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Investor Sentiment and Pre-IPO Markets

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ABSTRACT

We examine whether irrational behavior among small (retail) investors drives post-IPO prices. We use prices from the grey market (the when-issued market that precedes European IPOs) to proxy for small investors' valuations. High grey market prices (indicating overoptimism) are a very good predictor of first-day aftermarket prices, while low grey market prices (indicating excessive pessimism) are not. Moreover, we find long-run price reversal only following high grey market prices. This asymmetry occurs because larger (institutional) investors can choose between keeping the shares they are allocated in the IPO, and reselling them when small investors are overoptimistic.

Behavioral biases have become a popular explanation for a variety of asset-pricing phenomena which are hard to reconcile with a rational decision-making framework. For example, in the case of IPOs, Ritter and Welch (2002) conjecture that overenthusiasm among retail investors may explain high first-day returns and low long-run returns. However, the extent to which the presence 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

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determine whether such investors should be classified as irrational (i.e., sentiment) investors.[1]

We achieve this by virtue of Europe's pre-IPO (or "grey") markets, which enable investors to speculate on the future stock prices of companies that are about to go public. Before an IPO, the underwriter collects indications of interest from its network of large institutional investors in a process known as bookbuilding.[2] Concurrent with bookbuilding, investors can trade the shares in the grey market on a forward (i.e., when-issued) basis.[3] Since the typical grey market trader is a small investor,[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 show below, these relations depend on both how grey market investors form their valuations and how large investors respond to the small investors' beliefs during bookbuilding. We can therefore use these 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, 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 potentially 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 will simply depend on the information that each investor group has.

If, instead, grey market investors are (at least partially) irrational, then at times they will be overoptimistic and at times they will be excessively pessimistic. Bookbuilding investors can take advantage of the small investors by selectively off-loading their shares 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, valuing the shares above the fundamental value), the aftermarket price will be the small investors' reservation price and thus it will be highly correlated with the grey market

[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] Section III 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.

price. Instead, when the grey market price is low (indicating that small investors are excessively pessimistic, valuing the shares below the fundamental value), bookbuilding investors will not sell their shares to small investors, and the correlation between the grey market price and the aftermarket price will be much lower. Thus, small investors can cause the post-IPO price to be above the fundamental value but not below it.

When overoptimism by small investors causes prices to exceed the fundamental value in the immediate aftermarket, in the long run prices revert to the fundamental value. This results in negative long-run returns following excessively high grey market prices. In the case of low grey market prices, on the other hand, because the aftermarket price is always based on fundamentals, we do not expect to find such a reversal pattern.

In order to formalize and test our arguments, we first develop a theoretical model that yields the empirical implications described above. In the model, both grey market investors and bookbuilding investors 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 overweight the information in their signal. Thus, whether or not grey market investors are sentiment investors in this sense is an empirical question that can be answered in the context of our model.

Although we focus primarily on the effect that small investors' beliefs have on aftermarket prices, our story also has implications for the way IPO issue prices are set. Since grey market prices are publicly observable, the underwriter can condition the issue price on the grey market price. In particular, when the grey market price is high, the issuer anticipates that the bookbuilding investors will profit from selling their allocations to the overoptimistic investors in the aftermarket. The issuer therefore demands an increase in the issue price. 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), where the division of the surplus depends on the parties' relative bargaining power. Unless the issuer has all the bargaining power, the underwriter sets the issue price such that the IPO is underpriced, with both the issuer and the bookbuilding investors sharing in the surplus. Thus, positive issue-price revisions are likely followed by positive first-day returns, an empirical pattern referred to as the partial adjustment phenomenon (Hanley (1993)).

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 highly correlated with the aftermarket price when the grey market price is high, whereas the positive correlation is significantly smaller when the grey market price is low. This asymmetric relation has two main implications. First, small investors are irrational in that they overweight their information. Second, given that the more sophisticated bookbuilding investors understand that small investors are irrational, bookbuilding investors choose to take advantage of small investors when they are overoptimistic, but to ignore them when they are excessively pessimistic. The fact that the correlation is positive (although smaller) even when the grey market investors are not optimistic implies that they do 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 latter have higher valuations. In the long run, we find evidence of price reversals concentrated among IPOs whose grey-market prices are high, consistent with our predictions.

The effect of overoptimism is economically significant, with 75% of sample IPOs having a grey market price that is above the midpoint of the filing range set by the underwriter at the beginning of bookbuilding. We estimate that grey-market investors' overoptimistic demand causes these IPOs to trade at first-day prices that are 40.5% higher, on average, than they would have been in the absence of sentiment demand. Over the subsequent 12 months of trading, as overoptimism gives way to realistic expectations, prices fall. Of the IPOs with a grey market price above the range midpoint, 68% underperform the market over the next year. On average, prices fall by an estimated 12.0% to 21.4%, depending on the benchmark used to adjust for market movements.

Finally, we find an asymmetric relation between the issue price and the grey market price (each normalized relative to the midpoint of the filing range). This asymmetry is less strong than the asymmetry between the immediate aftermarket price and the grey market price, which suggests that optimistic grey market investors create a surplus that is shared between the issuer and the bookbuilding investors. Thus, the issuer benefits from the existence of the grey market, beyond any fundamental information that it may reveal.

We stress that our results pertain even to countries such as the United States that do not have a grey market for IPOs. 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, overoptimism among sentiment investors will generate short-run price patterns that can be profitably exploited by sophisticated investors. The existence of grey market data simply makes it easier to observe direct measures of small investors' valuations, and thus to test for the rationality of small investors in IPOs. This feature distinguishes our paper from other papers (mentioned below) that study the grey market, since their focus is on understanding the grey market itself.

Related Literature

Our paper is related to and partially motivated by the recent literature that investigates the role of investor sentiment in asset price patterns; see, for example, 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 specific stocks.

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.[5] Ritter and Welch (2002) show that this pattern is particularly strong during "hot market" periods. Purnanandam and Swaminathan (2004), who compare IPO offer prices to "fair values" computed using various price multiples of non-IPO industry peers, find that issues that are overpriced relative to fair value have higher first-day returns but lower long-run returns. To the extent that the overpricing is caused by sentiment investors, these patterns are consistent with our model. Krigman, Shaw, and Womack (1999) and Houge et al. (2001) find that a high level of first-day "flipping" (defined as sell-signed, large-block volume as a percentage of total volume) predicts low returns in the long run.[6] In line with our paper, flipping can be interpreted as the sale of bookbuilding investors' shares to grey market investors, which is also when we find low long-run returns.

Aggarwal, Krigman, and Womack (2002) relate the aftermarket price path to momentum traders, focusing on the role of research analysts and the media in creating momentum. They find that "extra hot" IPOs tend to have low long-run returns. Rajan and Servaes (2003) model two different types of irrational agents, namely 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. Ljungqvist, Nanda, and Singh (2004) argue that an initial price run-up may be due to "exuberant" investors leading to long-run underperformance. While their model has similarities with ours, Ljungqvist, Nanda, and Singh focus on explaining underpricing, which is needed to compensate regular investors for losses when "hot" markets end prematurely.

Testing behavioral theories often requires that one investigates the role of small investors. We use the grey market price as an indication of small investors' valuations. Prior studies sought to identify small investors' (or more specifically retail investors') behavior more indirectly. Ofek and Richardson (2003), for example, show that high initial returns occur when institutions sell IPO shares to retail investors on the first day, while Derrien (2005) finds that retail investors' bookbuilding demand in France correlates positively with the issue price and initial returns, and negatively with long-run performance.

In an empirical study that is complementary to our own, Dorn (2003) shows 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 grey market investors are sentiment investors. Löffler, Panther, and Theissen (2005) also study grey market data and document that grey market prices in Germany are unbiased estimates of first-day aftermarket prices.

[5] 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.

[6] 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.

Aussenegg, Pichler, and Stomper (2003) also study the German grey market, but the focus of their paper is IPO underpricing. In particular, they ask whether pricing-relevant information is obtained only during bookbuilding, or whether it can be obtained more cheaply from the grey market (a question modeled theoretically in Pichler and Stomper (2004)). They report finding no evidence that bookbuilding investors earn a rent for providing private information to the underwriter.

While the papers above study the efficiency and functioning of the grey market, the purpose of our paper is very different. We aim to identify the presence of investor sentiment in post-IPO markets. We exploit the existence of the grey market in order to isolate the valuation of small investors and test for their rationality. Our novel results that there is an asymmetry in the ability of grey-market prices to forecast aftermarket prices and long-run price reversals (depending on whether the grey market price is high or low) confirm the presence of sentiment investors.

The paper proceeds as follows. We present the model in Section I and discuss its empirical implications in Section II. Section III describes the data. Section IV presents the empirical results. Section V concludes.

I. The Model

An issuer wishes to sell S shares in an IPO. Each share has an unknown fundamental value $v \in [0, \bar{v}]$. Before setting the issue price P_I, the underwriter conducts bookbuilding to collect information from institutional investors. Simultaneously, in a publicly observable grey market, a different group of investors trades 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 $\alpha = 0$, the information of grey-market investors is irrelevant. We assume that bookbuilding investors' information is always relevant.[7]

The timing is as follows. First, the underwriter announces a filing range within which it expects to set the issue price. Then, both bookbuilding and grey market trading begin. 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.

A. Bookbuilding and Grey Market Investors

Investors who participate in bookbuilding observe a signal about the fundamental value v. The bookbuilding investors' aggregate private information is

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

denoted by s_B. At the same time, 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.[8] Unlike the grey market, bookbuilding is a confidential process; thus, 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 s_B, but we allow for the possibility that they overweight the importance of their own signal.[9] 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: If $\hat{\alpha} - \alpha > 0$, they are irrational. Note that only the expectation of s_B appears in equation (2), since grey-market investors do not observe the bookbuilding information.

Grey market trading results in a price $P_{GM} = E_G(v \mid s_G)$. 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 sets the issue price (and before the start of aftermarket trading), the bookbuilding information s_B is revealed.[10] Grey market investors update their valuation, starting from their prior valuation P_{GM}; that is,

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

where $\hat{P}_{GM}$ differs from P_{GM} because $\hat{P}_{GM}$ incorporates the observed s_B rather than its expectation.

B. Aftermarket

After the issue price is set and all S 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

[8] In a previous version of this paper (available upon request), we explain why underwriters discourage bookbuilding investors from participating in the grey market, by showing how such participation would interfere with the efficiency of information acquisition during bookbuilding.

[9] 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.

[10] A more realistic assumption might be that grey market investors infer the information from P_I.

investors value the shares at the potentially biased value $\hat{P}_{GM}$, whereas bookbuilding investors value the shares at the expected fundamental value given by equation (1).

We assume that aftermarket participants include investors with the same valuation as the grey market investors. In other words, the grey market price is representative of the valuation of a larger set of investors (perhaps retail investors). For simplicity, we continue to refer to this set of investors as grey market investors.[11]

Let P_{AM} denote the aftermarket price in the short run. If the fundamental value exceeds the price $\hat{P}_{GM}$ that grey market investors are willing to pay, then bookbuilding investors will not sell their shares to them. Thus, there will be no trading that involves grey market investors, and the aftermarket price will not depend on their valuation. In this case, the expected aftermarket price, P_{AM}, equals the expected fundamental value. If instead $\hat{P}_{GM}$ exceeds the fundamental value, the bookbuilding investors will want to sell all S shares to the grey market investors at this higher price.[12]

However, the price at which bookbuilding investors sell their shares may depend upon the depth of the market. If there are too few investors willing to buy all S shares at $\hat{P}_{GM}$, 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 at $\hat{P}_{GM} - \lambda S$, where λS captures the discount necessary to sell all S shares in the aftermarket. If the market is deep enough to sell all the shares at $\hat{P}_{GM}$, then $\lambda = 0$.

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

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

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 is 1. In the special case in which 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 equals the fundamental value.

C. Issue Price and Partial Adjustment

The previous subsection shows that the presence of irrational small investors can create a potential trading gain by causing the aftermarket price to exceed

[11] 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.

[12] We assume a restriction that prevents short sales in the immediate aftermarket.

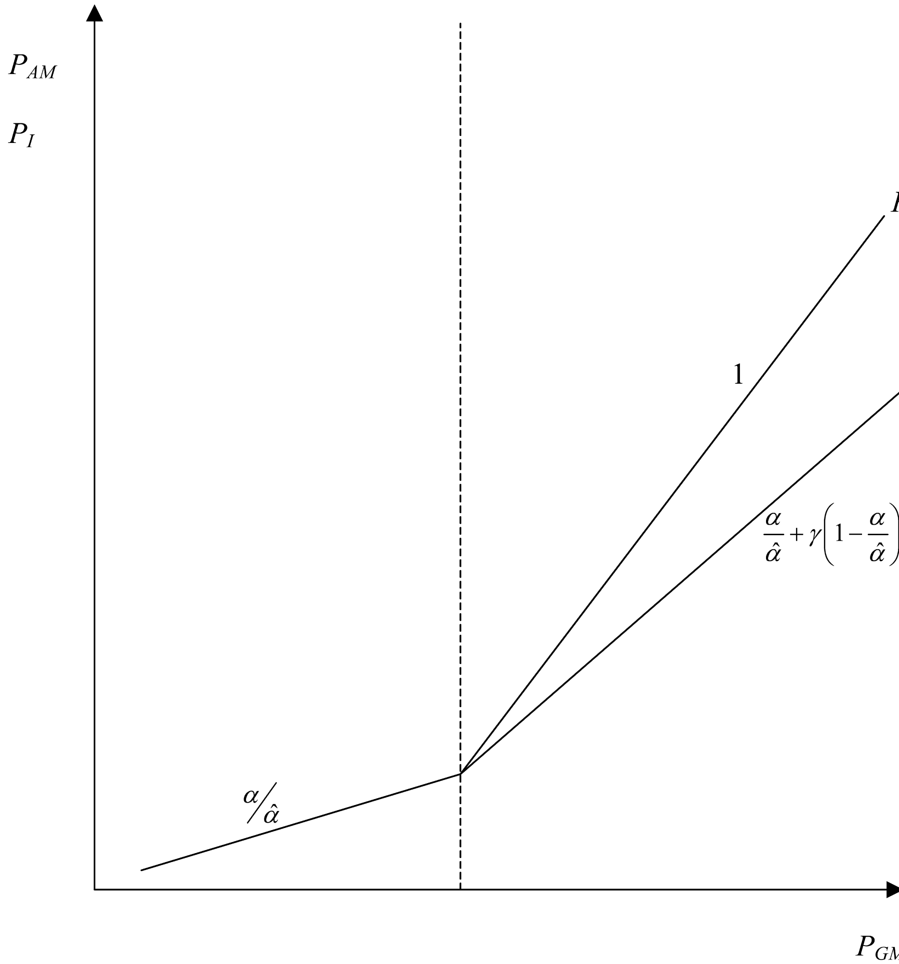

Figure 1. The relation between the grey-market price, the aftermarket price, and the issue price. This figure illustrates the theoretical relation between the grey-market price (P_{GM}), the aftermarket price (P_{AM}), and the issue price (P_I). The slope of each line segment is indicated. The relations 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.

the fundamental value. Who appropriates this surplus depends on how the issue price is set, which we model in this section.

The choice of the issue price depends on the underwriter's objective function.[13] While the underwriter is often assumed to maximize IPO proceeds, several papers argue that the underwriter may seek to set a lower issue price,

[13] A previous version of this paper (available on request) includes an explicit derivation of the optimal information extraction mechanism and the resulting underpricing. Maksimovic and Pichler (2004) present a model in which underpricing is not necessary if there are no constraints on the allocation of shares.

either because a lower issue price may allow it to place the shares more easily (Baron (1982)), or because it may want to divert some of the potential underpricing profits to its network of investors and possibly, in an indirect manner, to itself (Loughran and Ritter (2002)).

In this spirit, we model the choice of the issue price as the result of bargaining.[14] The total payoff (per share) to be split between the parties is P_{AM}. The payoff to the issuer is his proceeds, P_I, and the payoff to the underwriter and its network of investors is $P_{AM} - P_I$.[15] The underwriter's outside option has a value of zero: If the deal is cancelled, it earns no profits. On the other hand, if the issuer cancels the deal, he retains his shares and hence the value of his outside option is $E(v \mid s_G, s_B)$.[16]

Given the surplus to be shared, the value of the outside options, and potential differences in bargaining power, the generalized Nash bargaining solution is given by the payoffs to the two parties, x_1 and x_2:[17]

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

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 equation (6) is

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

The term $P_{AM} - E(v \mid s_G, s_B)$ is the surplus obtained when grey market investors are willing to pay more than the expected fundamental value, and γ is the proportion of this surplus that is captured by the issuer through a higher issue price. Note that $\gamma = 1$ corresponds to maximizing IPO proceeds, while $\gamma < 1$ corresponds to the issuer leaving part of the surplus on the table.

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 positive issue price revisions are correlated with high first-day returns. In our model, as long as the underwriter has some bargaining power, partial adjustment obtains.

Equation (7) implies that there is an asymmetric relation between P_{GM} and P_I (in addition to that between P_{GM} and P_{AM}). Since the issue price is based

[14] Loughran and Ritter (2002) and Daniel (2002) discuss IPO pricing as a bargaining process.

[15] 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)).

[16] 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 investment. Our analysis could easily accommodate this by setting a lower outside option.

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

on bookbuilding investors' reservation price, which in turn depends on their expectation of the aftermarket price, the asymmetry in the issue price is driven by the asymmetric relation between P_{GM} and P_{AM}.

These asymmetries are central to the arguments in this paper. The extent of the asymmetry between P_{GM} and P_{AM} does not depend on how the issue price is set; rather, it depends only 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. In contrast, the asymmetry between P_{GM} and P_I, depends on both the difference $\alpha - \hat{\alpha}$ and the bargaining power γ. If $\gamma = 1$, the relation between P_I and P_{GM} is exactly the same as that between P_{AM} and P_{GM}. However, for $\gamma < 1$, the asymmetry in P_I is reduced because part of the surplus (which is the root of the asymmetry) is now appropriated by the underwriter and its network of investors. Figure 1 represents both P_{AM} and P_I as functions of P_{GM} to illustrate both asymmetries.

II. Empirical Implications

The model allows us to make predictions about the relations among the grey market price P_{GM}, the aftermarket price P_{AM}, the issue price P_I, long-run returns, as well as other variables. Our main empirical predictions are as follows.

Hypothesis 1: P_{AM} is positively correlated with P_{GM}. If $\hat{\alpha} > \alpha$ (i.e., the grey market investors overweight their signal relative to its true weight in the fundamental value), the correlation is larger when P_{GM} is high. Moreover, if $\alpha > 0$, the correlation is positive even when P_{GM} is low.

Hypothesis 2: P_I is positively correlated with P_{GM}. If $\hat{\alpha} > \alpha$ and $\gamma > 0$, this correlation is larger when P_{GM} is high. If $\alpha > 0$, the correlation is positive even when P_{GM} is low.

Hypothesis 3: 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 4: Aftermarket trading volume is higher when P_{GM} is high, since in that case bookbuilding investors sell their shares to grey market investors in the aftermarket.

Finally, the model has implications for long-run returns. When grey market investors overweight their signal and are overoptimistic, P_{GM} exceeds the fundamental value, in which case we expect long-run reversal of the share price towards the fundamental value. In contrast, movement from P_{GM} to P_{AM} reflects grey market investors updating their valuation when they learn the bookbuilding information s_B. To the extent that grey market investors underweight this new information, we expect continuation in the long run. This implies the following hypothesis.

Hypothesis 5: 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, that is, if $\hat{\alpha} > \alpha$).

Apart from predicting positive first-day returns when both P_{GM} is high and the issuer has less than complete bargaining power ($\gamma < 1$), our model has no implications for IPO underpricing. Instead, our empirical tests focus on Hypotheses 1 through 5 in an attempt to determine whether post-IPO prices are driven by smaller investors and whether such investors are irrational.

III. Sample and Data

The data set consists of 486 companies that went public in 12 European countries between November 1995 and December 2002. The extent to which IPO shares are traded in grey markets varies widely from country to country. As a result, our data set is a subset of the universe of 2,723 IPOs 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*). Thus, sample companies come from a total of 20 countries.

Grey markets are usually organized not by an exchange but rather 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 widely reported.

Grey market trading typically begins on the day the company publishes its initial filing range 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.

Our grey market prices come from two large brokers, one based in Germany and the other in 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. For 262 companies we also have post-pricing grey market prices. 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.

We obtain information on the IPOs from an updated version of the data set compiled by Ljungqvist and Wilhelm (2002), based on Dealogic's Equityware, Thomson Financial's Securities Data Corporation, information from national exchanges, and a comprehensive news search. Firm and offer characteristics come from IPO prospectuses, and aftermarket trading prices and trading volumes come from Datastream. We convert monetary values—such as gross proceeds—into U.S. dollars using exchange rates on the first day of aftermarket trading.

Table I shows descriptive statistics for the full sample as well as the sample broken down 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 for which we have grey market prices varies from country to country. To allow the reader to assess how comprehensive our sample is, Table I reports the number of IPOs in each market during the entire period, as well as during the subperiods 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. London-based brokers frequently make grey markets in IPOs that take 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 returns ($P_{AM}/P_I - 1$) are high, averaging 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 filing range. On average, the last grey-market price before the issue price is finalized exceeds the midpoint of the filing range by 40.4%.

IV. 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. 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 also verified that our results are robust to outliers by winsorizing the price data at the 5% level. To conserve space, we do not report these robustness tests below.

A. The Short-Run Aftermarket Price

Hypothesis 1 predicts a strictly positive relation between the short-run aftermarket price, P_{AM}, and the grey market price, P_{GM}. Importantly, this relation is predicted to be asymmetric only if small investors are irrational. When P_{GM} is below the fundamental value, the relation will be positive only to the extent that P_{GM} contains information about the fundamental value (i.e., if $\alpha > 0$).

Note that the predicted asymmetry in the relation between P_{AM} and P_{GM} does not depend on how the underwriter chooses the issue price P_I. Instead, it relies purely on the result that grey market investors buy in the aftermarket only if they are excessively optimistic.

The ordinary least squares (OLS) regressions in Table II relate aftermarket prices to grey market prices. Regressions 1–3 focus on the overall relation

Table I

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 United States; 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. For companies that go public on more than one exchange, we take the listing country to be the home country or (if the company 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 12 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 12 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 bid-ask spread in the grey market (as a percentage of the mid-quote), just before the IPO issue price is set. The grey market premium is the percentage difference between the grey market price (based on the last transaction before the IPO, or the midpoint of the bid-ask spread when transaction prices are unavailable) and the midpoint of the filing range.

	Sample Window		No. of IPOs			Gross Proceeds ($ m)		Initial Return (%)		Quoted Spread (%)	Fraction Priced at High End of Range	Grey Market Premium Rel. to Midpoint of Filing Range, Mean (%)
	First Date	Last Date	w/Grey Market Prices	During Sample Window	Nov 1995–Dec 2002	Mean	Median	Mean	St.Dev.	Mean		
Full Sample	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

between P_{AM} and P_{GM}, without allowing for asymmetry. We normalize each price by the midpoint of the filing range, P_{mid}, in order to reduce the impact of both differences in scale and heteroskedasticity. We use the last reported grey market 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, which indicates that P_{AM} moves 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 the information available before aftermarket trading begins.

To determine whether P_{GM} simply proxies for the issue price, Regression 2 relates the aftermarket price to P_I instead. We find that P_{AM} is positively correlated with P_I, but the adjusted R^2 is much lower. 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.[18]

Regressions 1–3 also include the market index return (measured over the 3-month period before the IPO) as a control variable, as previous research shows that this variable is associated with market sentiment (see, for instance, Derrien (2005)). Although its coefficient is both economically and statistically significant in Regression 2, it loses all its significance when P_{GM} is included in Regressions 1 and 3. This suggests that while market-wide returns may capture general investor sentiment, they do not capture investor sentiment about specific IPOs very well. On the other hand, P_{GM} does a good job of capturing investors' stock-specific overoptimism or excessive pessimism (net of market-wide sentiment).

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 in which P_{GM} is higher or lower than the fundamental value. Because the fundamental value is unobservable to the econometrician, empirical studies usually take the midpoint of the filing range, P_{mid}, as a proxy for the underwriter's ex ante prior of the fundamental value.[19] Thus, if P_{GM} is above P_{mid}, it is more likely to be above the fundamental value. In Regressions 4 and 5 of Table II, 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 $P_{GM} > P_{\text{mid}}$, the coefficient of P_{GM} is 0.95 and again not significantly

[18] 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.

[19] Houston, James, and Karceski (2004) report evidence that in the United States, at the time of the technology boom, underwriters "low-balled" the filing ranges relative to what comparable valuations would imply. To ensure that our results are not driven by this bias we rerun the regressions in Tables II to V without technology and internet stocks. The results do not change. See Section IV.D.

Table II

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 filing 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 transaction price before the issue price was set (or the bid-ask midpoint when transaction prices are unavailable) 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 (based on Datastream's broad country indices) over the 3-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 filing ranges. Bid-ask spreads are missing for some IPOs, reducing the number of observations to 442. In columns (6) and (7), we restrict the sample to those priced strictly within the filing range ("Noncensored IPOs") to show that our results are not driven by the censoring of the P_I/P_{mid} variable. 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			Sample Split by		Noncensored IPOs	
				$P_{GM} > P_{\mathrm{mid}}$	$P_{GM} \le P_{\mathrm{mid}}$	$P_{GM} > P_{\mathrm{mid}}$	$P_{GM} \le P_{\mathrm{mid}}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
P_{GM}/P_{mid}	0.98***		0.95***	0.95***	0.56***	0.88***	0.45***
	(14.87)		(13.14)	(12.59)	(3.62)	(7.53)	(3.25)
P_I/P_{mid}		2.60***	0.44**	0.51*	0.53***	0.55	0.52***
		(11.50)	(2.46)	(1.66)	(3.12)	(1.12)	(3.85)
Market Index Return	0.05	2.12***	−0.01	0.03	−0.15*	−0.02	−0.15
	(0.23)	(5.10)	(−0.07)	(0.11)	(−1.78)	(−0.13)	(−1.35)
Grey Market Bid-Ask Spread	−0.62	0.41	−0.46	−0.73	−0.06	0.06	−0.21**
	(−1.52)	(0.80)	(−1.09)	(−1.11)	(−0.49)	(0.23)	(−2.34)
Log Gross Proceeds	−0.04***	−0.05***	−0.04***	−0.05***	−0.01	0.01	−0.01
	(−3.06)	(−3.00)	(−3.12)	(−3.02)	(−1.50)	(0.96)	(−1.09)
Adjusted R^2	75.4%	27.5%	75.7%	70.7%	68.4%	77.4%	79.1%
F-test: All Coeff. = 0	77.6***	52.7***	164.5***	64.4***	55.2***	38.4***	60.4***
No. of Observations	442	442	442	330	112	79	67

different from one. Thus, in this case, P_{AM} still moves approximately one-for-one with P_{GM}. However, when $P_{GM} \leq P_{\text{mid}}$, 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 pronounced kink, consistent with the illustration in Figure 1.[20]

The fact that the coefficient of P_{GM} is larger when P_{GM} is high implies that $\hat{\alpha} > \alpha$, that is, grey market investors are biased. 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.

The difference between the coefficients of P_{GM} in the two subsamples reflects how the overoptimism component of P_{GM} affects aftermarket prices. Multiplying this difference by $(P_{GM} - P_{\text{mid}})$ gives an estimate of the economic magnitude of this effect. For the sample of IPOs for which $P_{GM} > P_{\text{mid}}$, we calculate that aftermarket prices are 40.5% higher on average than they would have been without overoptimism (i.e., if P_{GM} equaled P_{mid}). Since this estimate of the effect of overoptimism is based on a regression that controls for market-wide movements, it should be interpreted as stock-specific (i.e., capturing investors' overoptimism about a specific IPO, relative to the IPO's value if it were valued in line with market comparables).[21]

Note that the relation between P_{GM} and P_{AM} in Regressions 4 and 5 is asymmetric even though these specifications include the (normalized) issue price, P_I, as a control variable. This suggests that our results are driven by the irrationality of grey market investors rather than the choice of P_I or Hanley's (1993) partial adjustment phenomenon. In Section IV.C, we provide additional evidence suggesting that our results are distinct from partial adjustment.

Finally, Hypothesis 3 predicts that when P_{GM} is high, the price at which the bookbuilding investors can sell their shares may be reduced if there is insufficient depth in the aftermarket and the issue is large. Thus, when P_{GM} is high, this implies a positive relation between P_{AM} and the depth of the grey market $(-\lambda)$ and a negative relation between P_{AM} and the issue size S. To capture these effects, the regressions in Table II include the bid-ask spread quoted by grey market brokers shortly before IPO pricing and the log of issue proceeds. 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.

[20] Transforming the variables with logarithms does not materially affect our results.

[21] If, as Houston, James, and Karceski (2004) argue, underwriters low-ball the filing range relative to market comparables, or if our control variable does not fully capture market-wide sentiment, our estimate of 40.5% may also be due in part to market-wide overoptimism.

[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.

It is well documented that issue prices in Europe are rarely set outside the filing range: Frequently they are set at the endpoints, especially at the top of the range (see Ljungqvist, Jenkinson, and Wilhelm (2003)). Since the price adjustment is much less informative when it is censored, Regressions 6 and 7 repeat Regressions 4 and 5 in the subsample of noncensored observations (i.e., require P_I to be set strictly within the filing range). Despite the substantial decrease in the number of observations, our results are qualitatively unchanged.

B. The Issue Price

Hypothesis 2 predicts an asymmetric relation between P_I and P_{GM}. In Table III, we report the results of the regressions testing this prediction. Since

Table III

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 filing range P_{mid}. The explanatory variable of interest is P_{GM}, the last grey market transaction price before the issue price was set (or the bid-ask midpoint when transaction prices are unavailable), which is also normalized by the midpoint of the initial filing range. To capture the predicted asymmetry, we define an indicator function that is 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 filing ranges. This reduces the number of observations in model (1) to 477. Model (2) excludes the grey market variables, linking issue prices to the domestic market index return (based on Datastream's broad country indices) over the 3-month period before the IPO only. Market momentum is a popular measure of market-wide investor sentiment. Model (3) includes two additional variables: The last bid-ask spread in the grey market (divided by its midpoint), which is available for 442 IPOs, and the logarithm of expected IPO proceeds (evaluated at P_{mid}). These variables are intended to control for the depth of the market, with insufficient depth predicted to result in more conservative issue prices. Throughout, we use censored regressions because European IPOs are rarely priced outside the initial filing range. t-statistics are reported in parentheses. Three and two asterisks indicate significance at the 1% and 5% level, respectively. Intercepts are not shown.

	Dependent Variable: Normalized Issue Price (P_I/P_{mid})		
	(1)	(2)	(3)
P_{GM}/P_{mid}	0.29***		0.31***
	(6.01)		(5.66)
$P_{GM}/P_{\text{mid}} \times$ Indicator ($P_{GM} > P_{\text{mid}}$)	0.15***		0.14***
	(7.29)		(6.42)
Market Index Return	0.20**	1.16***	0.24***
	(2.39)	(7.69)	(2.66)
Grey Market Bid-Ask Spread			−0.39***
			(−3.51)
Log Expected Gross Proceeds			−0.01***
			(−2.59)
LR test: All Coeff. = 0 (χ^2)	488.9***	70.2***	457.7***
No. of Observations	477	477	442
No. of Left-Censored Observations	51	51	50
No. of Right-Censored Observations	263	263	246

European underwriters rarely set the issue price outside the filing range, 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, that is, the issue price is set, respectively, at the maximum and the minimum of the filing range.

Regression 1 examines the relation between P_I and P_{GM} (both normalized relative to the midpoint of the filing range). To test for asymmetry, we interact P_{GM} with an indicator function that equals one if $P_{GM} > P_{\mathrm{mid}}$, and zero otherwise.[23] Overall, the fit of the model is very good in view of the highly significant likelihood ratio test. We find a positive and highly significant relation between P_I and P_{GM}, and an even stronger relation when $P_{GM} > P_{\mathrm{mid}}$. This result is consistent with Hypothesis 2. The fact that the relation is positive even when P_{GM} is low again suggests that $\alpha > 0$: P_{GM} contains information about the fundamental value. The higher correlation when P_{GM} is high suggests that the issuer appropriates part of the surplus through a higher issue price ($\gamma > 0$). This implies that the underwriter and the issuer know when P_{GM} is biased, and they include this bias when negotiating the issue price. Finally, note that when P_{GM} is high the total effect of P_{GM} on P_I (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, suggesting that part of the surplus from a high P_{AM} is appropriated by the underwriter and its network of investors (i.e., $\gamma < 1$).

Since both P_I and P_{GM} are normalized relative to P_{mid}, another way to read these results is that there is an asymmetry between the issue price revision and the "grey market revision." In other words, the grey market revision conveys information that is included in the offer price revision in an asymmetric fashion.

In Regression 1 we control for pre-IPO market index returns, which prior studies associate with market sentiment. For comparison, in Regression 2 we consider just the market index returns, that is, we exclude the terms involving P_{GM}. When we exclude P_{GM}, while we find a stronger relation between P_I and the market index, the explanatory power decreases substantially. As in Table II, this indicates that P_{GM} largely subsumes the market-momentum proxy, so market returns are at best a noisy proxy for investor sentiment at the level of specific securities.

Hypothesis 3 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. To capture this idea, Regression 3 of Table III adds the (logarithm of) expected issue proceeds and the grey market bid-ask spread.

[23] The large proportion of right-censored observations is the reason we introduce the indicator function to capture the asymmetry rather than split 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 in which $P_{GM} > P_{\mathrm{mid}}$, we would have little explanatory power since most observations would be censored.

Consistent with Hypothesis 3, we find negative and statistically significant relations between P_I and both the bid-ask spread and expected proceeds.

C. Robustness: Partial Adjustment Phenomenon

Table II shows an asymmetric relation between P_{AM} and P_{GM}. The regressions control for the partial adjustment phenomenon by including the issue price P_I among the explanatory variables. However, Bradley and Jordan (2002) and Lowry and Schwert (2004) argue that partial adjustment may be asymmetric: First-day returns are high following positive price revisions but are unrelated to negative price revisions. This raises the possibility that the evidence of asymmetry in P_{GM} in Table II is simply attributable to asymmetry in partial adjustment. However, when we split P_I/P_{mid} into two variables to separate positive and negative price revisions, the asymmetry in P_{GM} remains. The regression results for the high and low P_{GM} samples are

$$\begin{aligned} P_{GM} > P_{\mathrm{mid}}: \quad P_{AM}/P_{\mathrm{mid}} &= \underset{(12.45)}{0.95}\, P_{GM}/P_{\mathrm{mid}} + \underset{(0.48)}{0.22} P_I^+/P_{\mathrm{mid}} \\ &\quad + \underset{(1.20)}{0.92} P_I^-/P_{\mathrm{mid}} + \mathit{controls} \\ P_{GM} \le P_{\mathrm{mid}}: \quad P_{AM}/P_{\mathrm{mid}} &= \underset{(4.28)}{0.63} P_{GM}/P_{\mathrm{mid}} + \underset{(3.33)}{2.45} P_I^+/P_{\mathrm{mid}} \\ &\quad + \underset{(2.56)}{0.36} P_I^-/P_{\mathrm{mid}} + \mathit{controls}, \end{aligned}$$

where $P_I^+ = \mathrm{Max}\{P_I, P_{\mathrm{mid}}\}$ and $P_I^- = \mathrm{Min}\{P_I, P_{\mathrm{mid}}\}$, the controls are the same as in Table II, and heteroskedasticity-consistent t-statistics are shown in parentheses underneath the OLS coefficient estimates. Restricting the sample to noncensored observations as in Regressions 6 and 7 of Table II leaves our results similarly unaffected. Thus, the asymmetry in P_{GM} and partial adjustment are economically distinct phenomena.

D. Robustness: Industry Clustering and IPO Withdrawals

Since much of our data comes from the late 1990s, a period during which many technology companies went public, our results could be driven by the clustering of IPOs with similar characteristics. We test for robustness to industry clustering by excluding technology firms, using the algorithm described in Loughran and Ritter (2004), based on four-digit SIC codes. This procedure classifies 199 of our 477 sample companies as technology firms. However, since SIC codes do a poor job of identifying internet-related firms, we also identify internet companies manually on the basis of the business descriptions in the IPO prospectus. This leads us to drop a further 32 companies from the estimation sample. The empirical results reported throughout the paper are robust to excluding technology and internet firms. (We report the results for long-run returns in Table V. The results for the other tables are available on request.)

Thus far 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 the withdrawal of an IPO, the remaining observations with a low P_{GM} would tend to have positive bookbuilding information. This could potentially bias our results in the direction of the observed asymmetry in the relation between P_{GM} and P_I, and in that 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)).

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. Thus, the vast majority of IPOs are withdrawn at a very preliminary stage, and not in response to negative sentiment in the grey market.

E. 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 determine whether 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

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

where heteroskedasticity-consistent t-statistics are shown in parentheses underneath the OLS coefficient estimates. The adjusted R^2 is 96.9%. 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:

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

The adjusted R^2 in this specification is 14.4%. The coefficient estimated for $(P_I - P_{GM})/P_{\text{mid}}$ suggests that for every dollar difference between P_I and P_{GM}, grey market investors increase their valuation 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.

F. Aftermarket Trading Volume

Table IV examines the relation between P_{GM} and aftermarket trading volume (as a fraction of the shares sold in the IPO). According to Hypothesis 4, when P_{GM} is high, we expect high turnover because bookbuilding investors sell their shares to the grey market investors. When P_{GM} is low, bookbuilding investors have no reason to sell their shares in our model and trading volume will be lower.

We measure aftermarket trading volume both on the first day and over the first week following the IPO and use an indicator function that equals one when $P_{GM} > P_{\text{mid}}$, 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), consistent with Hypothesis 4.

However, a high P_{GM} might simply indicate that either the IPO or the equity market is "hot," and thus that high volume exists for reasons outside our model. In Regressions 2 and 5 we include the market index return (measured over the 3-month period before the IPO) to capture a hot market effect. In Regressions 3

Table IV

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 transaction price before the issue price was set (or the bid-ask midpoint when transaction prices are unavailable) exceeds the midpoint of the initial filing range. The controls in models (2)–(3) and (5)–(6) are the domestic market index return over the 3-month period before the IPO and the normalized first-day aftermarket 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 ($P_{GM} > P_{\text{mid}}$)	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

and 6 we also include the (normalized) first-day closing market price P_{AM} to capture whether the IPO is hot. After including these variables, the coefficient on the indicator function remains positive and significant.

G. Long-Run Returns

We now consider how P_{GM} and bookbuilding information are related to long-run aftermarket returns. A rough cut of the data suggests there is price reversal in the long run. Of the IPOs for which $P_{GM} > P_{\text{mid}}$, 68% underperform the market over the first year of trading.[24] When we sort the data into quartiles based on P_{GM} (relative to P_{mid}), we find that the quartile with the highest grey market prices subsequently loses 18.4% relative to the market index over the year. In contrast, the bottom quartile shows a positive return of 9.9%. More formally, we test Hypothesis 5 using the following regression:

$$\begin{aligned} &\frac{P_{LongRun} - P_{AM}}{P_{\text{mid}}} - \text{benchmark return} \\ &\quad = \alpha + \beta_1 \frac{P_{GM} - P_{\text{mid}}}{P_{\text{mid}}} + \beta_2 \frac{P_{AM} - P_{GM}}{P_{\text{mid}}} + \mathit{controls} + \epsilon. \end{aligned} \tag{8}$$

The dependent variable is the buy-and-hold return measured from the end of the first aftermarket trading day until 2, 3, 6, or 12 months later (less the normalized return on a benchmark portfolio, defined shortly).[25] As before, we normalize all variables by P_{mid}.[26]

The independent variables are the difference between the grey market price and the range midpoint ($P_{GM} - P_{\text{mid}}$) and the difference between the first-day aftermarket price and the grey market price ($P_{AM} - P_{GM}$). Together, these two variables add up to the entire price movement from P_{mid} to the price at the end of the first day of trading.

By splitting the price movement in this way, we can relate long-run returns separately to the two signals, s_G and s_B. The difference $P_{GM} - P_{\text{mid}}$ reflects the information revealed through grey market trading, while $P_{AM} - P_{GM}$ captures the price movement in response to the revelation of bookbuilding information. According to Hypothesis 5, long-run returns relate differently to the grey market signal and the bookbuilding signal. When P_{GM} exceeds the fundamental value, Hypothesis 5 predicts price reversal towards the fundamental value,

[24] Such underperformance is present both among internet/technology companies and among other companies. It is also present both during the 1999–2000 market boom and subsequent bust, though it is somewhat more frequent following the bust. For instance, of technology and internet IPOs completed before September 1999 for which $P_{GM} > P_{\text{mid}}$, 62.5% underperformed the market over the next year. Of those floated after September 1999, 85.6% underperformed the market.

[25] 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.

[26] 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.

that is, a negative relation between long-run returns and $P_{GM} - P_{\mathrm{mid}}$. Book-building information, in contrast, is assumed to be about fundamental value. If so, the difference between P_{AM} and P_{GM} should not be reversed in the long run. In fact, if grey market investors 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, and we expect a positive correlation between long-run returns and $P_{AM} - P_{GM}$. 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.[27]

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)). Therefore, we include controls for bank reputation (using market shares as in Megginson and Weiss (1991)) and venture-backed companies.

We estimate equation (8) with two alternative benchmark portfolios. The first is the market index in the relevant listing country.[28] The second is a style portfolio matched by firm size and book-to-market ratio. 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 independently 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).

The results are reported in Tables V and VI. The least squares regressions shown in Table V use the market index to compute abnormal returns and those in Table VI use the style indices. We present the results of regression (8) for the whole sample (partitioned on the basis of whether P_{GM} is above or below P_{mid}) and for a subset of firms that excludes all technology and internet firms (see Section IV.D).

When we partition the whole sample in Table V, we find a statistically significant negative relation between $P_{GM} - P_{\mathrm{mid}}$ and long-run returns for all horizons when $P_{GM} > P_{\mathrm{mid}}$, but not when $P_{GM} < P_{\mathrm{mid}}$. This is as predicted by Hypothesis 5. Since β_1 corresponds to $\frac{\alpha}{\hat{\alpha}} - 1$ when P_{GM} is high, this suggests that $\hat{\alpha} > \alpha$: Grey market investors overweight their signal, which is then 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. Consistent with our earlier results, this can be interpreted as evidence that P_{GM} contains some fundamental information. When $P_{GM} < P_{\mathrm{mid}}$, we do not find any reversal, consistent with Hypothesis 5.

[27] In terms of the model, the regression coefficient β_1 in (8) corresponds to $\frac{\alpha}{\hat{\alpha}} - 1 \leq 0$, and β_2 corresponds to $\frac{\hat{\alpha}-\alpha}{1-\hat{\alpha}} \geq 0$.

[28] We use Datastream country indices as our benchmark. Replacing the German index with the Neuer Markt index of mostly high-tech companies gives similar results.

Table V

Market-Adjusted Long-Run Returns

We estimate ordinary least squares (OLS) 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 $(R_{LR} - R_{\mathrm{mkt}})(P_{AM}/P_{\mathrm{mid}})$, where R_{LR} is the buy-and-hold return over the first 2, 3, 6, or 12 months of aftermarket trade, R_{mkt} is the contemporaneous return on the domestic market index (based on Datastream's broad country indices), and the multiplier $(P_{AM}/P_{\mathrm{mid}})$ 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. In columns (1) through (8), we split the sample according to whether P_{GM} was high. In columns (9) through (12), we estimate OLS regressions that are specified as in columns (1) through (4), except that we exclude all technology and internet firms. To classify firms into tech and non-tech, we use the algorithm described in Appendix 4 of Loughran and Ritter (2004), based on four-digit SIC codes. Internet companies are identified manually by inspecting IPO prospectuses. The lead underwriter's market share is included to control for the bank's reputation, and 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. Heteroskedasticity-consistent 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.

	Whole Sample								Excluding Tech and Internet Firms			
	$P_{GM} > P_{\mathrm{mid}}$				$P_{GM} \le P_{\mathrm{mid}}$				$P_{GM} > P_{\mathrm{mid}}$			
Horizon:	42 Days (1)	63 Days (2)	126 Days (3)	252 Days (4)	42 Days (5)	63 Days (6)	126 Days (7)	252 Days (8)	42 Days (9)	63 Days (10)	126 Days (11)	252 Days (12)
$(P_{GM} - P_{\mathrm{mid}})/P_{\mathrm{mid}}$	−0.25***	−0.23***	−0.43***	−0.72***	0.39	0.88	2.29	1.15*	−0.22**	−0.31**	−0.42**	−0.70***
	(−6.10)	(−2.89)	(−3.54)	(−5.33)	(1.12)	(1.22)	(1.57)	(1.87)	(−2.48)	(−2.35)	(−2.69)	(−2.92)
$(P_{AM} - P_{GM})/P_{\mathrm{mid}}$	0.10	0.65	0.78	0.20	1.16	2.10	5.00	−0.21	−0.18	−0.13	−0.18	−0.09
	(0.86)	(1.51)	(1.49)	(0.76)	(1.13)	(1.25)	(1.48)	(−0.42)	(−1.22)	(−0.71)	(−0.67)	(−0.35)
Lead Underwriter's	0.88*	1.46**	3.46**	5.72*	0.52	0.54	1.03	0.28	0.73	1.24**	2.03**	7.61
Market Share	(1.89)	(2.26)	(2.30)	(1.71)	(1.18)	(0.90)	(0.89)	(0.22)	(1.60)	(2.30)	(2.37)	(1.27)
Venture Dummy	0.02	−0.08	−0.06	0.02	0.13	0.25	0.55	0.15	−0.01	0.04	0.09	0.49
	(0.35)	(−1.23)	(−0.55)	(0.15)	(1.34)	(1.37)	(1.50)	(1.63)	(−0.06)	(0.27)	(0.40)	(1.66)
Adjusted R^2	3.1%	6.9%	9.1%	8.4%	6.6%	9.2%	15.3%	0.2%	1.0%	1.4%	2.9%	5.0%
F-test: All Coeff. = 0	14.0***	7.5***	9.3***	14.8***	0.9	1.3	0.9	3.6**	2.9*	3.3**	3.2**	2.8**
No. of Observations	358	358	358	358	119	119	119	119	171	171	171	171

Table VI

Benchmark-Adjusted Long-Run Returns

We estimate least squares (OLS) 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 $(R_{LR} - R_B)\,(P_{AM}/P_{\text{mid}})$, where R_{LR} is the buy-and-hold return over the first 2, 3, 6, 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 5×5 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, and 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. Heteroskedasticity-consistent 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.

	$P_{GM} > P_{\text{mid}}$				$P_{GM} \le P_{\text{mid}}$			
Horizon:	42 Days (1)	63 Days (2)	126 Days (3)	252 Days (4)	42 Days (5)	63 Days (6)	126 Days (7)	252 Days (8)
$(P_{GM} - P_{\text{mid}})/P_{\text{mid}}$	−0.20***	−0.15**	−0.27**	−0.41***	0.40	1.05	2.25	1.04
	(−4.49)	(−2.21)	(−2.70)	(−3.75)	(1.18)	(1.40)	(1.64)	(1.74)
$(P_{AM} - P_{GM})/P_{\text{mid}}$	0.10	0.58*	0.73*	0.26	1.33	2.31	5.16	0.19
	(0.88)	(1.70)	(2.02)	(1.64)	(1.30)	(1.35)	(1.59)	(0.48)
Lead Underwriter's	0.67	1.30*	3.09**	5.20	0.37	0.36	0.86	−0.21
Market Share	(1.51)	(1.94)	(2.08)	(1.54)	(0.84)	(0.60)	(0.75)	(−0.20)
Venture Dummy	0.02	−0.06	−0.05	0.05	0.14*	0.27	0.58	0.15*
	(0.34)	(−0.80)	(−0.35)	(0.27)	(1.79)	(1.69)	(1.56)	(1.88)
Adjusted R^2	1.6%	5.2%	7.1%	4.4%	9.1%	12.1%	17.0%	0.3%
F-test: All Coeff. = 0	5.9***	4.6***	5.7***	10.1***	1.5	1.0	0.8	2.8*
No. of Observations	358	358	358	358	119	119	119	119

The second variable, $P_{AM} - P_{GM}$, has a positive coefficient, which is 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 V.

As for the control variables, our results mirror those of Carter, Dark, and Singh (1998) for the United States. Long-run returns are significantly higher for companies that are taken public by underwriters with larger market shares. However, over the horizons we consider, we do not find that venture-backed companies perform better than companies not backed by venture capitalists.

The asymmetric relation between $P_{GM} - P_{\text{mid}}$ and long-run returns is still present, for all horizons, when we exclude technology and internet firms. The estimated coefficients are very similar, suggesting that the long-run price reversal is not driven by the presence of technology and internet firms.

The results in Table VI, wherein style-adjusted abnormal returns is the dependent variable, largely mirror those reported in Table V. We find significant reversal when P_{GM} is high, over all horizons considered. Unlike in Table V, we also find some evidence of continuation, in the sense that $P_{AM} - P_{GM}$ is positively and significantly related to long-run returns when $P_{GM} > P_{\text{mid}}$.[29]

Given the relatively short sample period, IPOs in our sample are clustered in calendar time and thus may not be statistically independent. To account for this, the reported t-statistics in both Tables V and VI allow for dependence among firms going public in the same quarter. Results are robust to clustering on issue month and on Fama and French (1997) industry, and also to bootstrapping.

Finally, we investigate whether these patterns are driven by the market-wide boom of 1999–2000 (results not shown) by allowing the effect of $P_{GM} - P_{\text{mid}}$ and $P_{AM} - P_{GM}$ to differ before and after the peak in March 2000. We find no evidence that our findings are driven by the evolution of the market-wide boom and bust: There is significant reversal both before and after the market peak.

How economically significant are these results? For the subset of IPOs for which $P_{GM} > P_{\text{mid}}$, the negative coefficient on $(P_{GM} - P_{\text{mid}})/P_{\text{mid}}$ in Table V corresponds to an average normalized 1-year return that is 41.6% lower than it would have been if grey market investors had not been optimistic about the company's prospects (i.e., if $P_{GM} = P_{\text{mid}}$), or 23.3% lower when considering the style-adjusted returns in Table VI. When we normalize the returns relative to P_{AM} rather than P_{mid}, average 1-year returns are 21.4% and 12.0% lower, depending on the benchmark.

V. Conclusion

We take advantage of the existence of the grey market for shares of companies about to go public to test whether sentiment among small investors

[29] As an alternative to Table VI we estimate Fama–French three-factor models, using country-specific SMB and HML factors from the international data section of Ken French's website. Our results (available upon request) are robust also to this alternative approach.

can explain well-known anomalies in post-IPO prices. When small investors are overoptimistic, they are willing to pay a price that exceeds fundamental value, so we should observe a high aftermarket price. When they are excessively pessimistic, 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 grey market and aftermarket prices. 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 underwriter. Finally, when the grey market price is above the fundamental value, we expect a price reversal in the long run.

Using grey market price data for a large set of European IPOs, we find evidence of the above asymmetric relations in the short-run aftermarket prices, the offer prices, and the long-run returns. The economic significance is substantial. Among IPOs traded at high grey market prices, we estimate that stock-specific overoptimism causes aftermarket prices to be 40.5% higher, on average, than they would have been in the absence of overoptimistic investors. These temporary price increases are partially reversed over the first year.

The combination of the asymmetric effect of the grey market price and the long-run reversal provides evidence of the existence of both sentiment investors, and sophisticated investors who take advantage of the sentiment investors. It appears that underwriters and bookbuilding investors take anticipated demand from overoptimistic investors into account, though only when they can profit from such demand by selling overpriced shares to sentiment investors in the aftermarket.

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