The issue price depends on the grey market and the bookbuilding information as follows:

$$\begin{aligned} &P_I(s_G,H) = V_H(H) - \tfrac{1-\pi}{\pi} k \left[V_M(L) - V_L(L)\right] \\ &P_I(s_G,M) = V_M(M) \\ &P_I(s_G,L) = V_L(L) \end{aligned} \tag{7}$$

where

$$V_{s_B}(\tilde{s}_B) \equiv Max\{E(v \mid s_G, s_B), \hat{P}_{GM}(s_G, \tilde{s}_B) - \lambda S\}. \tag{8}$$

Proof: See Appendix 1.

$V_{s_B}(\tilde{s}_B)$ represents the value of a share to an informed investor where s_B is the aggregate information from the two signals of the informed investors and $\tilde{s}_B$ is the aggregate information revealed through bookbuilding (and thus conveyed to grey market investors). When $s_B \neq \tilde{s}_B$, at least one investor misreported his signal. $V_{s_B}(\tilde{s}_B)$ is the maximum of the fundamental value and the resale value. Note that our notation suppresses the argument P_{GM} in the function V_{s_B} as the maximization is conducted for a given P_{GM}.

[12] *These assumptions are sufficient but by no means necessary for the proposition to hold.*

Although the quantities allocated do not depend on the grey market price, the issue price P_I depends on P_{GM} as well as on the announced signals. To highlight how the issue price, as expressed in (7), depends on the grey market price and the information in the book, we can divide the possible values of P_{GM} into intervals and present the issue price for each interval. The boundaries of the intervals and the actual expression for the issue price in each interval are derived in Appendix 1 and represented in Figure 1.

The vertical axis represents the possible values that P_{GM} can take. The issue price expression is different in different intervals. Moreover, within each interval, the issue price depends on the bookbuilding information, s_B. Figure 1 visualizes the asymmetry in the optimal mechanism. Let us start by looking at the two extreme intervals. When P_{GM} is very high (i.e., above v_1, where v_1 is defined in Appendix 1) the issue price is close to the grey market price (more precisely, the updated valuation of the grey market investors) and does not depend at all on the bookbuilding information. This follows because the grey market price is so high that bookbuilding investors are certain they can resell their shares in the aftermarket at a price higher than the fundamental value, regardless of what the fundamental value is. The underwriter takes advantage of this by setting P_I above the fundamental value. When P_{GM} is very low (below v_4), the issue price is based solely on the fundamentals. This is because the grey market valuation is so low that grey market investors are unwilling to buy shares in the aftermarket at a price above the fundamental value. In this case, the grey market is irrelevant and the mechanism is the standard bookbuilding mechanism. In the middle are cases in which the issue price is set equal to the fundamental value (minus an informational rent to be left to the bookbuilding investors for revealing their information truthfully) when the fundamental value is high, and equal to the updated grey market valuation otherwise. So, on average, the issue price is close to the grey market price when the grey market price is high, but not when the grey market price is low, creating an asymmetry in the issue price relative to the grey market price.

The extent of the asymmetry depends on α and $\hat{\alpha}$. When $(\hat{\alpha} - \alpha)$ is small, grey market investors overweight their signal only by a small amount. In this case, their valuation and the fundamental value will be similar and there will be less asymmetry. When $(\hat{\alpha} - \alpha)$ is large, grey market investors are much more overconfident in the relevance of their signal and their valuation can be much higher than the fundamental value. In this case, the issuer can take advantage of their overconfidence and set the issue price much higher than the fundamental value.

Recall that α indicates the relevance of the grey market signal for the fundamental value. In

the extreme case of $\alpha = 0$, the grey market price is not relevant for the fundamental value, which is completely determined by the bookbuilding information. In this case, when P_{GM} is low and the issue price is set equal to the fundamental value, there will be no relation between P_{GM} and the issue price. However, when the grey market price is high, it will be closely related to the issue price even though it contains no fundamental information. When $\alpha > 0$ the grey market price includes fundamental information. So, even when the grey market price is low there will be a positive relation between P_{GM} and the issue price. However, to the extent that $\hat{\alpha} > \alpha$, this relation will be weaker than when P_{GM} is high, so the asymmetry remains.

The issue price is based on the valuation of bookbuilding investors, which in turn depends on their expectation about aftermarket prices. Thus the asymmetry in the issue price is driven by the asymmetry in the aftermarket price P_{AM}, and there will be a stronger relation between P_{GM} and P_{AM} when P_{GM} is high.

Although we allow for shares to be sold in the aftermarket at a discount λS to capture a potential lack of depth, the results also hold when $\lambda = 0$. A larger λ implies that shares will be sold to grey market investors in the aftermarket less often but the basic asymmetry remains.

As explained above, the bookbuilding investors' expectations about the aftermarket are central to determining their willingness to pay and the choice of issue price. This aspect is similar in spirit to Busaba and Chang's (2002) model where investors have an incentive to misreport their information to the underwriter in order to fool uninformed investors and take advantage of them in the aftermarket. However, there are two main differences here. First, in our model the underwriter designs the optimal mechanism to account for bookbuilding investors' incentives to resell their shares. As a result, bookbuilding investors will not misreport their information. Second, since the grey market price signals the potential resale value in the aftermarket, the bookbuilding investors and the underwriter can take it into account when determining their actions.

This is why the existence of the grey market is beneficial to the issuer, even when it does not contain any information about the fundamental value of the shares ($\alpha = 0$). The valuation of the grey market investors affects the bookbuilding investors' valuation (because it affects the short-run aftermarket price) and thus provides a lower bound on their willingness to pay. If grey market investors are willing to pay a high price, the surplus that can be appropriated increases. Moreover, since this part of the valuation is publicly observable, the issuer can extract a larger part of the trading surplus from the bookbuilding investors.

2.5. Empirical Implications. The model allows us to make predictions about the relation between the grey market price P_{GM}, the issue price P_I, and the aftermarket prices in the short and long run, as well as other variables. Here we list the main empirical predictions. A more detailed analysis is conducted in Section 4, where we present the results.

Hypothesis 1: P_I is positively correlated with P_{GM}. Moreover, $\hat{\alpha} > \alpha$ implies that this correlation is larger when P_{GM} is high. $\alpha > 0$ implies that this correlation is positive even when P_{GM} is low.

Hypothesis 2: The short-run aftermarket price P_{AM} is positively correlated with P_{GM}. Moreover, $\hat{\alpha} > \alpha$ implies that this correlation is larger when P_{GM} is high. $\alpha > 0$ implies that this correlation is positive even when P_{GM} is low.

Hypothesis 3: When the reliability of the grey market signal increases, the correlations between P_{GM} and the issue price and between P_{GM} and the aftermarket price increase.

A more reliable grey market signal means that an investor, who is weighting this signal with the bookbuilding signal, should give additional weight to s_G. In other words, α should be higher. Thus P_{GM} will be more closely related to the fundamental value. While we do not explicitly model the grey market investors' bias, presumably $\hat{\alpha}$ will also be higher in this case.

Hypothesis 4: When P_{GM} is high, P_I and P_{AM} are negatively correlated with the issue size (S) and positively correlated with the depth of the grey market ($-\lambda$).

Hypothesis 5: Aftermarket trading volume is lower when P_{GM} is low and higher for high values of P_{GM} (when bookbuilding investors resell their shares to grey market investors in the aftermarket).

Since the share price converges in the long run to the fundamental value, $\alpha s_B + (1-\alpha)s_G$, we can compare the long-run return to the grey market price and the aftermarket price. To do this recall that when P_{GM} is high the aftermarket price is $P_{AM} = \hat{P}_{GM} - \lambda S = \hat{\alpha} s_B + (1-\hat{\alpha})s_G - \lambda S$. Thus the difference between the long-run price and the short-run aftermarket price (i.e., the long-run dollar return) is $(\hat{\alpha} - \alpha)(s_B - s_G) + \lambda S$. To the extent that $\hat{\alpha} > \alpha$, this return is positively related to the bookbuilding signal and negatively related to the grey market signal.

The difference between P_{AM} and P_{GM} (for high P_{GM}) is $(1-\hat{\alpha})(s_B - M)$, which is positively related to the bookbuilding information. Thus, there is a positive relation between the long-run return and $(P_{AM} - P_{GM})$ if $\hat{\alpha} > \alpha$. If $\hat{\alpha} = \alpha$ the two are unrelated.

Finally, P_{GM} equals $\hat{\alpha}(s_G) + (1 - \hat{\alpha})E(s_B))$ and so is related to the grey market information s_G. Thus, the long-run return should be negatively related to P_{GM} as long as $\hat{\alpha} > \alpha$. Hypothesis 6 summarizes this discussion.

Hypothesis 6: When P_{GM} is high, the long-run return (relative to P_{AM}) is negatively correlated with P_{GM} and positively correlated with the difference between P_{AM} and P_{GM} (to the extent that grey market investors do not fully update for s_B, i.e., if $\hat{\alpha} > \alpha$).

Intuitively, when P_{GM} exceeds the fundamental value, the immediate aftermarket price (P_{AM}) is closely related to the grey market investors' willingness to pay ($\hat{P}_{GM}$), which differs from the fundamental value if grey market investors overweight their own signal, i.e., if $\hat{\alpha} > \alpha$. In this case, we should expect reversal of the share price towards the fundamental value in the long run. In contrast, the difference between P_{AM} and P_{GM} captures grey market investors updating their valuation when they learn the bookbuilding information s_B. To the extent that they underweight the bookbuilding information, the share price movement from P_{GM} to P_{AM} is only a partial movement in the right direction and should continue in the same direction as the fundamental value is revealed over time.

3. Sample and Data

The dataset consists of 486 European-listed IPOs completed between November 1995 and December 2002 for which we have grey market prices. Grey market prices are not available systematically, so our dataset is a subset of the universe of firms going public in Europe over the sample period. Sample companies come from the following 20 countries: Austria (13), Belgium (1), Canada (1), Denmark (1), Finland (3), France (13), Germany (321), Greece (2), Ireland (2), Israel (7), Italy (61), Lithuania (1), Luxembourg (1), Netherlands (11), Norway (2), Spain (5), Sweden (2), Switzerland (11), the United Kingdom (24), and the United States (4).

Grey markets are usually organized not by an exchange but by independent brokers who make forward markets in IPO shares on a when-issued basis. Thus the structure of grey markets differs across countries and even within countries depending on the broker. Brokers quote spreads and investors can take a long or short position depending on their expectations. Usually, grey market prices are public information: not only are they available from the broker, but the financial news media often report grey market prices.

Grey market prices were obtained from two large brokers, based in Germany and the United

Kingdom, and supplemented with a news search. Information on the IPOs is derived from an updated version of the dataset compiled by Ljungqvist and Wilhelm (2002), based on Dealogic's Equityware, Thomson Financial's SDC, information from national exchanges, and a comprehensive news search.Aftermarket trading prices and trading volumes are from Datastream. We convert monetary values – such as gross proceeds – into U.S. dollars using exchange rates on the first day of trading.

Table 1 shows descriptive statistics for the sample as a whole as well as broken down by the twelve countries on whose exchanges sample companies list. Most sample firms (75 percent) list in Germany, 54 companies list in more than one country (usually the home country plus Frankfurt or London), and 43 companies do not list in their home country at all (including non-European issuers from Israel, the U.S., or Eastern Europe).

Although the sample IPOs span the period from November 1995 to December 2002, the range of dates varies from market to market, depending on which IPOs we have grey market prices for. In the UK, for instance, we have grey market prices for firms going public between June 1997 and July 2002. To allow the reader to assess how comprehensive our sample is, Table 1 reports the number of IPOs in each market during the entire period, as well as during the sub-periods for which we have IPOs with grey market prices for each country.

Over our sample period, Germany and Italy have the most active grey markets, while London-based brokers frequently make grey markets in IPOs taking place in other countries. Except in Germany, grey market trading is more common in larger IPOs. Reflecting the fact that many of our sample IPOs were completed in the late 1990s, the initial return ($P_{AM}/P_I - 1$) averages 36.3%. Bid-ask spreads in the grey market are quite wide, with quoted half spreads averaging 4.7%. A majority of IPOs (54.1%) are priced at the high end of the initial indicative price range. On average, the last grey market price before the issue price is finalized exceeds the price range midpoint by 40.4%.

4. Empirical Results

In this section we discuss the empirical results in light of our predictions.

4.1. The Offer Price. Hypothesis 1 discusses the relation between the issue price and the grey market price. We normalize these prices by the midpoint of the initial indicative price range in order to reduce the impact of differences in scale and of heteroskedasticity. The grey market price

that we use is the last reported transaction price before the issue price is set (or the midpoint of the bid-ask spread when transaction prices are unavailable). This corresponds to P_{GM} in the model.

It is well-documented that issue prices in Europe are rarely set outside the initial indicative price range; frequently they are set at the endpoints, especially at the top of the range (see Ljungqvist, Jenkinson, and Wilhelm (2003)). Consequently, the observed distribution of issue prices in our sample is censored at the range endpoints. To correct for this, we estimate censored regressions (Amemiya (1973)). These are similar to Tobit models, except that the point of censoring is observation-specific. Note that 54% of our observations are right-censored.

Our model distinguishes between the cases where the grey market price is higher or lower than the fundamental value. Because fundamental value is unobservable to the econometrician, empirical studies usually take the midpoint of the initial indicative price range as a proxy for the underwriter's ex ante prior of the fundamental value. Thus if the grey market price is above the midpoint it is more likely to be above the fundamentals. To capture the predicted asymmetry, we interact the grey market price with an indicator function that equals one if the grey market price exceeds the range midpoint , and zero otherwise.[13]

Table 2 reports the results. Regression 1 examines the relation between the issue price and the grey market price. Overall, the fit of the model is very good in view of the highly significant likelihood ratio test. As expected, we find a very significant relation between the issue price and the grey market price, and an even stronger relation when the grey market price is above the range midpoint. This result is consistent with Hypothesis 1: the grey market price is positively correlated with the issue price. The fact that the correlation is positive even when the grey market price is low suggests that $\alpha > 0$: the grey market price contains information about the fundamental value. The stronger relation for high levels of the grey market price reflects an asymmetry in the relation between the grey market price and the issue price. This is consistent with the asymmetry in the model when $\hat{\alpha} > \alpha$: the underwriter bases the issue price on the grey market price when it is high, but when the grey market price is low, the underwriter uses it only to the extent that it contains (partial) information about the fundamental value.

[13]The large proportion of right-censored observations is the reason why to capture the asymmetry we introduce the indicator function rather than splitting the sample between high and low levels of the grey market price, as we do in later tables. If we were to estimate the censored regression model for the subsample where the grey market price exceeds the range midpoint, we would have little explanatory power since for most observations the issue price would equal the top of the range.

In Regression 2 of Table 2 we also include the bid-ask spread quoted by grey market brokers shortly before IPO pricing and (the logarithm of) the gross proceeds from the issue (S). A wider bid-ask spread may indicate a lack of depth in the grey market. This may be due to a scarcity of traders in the grey market or a diversity of opinion among investors. Either way, bookbuilding investors may not be able to resell all their shares in the aftermarket at the (updated) grey market price $\hat{P}_{GM}$, causing the underwriter to price the issue more conservatively. Similarly, when the issue size is large, the issue price should reflect the greater difficulty of reselling the shares in the aftermarket. In the model, this is captured by the discount λS and gives rise to Hypothesis 4, which suggests the issue price should be negatively correlated with the issue size and positively correlated with the depth of the market ($-\lambda$).

Consistent with Hypothesis 4, in Regression 2 we find negative and statistically significant relations between the issue price P_I and the bid-ask spread, and between P_I and log proceeds S.

In Regression 3 we interact the bid-ask spread with log proceeds, since in the model the discount λS is the product of the two terms. We find a negative and statistically significant relation. Moreover, the relations in Hypothesis 4 refer to the case when the grey market price is high, since only then do the bookbuilding investors resell their shares to the grey market investors. To capture this asymmetry, Regression 4 includes the product of the bid-ask spread and the proceeds times an indicator function that equals one when the grey market price is above the range midpoint. Both the resulting coefficients are negative, but not statistically significant.

Finally, a wide bid-ask spread reflects greater divergence of opinion among grey market investors, possibly indicating a less reliable grey market signal (or a smaller α in the model). Hypothesis 3 predicts that the correlation between the issue price and the grey market price is weaker when the grey market signal is less reliable. In Regression 5, we attempt to capture this by interacting the bid-ask spread with the grey market price. We find that the coefficient of the interaction term is indeed negative and statistically significant, suggesting that the positive effect of the grey market price on IPO pricing is attenuated when the bid-ask spread is wider.

4.2. The Short-Run Aftermarket Price. The model suggests that when the grey market price exceeds the fundamental value, the first-day closing price reflects the price grey market investors are willing to pay for the shares (i.e., the grey market price adjusted for the information in the book). In Table 3, Regression 1, we see that the aftermarket price (at the end of the first day of trading) is indeed highly correlated with the grey market price. Since Table 2 demonstrated a

positive relation between the grey market price and the issue price, it is possible that Regression 1 simply captures the well-documented positive relation between issue prices and after-market prices (Hanley (1993)): issue prices contain bookbuilding information and so affect aftermarket prices. To investigate this further, Regression 2 relates the aftermarket price to the issue price. As expected, we find that the aftermarket price is higher, the higher is the issue price. The adjusted R^2, however, is much lower than in Regression 1. In Regression 3, we include both the grey market price and the issue price. The coefficient estimated for the grey market price remains highly significant but the issue price loses most of its explanatory power. In sum, high grey market prices predict aftermarket prices independent of the level of the issue price.[14]

So far, our results might be interpreted as evidence that P_{GM} is a good predictor of the aftermarket price in general. However, our model implies that the grey market price should be a better predictor when it is high. Hypothesis 2 suggests an asymmetry in the relation between the grey market price and the first-day closing price. When the grey market price is high, the aftermarket price reflects the (updated) valuation of grey market investors and we expect a close correlation between the grey market price and the first-day closing price. In contrast, when the grey market price is low, the aftermarket price depends on the fundamental value, so the grey market price should only be related to the aftermarket price to the extent that it contains information about the fundamental value.

At the same time, we also expect an asymmetry in the effect of the issue price on the aftermarket price. Specifically, issue prices should have a relatively stronger effect when the grey market price is low. When the grey market price is high, the bookbuilding information that is incorporated in the issue price affects the aftermarket price only through the updating of the grey market investors' valuation. When the grey market price is low, information in the book about the fundamental value is directly incorporated into the aftermarket price.

In Regressions 4 and 5 we capture the asymmetry by splitting the sample into two subsets. We find a stronger relation between the aftermarket price and the grey market price when P_{GM} is high (coefficient of 0.95) than when it is low (0.57), consistent with Hypothesis 2. The fact that the coefficient is larger when P_{GM} is high implies that $\hat{\alpha} > \alpha$. The fact that the coefficient is positive and significant even when P_{GM} is low is consistent with $\alpha > 0$. As for the issue price,

[14]Note that while the issue price depends on the grey market price, and the aftermarket price depends on the issue price and the grey market price, the system described by these two equations is triangular. Thus it can be consistently estimated using recursive, equation-by-equation estimation. See Greene (2002), p. 383.

the coefficient is the same in both cases but it is only statistically significant (at 5%) when P_{GM} is low, as expected.

According to Hypothesis 4, when P_{GM} is high, a wide bid-ask spread or a large issue size reduces bookbuilding investors' ability to sell their shares in the aftermarket at the grey market price. The negative coefficients for these variables in Regression 4 support this hypothesis (though they are statistically significant only for issue size). When the grey market price is lower than the range midpoint, on the other hand, the bid-ask spread and log proceeds have no significant effect on the aftermarket price (Regression 5).

4.3. Aftermarket Volume. Table 4 examines the relation between the grey market price and aftermarket trading volume (as a percentage of the shares sold in the IPO). Hypothesis 5 suggests that the relation should be a step function. When P_{GM} is high, we expect high turnover because bookbuilding investors sell their shares to the grey market investors whose valuation exceeds the fundamental value. When P_{GM} is low, bookbuilding investors have no reason to sell their shares in our model and so trading volume will be lower.

We measure aftermarket trading volume both on the first day and over the first week following the IPO. To capture the step function, we use an indicator function that equals one when P_{GM} is above the initial price range midpoint, and zero otherwise. We find a positive and statistically significant relation between volume and the indicator function, both for first-day volume (Regression 1) and first-week volume (Regression 4). This suggests that when the grey market price is high, bookbuilding investors are more likely to resell their shares in the aftermarket, consistent with the model.

A high grey market price could simply indicate that either the IPO or the market is "hot," which may lead to high volume for reasons outside our model. In Regressions 2 and 5 we introduce the market index return (measured from the pricing day until the end of the first day of trading) to capture a hot market. In Regressions 3 and 6 we also include the (normalized) first-day closing market price to capture whether the IPO is "hot." Even after controlling for these variables, the coefficient on the indicator function remains positive and significant. This implies that the positive relation between volume and the indicator function is not simply due to a high level of trading in "hot" IPOs or in active markets.

4.4. Long-Run Returns. We now consider how the grey market price and the results of bookbuilding are related to aftermarket returns in the long run.

Since the issue is priced above the fundamental value when the grey market price is high, we expect the price to revert towards the fundamental value in the long run, i.e., we expect negative long-run returns (Hypothesis 6). Moreover, Hypothesis 6 predicts that the information in the aftermarket that comes from bookbuilding should show continuance in the aftermarket.

The long-run returns are studied in Table 5. The dependent variable is the return measured from the end of the first aftermarket trading day until two, three, six or twelve months later, less the return on the domestic stock market index. The independent variables are the difference between the grey market price and the midpoint of the range ($P_{AM} - P_{mid}$), and the difference between the first-day aftermarket price and the grey market price ($P_{AM} - P_{GM}$). The dependent and independent variables are all measured as percentages relative to the midpoint of the range P_{mid}.

The intuition behind our specification is as follows. Using the range midpoint as the prior of the value of the shares, the difference between the publicly observed grey market price and the range midpoint reflects any information revealed through grey market trading. In the interval between the final pre-IPO grey market price and the start of the aftermarket, bookbuilding is concluded and the issue price is set. Therefore, the difference between the immediate first-day aftermarket price and the final pre-IPO grey market price represents the change in valuation due to the revelation of the bookbuilding information (assuming that no other information arrives in the meantime). These two types of information add up to the total information contained in the first-day aftermarket price.

Hypothesis 6 suggests that the long-run returns relate differently to the grey market information and the bookbuilding information.

When the grey market price exceeds the fundamental value, the first-day aftermarket price will be close to the grey market investors' reservation price. To the extent that their reservation price is unrelated to the fundamental value, the price should eventually revert to the fundamental value, and we should observe a negative relation between long-run returns and the difference between the grey market price and the range midpoint.

Bookbuilding information, by contrast, is assumed to be about fundamental value. If so, the difference between the aftermarket price and the grey market price should not be reversed in the

long run, that is, it should not be negatively correlated with long-run returns.

The correlation between long-run returns and the difference between the aftermarket price and the grey market price also sheds light on how grey market investors update using the bookbuilding information. If they fully update after observing the information ($\hat{\alpha} = \alpha$), there should be no correlation. If they instead exhibit conservatism ($\hat{\alpha} > \alpha$), then the movement from the grey market price to the first-day aftermarket price is only a partial movement towards the fundamental value. As they update further over time, the price continues to move towards the fundamental value. Thus, we should observe a positive correlation between long-run returns and the difference between the aftermarket price and the grey market price.

In Table 5, in addition to analyzing the full sample, we partition the sample based on whether the grey market price is above or below the range midpoint. The relation between long-run returns and the grey market information should hold only when the grey market price is high, since only then does the first-day aftermarket price relate to the grey market investors' reservation value.

In the full sample, for all horizons, we find a statistically significant negative relation between the grey market price and the long-run return. Furthermore, when we partition the sample into subsamples we find that the negative relation only holds when the grey market price is high. This suggests that $\hat{\alpha} > \alpha$, because the coefficient corresponds to $\frac{\alpha}{\hat{\alpha}} - 1$ when the grey market price is high. Thus, non-fundamental information is transmitted from the grey market to the aftermarket and is reversed in the long run. Moreover, depending on the horizon, the coefficients range from -0.24 to -0.77 (which are all significantly greater than -1), indicating that only part of the price difference between the grey market and range midpoint is reversed. This can be interpreted as evidence that the grey market contains some information about the fundamental value that is not reversed (i.e., $\alpha > 0$).

In contrast, the percentage difference between the first-day aftermarket price and the grey market price is not negatively related to the subsequent long-run return. As argued above, this is consistent with the hypothesis that the information in the book pertains to the fundamental value and is not reversed in the long run. The coefficient is positive when the grey market price is high, consistent with investors updating only gradually over time, but it is mostly not statistically significant.

5. Allowing Bookbuilding Investors to Trade in the Grey Market

In Section 2 we assumed that bookbuilding investors are not allowed to trade in the grey market. In reality, bookbuilding investors are able to participate in the grey market, but the underwriter actively discourages it (for example, by threatening to exclude them from future IPOs). Since the underwriter cannot directly observe whether a bookbuilding investor trades in the grey market, it is unclear how effective a prohibition would be. In this section we explicitly consider the possibility that bookbuilding investors trade in the grey market, and we show that a bookbuilding investor with a position in the grey market may have additional incentives not to report his signal truthfully. To avoid this problem, the underwriter might prohibit the bookbuilding investors from trading in the grey market. If he cannot enforce such a prohibition, he has to modify the mechanism in a revenue-decreasing way.

For simplicity, we consider the case in which bookbuilding investors can buy or sell only a limited number of shares, γ, in the grey market, so that they are price-takers. That is, their trades do not affect the grey market price.

The details of the argument are given in Appendix 2. Here we sketch the main steps and give the intuition of the results. We proceed as follows. We start by assuming the underwriter is using the mechanism in Proposition 1 and look at whether allowing bookbuilding investors to trade in the grey market affects the incentive compatibility constraints in the maximization problem.

We solve the model backward: assuming that a bookbuilding investor has taken a position (long or short) in the grey market, we look at how his incentive to truthfully report his signal changes. Then, we look at the investor's decision to buy or short-sell shares in the grey market, given that he can anticipate the signal he will report during bookbuilding.

A bookbuilding investor who observed a signal H and has gone long in the grey market will always reveal his signal truthfully since this can only have the effect of raising the resale price in the aftermarket. However, if he has a short position in the grey market he may have an incentive to lie and report a signal L. If the grey market price is sufficiently high ($P_{GM} > \alpha S_G + (1-\alpha)M + \lambda S$), he will have an incentive to report a signal L in order to manipulate the price downward and profit from his initial short position. But if $P_{GM} < \alpha S_G + (1-\alpha)M + \lambda S$, the aftermarket price does not depend on the updated valuation of the grey market investors, so he has no incentive to misreport his signal. An investor who observed a signal L will never be

induced to lie by a small position in the grey market.

Given these incentives, we look at whether a bookbuilding investor who observed H prefers to take a long position in the grey market (and truthfully reveal his signal) or whether he prefers to take a short position (and, when P_{GM} is high, misreport his signal). We find that the choice depends on the parameter λ.

If there is no lack of depth in the aftermarket ($\lambda = 0$), i.e., the bookbuilding investor knows that there are sufficient investors to whom he can resell shares at $\hat{P}_{GM}$ in the aftermarket, then an investor who has observed a signal H will find it more profitable to buy shares than to short sell them in the grey market. In such case, the investor will truthfully report his signal, so the underwriter need not be concerned if bookbuilding investors trade in the grey market.

The only situation in which trading in the grey market by bookbuilding investors could hurt the issuer arises when $\lambda > 0$, i.e., there is insufficient depth in the aftermarket. In this case, for sufficiently high P_{GM}, the bookbuilding investors take advantage of the discount in the aftermarket (λS) by short selling in the grey market and covering this position at a lower price.

Therefore, although the existence of the grey market is beneficial for the issuer in that it increases the expected IPO proceeds (as shown in Section 2), participation by bookbuilding investors in the grey market may not be. This result rationalizes investment bankers' efforts to discourage bookbuilding investors from participating in the grey market, particularly when P_{GM} is high. But the underwriter should only be concerned about bookbuilding investors participating in the grey market when they short sell and the aftermarket is expected to be thin.

6. Conclusions

We have taken advantage of the existence of a grey market for IPO shares to test whether conservatism on behalf of a set of investors can explain anomalies in post-IPO prices. We argue that when small investors are excessively optimistic, they will be willing to pay a price above the fundamental value, resulting in a high aftermarket price. When they are pessimistic, and value the shares below the fundamental value, they will be priced out of the aftermarket, in which case there will be no bias in the aftermarket price.

We use the grey market price as an indication of these investors' opinion, and predict an asymmetric relation between the grey market price and the aftermarket price. Using grey market price data for a set of European IPOs, we test this prediction and find that there is indeed an

asymmetric relation. We also find higher aftermarket trading volume when the grey market price is high, consistent with the model.

Looking at the long run, we find that when the grey market price is high (suggesting that smaller investors are optimistic), long-run returns are negative, while this pattern does not arise when the grey market price is low. Moreover, there is evidence that the movement from the grey market price to the aftermarket price shows continuance in the long run when the grey market price is high, suggesting that smaller investors update only partially, i.e., they exhibit conservatism.

Appendix 1

Proof of Proposition 1

Step 1. We focus on symmetric equilibria, i.e., informed investors are treated symmetrically. For a given s_G define $P_{\tilde{s}_B} \equiv P_I(s_G, \tilde{s}_B)$ as the issue price set when the aggregate information revealed through bookbuilding is $\tilde{s}_B$. The underwriter chooses the mechanism that maximizes expected proceeds:

$$\max_{P_{\tilde{s}_B}, q} S\left[\pi^2 P_H + 2\pi(1-\pi)P_M + (1-\pi)^2 P_L\right] \tag{9}$$

subject to the individual rationality constraints

$$V_{s_B}(s_B) \geq P_{\tilde{s}_B}, \tag{10}$$

the incentive compatibility constraint for informed investor i who observes a signal $s_i = H$,

$$\begin{array}{l} \pi \frac{S-q_u(H,H)}{2}\left[V_H(H) - P_H\right] + (1-\pi)\left[S - q_u(H,L) - q(L,H)\right]\left[V_M(M) - P_M\right] \\ \geq \pi q(L,H)\left[V_H(M) - P_M\right] + (1-\pi)\frac{S-q_u(L,L)}{2}\left[V_M(L) - P_L\right] \end{array} \tag{11}$$

and the incentive compatibility constraint for informed investor i who observes a signal $s_i = L$,

$$\begin{array}{l} \pi q(L,H)\left[V_M(M) - P_M\right] + (1-\pi)\frac{S-q_u(L,L)}{2}\left[V_L(L) - P_L\right] \\ \geq \pi \frac{S-q_u(H,H)}{2}\left[V_M(H) - P_H\right] + (1-\pi)\left[S - q_u(H,L) - q(L,H)\right]\left[V_L(M) - P_M\right] \end{array} \tag{12}$$

where the quantities are written so that the sum of the shares allocated to the two informed investors and the uninformed investor equals S.

We proceed as follows: we first ignore the second incentive compatibility constraint (12) and find the optimal solution. We then check that this constraint is in fact non-binding at the optimum.

Step 2. Since the number of shares sold always equals S and the underwriter charges all investors the same issue price, the quantity allocated to each investor does not directly affect proceeds. Thus, we choose the quantities to relax the incentive compatibility constraint (11) as much as possible since a slacker constraint will allow an optimum with a higher price.

This is achieved by setting $q_u(H,H) = q_u(H,L) = 0; q_u(L,L) = S(1-k); q(H,H) =$

$S/2; q(H,L) = S; q(L,H) = 0$; and $q(L,L) = Sk/2$. Substituting and dividing both sides by S, the incentive compatibility constraint for type H (equation (11)) becomes

$$\frac{\pi}{2}\left[V_H(H) - P_H\right] + (1-\pi)\left[V_M(M) - P_M\right] \geq (1-\pi)\frac{k}{2}\left[V_M(L) - P_L\right] \tag{13}$$

When this incentive compatibility constraint is binding, we can write it as

$$P_H = V_H(H) + \frac{2(1-\pi)}{\pi}\left[V_M(M) - P_M\right] - \frac{1-\pi}{\pi}k\left[V_M(L) - P_L\right] \tag{14}$$

If we substitute constraint (14) into the objective function, we obtain

$$\max_{P_i} S\left[\pi^2 V_H(H) + 2\pi(1-\pi)V_M(M) - \pi(1-\pi)kV_M(L) + \pi(1-\pi)kP_L + (1-\pi)^2 P_L\right] \tag{15}$$

subject to the individual rationality constraint (10).

The maximization function is increasing in P_L, so it is optimal to set P_L as high as possible subject to the individual rationality constraint, i.e., $P_L = V_L(L)$. The choice of P_H and P_M is indeterminate, so we consider the example when $P_M = V_M(M)$. The incentive compatibility constraint thus implies $P_H = V_H(H) - \frac{1-\pi}{\pi}k\left[V_M(L) - V_L(L)\right]$.

Step 3. Since we derived the optimal mechanism ignoring constraint (12), we have to check that this constraint is not violated at the optimum. First, note that if we substitute in (12) the optimal quantities q and q_u and issue price P_I, the constraint can be rewritten as:

$$k\left[V_M(L) - V_L(L)\right] \leq \frac{\pi}{1-\pi}\left[V_H(H) - V_M(H)\right] + 2\left[V_M(M) - V_L(M)\right] \tag{16}$$

where all terms in brackets are non-negative. From the assumption of equidistance $k < \frac{\pi}{1-\pi} = 1$ it is enough to show that $[V_H(H) - V_M(H)] \geq [V_M(L) - V_L(L)]$ for the constraint to be satisfied.

To check whether this constraint is satisfied, we have to substitute the values of the functions $V_{s_B}(\cdot)$. Depending on the value of P_{GM} these functions take different values. In the next step we determine the different values of these functions for different ranges of P_{GM}. We can then proceed to check that constraint (16) is satisfied for all these areas.

Step 4. The value of $V_{s_B}(\cdot)$ depends on whether it is equal to the fundamental or the resale value. We first determine when $V_{s_B}(\cdot)$ is equal to the fundamental value.

For any s_B and $\tilde{s}_B$, $V_{s_B}(\tilde{s}_B) = \alpha s_G + (1-\alpha)s_B$ (the fundamental value) if and only if

$$P_{GM} \leq (1-\hat{\alpha})M + \frac{\hat{\alpha}}{\hat{\alpha}-\alpha}[(1-\alpha)s_B - (1-\hat{\alpha})\tilde{s}_B + \lambda S] \equiv B(s_B, \tilde{s}_B) \tag{17}$$

Proof: Since $P_{GM} = E_G(v \mid s_G) = \hat{\alpha}s_G + (1-\hat{\alpha})E(s_B)$ we can derive that $s_G = \frac{1}{\hat{\alpha}}[P_{GM} - (1-\hat{\alpha})M]$.From the definition of $V_{s_B}(\tilde{s}_B)$ in (8), $V_{s_B}(\tilde{s}_B) = \alpha s_G + (1-\alpha)s_B$ if and only if

$$\alpha s_G + (1-\alpha)s_B \geq \hat{\alpha}s_G + (1-\hat{\alpha})\tilde{s}_B - \lambda S$$

Substituting for s_G and rearranging the terms gives (17).

Step 5. Let us distinguish three different areas:

1) $P_{GM} \leq B(M, H)$.

2) $P_{GM} > B(M, L)$.

3) $B(M, H) \leq P_{GM} < B(M, L)$.

where $B(M, H) < B(M, L)$ since, from (17), $B(s_B, \tilde{s}_B)$ decreases in $\tilde{s}_B$.

In the first area, from equation (17), $V_M(L) = V_M(H) = F_M$ and $V_H(H) = F_H$, where $F_{s_B} \equiv \alpha s_G + (1-\alpha)s_B$ (i.e., the fundamental value). Thus the constraint is satisfied if $(F_M - V_L(L)) \leq (F_H - F_M)$. Since $V_L(L) \geq F_L$ it is sufficient to show that $(F_M - F_L) \leq (F_H - F_M)$. Substituting for F_{s_B} we obtain

$$(1-\alpha)(M-L) \leq (1-\alpha)(H-M)$$

Since $M - L = H - M$, it is satisfied with an equality.

In the second area, $V_M(L) = V_L(L) = \hat{P}_{GM}(L) - \lambda S$. Thus the left-hand side equals 0. Since the right-hand side is always non-negative, the constraint is satisfied.

In the third area, $V_M(L) = F_M, V_H(H) = F_H, V_L(L) = \hat{P}_{GM}(L) - \lambda S$ and $V_M(H) = \hat{P}_{GM}(H) - \lambda S$. Thus the constraint is satisfied if

$$[F_M - \hat{P}_{GM}(L) + \lambda S] \leq [F_H - \hat{P}_{GM}(H) + \lambda S].$$

Substituting for F_M, $\hat{P}_{GM}(L)$, and $\hat{P}_{GM}(H)$, and using the assumption $\hat{\alpha} \geq \frac{1+\alpha}{2}$, the constraint is satisfied.

The optimal mechanism as a function of the grey market price

The expressions in Proposition 1 are written in terms of the functions $V_{s_B}(\tilde{s}_B)$, which depend on P_{GM}. Therefore the mechanism looks different over different ranges of P_{GM}. To see how the mechanism looks for different ranges of values of P_{GM} it is enough to substitute the actual values of the functions $V_{s_B}(\tilde{s}_B)$.

Since for a given P_{GM} we can always compute both the fundamental value and the resale value using equations (4) and (5), we can redefine the fundamental value and the resale value as functions of P_{GM}. The fundamental value is defined as $F_{s_B}(P_{GM}) \equiv E(v \mid s_G, s_B)$ and the resale value is defined as $\hat{P}_{GM}(P_{GM}, \tilde{s}_B) - \lambda S \equiv \hat{P}_{GM}(s_G, \tilde{s}_B) - \lambda S$.

We distinguish five different intervals of P_{GM}. The boundaries of these intervals are the values $\bar{v} > v_1 > v_2 > v_3 > v_4 > 0$, where

- v_1 is defined so that $\hat{P}_{GM}(v_1, H) - \lambda S = F_H(v_1)$. In other words, if the grey market price is $P_{GM} = v_1$, and the bookbuilding information is H, the fundamental value exactly equals the resale value of the shares;
- v_2 is defined so that $\hat{P}_{GM}(v_2, L) - \lambda S = F_M(v_2)$;
- v_3 is defined so that $\hat{P}_{GM}(v_3, M) - \lambda S = F_M(v_3)$; and
- v_4 is defined so that $\hat{P}_{GM}(v_4, L) - \lambda S = F_L(v_4)$.

The issue price in each interval is as follows:

1. If $P_{GM} \in [v_1, \bar{v}]$ then

$$\begin{cases} \text{if } \tilde{s}_B = H, & P_I = \hat{P}_{GM}(P_{GM}, H) - \lambda S, \\ \text{if } \tilde{s}_B = M, & P_I = \hat{P}_{GM}(P_{GM}, M) - \lambda S, \\ \text{if } \tilde{s}_B = L, & P_I = \hat{P}_{GM}(P_{GM}, L) - \lambda S. \end{cases}$$

2. If $P_{GM} \in [v_2, v_1]$ then

$$\begin{cases} \text{if } \tilde{s}_B = H, & P_I = F_H(P_{GM}), \\ \text{if } \tilde{s}_B = M, & P_I = \hat{P}_{GM}(P_{GM}, M) - \lambda S, \\ \text{if } \tilde{s}_B = L, & P_I = \hat{P}_{GM}(P_{GM}, L) - \lambda S. \end{cases}$$

3. If $P_{GM} \in [v_3, v_2]$ then

$$\begin{cases} \text{if } \tilde{s}_B = H, & P_I = F_H(P_{GM}) - \frac{1-\pi}{\pi} k[F_M(P_{GM}) - \hat{P}_{GM}(P_{GM}, L) + \lambda S], \\ \text{if } \tilde{s}_B = M, & P_I = \hat{P}_{GM}(P_{GM}, M) - \lambda S, \\ \text{if } \tilde{s}_B = L, & P_I = \hat{P}_{GM}(P_{GM}, L) - \lambda S. \end{cases}$$

4. If $P_{GM} \in [v_4, v_3]$ then

$$\begin{cases} \text{if } \tilde{s}_B = H, & P_I = F_H(P_{GM}) - \frac{1-\pi}{\pi} k[F_M(P_{GM}) - \hat{P}_{GM}(P_{GM}, L) + \lambda S], \\ \text{if } \tilde{s}_B = M, & P_I = F_M(P_{GM}), \\ \text{if } \tilde{s}_B = L, & P_I = \hat{P}_{GM}(P_{GM}, L) - \lambda S. \end{cases}$$

5. If $P_{GM} \in [0, v_4]$ then

$$\begin{cases} \text{if } \tilde{s}_B = H, & P_I = F_H(P_{GM}) - \frac{1-\pi}{\pi} k[F_M(P_{GM}) - F_L(P_{GM})], \\ \text{if } \tilde{s}_B = M, & P_I = F_M(P_{GM}), \\ \text{if } \tilde{s}_B = L, & P_I = F_L(P_{GM}). \end{cases}$$

Appendix 2: Allowing bookbuilding investors to trade in the grey market

In this Appendix we show when trading by bookbuilding investors in the grey market can affect the optimal mechanism and reduce expected IPO proceeds.

We proceed as follows. We assume that the underwriter is using the mechanism of Proposition 1 and check whether the incentive compatibility constraints are still satisfied.

We solve the model backward: assuming that a bookbuilding investor has taken a position in the grey market, we look at how his incentive to truthfully report his signal changes. Then, we look at the investor's decision to buy or short-sell shares in the grey market, given that he can anticipate the signal he will report during bookbuilding.

Consider an informed investor who has observed a signal $s_i = H$. We only need to look at the incentive compatibility constraint of this investor, since we showed in Appendix 1 that only this constraint is binding at the optimum.

If an investor who has observed a signal $s_i = H$ has no position at all in the grey market, his incentive compatibility constraint would be as in (12). However, if he has a position in the grey market, the incentive compatibility constraint would change.

If the investor has bought γ shares in the grey market, the constraint becomes

$$\begin{aligned} &\pi \tfrac{S}{2} \left[V_H(H) - P_H\right] + (1-\pi) S \left[V_M(M) - P_M\right] + \gamma \left[\pi V_H(H) + (1-\pi) V_M(M) - P_{GM}\right] \\ &\geq (1-\pi) \tfrac{Sk}{2} \left[V_M(L) - P_L\right] + \gamma \left[\pi V_H(M) + (1-\pi) V_M(L) - P_{GM}\right] \end{aligned} \tag{18}$$

The last term on the left-hand side represents the expected profit from buying γ shares in the grey market if he truthfully declares H. The last term on the right-hand side represents the expected profit from the grey market position if he falsely declares L.

Since the incentive compatibility constraint (12) was satisfied with equality in the mechanism of Proposition 1, constraint (18) is satisfied if and only if

$$\gamma \left[\pi V_H(H) + (1-\pi) V_M(M) - P_{GM}\right] \geq \gamma \left[\pi V_H(M) + (1-\pi) V_M(L) - P_{GM}\right].$$

Since $V_H(H) \geq V_H(M)$ and $V_M(M) \geq V_M(L)$ the inequality is always satisfied. Thus, an investor who observed a signal H and bought γ shares in the grey market will still tell the truth and declare H.

If instead the bookbuilding investor has a short position of γ shares in the grey market, his incentive compatibility constraint is satisfied if and only if

$$\gamma\left[P_{GM} - \pi V_H(H) - (1-\pi)V_M(M)\right] \geq \gamma\left[P_{GM} - \pi V_H(M) - (1-\pi)V_M(L)\right],$$

where the left-hand side is the expected profit from the short position if he truthfully announces his signal H, and the right-hand side is the profit if he misreports his signal as L. In both cases, the profits are given by the difference between the grey market price and the expected value to the investor of the shares he must deliver to cover the position. Since $V_H(H) \geq V_H(M)$ and $V_M(M) \geq V_M(L)$ this inequality is always weakly violated. If $P_{GM} \leq F_M + \lambda S$ (corresponding to $P_{GM} \leq v_3$, where v_3 is defined in Section 2.4), it is satisfied with equality, so the investor does not lie. However, if $P_{GM} > F_M + \lambda S$ the inequality is violated and he misreports his signal.

To summarize, when a bookbuilding investor with signal H is long in the grey market, he will have greater incentive to truthfully reveal his signal in order to raise the aftermarket price. If he is short in the grey market and the grey market price is sufficiently high, he will have an incentive to report a signal L in order to manipulate the price downward.

We now look at whether this bookbuilding investor prefers to take a long position in the grey market (and truthfully reveal his signal) or whether he prefers to take a short position (and misreport his signal when $P_{GM} > F_M + \lambda S$). Since the original constraint (12) is satisfied with equality, we only have to compare the additional profits from the respective grey market positions. The investor will prefer to buy shares in the grey market (and report truthfully) if and only if

$$\gamma\left[\pi V_H(H) + (1-\pi)V_M(M) - P_{GM}\right] \geq \gamma\left[P_{GM} - \pi V_H(M) - (1-\pi)V_M(L)\right] \tag{19}$$

In order to see when this inequality is satisfied, start by considering the special case of $\lambda = 0$. By substituting for the functions $V_{s_B}(\tilde{s}_B)$ one can verify that the inequality is always satisfied. Thus, an investor who has observed a signal H will buy shares in the grey market and declare the truth.

However, when $\lambda > 0$ the inequality may be violated. In particular, when P_{GM} is very high (i.e. $P_{GM} \geq F_H + \lambda S$), any $\lambda > 0$ results in a violation of the inequality. For intermediate values of P_{GM} ($F_M + \lambda S < P_{GM} < F_H + \lambda S$), the inequality will be violated for sufficiently large λ. For

lower levels of P_{GM} ($P_{GM} < F_M + \lambda S$) the inequality is irrelevant since, as shown above, even with a short position the investor has no incentive to misreport his signal.

Thus, when P_{GM} is high and $\lambda > 0$, allowing bookbuilding investors to trade in the grey market results in lower IPO proceeds.

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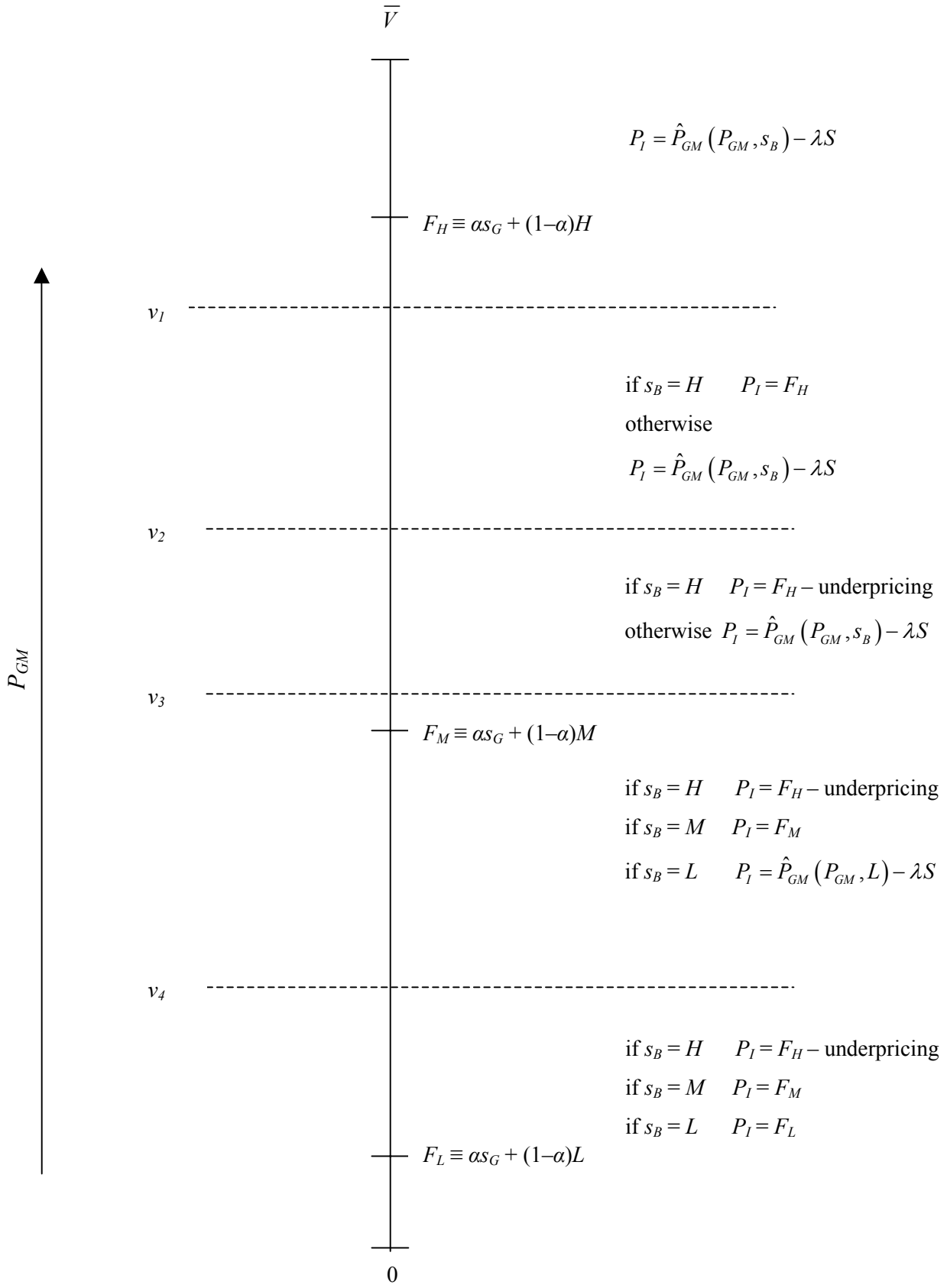

Figure 1. The issue price in the optimal mechanism. The figure illustrates the issue price (for $s_B = H, M, L$), as derived in Appendix 1, over the possible ranges of the grey market price. The boundaries v_2, v_2, v_3, v_4 are defined in Appendix 1. F_{sB} is the fundamental value when the bookbuilding signal is s_B (given P_{GM}). The figure is drawn for small positive values of λS. (When $\lambda = 0$, $F_M = v_3$.)

Table 1: Descriptive Statistics of IPOs with Available Grey Market Prices

We have grey market prices for 486 (mostly European) IPOs completed between November 1995 and December 2002. Sample companies are incorporated in the following 20 countries: Austria (13), Belgium (1), Canada (1), Denmark (1), Finland (3), France (13), Germany (321), Greece (2), Ireland (2), Israel (7), Italy (61), Lithuania (1), Luxembourg (1), Netherlands (11), Norway (2), Spain (5), Sweden (2), Switzerland (11), the United Kingdom (24), and United States (4). Note that there is no grey market in the U.S.; the four American companies are in the sample because they go public in Europe. Most companies go public in their home country, but some do not. Where a company goes public on more than one exchange, we take the listing country to be its home country or (if it doesn't list on a home-country exchange) the country in which most of the shares are placed. The table shows descriptive statistics for the sample as a whole as well as broken down by the twelve countries on whose exchanges sample companies list. We also show, for each listing country, the first and last date for which we have an IPO with grey market prices. This sample window varies from country to country. The sample for which we have grey market prices is a subsample of the 2,723 IPOs completed in the twelve listing countries shown between November 1995 and December 2002. Gross proceeds are shares sold (including the overallotment option if exercised) times the issue price, converted into U.S. dollars using exchange rates on the first trading day. Initial returns are computed using the closing price on the first trading day. Quoted half spread refers to the quoted bid-ask spread in the grey market, just before the IPO issue price is set. It is computed as half the difference between the bid and the ask divided by the midpoint of the spread.

	Sample window		No. of IPOs…			Gross proceeds ($m)		Initial return (%)				
	first date	last date	w/ grey market prices	during sample window	in Nov '95-Dec 2002	mean	median	mean	st.dev.	Quoted half spread (%), mean	Fraction priced at high end of range	Grey market price rel. to midpoint of price range, mean (%)
Total	Nov 1995	Dec 2002	486	1,755	2,723	343.7	53.0	36.3	65.6	4.7	54.1	40.4
By country of listing												
Austria	Nov 1997	Nov 2000	2	18	25	654.5	654.5	-2.5	6.6	6.9	0.0	5.1
Finland	Nov 1998	Dec 1999	3	22	58	686.7	531.0	74.6	91.9	1.6	33.3	53.0
France	Oct 1997	Dec 2001	14	409	544	1715.3	650.0	6.5	12.9	4.2	42.9	24.6
Germany	Nov 1995	Jul 2002	363	489	504	169.9	42.2	41.5	67.8	5.1	63.4	46.6
Greece	Oct 2000	Dec 2001	2	23	180	423.4	423.4	-4.6	0.6		0.0	-7.3
Italy	Nov 1995	Dec 2002	61	132	133	599.0	106.1	20.2	63.4	4.3	27.9	13.1
Netherlands	Mar 2000	Mar 2000	1	1	56	2829.0	2829.0	0.5			100.0	117.9
Norway	Mar 2000	May 2000	2	5	107	139.7	139.7	29.5	44.5	0.6	0.0	85.7
Spain	Jun 1999	May 2001	5	12	38	1374.0	915.7	10.5	13.2	5.1	20.0	11.8
Sweden	Jun 2000	Jun 2001	2	22	196	4405.4	4405.4	9.9	8.2	0.9	50.0	19.2
Switzerland	Dec 1996	Dec 2001	8	59	67	1097.4	153.8	50.1	99.8	1.7	12.5	36.0
United Kingdom	Jun 1997	Jul 2002	23	563	815	566.8	265.3	21.5	35.0	1.5	21.7	32.9

Table 2: Determinants of the Issue Price

The dependent variable in these regressions is the IPO issue price normalized by the midpoint of the initial price range. The explanatory variables are the last grey market price before the issue price was set (also normalized by the midpoint of the initial price range), the last bid-ask spread in the grey market (divided by its midpoint), and the logarithm of the IPO proceeds. To capture the predicted asymmetry, we define an indicator function set to one when the grey market price is above the midpoint of the initial indicative price range. Grey market prices are available for 486 IPOs. Nine of these are fixed-price offerings, so we lack information on their initial price ranges. This reduces the number of observations in model (1) to 477. Models (2) through (5) include the bid-ask spread, which is available for 442 IPOs. We use censored regressions because European IPOs are rarely priced outside the initial price range. *t*-statistics are reported in parentheses. Three and two asterisks indicate significance at the 1% and 5% level, respectively.

	Dependent variable: Issue price / midpoint of initial price range				
	(1)	(2)	(3)	(4)	(5)
Grey Market Price	0.30***	0.32***	0.32***	0.32***	0.38***
	(6.22)	(5.77)	(5.81)	(5.60)	(6.50)
Grey Market Price	0.15***	0.14***	0.15***	0.17***	0.14***
x Indicator(GM Price > midpoint)	(7.41)	(6.64)	(6.66)	(5.65)	(6.45)
Grey Market Bid-Ask Spread		-0.39***			
		(-3.45)			
Grey Market Bid-Ask Spread					-0.40***
x Grey Market Price					(-3.76)
Log gross proceeds		-0.01**			-0.01**
		(-2.01)			(-2.08)
GM Bid-Ask Spread x Proceeds			-0.08***	-0.05	
			(-3.24)	(-1.31)	
GM Bid-Ask Spread x Proceeds				-0.06	
x Indicator(GM Price > midpoint)				(-1.13)	
LR test: all coeff. = 0 (χ^2)	483.1***	446.8***	444.8***	446.1***	449.0***
No. of observations	477	442	442	442	442
No. of left-censored observations	51	50	50	50	50
No. of right-censored observations	263	246	246	246	246

Table 3: Determinants of the First-Day Aftermarket Price

The dependent variable in these regressions is the stock price at the end of the first day of aftermarket trading (normalized by the midpoint of the range) adjusted for the market index return from the pricing date to the end of the first day of aftermarket trading: P_{am}/P_{mid} − (1 + market index return). The explanatory variables are the last grey market price before the issue price was set (also normalized by the midpoint of the initial price range), the (normalized) issue price, the last bid-ask spread in the grey market (divided by its midpoint), and the logarithm of the IPO proceeds. White heteroskedasticity consistent *t*-statistics are given in parentheses. Three, two, and one asterisks indicate significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	Grey market > range midpoint (4)	Grey market ≤ range midpoint (5)
Grey Market Price	0.99***		0.95***	0.95***	0.57***
	(15.93)		(13.55)	(11.89)	(3.76)
Issue Price		3.21***	0.44**	0.51*	0.51***
		(13.50)	(2.44)	(1.66)	(3.07)
Grey Market Bid-ask Spread	-0.62	0.65	-0.46	-0.73	-0.06
	(-1.52)	(1.25)	(-1.09)	(-1.12)	(-0.43)
Log proceeds	-0.04***	-0.05***	-0.04***	-0.05***	-0.005
	(-3.07)	(-3.17)	(-3.12)	(-3.03)	(-1.18)
Adjusted R^2	75.4 %	20.8 %	75.7 %	70.7 %	67.8%
F-test: all coeff. = 0	98.0***	63.7***	205.4***	79.8***	69.2***
No. of observations	442	442	442	330	112

Table 4: Aftermarket Volume

The dependent variable in these regressions is the natural logarithm of first-day volume (as a percentage of the shares sold in the IPO), measured over the first day and first week of aftermarket trading. The main explanatory variable is an indicator function set to one when the last grey market price before the issue price was set exceeded the midpoint of the initial price range. The controls in models (2)-(3) and (5)-(6) are the domestic market returns over the bookbuilding period and the (normalized) first-day after-market price. White heteroskedasticity consistent *t*-statistics are given in parentheses. Three, two, and one asterisks indicate significance at the 1%, 5%, and 10% level, respectively.

	Log first-day volume			Log first-week volume		
	(1)	(2)	(3)	(4)	(5)	(6)
Indicator(GM Price > midpoint)	1.08***	1.07***	0.78***	1.00***	0.99***	0.71***
	(7.64)	(7.50)	(5.06)	(8.72)	(8.60)	(5.67)
Market Returns (pricing to first-day)		7.54***	5.86*		7.36***	5.73**
		(2.11)	(1.78)		(2.50)	(2.15)
First-day After-market Price			0.40***			0.38***
			(6.35)			(6.79)
Adjusted R^2	12.0 %	12.9 %	16.7 %	14.2 %	15.4 %	20.3 %
F-test: all coeff. = 0	58.3***	31.3***	40.8***	76.1***	40.8***	50.7***
No. of observations	443	443	443	443	443	443

Table 5. From Initial Price Range to Long-Run Prices

The dependent variables are market-adjusted long-run returns, measured relative to the first day of trading as $(P_{LR} - P_{AM})/P_{mid}$ less the contemporaneous return on the domestic market index. P_{LR} is the price after the first two, three, six and 12 months of trading. White heteroskedasticity consistent *t*-statistics are given in parentheses. Three and two asterisks indicate significance at the 1% and 5% level, respectively.

	Full sample				Grey market > range midpoint				Grey market ≤ range midpoint			
Horizon:	42 days	63 days	126 days	252 days	42 days	63 days	126 days	252 days	42 days	63 days	126 days	252 days
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	912)
GM Price – Range Midpoint	-0.20***	-0.18**	-0.38***	-0.66***	-0.25***	-0.24**	-0.47***	-0.77***	0.42	1.03**	1.92**	1.02**
Range Midpoint	(-3.22)	(-1.97)	(-3.37)	(7.27)	(-3.40)	(-2.17)	(-3.51)	(-6.95)	(1.41)	(1.97)	(2.16)	(2.01)
Aftermarket Price – GM Price	0.13	0.76**	0.84	0.05	0.10	0.73**	0.81	0.03	1.25	2.20	1.32	-0.80
Range Midpoint	(1.04)	(2.41)	(1.51)	(0.15)	(0.79)	(2.21)	(1.41)	(0.09)	(1.30)	(1.58)	(0.89)	(-0.99)
Adjusted R^2	2.3 %	6.6 %	5.9 %	4.6 %	2.9 %	7.1 %	7.1 %	5.3 %	6.0 %	8.1 %	2.5 %	0.8 %
F-test: all coeff. = 0	7.3***	9.9***	16.9***	45.3***	7.7***	10.4***	18.5***	41.0***	1.1	2.0	2.3	3.1
No. of observations	446	446	446	446	330	330	330	330	116	116	116	116