Investor Sentiment and Pre-IPO Markets*

Francesca Cornelli
(London Business School and CEPR)

David Goldreich
(London Business School and CEPR)

Alexander Ljungqvist
(New York University and CEPR)

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Abstract. We investigate whether irrational behavior by small investors drives post-IPO prices. We use the prices from the grey market, the when-issued market that precedes European IPOs, as a proxy for small investors' valuations. We find that when the grey market price is high, indicating overly optimistic investors, it is a very good predictor of the first-day aftermarket price. However, when the grey market price is low, indicating excessive pessimism, it is less correlated with the aftermarket price. Moreover, we find long-run price reversal only when the grey market price is high. We interpret these asymmetric patterns as evidence that irrational small investors affect post-IPO prices upwards, but not downwards. This happens because large institutional investors, who are allocated IPO shares, take advantage of small irrational investors by reselling shares to them in the aftermarket when the small investors are overoptimistic, but not when they are excessively pessimistic.

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1. Introduction

Behavioral biases have become a popular explanation for a variety of asset pricing phenomena that are hard to reconcile with a rational decision-making framework. For example, in the case of IPOs, Ritter and Welch (2002) argue that overenthusiasm among retail investors may explain high first-day returns and low long-run returns. However, the extent to which the participation of irrational investors (motivated by "investor sentiment") can account for these phenomena is controversial, not least because of the difficulty in empirically identifying the demand curves of different investor groups. Our aim in this paper is to study whether post-IPO prices are driven by smaller investors and to determine whether such investors should be classified as irrational investors (or "sentiment investors").[1]

We achieve this by taking advantage of the existence of pre-IPO (or "grey") markets in many European countries in which investors speculate on the future stock prices of companies that are about to go public. Before an IPO, the underwriter collects indications of interest from his network of large institutional investors in a process known as bookbuilding.[2] At the same time as bookbuilding, the grey market takes place in which investors can trade the shares on a forward (or when-issued) basis.[3] Since investors who trade in the grey market are typically small investors,[4] the grey market provides a unique opportunity to isolate the valuations of this subset of investors and thus to examine the relation between the valuation of small investors and i) the prices at which newly listed companies trade in the aftermarket, ii) the issue price set by the investment bank, and iii) long-run stock performance.

As we will show, these relations depend on how grey market investors form their valuations and how large investors respond to the small investors' beliefs during the bookbuilding process. Therefore, we can use the empirical relations to test whether small investors are irrational and are exploited by the underwriter and the bookbuilding investors.

To the extent that grey market investors are representative of small investors in general,

[1] See Shleifer (2000) for a survey of investor sentiment and its theoretical underpinnings. See Daniel, Hirshleifer, and Subrahmanyam (1998) and Barberis, Shleifer, and Vishny (1998) for models of investor sentiment.

[2] For a description of bookbuilding see Cornelli and Goldreich (2001) and Ljungqvist and Wilhelm (2002).

[3] Depending on the broker, settlement may be in shares or in cash based on the share price at the end of the first day of aftermarket trading. Section 4 describes the grey market in detail.

[4] Conversations with grey market brokers confirm that grey market investors are primarily retail investors and smaller institutions. In fact, some investment banks are known to actively discourage bookbuilding investors from participating in the grey market. Moreover, the bid-ask spread in the grey market is very wide, averaging 9.5%, discouraging institutional investors from participating.

their valuation (as captured by the grey market price) is indicative of the price at which small investors will be willing to buy shares in the aftermarket from the more sophisticated bookbuilding investors who are allocated shares in the IPO. If small investors are perfectly rational, then their valuation will not be fundamentally different from that of bookbuilding investors and the relation between the grey market price and the first-day aftermarket price should just depend on the information each investor group has.

If instead grey market investors are (at least partially) irrational, then they will at times be overoptimistic and at times excessively pessimistic. Large bookbuilding investors can take advantage of the small investors by selectively selling their shares to them in the aftermarket whenever the small investors are overoptimistic. This creates an asymmetry in the relation between the grey market price and the aftermarket price. When the grey market price is high (indicating that small investors are overoptimistic and value the shares above the expected fundamental value), the aftermarket price will be the small investors' reservation price and thus will be highly correlated with the grey market price. When instead the grey market price is low (indicating that small investors are excessively pessimistic and value the shares below the expected fundamental value), bookbuilding investors who are allocated shares in the IPO will not sell their shares to small investors, and the correlation between the grey market price and the aftermarket price will be much lower.

Such an asymmetry in the relation between grey market prices and aftermarket prices would have a number of implications. First, small investors cause post-IPO prices to be above the fundamental value when they are overoptimistic, but never below it when they are overly pessimistic.[5] Second, small investors are irrational in that they overweight their information leading to overoptimism and excessive pessimism. Third, more sophisticated investors are aware that small investors are irrational, and choose to take advantage of them when they are overoptimistic, but ignore them when they are excessively pessimistic. Note that if small investors are perfectly rational, there will be no asymmetry.

This hypothesis also has implications for long-run returns. As explained above, when grey market investors are overoptimistic (i.e., the grey market price is excessively high), their demand will cause the shares to trade at a price higher than the fundamental value in the immediate aftermarket. In the long run, prices will revert to the fundamental value, so we

[5]Prices can be biased upwards but never downwards as long as excessively pessimistic investors are priced out of the market (due to short sale constraints).

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.

Although our story is primarily about the effect that small investors' beliefs have on aftermarket prices, it also has implications for the choice of the issue price. In fact, since the grey market price is publicly observable, the underwriter can condition the issue price on the grey market price. In particular, when the grey market price is high, he anticipates that there will be additional surplus from the high price that small investors are willing to pay in the aftermarket. The question is whether the underwriter increases the issue price to appropriate the surplus or not. If the issue price is not set to fully capture the surplus, the well documented partial adjustment phenomenon results and the underwriter allocates shares to bookbuilding investors who can resell them at a profit to overoptimistic small investors.[6]

In order to formalize and test our arguments, we proceed as follows. First, we develop a theoretical model to derive the empirical implications described above. The model allows us to test for the rationality of small investors' demand for new stock issues (and the consequent response of underwriter and bookbuilding investors) by testing for an asymmetry in the relation between grey market and aftermarket prices and price reversals in the long run. In the model, both grey market investors and large institutional investors who participate in bookbuilding receive signals of the fundamental value of the shares. It should be stressed that the model predicts an asymmetric relation between the grey market price and aftermarket prices only if grey market investors are sentiment investors who overweight the information in their signal. Thus, whether or not grey market investors are sentiment investors is an empirical question which can be answered in the context of our model.[7] To allow for partial adjustment, we model the choice of the issue price as a bargaining game between the issuer and the underwriter (who acts on behalf of the bookbuilding investors) in which the division of the surplus depends on the parties' bargaining power.

We then test the predictions of the model using grey market price data for a large set of European IPOs completed between 1995 and 2002. We find that the grey market price is

[6]Partial adjustment (Hanley (1993)) is the phenomenon that high issue prices (relative to the indicative price range announced by the underwriter at the beginning of bookbuilding) are followed by positive first-day returns. The relation between this argument and that in Loughran and Ritter (2002)and Loughran and Ritter (2004) is explained below in Section 2.

[7]Similar predictions would arise if grey market investors are less well informed than bookbuilding investors, but do not fully update when they observe the aftermarket price. This behavior is closely related to that in our model except that the irrationality occurs when trading begins in the aftermarket, rather than before.

highly correlated with the aftermarket price when the grey market price is high, while there is a significantly smaller positive correlation when the grey market price is low. This suggests that when small investors are overoptimistic, their valuation drives the price in the immediate aftermarket. The fact that there is a small correlation even when they are not optimistic implies that grey market investors have some information about the fundamental value. We also find higher levels of aftermarket trading volume when the grey market price is high, consistent with bookbuilding investors selling their shares to grey market investors only when the grey market investors have higher valuations. These empirical findings support the view that sentiment investors can drive up prices in the short-run aftermarket.

In the long run, we find evidence of price reversal concentrated among IPOs whose grey market prices were high, consistent with our predictions. Such reversal is further evidence that grey market prices are driven by investor sentiment.

We also find an asymmetric relation between the issue price and the grey market price, but it is less strong than the asymmetry between the immediate aftermarket price and the grey market price, consistent with both elements of our model: small investors' irrationality and underwriters' bargaining power.

We stress that our results are also relevant for countries that do not have a grey market for IPOs (such as the United States). As long as some investors are motivated by sentiment, and the underwriter and the major institutional investors have some sense of what these investors are willing to pay, sentiment investors will drive short-run prices upwards when they are overoptimistic.[8] The role of the grey market in this study is that it allows us to observe small investors' valuations easily and directly, enabling us to test for the rationality of small investors in IPOs.

Related literature

Our paper is related to and partially motivated by the recent literature investigating the role of investor sentiment in asset price patterns, including Neal and Wheatley (1998) and Baker and Wurgler (2003). While this literature considers sentiment as a market-wide phenomenon, the grey market enables us to proxy for investor sentiment with respect to individual stocks.

[8]Das and Chen (2004) capture the sentiment of small investors through messages posted in internet stock market forums and find a strong link to market movements. So, it seems reasonable to assume that underwriters have a sense of small investors' opinions of forthcoming IPOs.

Perhaps more directly, our study is motivated by empirical patterns documented in the IPO literature. Ritter (1991) presents evidence that high first-day returns are followed by abnormally low returns in the long-run.[9] Ritter and Welch (2002) show that this pattern is particularly strong during "hot market" periods. Purnanandam and Swaminathan (2004) compare IPO offer prices to "fair values" computed using various price multiples of non-IPO industry peers. They find that issues that are overpriced relative to fair value have higher first-day returns but lower returns in the long run. If the overpricing is caused by sentiment investors, these patterns are consistent with our model. Krigman, Shaw, and Womack (1999) and Houge, Loughran, Suchanek, and Yan (2001) find that a high level of first-day "flipping" (defined as the sell-signed, large-block volume as a percentage of total volume) predicts low returns in the long run.[10] In the context of our paper, flipping can be interpreted as book-building investors selling their shares to grey market investors, which is also when we find low long-run returns.

Other papers have also attributed IPO patterns to the presence of sentiment 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. Aggarwal, Krigman, and Womack (2002) relate the aftermarket price path to momentum traders, and focus on the role of research analysts and the media in creating momentum. They find that "extra hot" issues tend to have low long-run returns. Rajan and Servaes (2003) model two different types of irrational agents, feedback traders and sentiment investors (similar to our grey market investors). Proxying for investor sentiment using market-to-book ratios, they find a positive correlation with first-day returns and a negative correlation with long-run returns.

In a theoretical paper, Ljungqvist, Nanda, and Singh (2004) argue that an initial price run-up may be due to the existence of "exuberant" investors and may lead to long-run underperformance. Their model has similarities with ours but focuses on explaining underpricing, which is needed to compensate regular investors for losses when "hot" markets end prematurely.

Testing behavioral theories often requires investigating the role of small investors. While

[9]Unlike related studies, Ritter (1991) includes penny stocks in his sample, for which the reversal pattern is most pronounced. Note that penny stocks are mostly traded by small investors, similar to those who trade in the grey market.

[10]However, Boehmer, Boehmer, and Fishe (2004) find that it is flipping over a longer horizon, rather than first-day flipping, that is related to returns.

we use the grey market price as an indication of small investors' valuation, other studies have sought to identify small investors' (or more specifically retail investors') behavior by focusing on ownership patterns 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 institutional ownership shortly after the IPO and finds that high institutional ownership forecasts higher returns in hot markets up to three years after the issue date. In a sample of French IPOs, Derrien (2004) finds that retail investors' bookbuilding demand correlates positively with the issue price and initial returns, and negatively with long-run performance. The findings in these papers are consistent with our paper, since we predict that bookbuilding investors sell their shares to small investors when they are overvalued.

In an empirical study that is complementary to our findings, Dorn (2003) finds that the volume of grey market trading among the customers of a German retail brokerage is correlated with high initial returns and low long-run returns, which he views as evidence that investors in the grey market are sentiment investors. Other papers that study the German grey market include Löffler, Panther, and Theissen (2004) who document that grey market prices are unbiased estimates of first-day aftermarket prices, and Aussenegg, Pichler, and Stomper (2003). While the main focus of our paper is the effect of small investors' valuations, as reflected in the grey market, on aftermarket prices, Aussenegg at al. focus on the IPO pricing process, and in particular on whether information useful for pricing the issue comes from bookbuilding or from the grey market. They report finding no partial adjustment phenomenon in Germany. While the absence of a partial adjustment phenomenon may appear to be in contrast with our findings, note that they define partial adjustment only relative to private information in bookbuilding, interpreted as a rent necessary for extracting information from bookbuilding investors. In line with most of the literature, we define partial adjustment as the price adjustment relative to the expected aftermarket price whatever the source of the information. Finally, in related theoretical work, Pichler and Stomper (2004) model the interaction between bookbuilding and the grey market when grey market investors have similar information to bookbuilding investors. They ask whether the existence of a grey market helps or hinders information aggregation in bookbuilding. In contrast, we introduce a class of investors who have (potentially) different information from bookbuilding investors, in order to explain certain IPO phenomena, and to show how these (possibly biased) investors affect prices.

The paper proceeds as follows. In Section 2 we present the model. We discuss the empirical

implications in Section 3. Section 4 describes the data. Section 5 presents the empirical results. Section 6 concludes.

2. The model

An issuer wishes 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 about v from institutional investors. Simultaneous with bookbuilding, a publicly observable grey market takes place in which a different group of investors trade the shares on a when-issued basis.

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

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

where $0 \leq \alpha < 1$. In the extreme case of $\alpha = 0$, grey market investors' information is irrelevant. We assume that bookbuilding investors' information is always relevant.[11]

The timing is as follows. First, the underwriter announces a price range within which he expects to set the issue price, based on his prior beliefs (i.e., the initial indicative price range). Then, both bookbuilding and grey market trading begins. At the end of bookbuilding, the underwriter observes the bookbuilding information as well as the grey market price and sets the issue price. When the issue price is set, the bookbuilding information is revealed to all. Finally, aftermarket trading begins.

2.1. Bookbuilding and grey market investors. Investors who participate in bookbuilding investors are informed as they observe a signal about the fundamental value v. s_B is thus the information that can be obtained by aggregating the private information of bookbuilding investors.

At the same time as bookbuilding, grey market investors trade the shares on a when-issued basis. We assume that bookbuilding investors are not allowed to trade in the grey market. (We discuss the role of this assumption in Section 2.5.) Since in reality the grey market price

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

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

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.[12] In other words, after observing s_G, their expectation of the fundamental value of the shares is

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

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 signal. Only if $\hat{\alpha} - \alpha > 0$ are they irrational. Note that only the expectation of s_B appears in equation (2), since grey market investors do not observe the bookbuilding information at this point.

Grey market trading results in a price P_{GM}, reflecting investors' beliefs about the fundamental value v. 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 as follows:

$$s_G = \frac{P_{GM} - (1 - \hat{\alpha}) E(s_B)}{\hat{\alpha}} \tag{3}$$

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.[13] Grey market investors then update their valuation, starting from their prior valuation P_{GM}, to

$$\begin{aligned} \hat{P}_{GM} \equiv \hat{P}_{GM}(s_G, s_B) &= \hat{\alpha} s_G + (1 - \hat{\alpha}) s_B \\ &= P_{GM} + (1 - \hat{\alpha})(s_B - E(s_B)). \end{aligned} \tag{4}$$

[12] This bias, which we refer to as "investor sentiment," is analogous to "overconfidence" as in Daniel, Hirshleifer, and Subrahmanyam (1998) or "conservatism" as in Barberis, Shleifer, and Vishny (1998), and is supported by experimental evidence that individuals are slow to change their beliefs in the face of new evidence.

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

$\hat{P}_{GM}$ 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 captures the extent to which grey market investors hold biased expectations.

2.2. Aftermarket. After the issue price is set and the shares are allocated to 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 and only 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 market investors themselves or other (perhaps retail) investors who did not trade in the grey market. In other words, the grey market price is representative of the valuation of a larger set of investors. For simplicity, we continue to refer to this set of investors as grey market investors.[14]

Let P_{AM} denote the aftermarket price in the short-run. If the fundamental value of the shares exceeds the price $\hat{P}_{GM}$ that 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 $\hat{P}_{GM}$ 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 sell their shares also depends upon the depth of 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 sell their shares at $\hat{P}_{GM}$, extracting all the surplus from trading. However, if there are too few investors willing to buy all S shares at $\hat{P}_{GM}$, for example if demand 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

[14]Dorn (2003) finds a strong positive correlation between the volume of retail trade in the grey market and retail volume on 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.

necessary to sell all S shares 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 $\lambda = 0$.

To summarize, the aftermarket price will equal the maximum of the expected fundamental value and the updated grey market price, adjusted for market depth:

$$\begin{aligned} P_{AM} &= \text{Max}\{E(v \mid s_G, s_B), \hat{P}_{GM} - \lambda S\} \\ &= \text{Max}\{\alpha s_G + (1-\alpha)s_B, \hat{\alpha} s_G + (1-\hat{\alpha})s_B - \lambda S\} \end{aligned} \tag{5}$$

Figure 1 illustrates this asymmetric relation between P_{AM} and P_{GM}. When the grey market price is low, P_{AM} rises as a function of P_{GM} with a slope of $\frac{\alpha}{\hat{\alpha}} \leq 1$. When P_{GM} is high, the slope becomes 1. In the special case when grey market investors are rational ($\hat{\alpha} = \alpha$), the relation between P_{AM} and P_{GM} is a straight line, so there is no asymmetry.

In the long run, all uncertainty is resolved and the price will equal the fundamental value.

2.3. Issue price and partial adjustment. Before setting the issue price, the underwriter extracts the private information of bookbuilding investors. Since our goal is not to explain bookbuilding-related underpricing, we do not model the information extraction mechanism, but assume that the information is truthfully revealed. However, our analysis can be extended to reflect the underpricing required to induce information revelation.[15]

The choice of the issue price depends on the underwriter's objective function. While the underwriter is often assumed to maximize IPO proceeds for the issuer, several recent papers have argued that he may instead seek to set a lower issue price. The underwriter may benefit from increased underpricing, either because a lower issue price may allow him to place the shares more easily (Baron (1982)), or because he may want to divert some of the potential underpricing profits to his network of investors and possibly, in an indirect manner, to himself (Loughran and Ritter (2004)). These papers view the interaction between the issuer and the underwriter as a bargaining game.[16]

[15] A previous version of this paper (available on request) includes an explicit derivation of the optimal mechanism and the resulting underpricing under a set-up very similar to that in this paper based on Benveniste and Spindt (1989) and Biais and Faugeron-Crouzet (2002). Maksimovic and Pichler (2004) present a model in which underpricing is not necessary if there are no constraints on the allocation of shares.

[16] See, for example, Loughran and Ritter (2002, 2004) and Daniel (2002).

In this spirit, we explicitly model the choice of the issue price as the result of bargaining. The total payoff (per share) to be split between the parties is P_{AM}, the expected aftermarket price of the shares. The payoff to the issuer is his revenue, P_I. The payoff to the underwriter (acting on behalf of his network of investors) is $P_{AM} - P_I$. The bargaining power of the issuer vis à vis the underwriter depends on various factors: for example, the issuer's ability to cancel the IPO late in the process (Daniel (2002)), or the quality of research coverage provided by the underwriter's analysts (Loughran and Ritter (2004)). The underwriter's outside option has a value of zero: if the deal is cancelled, he earns no profits. If the issuer cancels the deal, he retains his shares and all future dividends, hence the value of his outside option is the expected fundamental value $E(v \mid s_G, s_B)$.[17]

Given the surplus to be shared, the value of the outside options, and allowing for differences in bargaining power, the generalized Nash bargaining solution is given by the payoffs to the two parties, x_1 and x_2, equal to[18]

$$\arg\max_{x_1,x_2}(x_1 - \text{outside option}_1)^{\gamma}(x_2 - \text{outside option}_2)^{1-\gamma},$$

where γ and $(1-\gamma)$ are the relative bargaining powers of the two parties. In our context, this corresponds to

$$\arg\max_{P_I}(P_I - E(v \mid s_G, s_B))^{\gamma}(P_{AM} - P_I)^{1-\gamma}. \tag{6}$$

The solution to (6) is:

$$\begin{aligned} P_I &= E(v \mid s_G, s_B) + \gamma\left[P_{AM} - E(v \mid s_G, s_B)\right] \\ &= E(v \mid s_G, s_B) + \gamma \text{Max}\left\{0, \hat{P}_{GM} - \lambda S - E(v \mid s_G, s_B)\right\} \\ &= \alpha s_G + (1-\alpha)s_B + \gamma \text{Max}\left\{0, (\hat{\alpha} - \alpha)(s_G - s_B) - \lambda S\right\}. \end{aligned} \tag{7}$$

[17] One could argue that the issuer loses additional value if he walks away from an IPO at a late stage by suffering a loss of reputation, reduced liquidity, or reduced access to funds for future investments. Our analysis could easily accommodate this by setting the outside option at a lower value. For simplicity, we ignore this possibility.

[18] See Osborne and Rubinstein (1990), page 21.

$P_{AM} - E(v \mid s_G, s_B)$ is the surplus obtained when grey market investors are willing to pay more than the expected fundamental value. γ is the proportion of the surplus the issuer retains through a higher issue price (which depends on his bargaining power). $\gamma = 1$ corresponds to the traditionally assumed objective function of maximizing IPO proceeds, while $\gamma < 1$ corresponds to the issuer leaving part of the surplus on the table for the bookbuilding investors.

When $\gamma < 1$, the issue price is set below the expected aftermarket price whenever grey market investors are overoptimistic. This corresponds to Hanley's (1993) partial adjustment phenomenon, the empirical regularity that high issue prices are correlated with high first-day returns. In our model, the degree to which the underwriter adjusts the issue price to the higher expected aftermarket price is the outcome of bargaining between the issuer and underwriter. As long as the underwriter has some bargaining power, partial adjustment results.

Equation (7) implies an asymmetric relation between P_{GM} and P_I. When P_{GM} is high, P_I is closely related to P_{GM}, but when P_{GM} is low, P_I is only related to the grey market price to the extent that s_G is a component of the fundamental value. Since the issue price is based on the bookbuilding investors' reservation price, which in turn depends on their expectation about the aftermarket price, the asymmetry in the issue price is driven by the asymmetric relation between P_{GM} and P_{AM} derived in equation (5).

Figure 1 represents both P_{AM} and P_I as functions of P_{GM} to illustrate both asymmetric relations. For sufficiently high P_{GM}, the slope of P_I increases from $\frac{\alpha}{\hat{\alpha}}$ to $\frac{\alpha}{\hat{\alpha}} + \gamma(1 - \frac{\alpha}{\hat{\alpha}})$. Note that if $\gamma = 1$ (the issuer appropriates all the surplus), the relation between P_I and P_{GM} is exactly the same as the relation between P_{AM} and P_{GM}. However, for $\gamma < 1$, the asymmetry is reduced. This is because part of the increase in the aftermarket price above the fundamental value (which is the root of the asymmetry) is now appropriated by the underwriter and his network of investors.

2.4. Discussion. The asymmetric relations between the grey market price and the issue and aftermarket prices are central to the arguments presented in this paper. The extent of the asymmetries depends on the difference between α and $\hat{\alpha}$, that is, the true weight of the grey market signal s_G in v and the weight as perceived by (possibly irrational) grey market investors. When $(\hat{\alpha} - \alpha)$ is small, grey market investors overweight their signal only by a small amount and there will be little asymmetry. When $(\hat{\alpha} - \alpha)$ is large, their valuation can greatly exceed the fundamental value, so P_{AM} and P_I can also be much higher than the fundamental

value.

When the grey market price, P_{GM}, is below the fundamental value, the relation between P_{GM} and the aftermarket and issue prices depends on the value of α, the weight of the grey market signal in v. If $\alpha > 0$, the grey market price contains fundamental information, and there will be a positive relation between P_{GM} and the aftermarket and issue prices even when P_{GM} is low. However, to the extent that $\hat{\alpha} > \alpha$, this relation will be weaker than when P_{GM} is high, so the asymmetry remains.

Note that the result in (7), based on the bargaining model, is similar in spirit to prospect theory (as in Loughran and Ritter (2002)). Under prospect theory the issuer forgoes part of the potential gain above a reference point taken to be the issuer's prior expectation of the share value before any information is collected (perhaps based on the initial indicative price range). In our model, the issuer and the bookbuilding investors share the surplus that can be extracted from grey market investors when P_{GM} is above the fundamental value. The bookbuilding investors share in this surplus because it arises only if the IPO succeeds, in contrast to the fundamental value which is obtained regardless of whether an IPO occurs.

2.5. Is the grey market beneficial to issuers?. Our model implies that the existence of the grey market is beneficial to the issuer even when it does not produce any information about the fundamental value of the shares ($\alpha = 0$). When the grey market investors are optimistic, their valuation affects the bookbuilding investors' willingness to pay for the stock in the IPO, and thereby increases the surplus that can be appropriated by the issuer.

Although the grey market increases the available surplus, investment banks are known to discourage bookbuilding investors from participating in the grey market. This can be understood by considering how trading in the grey market by bookbuilding investors affects the bookbuilding process. If such trading were allowed, bookbuilding investors would buy shares in the grey market when P_{GM} is low relative to their information, and would short sell when it is high. While we do not model how the underwriter extracts information in the bookbuilding process, one could imagine that holding a position in the grey market would affect a bookbuilding investor's incentives to truthfully reveal his information. Under certain conditions, a bookbuilding investor with a positive signal might be tempted to short sell in the grey market and misrepresent his signal to the underwriter. As a result, more underpricing

would be necessary to elicit truthful revelation.[19] So, although the grey market is beneficial to the issuer and the underwriter, the underwriter will discourage bookbuilding investors from participating in the grey market.

3. Empirical implications

The model allows us to make predictions about the relation between the grey market price P_{GM}, the aftermarket price P_{AM}, the issue price P_I, long-run returns, as well as other variables. Here we list the main empirical predictions. A more detailed discussion is conducted in Section 5, where we present the results.

Hypothesis 1: 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 the correlation is positive even when P_{GM} is low.

Hypothesis 2: P_I is positively correlated with P_{GM}. Moreover, $\hat{\alpha} > \alpha$ implies that this correlation is larger when P_{GM} is high (as long as $\gamma > 0$). $\alpha > 0$ implies that the correlation is positive even when P_{GM} is low.

Hypothesis 3: When the reliability of the grey market signal s_G increases, the correlations of P_{GM} with P_I and P_{AM} increase.

A more reliable grey market signal s_G means that an investor 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 the model does not necessarily imply it, presumably $\hat{\alpha}$ will also be higher.

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 higher when P_{GM} is high than when P_{GM} is low, since when P_{GM} is high bookbuilding investors sell their shares to grey market investors in the aftermarket.

Finally, the model has implications for long-run returns. Intuitively, when P_{GM} exceeds the fundamental value, the immediate aftermarket price (P_{AM}) is closely related to the grey market

[19] In a previous version of this paper (available one request), we explicitly model the optimal mechanism for information revelation in bookbuilding and derive the conditions under which participation by bookbuilding investors in the grey market lowers IPO proceeds.

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 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 this new 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. This discussion is summarized as:

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 overweight s_G relative to s_B, i.e., if $\hat{\alpha} > \alpha$).

The correlations predicted in Hypothesis 6 can be derived more formally from the model as follows. The share price converges in the long run to the fundamental value $\alpha s_B + (1-\alpha)s_G$. Recall that when P_{GM} is high, the short-run aftermarket price is $P_{AM} = \hat{P}_{GM} - \lambda S = \hat{\alpha} s_B + (1-\hat{\alpha})s_G - \lambda S$ (i.e., the reservation price of the grey market investors). Thus, the difference between the long-run price and the short-run price is $(\hat{\alpha} - \alpha)(s_B - s_G) + \lambda S$. This is the long-run return in dollars. To the extent that $\hat{\alpha} > \alpha$, this return is positively related to the bookbuilding signal s_B and negatively related to the grey market signal s_G. If $\hat{\alpha} = \alpha$, the short-run aftermarket price is already the expected fundamental value, so the long-run returns are zero.

The difference between P_{AM} and P_{GM} (for high P_{GM}) is $(1-\hat{\alpha})(s_B - E(s_B)) - \lambda S$, which is positively related to the bookbuilding signal. Thus, there is a positive relation between the long-run return and $(P_{AM} - P_{GM})$ if and only if $\hat{\alpha} > \alpha$.

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

4. Sample and data

The dataset consists of 486 companies which went public in 12 European countries between November 1995 and December 2002 and for which we have grey market prices. The extent to which IPO shares are traded in grey markets varies from country to country. For instance, in Germany and Italy most IPOs trade in the grey market while in France or Sweden very few

do. As a result, our dataset is a subset of the universe of 2,723 firms going public in the 12 countries over the sample period.

While we only consider firms that go public in Europe, our sample does include a small number of non-European companies that obtained a first-time listing in a European country (typically Germany's *Neuer Markt*). Sample companies come from a total of 20 countries.

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 bid-ask 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 they are often reported in the financial news media.

Grey market trading typically begins on the day the company publishes its initial indicative price range, (the range of prices within which the underwriter expects to price the issue), and concludes on the day before the stock begins trading on the stock market. Often, IPOs are priced a day or two before stock market trading begins, in which case grey market trading continues for a short while *after* the IPO has been priced.

Grey market prices come from two large brokers, based in Germany and the United Kingdom, and are supplemented with a news search. For every company in our sample, we have the last grey market price established *before* the IPO is priced, and for 262 companies we also have post-pricing grey market prices.[20] Whenever available, we use the last transaction price before the IPO. When transaction prices are unavailable, we use the midpoint of the grey-market bid-ask spread.

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. Firm and offer characteristics are taken from the IPO prospectuses. 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

[20]Other than this, we do not have a time series of grey market prices for our sample companies. For an analysis of a limited sample of daily grey market prices, see Löffler, Panther, and Theissen (2004).

by the 12 countries on whose exchanges sample companies list. Most sample firms (75%) 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.

Although the sample IPOs span the period from November 1995 to December 2002, the range of dates varies from market to market, depending on the IPOs for which we have grey market prices. 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 and Italy, 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 spreads averaging 9.5%. Just over half the 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 midpoint of the indicative price range by 40.4%.

5. Empirical results

We now discuss the empirical results in light of our predictions. Since we pool data from several countries whose grey market and bookbuilding practices likely differ in subtle ways, we initially estimated all our models with country fixed effects but found these to be insignificant. Similarly, we obtain qualitatively similar results if we restrict the sample to firms going public in Germany, which has the most active grey market in our sample. We have also verified that our results are robust to outliers by winsorizing the price data at the 5% level. To conserve space, none of these robustness tests is reported.

5.1. The short-run aftermarket price. Hypothesis 1 predicts a positive relation between the short-run aftermarket price, P_{AM}, and the grey market price, P_{GM}. Importantly, this relation is asymmetric if small investors are irrational. When P_{GM} exceeds the fundamental value, bookbuilding investors resell their shares in the aftermarket, and the first-day closing price P_{AM} should be close to the price that grey market investors are willing to pay. Thus, P_{AM}

should be highly correlated with P_{GM}. In contrast, when P_{GM} is below the fundamental value, bookbuilding investors will not resell their shares to grey market investors, so the correlation between P_{AM} and P_{GM} should be lower. In this case, there will be a positive correlation only to the extent that P_{GM} contains some information about the fundamental value (i.e., $\alpha > 0$).

Note that the predicted asymmetry in the correlation between P_{AM} and P_{GM} does not depend on how the underwriter chooses the issue price. It relies purely on the result that grey market investors buy in the aftermarket only if they are excessively optimistic ($\hat{\alpha} > \alpha$).

The least-squares regressions in Table 2 relate aftermarket prices to grey market prices. Regressions 1 to 3 focus on the overall relation between P_{AM} and P_{GM}, without allowing for asymmetry. We normalize each price by the midpoint of the initial indicative price range, P_{mid}, 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).

Regression 1 shows that P_{AM} is indeed highly correlated with P_{GM}. The estimated coefficient of 0.98 is not significantly different from one. This indicates that P_{AM} is closely related to P_{GM}, moving one-for-one with P_{GM}. The adjusted R^2 is 75.4%, so the regression captures a sizable part of the variation in P_{AM} using only information available before aftermarket trading begins.

To see if P_{GM} simply proxies for the issue price, Regression 2 relates the aftermarket price to P_I instead. P_{AM} is positively correlated with P_I, but the adjusted R^2 is much lower than in Regression 1. When we use both P_I and P_{GM} as explanatory variables in Regression 3, the coefficient of P_{GM} is still not significantly different from one, and P_I only adds a small amount of explanatory power (as captured by the modest increase in the adjusted R^2). In sum, grey market prices predict aftermarket prices much better than do issue prices.[21]

Regressions 1 to 3 also include the market index return (measured over the three-month period prior to the IPO) as a control variable. This variable has previously been associated with market sentiment (see, for instance, Derrien (2004)). It is interesting to see how its coefficient varies across Regressions 1 to 3. Although the coefficient is both economically and statistically significant in Regression 2, it loses all its significance when P_{GM} is included

[21]Note that even though the model predicts that P_I depends on P_{GM}, and that P_{AM} is related to P_I and P_{GM}, the system described by these two equations is triangular. Thus, it can be consistently estimated recursively, that is, by equation-by-equation estimation. See Greene (2003), p. 383.

in Regressions 1 and 3. This suggests that while market-wide returns may capture general investor sentiment, as Derrien (2004) argues, it does not capture investor sentiment about specific IPOs very well – and certainly much less well than P_{GM}.

Although our results so far might be interpreted simply as evidence that P_{GM} is a good predictor of P_{AM}, a different conclusion emerges when we allow for asymmetry in the empirical relation. According to the model, we need to distinguish between instances when P_{GM} is higher than the fundamental value and when it is lower. Because the fundamental value is unobservable to the econometrician, empirical studies usually take the midpoint of the initial indicative price range, P_{mid}, as a proxy for the underwriter's ex ante prior of the fundamental value. Thus, if P_{GM} is above P_{mid} it is more likely to be above the fundamentals. In Regressions 4 and 5 of Table 2, we capture the asymmetry by splitting the sample into two subsets based on whether P_{GM} is above or below P_{mid}. We find that when $P_{GM} > P_{mid}$, the coefficient of P_{GM} is 0.95 and again not significantly different from one. Thus, in this case, P_{AM} still moves approximately one-for-one with P_{GM}. However, when $P_{GM} < P_{mid}$, the coefficient of P_{GM} is only 0.56 and is significantly less than one. Moreover, the coefficients in the two subsamples are significantly different from one another. In other words, the estimated relation is positively sloped and exhibits a kink, consistent with the illustration in Figure 1.

The fact that the coefficient of P_{GM} is larger when P_{GM} is high implies that $\hat{\alpha} > \alpha$, i.e., that grey market investors are biased. The dependent variable, P_{AM}, is the updated valuation of the grey market investors (adjusted for downward sloping demand) and therefore should move one-for-one with P_{GM}. The fact that the coefficient is significantly positive even when P_{GM} is low suggests that $\alpha > 0$, i.e., that P_{GM} contains some fundamental information. Although in this case P_{AM} depends on the fundamental value and not directly on the valuation of grey market investors, to the extent that their opinion contains some information about fundamentals, P_{AM} and P_{GM} will still have some positive correlation.

Prior studies have documented a different sort of asymmetry: starting with Hanley (1993), several papers have shown an asymmetric relation between aftermarket returns and the issue price (the partial adjustment phenomenon). To distinguish our asymmetry from partial adjustment, regressions 4 and 5 include the (normalized) issue price, P_I, as a control variable, which we know from Regressions 2 and 3 is related to P_{AM}. The fact that we find the asymmetry between P_{AM} and P_{GM} even when controlling for P_I does not mean that there is no partial adjustment (as we will see in Table 3). It simply confirms that our asymmetry originates in

P_{AM} and is driven by the irrationality of grey market investors. How the underwriter sets P_I given the expected aftermarket price determines whether there is partial adjustment.

Finally, Hypothesis 4 predicts that when P_{GM} is high, the price at which the bookbuilding investors can sell their shares in the aftermarket may be reduced if there is insufficient depth in the market and the issue is large. This implies a negative correlation between P_{AM} and the issue size S, and a positive correlation between P_{AM} and the depth of the grey market $(-\lambda)$, when P_{GM} is high. To capture these effects, the regressions shown in Table 2 include the log of issue proceeds and the bid-ask spread quoted by grey market brokers shortly before IPO pricing. A wider bid-ask spread may indicate a lack of depth in the grey market, either due to a scarcity of traders in the grey market or due to a diversity of opinion among investors.[22] When P_{GM} is high, we find negative coefficients for both these variables (Regression 4), though only the coefficient of log issue proceeds is statistically significant. When P_{GM} is low (Regression 5), neither the bid-ask spread nor log issue proceeds has a significant effect on P_{AM}, as expected.

5.2. The issue price. Hypothesis 2 predicts an asymmetric relation between the issue price P_I and the grey market price P_{GM}, assuming the issuer appropriates part of the surplus generated when the grey market investors are excessively optimistic. In Table 3, we report the results of the regressions testing this prediction.

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)), with censoring from both above and below. Censored regressions are similar to Tobit models, except that the point of censoring is observation-specific. Note that 54.1% of our observations are right-censored, while 10.5% are left-censored.

To test for the asymmetry, we interact P_{GM} with an indicator function that equals one if $P_{GM} > P_{mid}$, and zero otherwise.[23]

[22] An alternative measure of depth is trading volume in the grey market. However, grey market volume data are not available on a systematic basis.

[23] The large proportion of right-censored observations is the reason why we introduce the indicator function to capture the asymmetry rather than splitting the sample between high and low levels of P_{GM}, as we do elsewhere. If we were to estimate the censored regression model for the subsample where $P_{GM} > P_{mid}$, we would have little explanatory power since for most observations the issue price would equal the top of the range.

Regression 1 of Table 3 examines the relation between P_I and P_{GM}. Overall, the fit of the model is very good in view of the highly significant likelihood ratio test. As expected, we find a positive and highly significant relation between P_I and P_{GM}, and an even stronger relation when $P_{GM} > P_{mid}$. This result is consistent with Hypothesis 2. The fact that the correlation is positive even when P_{GM} is low again suggests that $\alpha > 0$: P_{GM} contains information about the fundamental value. The higher correlation for high P_{GM} reflects an asymmetry in the relation between the P_{GM} and the P_I. Moreover, the fact that the asymmetry is manifest in the issue price suggests that $\gamma > 0$, i.e., the issuer has some bargaining power and can raise P_I to take advantage of the overoptimism of grey market investors. This suggests not only that grey market investors are driven by sentiment, but also that the underwriter and the issuer are aware that P_{GM} is biased, and include this bias in their valuation only when the bookbuilding investors expect to profit from it by selling shares to grey market investors in the aftermarket.

Our results show that the issuer has some bargaining power enabling him to capture some of the surplus by negotiating a higher issue price. However, part of the surplus from a high P_{AM} is appropriated by the underwriter and his network of bookbuilding investors. This partial adjustment effect is in evidence in Table 3: the effect of P_{GM} on P_I when P_{GM} is high (summing the coefficients of P_{GM} and P_{GM} times the indicator function) is much less than the one-for-one relation between P_{AM} and P_{GM} described in the previous section.

Regression 1 also controls for pre-IPO market index returns (measured over the three-month period prior to the IPO) which prior studies have associated with market sentiment. While we find a positive and statistically significant coefficient on market index returns, the strong positive and asymmetric relation between P_{GM} and P_I suggests that P_{GM} contains additional information beyond the market-wide returns. This is not surprising, since market returns are at best a noisy proxy for investor sentiment, especially at the level of individual securities. In comparison, in Regression 2 we focus on market index returns by excluding the terms involving P_{GM}. Without the grey market price, we find a much stronger relation between P_I and the market index, though the explanatory power decreases substantially. Similar to the evidence in Table 2, this indicates that P_{GM} largely subsumes the market-momentum proxy for irrational investor behavior.

Regression 3 of Table 3 adds the (logarithm of) expected issue proceeds and the grey-market bid-ask spread. Hypothesis 4 predicts that if bookbuilding investors fear that they

may not be able to sell all their shares in the aftermarket at the (updated) grey market price $\hat{P}_{GM}$ due to insufficient depth, the underwriter will likely price the IPO more conservatively. Consistent with this hypothesis, in Regression 3 we find negative and statistically significant relations between P_I and the bid-ask spread, and between P_I and expected proceeds S.

Finally, to the extent that a wide bid-ask spread reflects greater divergence of opinion among grey market investors, it may indicate a less reliable grey market signal (i.e., a smaller α in the model). Hypothesis 3 predicts that the correlation between P_I and P_{GM} is weaker when the grey market signal is less reliable. In Regression 5, we capture this by interacting the bid-ask spread with P_{GM}. 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.

5.3. Robustness: Industry clustering. It is possible that our results are driven by the clustering of IPOs with similar characteristics. After all, much of our data comes from the late 1990s, a period when many technology companies went public. We test for robustness to industry clustering by excluding technology firms, as classified using the algorithm described in Loughran and Ritter (2004), based on four-digit SIC codes. This classifies 199 of the 477 sample companies as technology firms. Regression 5 in Table 3 illustrates that excluding technology firms from the sample leaves our results unchanged. The empirical results reported throughout the paper are similarly robust to excluding technology firms. (Results are available on request.)

5.4. Robustness: IPO withdrawals. Until now we have ignored the possibility that IPOs could be withdrawn after the start of grey market trading. If a combination of negative sentiment in the grey market and negative information in bookbuilding leads to IPOs being withdrawn, the remaining observations with a low P_{GM} would tend to have positive bookbuilding information. This could potentially bias the results in the direction of the asymmetry in the relations between P_{GM} and P_I, and between P_{GM} and P_{AM}. Since we do not observe P_I and P_{AM} for withdrawn IPOs, the distribution of observed prices has truncated support with the usual result that regression coefficients may be estimated with bias (Heckman (1979)).

It is an empirical question whether IPOs are withdrawn in response to negative sentiment in the grey market. To investigate the possible extent of bias in our sample, we estimate the frequency with which IPOs are withdrawn after grey market trading has begun in Germany,

the most active grey market in our sample. Between 1997 and 2002, there were 485 completed IPOs in Germany. Over the same period, a further 236 companies announced their intention to go public (according to Reuters and VWD, a German news wire service). Of these 236 withdrawn issues, only 20 (8.5%) were withdrawn *after* grey market trading had begun.[24] Thus, the vast majority of IPOs are withdrawn at a very preliminary stage, and not in response to negative sentiment in the grey market.[25]

5.5. Updating. Our data allow us to investigate the extent to which grey market investors update their valuations upon learning the outcome of bookbuilding. Often, grey market trading continues for a short time after bookbuilding concludes and P_I is set, (but before aftermarket trading begins). For a subsample of 262 IPOs, we observe post-bookbuilding grey market prices, which correspond to $\hat{P}_{GM}$ in the model. To see if grey market investors incorporate the bookbuilding information revealed through P_I, we regress $\hat{P}_{GM}$ on P_I and P_{GM} (normalizing all three prices by P_{mid}). The estimated equation is:

$$\hat{P}_{GM}/P_{mid} = \underset{(-2.41)}{-0.14} + \underset{(2.96)}{0.23} P_I/P_{mid} + \underset{(33.82)}{0.92}\, P_{GM}/P_{mid}$$

where heteroskedasticity-consistent t-statistics are shown in parentheses underneath the OLS coefficient estimates. The adjusted R^2 is 96.9%. The coefficient estimated for P_{GM} is significantly less than one ($p = 0.004$), while the coefficient for P_I is significantly greater than zero ($p = 0.003$). This suggests that grey market investors do adjust their expectations, and that bookbuilding information is incorporated in $\hat{P}_{GM}$.

The following alternative specification quantifies the extent to which grey market investors update upon learning P_I:

$$(\hat{P}_{GM} - P_{GM})/P_{mid} = \underset{(1.21)}{0.01} + \underset{(2.80)}{0.07}(P_I - P_{GM})/P_{mid}$$

[24] Among these 20 withdrawn IPOs, the last recorded grey market price before withdrawal was, on average, 8.3% below the midpoint of the initial indicative price range. Six of the 20 firms traded above the range midpoint at the time of withdrawal.

[25] In a similar exercise, using an earlier sample of German firms that that announced the intention to go public, Boehmer and Ljungqvist (2004) find that almost all withdrawn IPOs occurred at a very preliminary stage, well before bookbuilding (and thus grey market trading) had begun.

The adjusted R^2 in this specification is 14.4%. The coefficient estimated for $(P_I - P_{GM})/P_{mid}$ suggests that for every dollar difference between P_I and P_{GM}, grey market investors increase their reservation price by seven cents. So although we find that grey market investors update when they observe the results of bookbuilding, they only update by a relatively small amount.

5.6. Aftermarket trading volume. Table 4 examines the relation between P_{GM} and aftermarket trading volume (as a fraction 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 $P_{GM} > P_{mid}$, 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 P_{GM} is high, bookbuilding investors are more likely to sell their shares in the aftermarket, consistent with Hypothesis 5.

However, a high P_{GM} might simply indicate that either the IPO or the equity market is "hot," leading to high volume for reasons outside our model. In Regressions 2 and 5 we include the market index return (measured over the three-month period before the IPO) to capture a hot market. In Regressions 3 and 6 we also include the (normalized) first-day closing market price P_{AM} to capture whether the IPO is hot. Even after including 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 very active markets.

5.7. Long-run returns. We now consider how P_{GM} and the results of bookbuilding are related to long-run aftermarket returns. We test these relations using the following regression:

$$\frac{P_{LongRun} - P_{AM}}{P_{mid}} - \text{benchmark return} = \alpha + \beta_1 \frac{P_{GM} - P_{mid}}{P_{mid}} + \beta_2 \frac{P_{AM} - P_{GM}}{P_{mid}} + controls + \epsilon \tag{8}$$

The dependent variable is the buy-and-hold return measured from the end of the first aftermarket trading day until two, three, six, or twelve months later (less the normalized return on a benchmark portfolio, defined shortly).[26] In our model, $P_{LongRun} - P_{AM} = (\hat{\alpha} - \alpha)(s_B - s_G) + \lambda S$ when P_{GM} is above the fundamental value. When P_{GM} is below the fundamental value, $P_{LongRun} - P_{AM} = 0$. As before, we normalize all variables by P_{mid}.[27]

The main independent variables are the difference between the grey market price and the range midpoint ($P_{GM} - P_{mid}$) and the difference between the aftermarket price on the first trading day and the grey market price ($P_{AM} - P_{GM}$), both normalized by the range midpoint. Together, these two variables add up to the entire price movement from the prior expected value of the shares, P_{mid}, to the price at the end of the first day of aftermarket trading, P_{AM}.

By splitting the price movement in this way, we can relate long-run returns separately to the two different signals, s_G and s_B, of our model. $P_{GM} - P_{mid}$ reflects the information revealed through grey market trading. Specifically, $P_{GM} - P_{mid} = \hat{\alpha}(s_G - E(s_G))$ where P_{mid} is the ex-ante expected value, $E(v)$. The second explanatory variable, $P_{AM} - P_{GM}$, captures the price movement that occurs in response to bookbuilding being concluded and the issue price being set.[28] When P_{GM} is high, $P_{AM} - P_{GM} = (1 - \hat{\alpha}(s_B - E(s_B)) - \lambda S$, representing the change in valuation due to the revelation of bookbuilding information (assuming that no other information arrives in this short interval).

According to Hypothesis 6, long-run returns relate differently to the grey market signal and the bookbuilding signal. When P_{GM} exceeds the fundamental value, the first-day aftermarket price will be close to the grey market investors' reservation price. To the extent that grey market investors overweight their signal s_G (i.e., $\hat{\alpha} > \alpha$), their reservation price diverges from the fundamental value. Since prices eventually revert to the fundamental value, Hypothesis 6 predicts a negative relation between long-run returns and the difference between P_{GM} and P_{mid}. Specifically, the coefficient β_1 in (8) equals $-\frac{\hat{\alpha}-\alpha}{\hat{\alpha}} = \frac{\alpha}{\hat{\alpha}} - 1$ which is negative if $\hat{\alpha} > \alpha$.

Bookbuilding information, by contrast, is assumed to be about fundamental value. If so,

[26] For the one firm that does not survive to its first trading anniversary, we record the return to the delisting date and adjust for benchmark returns up to the first trading anniversary.

[27] We normalize all variables by the same price, since this allows us to write the coefficients as simple functions of the model parameters. Our results are not sensitive to this normalization choice, and remain unchanged if we express each variable as a conventional return instead.

[28] An alternative way to capture the incremental information from bookbuilding is to use an independent variable equal to the residuals of regressing P_{AM} on P_{GM}. We have repeated the analysis using this method and the results are virtually identical to those reported here.

the difference between the P_{AM} and P_{GM} should not be reversed in the long run, that is, it should not correlate negatively with long-run returns. Whether this correlation is zero or positive depends on how grey market investors update using the bookbuilding information, s_B. If they overweight their own information (i.e., $\hat{\alpha} > \alpha$), then the movement from P_{GM} to P_{AM} is only a partial movement towards the fundamental value (assuming P_{GM} is above the fundamental value), and we expect a positive correlation between long-run returns and $P_{AM} - P_{GM}$. (The coefficient β_2 in (8) equals $\frac{\hat{\alpha}-\alpha}{1-\hat{\alpha}} > 0$.

On the other hand, when P_{GM} is below the fundamental value, P_{AM} already reflects the expected fundamental value so we expect neither reversal nor continuance in the long run.

Prior work suggests that IPO long-run performance is positively related to the underwriter's reputation (Carter, Dark, and Singh (1998)) and to the presence of venture capitalists (Brav and Gompers (1997)). We therefore include controls for bank reputation (using market shares as in Megginson and Weiss (1991)) and a dummy variable identifying venture-backed companies. In computing market shares, we are careful to track the many mergers among underwriters that occurred during our sample period.

We estimate equation (8) with two alternative benchmark portfolios. The first is simply the market index in the relevant listing country. The second is a style portfolio that takes into account that IPO companies are typically much smaller and more likely growth companies compared to companies in the index portfolio. The style portfolios are constructed as follows. For each listing country and each sample year, we assign the universe of listed companies (as reported in Datastream) to 25 portfolios by sorting into size (i.e., market capitalization at calendar year-end) and market-to-book quintiles. We then match each sample company to one of its listing country's 25 benchmark portfolios using the sample company's year-end market capitalization and market-to-book ratio, and compute abnormal returns as per equation (8).[29]

Given the relatively short sample period, sample IPOs are clustered in calendar time and so may not be statistically independent. To account for this, we compute t-statistics that allow for dependence among firms going public in the same quarter. That is, firms going public in different quarters are assumed to be independent, while firms going public in the same quarter are not. Results are robust to clustering on issue month or Fama and French

[29]For some sample companies, Datastream does not report accounting data so we rely on information from the IPO prospectuses instead.

(1997) industry, and to bootstrapping.

The results are reported in Tables 5 and 6. The least-squares regressions shown in Table 5 use the market index to compute abnormal returns. We present the results of regression (8) for the full sample as well as a partition of the sample based on whether P_{GM} is above or below P_{mid}. The predicted relations should hold only when P_{GM} 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 $P_{GM} - P_{mid}$ and long-run returns. Partitioning the sample, we see that this negative relation only holds when $P_{GM} > P_{mid}$, as predicted by Hypothesis 6. Since $\beta_1 = \frac{\alpha}{\hat{\alpha}} - 1$ when P_{GM} is high, this suggests that $\hat{\alpha} > \alpha$: grey market investors overweight their signal. Thus, non-fundamental information that is transmitted from the grey market to the aftermarket is reversed in the long run. Moreover, depending on the horizon, the coefficients range from -0.23 to -0.72 (all significantly greater than -1), indicating that only part of the price difference between P_{GM} and P_{mid} is reversed. This can be interpreted as evidence that P_{GM} contains some information about the fundamental value (i.e., $\alpha > 0$) and so does not reverse completely. When $P_{GM} < P_{mid}$, we do not find any reversal, consistent with Hypothesis 6.

The second variable, $P_{AM} - P_{GM}$ has a positive coefficient, consistent with the hypothesis that the information in the book pertains to the fundamental value and is not reversed in the long run. However, its coefficient is never statistically significant in Table 5.

As for the control variables, our results mirror those of Carter, Dark, and Singh (1998) for the U.S. in that long-run returns are significantly better for companies taken public by underwriters with larger market shares. However, we do not find that venture-backed companies perform better than non-venture-backed companies (at least not over the horizons we consider).

Table 6 re-estimates the Table 5 models using style-adjusted abnormal returns as the dependent variable. The results largely mirror those reported in Table 5: we find significant reversal when P_{GM} is high, over all horizons considered. Unlike in Table 5, we also find some evidence of continuation, in the sense that $(P_{AM} - P_{GM})$ is positively and significantly related to long-run returns.

Finally, we investigate whether these patterns are driven by the market-wide bubble of 1999-2000 (results not shown). We do so by allowing the effect of $(P_{GM} - P_{mid})$ and $(P_{AM} -$

P_{GM}) to differ before and after the bubble burst in March 2000. We find no evidence that our findings are driven by the evolution of the market-wide bubble: there is significant reversal both among companies that floated during the bubble and those that traded after the bubble had deflated. What appears more important than the market-wide bubble is stock-specific bubbles, which we can identify by virtue of our grey-market variables.[30]

6. Conclusion

We have taken advantage of the existence of the grey market for shares of companies about to go public to test whether behavioral biases among small investors can explain well-known anomalies in post-IPO prices. In our model, when small investors are overoptimistic, they are willing to pay a price above the fundamental value, resulting in a high aftermarket price. When they are excessively pessimistic, and value the shares below the fundamental value, they are priced out of the market, in which case we predict no bias in the aftermarket price. This argument implies an asymmetric relation between the grey market price and the aftermarket price. To the extent that the issuer can appropriate the surplus by setting a higher issue price when the aftermarket price is expected to be above the fundamental value, there will also be an asymmetric relation between the grey market price and the issue price. However, this second asymmetry will be weaker if the issuer does not have all the bargaining power vis à vis the bookbuilding investors.

Using grey market price data for a large set of European IPOs, we find evidence of such asymmetric relations. Moreover, when the grey market price is high, we find that long-run returns are negatively correlated with the grey market price, while this pattern does not arise when the grey market price is low. When small investors drive the price upward in the short-run aftermarket, there is a reversal as the price converges towards the fundamental value in the long run.

The combination of the asymmetric effect of the grey market price and the long-run reversal provides evidence of the existence of sentiment investors, as well as sophisticated investors who take advantage of the sentiment investors. The underwriter and bookbuilding investors consider the opinion of grey market investors to be biased, and take it into account only when they can profit from it by selling overpriced shares to them in the aftermarket.

[30]This mirrors our finding in Table 3 that prior market-wide index returns ("momentum") are a poor proxy for sentiment when compared with stock-specific grey market trading prices.

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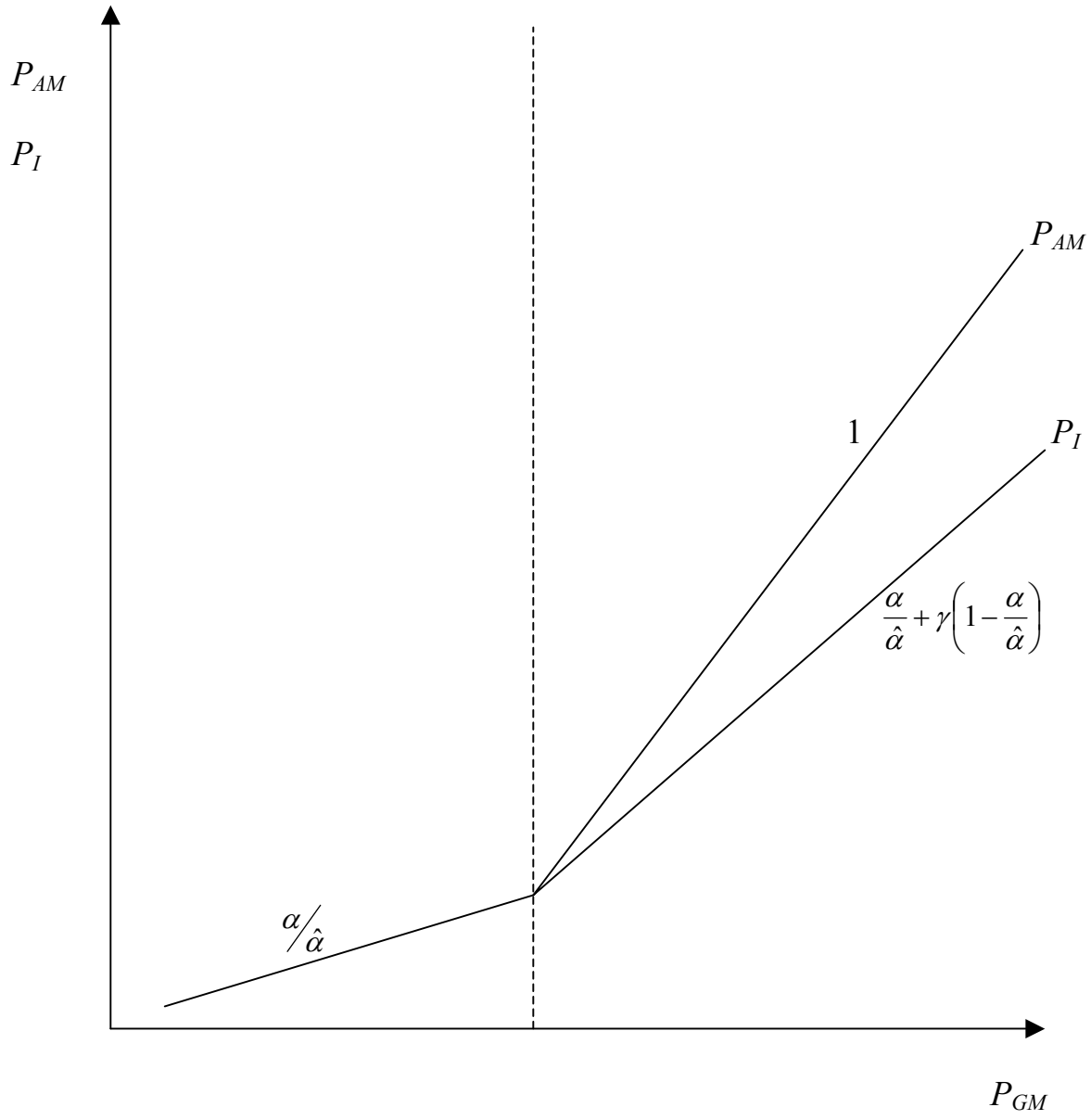

Figure 1: This figure illustrates the theoretical relation between the grey market price (P_{GM}), the aftermarket price (P_{AM}), and the issue price (P_I). The slope of each line segment is indicated. The relations are asymmetric if grey market investors overweight their signal (i.e. if $\hat{\alpha} > \alpha$). The difference between the aftermarket price and the issue price reflects the partial adjustment phenomenon.

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 does not 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 spread refers to the quoted bid-ask spread in the grey market, just before the IPO issue price is set. It is computed as 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 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	9.5	54.1	40.4
By country of listing												
Austria	Nov 1997	Nov 2000	2	18	25	654.5	654.5	-2.5	6.6	13.8	0.0	5.1
Finland	Nov 1998	Dec 1999	3	22	58	686.7	531.0	74.6	91.9	3.1	33.3	53.0
France	Oct 1997	Dec 2001	14	409	544	1715.3	650.0	6.5	12.9	8.3	42.9	24.6
Germany	Nov 1995	Jul 2002	363	489	504	169.9	42.2	41.5	67.8	10.2	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	8.7	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	1.1	0.0	85.7
Spain	Jun 1999	May 2001	5	12	38	1374.0	915.7	10.5	13.2	10.3	20.0	11.8
Sweden	Jun 2000	Jun 2001	2	22	196	4405.4	4405.4	9.9	8.2	1.8	50.0	19.2
Switzerland	Dec 1996	Dec 2001	8	59	67	1097.4	153.8	50.1	99.8	3.3	12.5	36.0
United Kingdom	Jun 1997	Jul 2002	23	563	815	566.8	265.3	21.5	35.0	3.0	21.7	32.9

Table 2. 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), P_{AM} / P_{mid}, adjusted for the market index return from the pricing date to the end of the first day of aftermarket trading. The explanatory variables are the normalized last grey market price before the issue price was set P_{GM} / P_{mid}, the normalized issue price P_I / P_{mid}, the last bid-ask spread in the grey market (divided by its midpoint), and the logarithm of the IPO proceeds. We also include the domestic market index return over the three-month period before the IPO as a control variable. Grey market prices are available for 486 IPOs. Nine of these are fixed-price offerings, so we lack information on their initial price ranges. Bid-ask spreads are missing for some IPOs, reducing the number of observations to 442. White heteroskedasticity consistent *t*-statistics are given in parentheses. Results are robust to clustering standard errors on the month or quarter of the IPO, or on the IPO firm's Fama-French (1997) industry, rather than assuming cross-sectional independence. They are also robust to bootstrapping. Three, two, and one asterisks indicate significance at the 1%, 5%, and 10% level, respectively. Intercepts are not shown.

	Full sample			$P_{GM} > P_{mid}$	$P_{GM} \leq P_{mid}$
	(1)	(2)	(3)	(4)	(5)
P_{GM} / P_{mid}	0.98***		0.95***	0.95***	0.56***
	(14.87)		(13.14)	(12.59)	(3.62)
P_I / P_{mid}		2.60***	0.44**	0.51*	0.53***
		(11.50)	(2.46)	(1.66)	(3.12)
Market index return	0.05	2.12***	-0.01	0.03	-0.15*
	(0.23)	(5.10)	(-0.07)	(0.11)	(-1.78)
Grey market bid-ask spread	-0.62	0.41	-0.46	-0.73	-0.06
	(-1.52)	(0.80)	(-1.09)	(-1.11)	(-0.49)
Log gross proceeds	-0.04***	-0.05***	-0.04***	-0.05***	-0.01
	(-3.06)	(-3.00)	(-3.12)	(-3.02)	(-1.50)
Adjusted R^2	75.4 %	27.5 %	75.7 %	70.7 %	68.4 %
F-test: all coeff. = 0	77.6***	52.7***	164.5***	64.4***	55.2***
No. of observations	442	442	442	330	112

Table 3. Determinants of the Issue Price

The dependent variable in these regressions is the IPO issue price P_I normalized by the midpoint of the initial price range P_{mid}. The explanatory variables are the last grey market price before the issue price was set P_{GM} (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 expected IPO proceeds (evaluated at P_{mid}). We also include the domestic market index return over the three-month period before the IPO as a control variable. To capture the predicted asymmetry, we define an indicator function set to one when P_{GM} is above P_{mid}. 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. Model (2) excludes the grey market variables, linking issue prices to market momentum and expected IPO proceeds only. Models (3) through (5) include the bid-ask spread, which is available for 442 IPOs. In model (5), we check for robustness to excluding technology firms (classified based on four-digit SIC codes following Loughran and Ritter (2004)). We use censored regressions because European IPOs are rarely priced outside the initial price range. *t*-statistics are reported in parentheses. Three, two, and one asterisks indicate significance at the 1%, 5%, and 10% level, respectively. Intercepts are not shown.

	Dependent variable: Normalized Issue Price (P_I / P_{mid})				
	(1)	(2)	(3)	(4)	(5)
P_{GM} / P_{mid}	0.29***		0.31***	0.37***	0.37***
	(6.01)		(5.66)	(6.42)	(5.14)
P_{GM} / P_{mid}	0.15***		0.14***	0.13***	0.13***
x Indicator(P_{GM} > P_{mid})	(7.29)		(6.42)	(6.22)	(4.54)
Market index return	0.20**	1.15***	0.24***	0.24***	0.24**
	(2.39)	(7.65)	(2.66)	(2.67)	(2.16)
Grey market bid-ask spread			-0.39***		-0.34***
			(-3.51)		(-2.71)
Grey market bid-ask spread				-0.40***	
x P_{GM} / P_{mid}				(-3.83)	
Log expected gross proceeds		-0.02*	-0.01***	-0.01***	-0.01
		(-1.76)	(-2.59)	(-2.66)	(-1.33)
LR test: all coeff. = 0 (χ^2)	488.9***	73.3***	457.7***	460.0***	283.6***
No. of observations	477	477	442	442	253
No. of left-censored observations	51	51	50	50	32
No. of right-censored observations	263	263	246	246	128

Table 4. OLS Regressions of Aftermarket Turnover as the Dependent Variable

The dependent variable in these regressions is the natural logarithm of first-day turnover (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 (P_{GM}) exceeded the midpoint of the initial price range (P_{mid}). The controls in models (2)-(3) and (5)-(6) are the domestic market index return over the three-month period before the IPO and the normalized first-day after-market price (P_{AM} / P_{mid}). White heteroskedasticity consistent *t*-statistics are given in parentheses. Results are robust to clustering standard errors on the month or quarter of the IPO, or on the IPO firm's Fama-French (1997) industry, rather than assuming cross-sectional independence. They are also robust to bootstrapping. Three and two asterisks indicate significance at the 1% and 5% level, respectively. Intercepts are not shown.

	Log first-day turnover			Log first-week turnover		
	(1)	(2)	(3)	(4)	(5)	(6)
Indicator($P_{GM} > P_{mid}$)	1.08***	0.89***	0.70***	1.00***	0.84***	0.65***
	(7.64)	(6.15)	(4.59)	(8.72)	(7.25)	(5.25)
Market returns		2.84***	2.12***		2.47***	1.74**
		(4.48)	(3.20)		(4.69)	(3.19)
P_{AM} / P_{mid}			0.33***			0.33***
			(4.70)			(5.34)
Adjusted R^2	12.0 %	15.7 %	18.0 %	14.2 %	18.0 %	21.3 %
F-test: all coeff. = 0	58.3***	40.7***	44.3***	76.1***	48.7***	50.9***
No. of observations	443	443	443	443	443	443

Table 5. Market-Adjusted Long-Run Returns

We estimate least-squares regressions with market-adjusted long-run returns as the dependent variables. Long-run returns are measured from the first day of aftermarket trading, and are defined as $(R_{LR} - R_{mkt})(P_{AM}/P_{mid})$ where R_{LR} is the buy-and-hold return over the first two, three, six or 12 months of aftermarket trade, R_{mkt} is the contemporaneous return on the domestic market index, and the multiplier (P_{AM}/P_{mid}) is used to ensure that the dependent variables are consistent with the normalization of the independent variables. A month is defined as 21 trading days. The lead underwriter's market share is included to control for the bank's reputation. It is computed as the within-country share of proceeds underwritten by the issuer's lead underwriter (or in the case of joint leads, their average market share). The venture dummy equals one if the issuing company has a venture capital or private equity fund among its pre-IPO shareholders. For the one firm that does not survive to its first trading anniversary, we measure its return to the delisting date and adjust for market movements up to the first trading anniversary. *t*-statistics, given in parentheses, are based on standard errors that are clustered on the quarter in which the IPO took place. That is, firms going public in different quarters are assumed to be independent, while firms going public in the same quarter are not. Results are robust to clustering on issue month or Fama-French (1997) industry, and to bootstrapping. Three, two, and one asterisks indicate significance at the 1%, 5%, and 10% level, respectively. Intercepts are not shown.

	Full sample				$P_{GM} > P_{mid}$				$P_{GM} \leq P_{mid}$			
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)	(12)
$(P_{GM} - P_{mid})/P_{mid}$	-0.20***	-0.18*	-0.38**	-0.61***	-0.25***	-0.23***	-0.43***	-0.72***	0.39	0.88	2.29	1.15*
	(-4.42)	(-1.95)	(-2.73)	(-4.16)	(-6.10)	(-2.89)	(-3.54)	(-5.33)	(1.12)	(1.22)	(1.57)	(1.87)
$(P_{AM} - P_{GM})/P_{mid}$	0.12	0.67	0.83	0.22	0.10	0.65	0.78	0.20	1.16	2.10	5.00	-0.21
	(1.06)	(1.54)	(1.56)	(0.80)	(0.86)	(1.51)	(1.49)	(0.76)	(1.13)	(1.25)	(1.48)	(-0.42)
Lead underwriter's market share	0.86**	1.29**	2.98**	4.46*	0.88*	1.46**	3.46**	5.72*	0.52	0.54	1.03	0.28
	(2.15)	(2.58)	(2.28)	(1.71)	(1.89)	(2.26)	(2.30)	(1.71)	(1.18)	(0.90)	(0.89)	(0.22)
Venture dummy	0.06	0.01	0.11	0.08	0.02	-0.08	-0.06	0.02	0.13	0.25	0.55	0.15
	(0.92)	(0.12)	(0.64)	(0.63)	(0.35)	(-1.23)	(-0.55)	(0.15)	(1.34)	(1.37)	(1.50)	(1.63)
Adjusted R^2	2.6 %	6.3 %	7.6 %	6.7 %	3.1 %	6.9 %	9.1 %	8.4 %	6.6 %	9.2 %	15.3 %	0.2 %
F-test: all coeff. = 0	6.6***	6.9***	6.0***	9.4***	14.0***	7.5***	9.3***	14.8***	0.9	1.3	0.9	3.6**
No. of observations	477	477	477	477	358	358	358	358	119	119	119	119

Table 6. Benchmark-Adjusted Long-Run Returns

We estimate least-squares regressions with benchmark-adjusted long-run returns as the dependent variables. Long-run returns are measured from the first day of aftermarket trading, and are defined as $(R_{LR} - R_B)(P_{AM}/P_{mid})$ where R_{LR} is the buy-and-hold return over the first two, three, six or 12 months of aftermarket trade and R_B is the contemporaneous return on a size and book-to-market matched benchmark (based on a 5x5 sort of all Datastream listed companies in the relevant domestic market). The multiplier (P_{AM}/P_{mid}) is used to ensure that the dependent variables are consistent with the normalization of the independent variables. A month is defined as 21 trading days. The lead underwriter's market share is included to control for the bank's reputation. It is computed as the within-country share of proceeds underwritten by the issuer's lead underwriter (or in the case of joint leads, their average market share). The venture dummy equals one if the issuing company has a venture capital or private equity fund among its pre-IPO shareholders. For the one firm that does not survive to its first trading anniversary, we measure its return to the delisting date and adjust for benchmark returns up to the first trading anniversary. *t*-statistics, given in parentheses, are based on standard errors that are clustered on the quarter in which the IPO took place. That is, firms going public in different quarters are assumed to be independent, while firms going public in the same quarter are not. Results are robust to clustering on issue month or Fama-French (1997) industry, and to bootstrapping. Three, two, and one asterisks indicate significance at the 1%, 5%, and 10% level, respectively. Intercepts are not shown.

	Full sample				$P_{GM} > P_{mid}$				$P_{GM} \leq P_{mid}$			
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)	(12)
$(P_{GM} - P_{mid})/P_{mid}$	-0.14***	-0.11	-0.22*	-0.29**	-0.20***	-0.15**	-0.27**	-0.41***	0.40	1.05	2.25	1.04
	(-3.01)	(-1.33)	(-1.86)	(-2.66)	(-4.49)	(-2.21)	(-2.70)	(-3.75)	(1.18)	(1.40)	(1.64)	(1.74)
$(P_{AM} - P_{GM})/P_{mid}$	0.13	0.61*	0.79**	0.28	0.10	0.58*	0.73*	0.26	1.33	2.31	5.16	0.19
	(1.12)	(1.74)	(2.12)	(1.67)	(0.88)	(1.70)	(2.02)	(1.64)	(1.30)	(1.35)	(1.59)	(0.48)
Lead underwriter's market share	0.68*	1.13**	2.66*	3.95	0.67	1.30*	3.09**	5.20	0.37	0.36	0.86	-0.21
	(1.75)	(2.21)	(2.01)	(1.50)	(1.51)	(1.94)	(2.08)	(1.54)	(0.84)	(0.60)	(0.75)	(-0.20)
Venture dummy	0.06	0.03	0.13	0.10	0.02	-0.06	-0.05	0.05	0.14*	0.27	0.58	0.15*
	(0.98)	(0.34)	(0.70)	(0.68)	(0.34)	(-0.80)	(-0.35)	(0.27)	(1.79)	(1.69)	(1.56)	(1.88)
Adjusted R^2	1.3 %	4.9 %	6.0 %	3.0 %	1.6 %	5.2 %	7.1 %	4.4 %	9.1 %	12.1 %	17.0 %	0.3 %
F-test: all coeff. = 0	2.9**	4.3***	3.6**	6.4***	5.9***	4.6***	5.7***	10.1***	1.5	1.0	0.8	2.8*
No. of observations	477	477	477	477	358	358	358	358	119	119	119	119