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Risk, Reputation, and IPO Price Support

KATHARINA LEWELLEN*

ABSTRACT

Immediately following an initial public offering, underwriters often repurchase shares of poorly performing offerings in an apparent attempt to stabilize the price. Using proprietary Nasdaq data, I study the price effects and determinants of price support. Some of the key findings are (1) Stabilization is substantial, inducing price rigidity at and below the offer price; (2) I find no evidence that stocks with larger information asymmetries are stabilized more strongly; (3) Larger underwriters stabilize more, perhaps to protect their reputations with investors; and (4) Investment banks with retail brokerage operations stabilize much more than other banks, inconsistent with the view that stabilization benefits primarily institutional investors.

THE INITIAL PUBLIC OFFERING (IPO) is a critical step for young entrepreneurial firms, providing them access to the public equity market for the first time. Because of this important role, a large literature studies the functioning of the IPO market. Researchers have noted, in particular, two important features of the pricing process: underwriters systematically underprice IPOs and, immediately following the offering, underwriters often repurchase shares of poorly performing IPOs in an apparent attempt to stabilize the price. The second phenomenon—price support—has received comparatively little attention even though price support is important to investors and may have an indirect effect on underpricing.

This paper extends the empirical literature on price support along two dimensions. First, I investigate the price and volume effects of stabilization for a large sample of IPOs using proprietary transaction data obtained from Nasdaq. Second, the data provide a unique opportunity to study the cross-sectional determinants of price support. The goal is to better understand what factors influence an underwriter's decision to stabilize an IPO. The analysis also sheds light on theories of price support that to date have not been empirically examined.

The literature offers several explanations for price support. A common perspective is that price support, like underpricing, helps mitigate adverse

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selection problems in the IPO market. Benveniste, Busaba, and Wilhelm (1996) ("BBW" hereafter) argue that stabilization is effectively a put option given to institutional investors as a reward for revealing private information during the pre-offering period. Chowdhry and Nanda (1996) ("CN" hereafter) suggest, instead, that the put option compensates uninformed investors for the "winner's curse," in the spirit of Rock (1986). Alternatively, Hanley, Kumar, and Seguin (1993) suggest that price support allows underwriters to disguise overpriced offerings from investors by temporarily inflating the stock price. Schultz and Zaman (1994) argue that stabilization increases the stock price permanently by reducing the supply of shares, and thereby helps to distribute overpriced shares to initial investors.

One difficulty in testing these ideas is that underwriters do not formally commit to price support, nor do they publicly disclose stabilizing activities. Hence, little information on price support is available from public sources. This paper uses proprietary transaction data for a large sample of Nasdaq IPOs. The data identifies, for every trade, the type of each trading party (e.g., whether it is a marketmaker or a broker trading on behalf of a customer) and indicates which party is buying and which is selling. This allows me to track investor selling activity for 20 days after the offering. Using this information, I construct measures of price support based on the underwriter's inventory accumulation, the "stickiness" of the bid (i.e., the extent to which the bid reacts to selling pressure), and the closeness of the bid to the offer price.

I start by documenting how price support affects prices and trading volume in the aftermarket. Similar to Ellis, Michaely, and O'Hara (2000) and Aggarwal (2000), I find that underwriters accumulate large inventories of cold IPOs on the first day of trading, consistent with price support. Stock prices are extremely rigid at and below the offer price, in the sense that it requires large selling pressure to induce a price decline. For example, if a stock opens the first day at the offer price, marketmakers repurchase, on average, 6.0% of shares offered before they allow the bid to drop. The corresponding number is 2.1% for IPOs that open below the offer price, and only 0.4% for stocks that open above the offer price. The unusual bid rigidity at and below the offer price suggests that underwriters are willing to repurchase cold IPOs at inflated prices.

Interestingly, there is little evidence that stock prices decline after stabilization is withdrawn. Thus, stabilization appears, at least in the short run, to raise the equilibrium stock price. Further, there are a disproportionate number of stocks for which the bid price remains exactly at the offer price for several days after the IPO, in spite of strong selling pressure on day 1. These patterns are consistent with a downward-sloping demand curve for IPOs. Alternatively, it is possible that underwriters have private information about the stabilized stocks and repurchase only IPOs that they believe are either undervalued or fairly valued.

In the second part of the paper, I investigate how price support varies across stocks. I begin by examining several predictions suggested by CN and BBW. As mentioned earlier, both papers argue that stabilization helps mitigate information asymmetries in the IPO market and, in that sense, is a substitute

to underpricing. A natural empirical implication is that, other things equal, stocks with more information asymmetries should exhibit more underpricing or stronger price support. I do not find support for this hypothesis. Instead, price support appears strongest for IPOs that are less risky, that is, that are larger and have lower gross spreads, and for IPOs underwritten by larger, more reputable underwriters. A story that is consistent with these findings is that while underwriters avoid stabilizing risky IPOs, large underwriters absorb inventory risk better and, hence, stabilize more strongly. However, Aggarwal (2000) finds that underwriters usually oversell the issue and begin the first day of trading with a short position.[1] Therefore, it is not clear how important risk considerations are in practice because underwriters can implicitly hedge inventory risk. Alternatively, large underwriters may be more willing to support overpriced IPOs to protect their reputation with investors. Similarly, only reputable underwriters are able to credibly commit to price support at the time of the offering. Consistent with the reputation hypothesis, I find that underwriters stabilize less extensively on days when the stock market is doing poorly, that is, when the weak IPO performance can be attributed to market-wide events outside the underwriter's control.

Although IPO risk and underwriter size are important in explaining price support, a closer look at the data suggests that they are not the full story. Replacing the underwriter-size measure by underwriter fixed effects substantially increases the adjusted R^2 in the price support regression. The underwriter fixed effects are economically very significant. For example, ranking top-20 investment banks by price support, "Bank 3" accumulates, on average, 25% of shares offered on day 1 for IPOs that close at or below the offer price, but "Bank 18" accumulates only 2.6% of shares offered. This difference is significant at the 1% level, even after controlling for IPO characteristics. Thus, it appears that underwriter heterogeneity, unrelated to size and reputation, is a major determinant of price support. This result is difficult to reconcile with the existing stabilization models, and it raises the question of what investment bank characteristics are responsible for the large differences in price support.

To explore this question, I examine several key characteristics of large investment banks. The type of an investment bank's client base emerges as one of the most important determinants of price support. Aggarwal (2003) shows that banks with significant retail brokerage operations distribute a higher fraction of IPO shares to retail investors. I find strong evidence that these "retail" banks are more committed to stabilization than other top-20 investment banks. After controlling for underwriter size and IPO characteristics, retail banks repurchase 11.5% of shares offered more on day 1 (for cold IPOs) than other top-20 investment banks. This result is surprising. Evidence in prior studies suggests

[1] Underwriters have an option to purchase an additional 15% of shares offered from the issuer after the IPO (overallotment option). If the IPO trades above the offer price in the aftermarket, underwriters typically exercise the overallotment option to cover the initial short position. If the IPO trades below the offer price, underwriters tend to cover the short position by repurchasing shares in the aftermarket. Frequently, underwriters take naked short positions, in excess of 15% of shares offered, which are covered by repurchasing shares in the aftermarket.

that price support benefits mostly large institutional traders: Empirically, institutions are more likely to take advantage of stabilization by flipping cold IPOs (Benveniste, Erdal, and Wilhelm (1998), Aggarwal (2003)). At face value, this seems inconsistent with stronger price support by retail banks.

I suggest three explanations for these results. First, retail banks might value price support because it allows them to discriminate among investors: A promise to repurchase weak IPOs can be targeted to specific investors. Second, Hanley et al. (1993) suggest that underwriters support prices to disguise weak offerings from initial investors. If such tactics indeed take place, they are probably targeted at unsophisticated investors, and therefore may be favored by retail banks. Third, it is possible that retail banks suffer larger reputational damage from ex post overpriced IPOs (Section IV.D discusses this idea in detail). This hypothesis is consistent with retail banks using price support more extensively to protect their reputations with investors. To examine these hypotheses, I study the behavior of retail and institutional investors in the aftermarket using transaction size as a proxy for investor type. I find little evidence that retail banks temporarily inflate prices to confuse unsophisticated investors, and the overall evidence is more consistent with reputation and discriminatory motives for price support.

This paper extends the empirical literature on price support. Most studies focus on the price effects of stabilization, using indirect measures. Ruud (1993) shows that the distribution of initial returns is nearly censored at 0, which suggests that underwriters stabilize IPOs at the offer price. Schultz and Zaman (1994) find that underwriters are significantly more active on the inside bid for overpriced issues than for underpriced issues, consistent with underwriters making stabilizing bids for cold IPOs. Hanley et al. (1993) and Hanley, Lee, and Seguin (1996) show that stocks that close near the offer price on day 1 subsequently decline and their bid-ask spreads subsequently widen, consistent with prices adjusting to equilibrium after withdrawal of price support. (My tests provide contradictory evidence.) More recently, Aggarwal (2000) describes how price support is performed on Nasdaq. She shows, for example, that underwriters almost never disclose stabilizing bids to market participants, and that they start the first day of trading with large short positions in the IPO stock. Ellis et al. (2000) estimate underwriters' profits from aftermarket trading and explore underwriters' aftermarket activities. Prabhala and Puri (1999) examine cross-sectional variation in price support. They test a different set of predictions and, because they only have publicly available data, use a less precise measure of stabilization than the current paper.

This paper is organized as follows. Section I discusses models of price support. Section II describes the data and the sample selection process. Section III presents the intraday analysis. The cross-sectional tests are discussed in Section IV. Section V concludes.

I. Motives for Price Support

The literature offers several explanations for price support, which I briefly summarize in this section. Section I.C suggests an alternative

perspective on price support that emphasizes the role of the underwriter's reputation.

A. Price Support as a Reward to Investors and a Bonding Mechanism

CN build on Rock's (1986) model of underpricing, arguing that stabilization provides an alternative way to compensate uninformed investors for the winner's curse. A commitment to repurchase shares at the offer price is equivalent to giving investors a put option, which is valuable after the offering if the market price is lower than the offer price. Since uninformed investors are more likely to end up with overpriced IPOs, they value the put option (before the offering) more than informed investors. Thus, CN argue that stabilization may be more efficient than underpricing in compensating uninformed investors for adverse selection costs.

BBW model the pre-offering stage of the issuing process, during which investors submit indications of interest to the underwriter. The underwriter uses this information to determine IPO allocations and the offer price. Informed investors have no incentive to disclose high interest, since this causes the underwriter to raise the offer price. Therefore, the underwriter rewards investors who convey good information with higher allocations of underpriced stocks (see also Benveniste and Spindt (1989)). This mechanism allows underwriters to obtain private information available in the market, but it also creates a new problem: The underwriter has an incentive to overstate investor interest at the IPO. The role of price stabilization in this framework is to establish the underwriter's credibility with investors. The commitment to repurchase shares at the offer price bonds against deliberate overpricing. Further, stabilization is an alternative to underpricing as a way to reward informed investors for submitting truthful information in the pre-offering stage.

Similar to CN and BBW, Prabhala and Puri (1999) consider stabilization as an explicit commitment by the underwriter to repurchase IPO shares in the aftermarket at the offer price. Stabilization makes the IPO process more efficient because it encourages the underwriter to produce more information about the IPO before the offering (lower uncertainty about the IPO value makes the put option less valuable). The additional information reduces adverse selection problems at the offering stage and improves liquidity in the aftermarket.

B. Price Support as Form of Price Manipulation

Hanley et al. (1993) suggest that stabilization temporarily inflates the stock price and allows underwriters to disguise overpriced offerings. They argue that "if a price drop [after IPO] is apportioned over a number of days, the perception of overpricing may be obscured by intervening market moves or informational shocks, thus concealing the overpricing from the underwriter's clients (both investors and issuers)." Although this argument has not been explored further, it seems unlikely that underwriters could easily deceive issuers and sophisticated investors who can infer price support from price and trading patterns. However, it is possible that underwriters try to disguise weak issues from

individual investors, perhaps to encourage retail demand in future offerings.[2] A related reason for price manipulation arises if unsophisticated investors engage in positive-feedback trading after the IPO.[3] By disguising the weakest IPOs from these investors, underwriters could mitigate price pressure caused by momentum traders.

Schultz and Zaman (1994) suggest that the purpose of price support is to permanently increase the aftermarket stock price. They point out that because of settlement delays, investors can renege on their IPO allocations during the first few days after the stock begins trading. Investors have an incentive to do so if the IPO trades below the offer price because they can purchase the stock at a lower price in the aftermarket than in the primary market. To prevent a cascade of offer withdrawals, the underwriter promises to repurchase shares in the aftermarket at the offer price. This strategy is successful because underwriters are able to permanently affect the market price by reducing the supply of IPO shares. Finally, Fishe (2001) argues that underwriters choose the offer price, the overallotment, and the degree of price support to maximize their profits from the offering, including the profits from aftermarket trading.

C. Price Support and Underwriter Reputation

An alternative reason that underwriters might choose, ex post, to support weak IPOs is to protect their reputations with investors. This motive has received less attention in the literature, though related ideas appear in Hanley et al. (1993), BBW, and Prabhala and Puri (1999), and many authors emphasize the importance of underwriter reputation.[4] Underwriters are third-party intermediaries that produce information about new issues and certify the issue price. An underwriter's reputation mitigates incentive problems that arise in this certification process. Investors infer an underwriter's ability, effort, and honesty by observing past performance. Incidents of overpricing hurt the underwriter's reputation and decrease future underwriting revenues. Consistent with this story, Beatty and Ritter (1986) and Dunbar (2000) show that investment banks that price IPOs inaccurately subsequently loose market share. Similarly, Nanda and Yun (1997) document that overpriced offerings are associated with subsequent declines in the underwriter's market value.

It seems interesting to consider the role of price support in this context. Underwriters face uncertainty about the IPO's value when they set the offer price. Thus, even honest and competent banks can make mistakes and overprice their IPOs. Such mistakes are probably difficult to distinguish from incompetence,

[2] Consistent with this idea, Hanley et al. (1996) document that closed-end fund IPOs, which are marketed to individual investors, exhibit significant price declines following week 3 after the IPO. The authors attribute these price declines to the withdrawal of price support.

[3] Barry and Jennings (1993) and Affleck-Graves, Hedge, and Miller (1996) document short-term price continuation after IPOs that is consistent with momentum trading. Also, several anecdotal accounts of momentum trading appear in the financial press (e.g., Lucchetti (1999), Prial (1999)).

[4] Some examples are Beatty and Ritter (1986), Booth and Smith (1986), Carter and Manaster (1990), and Chemmanur and Fulghieri (1994).

negligence, or even deliberate overpricing. By supporting a weak IPO, an underwriter can reduce losses to investors in situations in which the IPO proves, ex post, to be overpriced. Moreover, the bank's willingness to support an issue can signal to investors that it acted in good faith at the offering. In short, price support can be viewed as an ex post action aimed at protecting the underwriter's reputation with investors.

An interesting question is why underwriters do not explicitly commit to price support but, instead, decide ex post whether, and how much, to stabilize.[5] One could argue that an explicit commitment could be both technically enforceable and more effective in binding the underwriter against overpricing or insufficient due diligence. However, even the best legally binding contract could be too costly to enforce.[6] It may have to specify precisely under what conditions the underwriter provides price support, how many shares are to be repurchased, and at what prices. Moreover, the contract may have to define contingencies that are observable only indirectly through signals, such as the IPO market price, which can be manipulated by the underwriter or by investors.[7] Finally, it could be efficient to leave the underwriter some discretion in his choice of price support if, after the offering, the underwriter is better informed than investors about the costs of providing price support.[8]

II. Sample, Data, and Descriptive Statistics

A. Sample Selection

The paper examines 1,422 firm-commitment IPOs issued on Nasdaq from 1996 through 1999. The availability of proprietary transaction data restricts the sample to this 4-year period and to Nasdaq IPOs. I begin with a sample of all IPOs in the Securities Data Company (SDC) new issues database that went public from January 1996 through December 1999. I exclude all nonoriginal IPOs, unit issues, and spin-offs, which leaves 2,095 IPOs. From this sample, I keep 1,690 stocks listed (according to SDC) on the Nasdaq National Market or on the SmallCap Market, of which I obtain Nasdaq trading and quote data for 1,511. Further, I require that the IPO-related variables (e.g., the offer price and the number of shares offered) be available on SDC, which reduces the sample to 1,422 IPOs. Because the paper focuses on price support, some tests use a smaller sample of 280 cold IPOs with negative or 0 initial returns. Some cross-sectional tests use publicly available information from the lead underwriter's financial statements. For these tests, I construct a smaller sample of 738 IPOs (122 cold

[5] There are many instances in which discretionary promises, such as price support, are used in financial markets. Boot, Greenbaum, and Thakor (1993) provide several examples, such as parent companies writing "comfort letters" to assure creditors that the parent will provide financial assistance to a subsidiary in distress, or mutual fund managers voluntarily repurchasing defaulted commercial paper at par from funds under their management.

[6] See, for example, Williamson (1975) and Hart and Moore (1988).

[7] See, for example, Allen and Gale (1992) on moral hazard in financial contracting.

[8] See Boot et al. (1993) on reputation and discretion in financial contracting.

IPOs) underwritten by the top-20 lead underwriters. The lead underwriters are ranked based on the aggregate proceeds of all IPOs taken public in the 1990s.

B. Data

Transaction data are provided by the National Association of Securities Dealers, Inc. (NASD) Economic Research Department. The data set contains transaction time, price, and volume for each trade during the 20 trading days following the IPO. In addition, the data set contains variables that identify each trading party as either a marketmaker or an order-entry firm, and an indicator that identifies who is buying and who is selling. An order-entry firm is usually a broker trading on behalf of a customer. This information allows me to track total marketmaker inventory accumulation for each IPO. For example, if a marketmaker buys 1,000 shares from an order-entry firm, then I know that aggregate marketmaker inventory increases by 1,000 shares. Trades between two marketmakers or two order-entry firms have no impact on marketmaker total inventory.

The data set is similar to the smaller sample used by Ellis et al. (2000), except that I do not know the precise identities of the trading parties. Consequently, I can compute only the aggregate marketmaker inventories rather than, as in their paper, the inventories of the lead underwriter. The evidence in Ellis et al. suggests that this aggregate measure is a very good proxy for the underwriter's inventory because the lead underwriter is always a marketmaker for the IPO stock and accounts for the lion's share of the marketmakers' total inventory position in the stock. In their sample, the lead underwriter accounts for approximately 80% of the marketmakers' inventory accumulation on day 1. Although Ellis et al. do not provide this information separately for cold and hot IPOs, I expect that the lead underwriter's share could be higher for cold IPOs because of price stabilization.

The IPO-related variables, for example, the offer price, offer date, number of shares offered, etc., come from SDC. I collect financial statement information concerning the top investment banks from 10-K filings and annual reports for fiscal year 1999 or for the last fiscal year in which the bank appears in the sample. Information on mutual funds managed by each investment bank comes from the Center for Research in Security Prices (CRSP) Mutual Funds Database. Because the sample period includes the internet bubble of the late 1990s, I control for internet IPOs in all regressions. To identify internet stocks, I use the classification described in Demers and Lewellen (2003). Their classification relies on the Morgan Stanley Dean Witter *Technology and Internet IPO Yearbook (6th ed.)* and on the InternetStockList™ provided at http://www.internetnews.com/stocks/list/ by Internet.com.

C. Descriptive Statistics

Tables I and II show summary statistics for the sample. Table I presents separately a subsample of 738 IPOs taken public by the top-20 underwriters,

Table I

Descriptive Statistics

The full sample consists of 1,422 Nasdaq IPOs from 1996 through 1999 (some variables have missing values). Variable definitions are in the Appendix. An IPO is classified as cold if its initial return is equal to or less than 0. PROC ($ mil) are the IPO proceeds. AGE is the number of years from the founding year to the IPO. SALES (PPE) is the ratio of sales (PPE plus Inventory) to total assets. INTERN is a dummy variable for internet IPOs. URANK is underwriter rank measured as total proceeds of IPOs underwritten by the underwriter during the 1990s in percent of total proceeds of all IPOs in the 1990s. GRSP (%) is gross spread. VC is a dummy variable equal to 1 if the IPO is backed by venture capital. INIRET (%) is the initial return from the offer price to the closing price on day 1. UPDATE (%) is the return from the midpoint of the filing range to the offer price. IPONUM is the number of firms with the same two-digit SIC code going public during the 30 days before the IPO. SECOND (%) is the fraction of secondary shares sold in the IPO. INV (%) is the marketmakers' accumulation of IPO shares on the first day after the IPO in percent of shares offered. INVBID and INVBID2 (%) are measures of bid stickiness at the offer price on day 1. These measures are defined only for cold IPOs that trade at the offer price on day 1 (see definitions in the Appendix).

	All Underwriters						Top 20 Underwriters					
	Cold IPOs (280)			All IPOs (1,422)			Cold IPOs (122)			All IPOs (738)		
	Mean	Median	*SD*	Mean	Median	*SD*	Mean	Median	*SD*	Mean	Median	*SD*
PROC	35.44	24.90	32.54	49.36	35.00	97.91	52.34	38.15	39.12	70.66	48.40	130.76
AGE	10.49	6.00	14.06	10.06	6.00	13.66	9.38	5.50	10.98	9.43	5.00	13.56
SALES	3.92	0.96	26.33	1.84	1.00	12.51	3.13	0.74	21.50	1.45	0.83	9.22
PPE	0.28	0.19	0.26	0.28	0.19	0.26	0.28	0.19	0.26	0.28	0.19	0.26
INTERN	0.16	0.00	0.37	0.20	0.00	0.40	0.19	0.00	0.39	0.29	0.00	0.45
URANK	1.61	0.32	3.56	3.16	0.72	6.34	3.54	1.42	4.75	5.97	2.46	7.82
VC	0.45	0.00	0.50	0.46	0.00	0.50	0.56	1.00	0.50	0.61	1.00	0.49
GRSP	7.29	7.00	0.93	7.25	7.00	0.88	6.93	7.00	0.39	6.94	7.00	0.28
INIRET	−3.46	0.00	5.75	31.33	12.50	58.14	−3.86	−1.14	6.68	44.84	20.16	70.81
UPDATE	−10.65	−10.00	17.25	4.05	0.00	26.39	−12.73	−12.50	16.12	9.28	7.14	27.93
IPONUM	5.32	2.00	7.19	6.13	2.00	7.70	5.11	2.00	7.22	7.47	4.00	8.62
SECOND	4.27	0.00	10.07	6.90	0.00	14.09	4.65	0.00	10.04	7.16	0.00	14.75
INV	9.03	6.90	9.46	1.64	0.23	8.91	11.82	10.09	10.50	1.73	0.00	8.68
INVBID	3.77	1.40	5.34	–	–	–	5.45	3.48	6.21	–	–	–
INVBID2	4.45	1.85	6.08	–	–	–	6.98	5.22	7.14	–	–	–

Table II
Means by Year

The full sample consists of 1,422 Nasdaq IPOs from 1996 through 1999 (some variables have missing values). Variable definitions are in the Appendix. An IPO is classified as cold if its initial return is equal to or less than 0. PROC ($ mil) are IPO proceeds. AGE is the number of years from the founding year to the IPO. SALES (PPE) is the ratio of sales (PPE plus Inventory) to total assets. INTERN is a dummy variable for internet IPOs. URANK is underwriter rank measured as total proceeds of IPOs underwritten by the underwriter during the 1990s in percent of total proceeds of all IPOs in the 1990s. GRSP (%) is gross spread. VC is a dummy variable equal to 1 if the IPO is backed by venture capital. INIRET (%) is the initial return from the offer price to the closing price on day 1. UPDATE (%) is the return from the midpoint of the filing range to the offer price. IPONUM is the number of firms with the same two-digit SIC code going public during the 30 days before the IPO. SECOND (%) is the fraction of secondary shares sold in the IPO. INV (%) is the marketmakers' accumulation of the IPO shares on the first day after the IPO in percent of shares offered. INVBID and INVBID2 (%) are measures of bid stickiness at the offer price on day 1. These measures are defined only for cold IPOs that trade at the offer price on day 1 (see definitions in the Appendix).

	All IPOs (1,422)				Cold IPOs (280)			
Year	1996	1997	1998	1999	1996	1997	1998	1999
PROC	36.51	39.13	46.68	80.53	29.50	26.38	48.68	47.71
AGE	11.08	11.78	10.65	6.74	9.85	9.03	18.97	6.96
SALES	2.32	2.53	1.27	0.84	4.69	6.40	1.31	1.36
PPE	0.24	0.31	0.31	0.28	0.24	0.31	0.31	0.28
INTERN	0.05	0.06	0.14	0.61	0.06	0.10	0.04	0.56
URANK	2.15	2.17	3.40	5.54	1.47	1.21	1.53	2.47
VC	0.45	0.36	0.33	0.67	0.50	0.44	0.28	0.49
GRSP	7.35	7.34	7.24	7.02	7.17	7.57	7.29	7.14
INIRET	17.53	14.62	23.85	73.06	−3.11	−2.28	−3.06	−5.99
UPDATE	0.21	−2.48	1.44	17.78	−11.19	−12.61	−12.44	−5.56
IPONUM	5.43	2.85	3.35	12.02	5.31	2.66	2.59	11.07
SECOND	7.57	9.19	7.01	3.58	4.85	4.17	5.66	2.12
INV	1.53	2.54	3.07	0.09	7.68	7.58	10.69	12.14
INVBID	–	–	–	–	4.91	3.56	4.32	2.17
INVBID2	–	–	–	–	5.52	4.23	5.51	2.74
COLD	0.20	0.21	0.23	0.16	–	–	–	–
N	533	338	203	348	108	71	46	55

discussed in more detail in Section IV.D. The average firm in the total sample is 10 years old (the median is 6 years) and raises $49.4 million proceeds (the median is $35.0 million). The subsample of 280 cold IPOs with 0 or negative initial returns has similar age, raises lower proceeds, and is underwritten by less reputable underwriters.[9] Marketmakers accumulate significantly higher

[9] The cold IPOs are also smaller based on the pre-IPO book value of assets—the mean (median) assets are $39.4 ($11.9) million for cold IPOs, compared to $81.5 ($18.8) million for all IPOs. One potential explanation for these differences is that riskier IPOs, that is, those that are more difficult to price, are more likely to experience extreme initial returns, and, therefore, more likely to end up in the left tail of the initial return distribution. Based on prior studies, riskier IPOs tend to be smaller and are associated with less reputable underwriters.

inventories of cold IPOs than hot IPOs on day 1. The mean accumulation for cold IPOs is 9.0% of shares offered compared with 1.6% of shares offered for the total sample. This difference is consistent with the presence of price support.

Table II documents several interesting patterns across the 4-year sample period. The average IPO firm raised more proceeds and became less mature. The average age declined from 11.1 years in 1996 to 6.7 years in 1999, and the average sales-to-assets ratio declined from 2.3 to 0.8 during the same period. These changes are most pronounced in 1999, and coincide with the explosion of internet IPOs in the same year. Internet IPOs make up 61% of the total sample in 1999, compared to 5% in 1996, and 14% in 1998. Average underpricing increases dramatically during the sample period (from 17.5% in 1996, to 23.9% in 1998, and to 73.1% in 1999), and is accompanied by an increase in the average underwriter rank (from 2.2 in 1996, to 3.4 in 1998, and to 5.5 in 1999).

There is some evidence that price support for cold IPOs increased during the sample period. In particular, marketmaker inventory accumulation was close to 7.6% during the first two sample years but increased to 10.7% in 1998, and to 12.1% in 1999. The two alternative measures of price support reported in Tables I and II are described in detail in Section III. Roughly speaking, the variables capture an underwriter's determination to stabilize a stock at the offer price. They measure the average selling pressure that precedes each bid revision on day 1, given that the bid is currently at the offer price. The two variables show no significant changes during the first 3 sample years, and then decline significantly in 1999. Overall, the trend in price support is ambiguous. Later tests include year dummies in all regressions and confirm the robustness of all results excluding year 1999.

III. Price and Volume Effects of Price Support

In this section, I examine the intraday behavior of prices and volume following IPOs. The goal is to understand how underwriters support prices in the aftermarket and how stabilization affects prices and trading volume. In addition, the evidence helps identify stabilized stocks and suggests several measures of stabilization for the cross-sectional tests. The intraday analysis focuses on several questions: At what prices do underwriters stabilize IPOs? Is the promise to repurchase shares at the offer price an important part of the stabilization commitment? Do underwriters adjust the level of stabilization to reflect trading imbalances and information during the stabilization period? What is the magnitude and the duration of price support? How do stock prices adjust after withdrawal of price support?

A. How to Recognize Price Support?

I define price stabilization as share purchases made by the underwriter that are designed to increase the aftermarket stock price. This definition emphasizes the underwriter's intent to influence the stock price. Since the underwriter's intent cannot be observed, it is impossible to precisely identify stabilized stocks

or to perfectly measure the degree of stabilization. Therefore, I explore three possible measures of price support based on stock price behavior and trading volume that are likely to reflect price support.

My first measure of price support is based on the idea that the underwriter's offer to repurchase shares at an inflated price should induce selling pressure as investors take advantage of the artificially high price. Stabilized stocks should exhibit an unusually high selling volume from investors to the underwriting syndicate, so the first measure is the change in the marketmakers' inventory position after the offering (in the following, I refer to this measure as "marketmakers' inventory accumulation" or "investors' net sales"). This measure is similar to that used in Ellis et al. (2000). Based on their evidence, the change in the marketmakers' inventory position is a good proxy for the change in the syndicate's position because the syndicate members, and in particular the lead underwriter, account for most of the marketmakers' trading in the IPO aftermarket.

The underwriter might respond in one of two ways to the selling pressure that accompanies price support. One possibility, often assumed in the literature, is that the underwriter maintains the bid at a particular level, typically the offer price, throughout the stabilization period. Alternatively, the underwriter might respond to the selling pressure by periodically revising the level of price support. In either scenario, selling pressure accompanied by a "stickiness" of the stock price is consistent with price support. Thus, the second proxy for price support tries to capture the degree of price stickiness on the first trading day. For each stock, I compute the average change in marketmaker inventory that precedes each downward bid revision on day 1. The inventory change is measured starting from the previous bid revision. This quantity should measure the degree of investor selling pressure needed to induce a marketmaker to lower the inside bid.

Finally, the third indication of price support is motivated by Ruud (1993) and Prabhala and Puri (1999). They document that the distribution of initial returns is almost censored at 0 with an unusually low probability of negative returns. Both studies suggest that these patterns are caused by stabilizing transactions aimed at preventing the market price from dropping below the offer price. Based on this reasoning, Prabhala and Puri propose an indicator variable as a measure of price support that is equal to 1 if the IPO closes the first trading day at the offer price (stabilized) and is equal to 0 if it closes below the offer (not stabilized). Note, however, that this measure assumes that no (or less) stabilization occurs below the offer price, and the evidence below presents a more complex picture. Nevertheless, I explore the frequency of trades on day 1 occurring exactly at versus below the offer price as a third potential indication of price support.

While the three variables should provide a good description of the behavior of stabilized stocks, each variable is an imperfect proxy. For example, even though high selling pressure and price stickiness is consistent with price support, a similar pattern could also occur, at least in principle, for poorly performing stocks that are not stabilized. Aggarwal (2000) finds that underwriters begin

the first trading day with large short positions in IPO stocks. They usually have an option to cover the short position by purchasing an additional 15% of shares offered from the issuer (the overallotment option). However, if a stock trades sufficiently below the offer price, at a discount larger than the gross spread, the underwriter would prefer to cover the short position by repurchasing shares in the aftermarket. Such repurchases do not unambiguously reveal an underwriter's intention to support an issue, although they may affect the market price and trading behavior in a similar way. Therefore, the empirical tests attempt to control for these repurchases.[10]

B. Price Support on the First Day after IPO

B.1. Trading at the Offer Price

I start by examining the third indication of price support, the frequency of trading at and around the offer price. If underwriters commit to stabilize stocks at the offer price, we should observe an unusual frequency of trades, mostly sales, at this price level. In contrast, trading below the offer price should be relatively infrequent. Figure 1 provides evidence of such a pattern. The top panel compares the frequency of trading at various price levels on the first day of trading. Price levels are measured in number of ticks ($0.125) above the offer price. The thin line shows the number of stocks that have at least one trade at a given price level on day 1. The line is asymmetric around 0, suggesting that trading at negative prices is relatively rare. Consistent with this pattern, only 13 stocks in the sample open below the offer price and stay there throughout day 1, compared to 550 stocks trading only above the offer price. The bold line in the top panel answers the following question: Given that a stock trades at a particular price level on day 1, what is, on average, the fraction of all first-day trades that occur exactly at that price? Again, the line has an extreme spike at 0, consistent with stabilization at the offer price. For an average stock that trades at the offer price, 28% of all trades occur exactly at the offer. For other price levels, the average frequency does not exceed 12%. The bottom panel of Figure 1 shows a full histogram for the subsample of stocks with at least one trade at the offer price on day 1. It shows, for example, that, for almost half of these stocks, at least 20% of all first-day trades occur exactly at the offer. Overall, these results are consistent with price support at the offer price inflating prices of overpriced IPOs.

B.2. Inventory Accumulation

Table III shows underwriter inventory accumulation for four groups of stocks classified by under- or overpricing. I look separately at stocks trading at the offer price because Figure 1 suggests that these stocks are stabilized most strongly. I

[10] Alternatively, one could argue that underwriters oversell an issue because they intend to support the price if the stock performs poorly in the aftermarket. Under this assumption, the existence of a short position itself reveals the intention to stabilize.

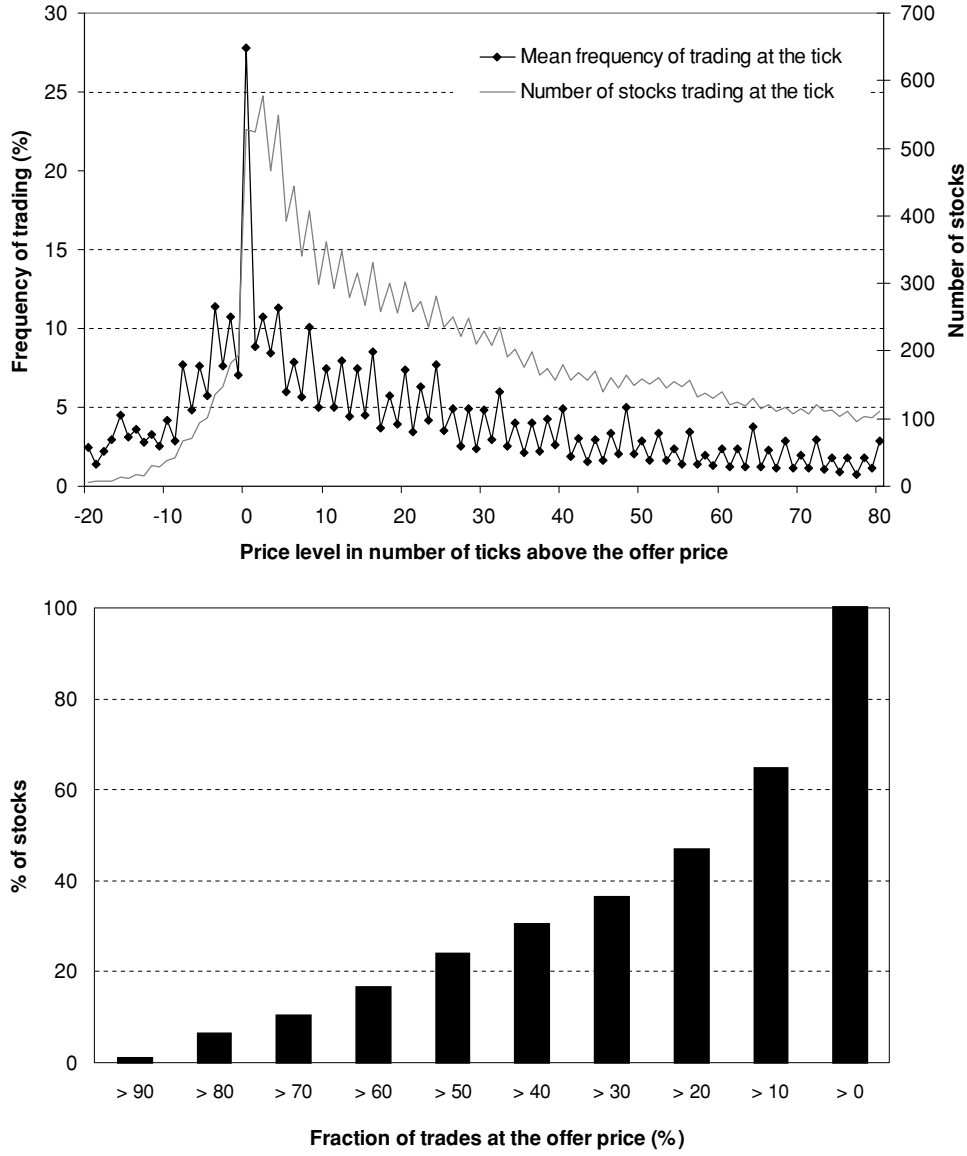

Figure 1. Frequency of trading at and around the offer price on day 1. The top figure compares the frequency of trading on day 1 at various price levels around the offer price. Price levels are measured in the number of ticks above the offer price (tick = \$0.125). The thin line depicts the number of stocks that trade at least once at a given price level on day 1. The bold line shows the average fraction of trades at each price level for stocks that trade at least once at that price. The bottom figure focuses on 527 stocks that trade at least once at the offer price on day 1. It shows a histogram of percent of all first-day trades executed at the offer price. For example, 65% of the 527 stocks trade at least 10% of time at the offer price.

Table III

Marketmaker Inventories and Trading Imbalance on the First Trading Day after the IPO

The sample consists of 1,422 Nasdaq IPOs from 1996 through 1999. MM inventory is the marketmaker inventory accumulation on the first day after the IPO in percent of shares offered. Trading imbalance is computed based on the Lee and Ready (1991) algorithm as the seller-initiated transaction volume minus the buyer-initiated transaction volume on day 1 in percent of shares offered. In Panel A, stocks are classified based on the opening return, i.e., the return from the offer price to the first quoted bid. The panel shows the total MM inventory accumulation and trading imbalance on day 1. Panel B (C) shows the average inventory accumulation and trading imbalance on day 1 preceding a bid decrease (increase). The accumulation is counted for each bid from the time the bid is quoted to the next bid revision (or to the end of trading on day 1 for the last bid). For example, Panel C shows that when a bid is at the offer price on day 1, marketmakers accumulate, on average, 3.31% of the shares offered before they revise the bid downwards. Finally, Panel D shows, separately, the average inventory accumulation on day 1 for stocks that had no bid changes on that day. The stocks are grouped based on the level of the opening bid on day 1.

	MM Inventory			Trading Imbalance			
Price range	Mean	Median	*SD*	Mean	Median	*SD*	*N*
Panel A: Total Inventories (Trading Imbalance): Stocks with the Opening Return in a Given Range							
Less than −7%	6.42	5.42	6.51	8.58	4.49	11.98	13
−7% to 0%	8.64	8.18	9.62	16.19	15.19	16.65	30
0%[a]	8.42	4.69	9.96	25.16	21.82	18.70	228
0%[b]	1.87	0.44	6.50	8.84	6.38	12.25	164
0–60%	0.45	0.04	7.50	12.46	8.65	20.10	809
More than 60%	−3.39	−3.31	9.79	1.14	1.95	25.08	178
Panel B: Inventories (Trading Imbalance) before a Bid Decrease by the Level of the Current Bid							
Less than −7%	0.06	0.00	0.77	0.19	0.02	1.55	1,346
−7% to 0%	0.18	0.01	1.04	0.38	0.03	1.79	1,875
0%	3.31	0.77	5.56	10.35	3.15	14.97	288
0–60%	−0.03	0.00	0.89	0.18	0.01	1.44	33,169
More than 60%	−0.01	0.00	0.37	0.00	0.00	0.55	64,563
Panel C: Inventories (Trading Imbalance) before a Bid Increase by the Level of the Current Bid							
Less than −7%	0.15	0.00	0.92	0.19	0.00	1.42	1,537
−7% to 0%	0.24	0.00	1.51	0.41	0.00	2.34	1,769
0%	1.78	0.20	4.49	4.75	0.58	10.87	785
0–60%	0.01	0.00	1.17	0.08	−0.01	1.60	39,384
More than 60%	0.00	0.00	0.58	0.00	−0.01	0.68	81,864
Panel D: Inventories (Trading Imbalance) for Stocks with No Bid Change on Day 1							
Less than 0%	3.60	0.50	5.82	6.34	0.02	21.16	3
0%	2.53	0.38	5.16	24.79	20.65	18.44	78
More than 0%	0.86	0.15	2.13	8.92	3.50	12.58	18

[a]Stocks with opening bid at the offer price and closing bid at or below the offer price.
[b]Stocks with opening bid at the offer price and closing bid above the offer price.

also show separately a group of stocks that trade in the range −7% to 0% below the offer price because in this range, an underwriter's buying is most likely motivated by the intention to support prices. If an underwriter's objective was only to cover his short position, he could do so by purchasing up to 15% of shares offered from the issuer at a discount from the offer price of approximately 7%. (In my sample, 263 out of 280 overpriced stocks have a gross spread of 7% or higher.) Finally, I assume that no stabilization is needed for stocks trading above the offer price, which allows me to use these stocks as a benchmark sample.

In Panel A of Table III, stocks are assigned to groups based on the opening return. Generally, the table shows strong inventory accumulation for all groups of overpriced IPOs and almost no accumulation for underpriced IPOs, consistent with price support. Interestingly, there is no evidence that stabilization is strongest at the offer price, which is surprising given the results in Figure 1. Stocks that open in the −7% to 0% range exhibit inventory accumulation of 8.64% of shares offered; I find that 83% of this accumulation occurs when the bid is actually below the offer price. This compares to an average accumulation of 5.7% of shares offered for stocks that open at the offer price, and 8.42% for stocks that open at the offer price but close at or below it.[11] For the last group, 65% of total accumulation occurs when the bid is at the offer, and 27% when it is below the offer.

The proprietary database used in this paper provides a direct measure of investors' net selling volume. Since it is not possible to identify buys and sales using publicly available data, many previous studies use trading imbalances estimated using the Lee and Ready (1991) algorithm.[12] For comparison, the right panel of Table III reports the estimates for my sample. The Lee and Ready trading imbalance substantially overstates investor net selling volume, sometimes by a factor of two or more. Further, the bias varies strongly across cold and hot IPOs. This is important because studies that use the Lee and Ready algorithm to identify net selling often make comparisons across these groups of stocks. I find that the discrepancy is caused, to a large extent, by interdealer trades that occur more frequently at the bid than at the ask.

B.3. Price Stickiness

Figure 1 documents price rigidity at the offer price. Panels B–D in Table III show a second measure of price stickiness, namely, the average net selling volume preceding a downward bid adjustment for various starting levels of the bid; the net selling volume is computed beginning at the previous bid adjustment. The results confirm that underwriters are reluctant to lower the bid below the offer price. On average, marketmakers accumulate 3.31% of shares offered on

[11] Some stocks that open at the offer price may not need to be supported because their prices subsequently rise. Out of 392 stocks that open at the offer, 164 (42%) close above the offer. For comparison, out of 43 stocks that open below the offer, only 7 (16%) close above the offer.

[12] Roughly speaking, the algorithm classifies trades as buyer- or seller-initiated based on whether they occur closer to the bid or ask (see Lee and Ready (1991) for details). Trading imbalance is then equal to seller-initiated trading volume minus buyer-initiated trading volume.

day 1 before they are willing to lower the bid if it is currently at the offer price. No comparable rigidity is observed at any other bid level. The estimate of 0.18% of shares offered for the bid between −7% and 0% seems low compared to the stickiness at the offer price. However, it is still substantially higher than for the benchmark sample of underpriced stocks (−0.02% of shares offered), and the difference is statistically significant at the 1% level. These relatively slow bid adjustments observed in the subsample of overpriced IPOs are consistent with price support. It appears that underwriters are committed to prevent prices from falling below the offer price. Although strong inventory accumulation continues at lower bid levels, underwriters exert less effort to maintain a particular bid.

C. When Does Stabilization End?

Figure 2 documents the average marketmakers' inventory accumulation during the first 20 trading days following the IPO for under- and overpriced stocks. The figure confirms the evidence in Ellis et al. (2000) and Aggarwal (2000) that the strongest share repurchases of cold IPOs, presumably by the lead

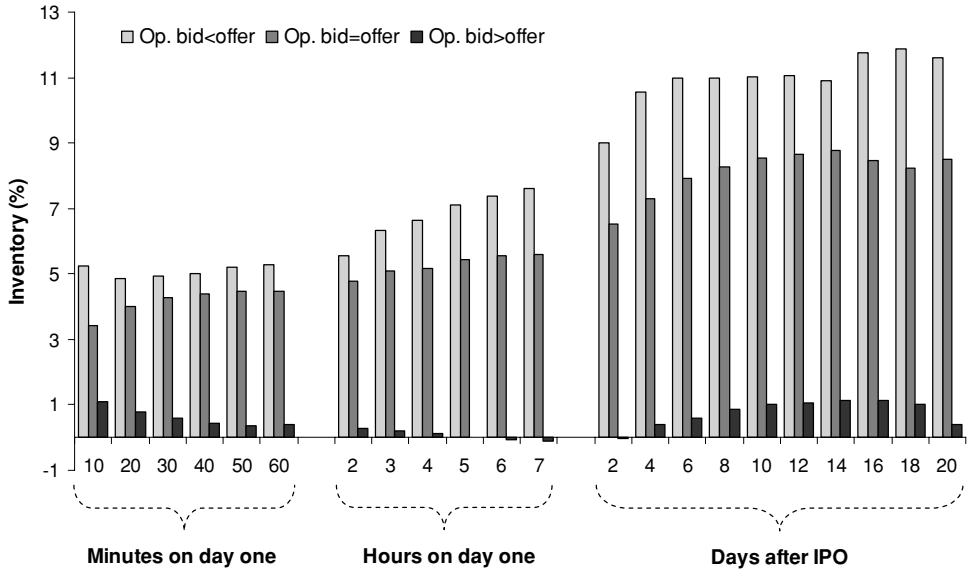

Figure 2. Marketmaker inventory accumulation during the first 20 trading days after the IPO. The sample consists of 1,422 Nasdaq IPOs from January 1996 through December 1999. The figure depicts the average marketmaker inventory accumulation during the first 20 days after IPO. The averages are computed for three groups of stocks classified based on the level of the opening bid on day 1 relative to the offer price. The figure shows inventory accumulation (cumulative) for various time intervals starting from the beginning of trading on day 1: (1) 10-minute intervals for the first hour of trading on day 1; (2) 1-hour intervals for the first trading day; (3) 2-day intervals for the first 20 days after IPO.

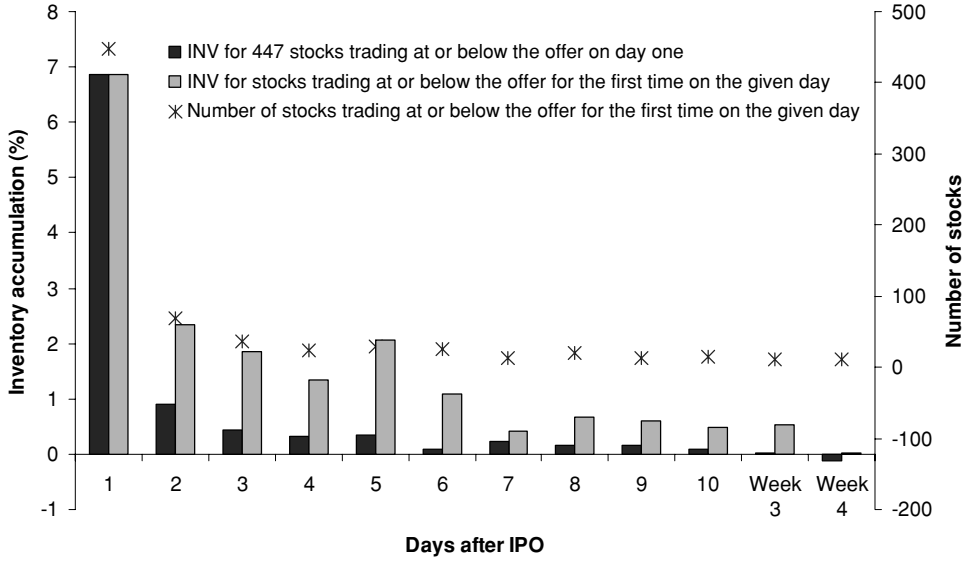

Figure 3. Marketmaker inventory accumulation during the first 20 trading days after the IPO. The figure depicts the average marketmaker inventory accumulation during the first 20 days after the IPO (not cumulative) for different groups of stocks. The dark bars show 477 stocks that trade at or below the offer price on day 1. The light bars show groups of stocks that trade at or below the offer price for the first time on the given day. For example, the light bar for "day 2" shows 69 stocks that start trading above the offer price and decline for the first time on day 2; the light bar for "day 3" shows 37 stocks that start trading above the offer price and decline for the first time on day 3, etc. All classifications are based on the level of bid prices relative to the offer price.

underwriter, take place on the first trading day, but that inventory buildup continues after day 1. For the 392 stocks that open at the offer price, the average share accumulation is positive and statistically significant for 10 consecutive trading days after the IPO. Figure 3 shows that stabilization after day 1 is stronger for IPOs that initially trade above the offer price and subsequently decline.[13] Figure 2 presents more detailed evidence on the timing of marketmaker repurchases. Interestingly, an extremely high fraction of net repurchases takes place during the first few minutes of trading. For example, for stocks opening below the offer price, the first 5 minutes account for 55% of total inventory accumulation on day 1 and the first 10 minutes account for 66%. Overall, the evidence suggests that stabilization is strongest on the first trading day, particularly during the first minutes of trading, but it continues to a lesser degree over the following 2 weeks.

Table IV documents in more detail how the withdrawal of price support occurs. The table shows the timing of subsequent bid decreases for various groups

[13] This is consistent with Boehmer and Fishe's (2004) clinical study of short covering. In their example, an IPO trades above the offer price for several days after IPO and declines below that level on day 8. On that day, the underwriter steps up share repurchases.

Table IV

Timing of and Selling Pressure Preceding the First Six Bid Revisions after the IPO

The sample consists of 1,422 Nasdaq IPOs from 1996 through 1999. The left panel shows the average marketmaker inventory accumulation in percent of shares offered preceding each consecutive bid revision. The inventory accumulation is measured from the previous bid revision (or, for the first bid, from the beginning of trading). The right panel shows the average duration of the bid in hours. Only time during trading days between 9:30 a.m. and 4:00 p.m. is counted. For example, if a bid does not change from 3:00 p.m. on Friday to 11:00 a.m. on Monday, the bid duration is 2.5 hours (1 hour on Friday and 1.5 hours on Monday). Panels A through D show various subsamples of stocks classified based on the initial bid levels. *N* is the number of stocks in each subsample. *N* tends to decline with the number of bid changes because some stocks have less than six bid changes during the 20-day window post-IPO.

Bid # from Beginning of Day 1	Inventory Accumulation at the Bid (%)			Duration of the Bid (Hours)			
	Mean	Median	*SD*	Mean	Median	*SD*	*N*
Panel A. Stocks with the First Six Bids below the Offer							
1	2.51	0.98	4.37	4.85	0.02	18.89	36
2	1.24	0.50	2.05	0.87	0.02	3.92	36
3	0.79	0.00	3.98	0.24	0.03	0.75	35
4	1.17	0.39	2.08	1.13	0.03	5.38	34
5	0.76	0.05	1.78	1.48	0.03	5.20	34
6	0.46	0.01	1.73	1.45	0.03	6.71	34
Panel B: Stocks with the Opening Bid at the Offer and the Subsequent Five Bids below the Offer							
1	6.51	3.41	7.66	11.03	0.18	23.04	116
2	1.07	0.20	2.52	1.40	0.02	5.17	111
3	1.09	0.20	2.52	3.09	0.03	12.32	111
4	0.68	0.20	1.58	3.42	0.03	10.95	110
5	0.68	0.19	2.23	1.35	0.08	5.07	107
6	0.31	0.00	2.29	1.97	0.07	5.89	106
Panel C: All Stocks with the Opening Bid at the Offer							
1	3.96	1.20	6.36	8.02	0.17	21.66	392
2	0.41	0.04	1.96	1.59	0.03	5.12	387
3	0.93	0.07	3.18	4.80	0.05	15.87	382
4	0.31	0.04	1.33	2.61	0.05	8.94	377
5	0.34	0.06	2.21	2.57	0.08	8.48	371
6	0.18	0.00	1.81	2.40	0.10	7.77	368
Panel D: All Stocks with the Opening Bid above the Offer							
1	0.69	0.14	3.42	0.49	0.02	3.39	987
2	0.46	0.00	3.54	0.54	0.02	4.33	986
3	0.19	0.00	2.34	0.96	0.02	6.51	984
4	0.00	0.00	4.15	0.44	0.02	2.95	983
5	0.12	0.00	2.70	0.71	0.02	3.96	983
6	0.07	0.00	2.01	0.51	0.02	2.97	981

of stocks classified based on the level of initial bid prices. I measure timing in two ways. First, I compute the duration of each bid in minutes (the table reports fractions of an hour). Second, I compute the average inventory accumulation at each bid. The table reveals several interesting patterns. First, underwriters seem to adjust the stabilizing bid to selling pressure gradually rather than withdraw it completely at one point in time: Selling pressure tends to decline after subsequent bid changes. Second, the strongest investor sales occur at the first bid quoted when trading begins, consistent with the evidence in Figure 2. For stocks that open at the offer price and subsequently decline, marketmakers accumulate, on average, 6.5% of shares offered before the bid drops for the first time. The inventory accumulation between the first and the second bid change is only 1.1% of shares offered. Third, on average, it takes a long time (measured in hours) before the underwriter allows the bid to drop below the offer price. For an average stock that opens at the offer price, the first bid change occurs after 8 hours of trading (the median is 0.2 hours). For comparison, the mean is 0.5 hours (the median is 0.02) for stocks that open above the offer price.

The last observation is particularly puzzling. For some stocks, the bid remains at the offer price for several days after the IPO; for other stocks, the bid drops below the offer price within the first few minutes of trading (Table V shows this heterogeneity in more detail). What makes marketmakers fix the bid for some stocks for so long? Extensive stabilization is likely to be costly to the underwriter, and there are two interpretations for why some stocks are stabilized longer than others. Underwriters might commit to support some stocks longer (in calendar time) in spite of higher costs. Alternatively, underwriters may maintain the bid at the offer price only if the offer price is sufficiently close to the equilibrium market price and the stabilizing bid does not cause large selling pressure. Further analysis supports the second interpretation. In Table V, stocks are partitioned into quintiles based on the calendar-time duration of the first bid. The table shows that cold IPOs with longer durations of the first bid exhibit lower inventory accumulation on day 1. This suggests that stocks that remain at the offer price longer are not necessarily stabilized more strongly. Instead, these stocks exhibit a relatively low "true" return volatility and their equilibrium market price is closer to the offer price.

D. Do Prices Decline after Stabilization Ends?

The final set of tests focus on price adjustments after the termination of price support. In principle, the analysis could provide direct evidence on how strongly underwriters inflate prices during the stabilization period: If stabilization affects prices temporarily, prices should adjust to their equilibrium levels after the withdrawal of price support. However, stabilization may have a long-lasting or even permanent effect on prices. If demand curves for IPO stocks are downward sloping, perhaps because investors do not rationally learn from prices, then we should observe little or no price adjustment following the withdrawal of

Table V

Selling Pressure by the Duration of the First Bid on Day 1

The sample consists of 1,422 Nasdaq IPOs from 1996 through 1999. The table shows measures of selling pressure for groups of stocks ranked by the duration of the first bid on day 1. Selling pressure is measured as the marketmaker inventory accumulation in percent of shares offered. The middle panel shows accumulation at the first bid, and the right panel shows total accumulation on the first trading day. The left panel shows the duration of the first bid in hours. Panels A–D show subsamples of stocks classified based on the level of the first bid.

Ranks Based on Duration of the First Bid	Duration of the First Bid (Hours)		Inventory Accumulation at the First Bid (%)		Inventory Accumulation on Day 1 (%)		
	Mean	Median	Mean	Median	Mean	Median	*N*
Panel A: Stocks with Opening Bid below the Offer Price							
1-Shortest	0.00	0.00	−0.14	0.01	9.09	7.78	16
2	0.02	0.02	4.06	3.14	12.88	11.30	10
3	0.07	0.05	3.65	1.25	3.21	1.48	8
4-Longest	19.42	0.37	3.71	0.61	4.74	3.51	9
Panel B: Stocks with Opening Bid at the Offer Price and a Subsequent Bid Decrease							
1-Shortest	0.01	0.02	1.15	0.94	13.16	13.87	30
2	0.05	0.05	5.91	3.58	11.42	7.51	25
3	0.15	0.13	8.08	6.14	12.76	10.95	24
4	4.23	2.16	6.71	3.42	7.61	1.87	26
5-Longest	52.65	52.67	9.52	8.90	3.55	0.47	26
Panel C: Stocks with Opening Bid at the Offer Price							
1-Shortest	0.01	0.00	0.73	0.14	6.65	2.54	94
2	0.05	0.05	4.30	1.53	6.75	3.34	58
3	0.18	0.17	4.80	1.81	6.47	2.33	84
4	1.75	1.13	4.97	2.23	5.53	1.86	78
5-Longest	38.34	25.43	5.66	3.52	3.01	0.44	78
Panel D: Stocks with Opening Bid above the Offer Price							
1-Shortest	0.00	0.00	0.18	0.00	−1.42	−0.98	483
2	0.02	0.02	0.42	0.31	0.28	0.12	148
3	0.05	0.05	1.43	0.79	0.68	0.44	171
4-Longest	2.57	0.25	1.58	1.21	1.58	0.39	185

price support.[14] Also, underwriters might have private information about the IPO and repurchase only those stocks that they consider to be undervalued. In this case, stabilization might be associated with 0 or even positive subsequent returns.

[14] This is consistent with Zhang (2004) who argues that underwriters can affect the aftermarket demand for IPO stock, and thus the equilibrium price, by overallocating IPO shares at the offering and subsequently buying them back.

The analysis of returns is complicated by a puzzling phenomenon. Barry and Jennings (1993) find short-term price continuation for over- and underpriced IPOs. This phenomenon is not necessarily related to price support. The tests below attempt to control for continuation unrelated to price support.

Table VI presents cumulative Nasdaq-adjusted returns for 20 trading days after the IPO for groups of stocks sorted both based on the level of the closing bid on day 1 and based on the inventory accumulation on day 1. The results confirm previous evidence of short-term price momentum for Nasdaq IPOs. Stocks with the closing bid above the offer price earn a cumulative return of 1.1% during the first 10 days after the IPO and 6.4% during the first 20 days. The estimates are −4.8% and −0.04%, respectively, for stocks with negative initial returns; the differences between the two groups of stocks are statistically significant for 19 out of 20 trading days. Several authors attribute the price decline for cold IPOs to the withdrawal of stabilization. Unfortunately, this conjecture is less convincing given the anomalous price continuation of both under- and overpriced IPOs.

To shed light on these issues, Table VI compares the returns for stocks with above- and below-median inventory accumulation on day 1 for each subsample. If stabilization affects prices temporarily, we should observe a negative association between net selling volume and the subsequent price adjustment. The evidence in Table VI does not support this conjecture. Overpriced stocks that appear less stabilized, that is, have below median net selling volume on day 1, experience significantly stronger price declines starting after the IPO than overpriced stocks with above-median net selling. There is some evidence of temporary price effects for stocks that close the first day of trading at the offer price. For this group, stocks with above-average inventory accumulation on day 1 experience a significantly stronger price decline starting on day 2. However, it is not clear if this price decline is caused by price support; the last three columns in Table VI show that underpriced stocks, which are probably not stabilized, exhibit a similar pattern. Also, the poor performance reverses to some extent after day 10. Overall, the evidence suggests that stabilization could have a long-lasting effect on prices, or that underwriters choose to stabilize stocks that they consider close to fairly valued.

E. Summary

In sum, the analysis above reveals several interesting patterns: (1) Marketmakers purchase large fractions of cold IPOs at and below the offer price, which is consistent with price support. (2) Stock prices are extremely sticky at the offer price in the sense that large selling pressure is required to move the bid. This suggests that underwriters commit to repurchase shares at the offer price, though they stabilize at lower prices too. (3) More than 50% of the first-day net selling volume for cold IPOs occurs during the first 5 minutes of trading, often before the first bid adjustment. After that, stabilization is withdrawn gradually with selling pressure declining slowly after subsequent bid decreases. (4) There

Table VI

Cumulative Nasdaq-Adjusted Returns for 20 Days after the IPO

The sample consists of 1,422 Nasdaq IPOs from 1996 through 1999. The cumulative bid returns are computed starting from the closing bid on the first trading day. The daily raw returns are adjusted by subtracting the contemporaneous return on the Nasdaq Composite Index. IPOs are grouped based on the level of the closing bid on day 1 relative to the offer price. Each subsample is then divided into two groups with the first-day marketmaker inventory accumulation below and above the subsample median. The *t*-statistics are for the difference in the mean cumulative return for stocks with below-median inventories and stocks with above-median inventories.

	Below Offer Price (152 IPOs)				At Offer Price (194 IPOs)				Above Offer Price (1,064 IPOs)			
Closing Bid Inventory	All IPOs	Below Median	Above Median	*t* for Difference	All IPOs	Below Median	Above Median	*t* for Difference	All IPOs	Below Median	Above Median	*t* for Difference
2	−0.68	−0.78	−0.59	0.22	−0.98	−0.23	−1.74	−3.12	0.22	0.80	−0.36	−2.24
3	−1.04	−0.94	−1.14	−0.17	−1.07	−0.10	−2.05	−2.28	0.20	0.55	−0.16	−0.98
4	−1.04	−0.70	−1.38	−0.50	−1.55	−0.25	−2.86	−2.37	0.09	0.58	−0.42	−1.23
5	−2.14	−2.02	−2.26	−0.14	−1.58	−0.84	−2.33	−1.27	0.20	0.90	−0.51	−1.53
6	−3.65	−4.14	−3.16	0.58	−1.50	−1.17	−1.84	−0.55	0.17	1.01	−0.70	−1.79
7	−4.28	−5.08	−3.49	0.87	−1.74	−1.27	−2.22	−0.72	0.26	1.11	−0.62	−1.81
8	−4.73	−5.45	−4.01	0.67	−1.92	−0.99	−2.85	−1.25	0.36	1.12	−0.43	−1.62
9	−5.01	−6.43	−3.60	1.03	−2.42	−0.90	−3.95	−1.80	0.72	1.68	−0.27	−1.87
10	−4.83	−6.83	−2.85	1.41	−2.72	−0.79	−4.66	−2.18	1.06	2.20	−0.11	−2.04
11	−4.35	−7.35	−1.38	1.85	−2.85	−0.84	−4.88	−2.13	1.45	3.09	−0.24	−2.71
12	−4.50	−7.18	−1.86	1.71	−2.77	−1.15	−4.42	−1.70	1.95	4.12	−0.28	−3.31
13	−4.99	−7.60	−2.42	1.64	−2.87	−1.34	−4.41	−1.59	2.24	4.40	0.02	−3.26
14	−4.87	−7.12	−2.64	1.35	−3.08	−1.60	−4.58	−1.47	2.76	5.14	0.30	−3.45
15	−4.49	−7.62	−1.35	1.66	−2.85	−2.02	−3.69	−0.79	3.37	6.18	0.47	−3.93
16	−2.92	−6.37	0.45	1.61	−2.56	−2.53	−2.59	−0.03	4.35	7.67	0.93	−4.42
17	−1.73	−6.18	2.54	1.88	−2.85	−2.23	−3.45	−0.55	4.89	8.50	1.17	−4.67
18	−1.13	−6.85	4.37	2.36	−2.15	−1.46	−2.84	−0.58	5.68	9.61	1.61	−4.80
19	−0.68	−6.15	4.64	2.24	−1.56	−0.61	−2.47	−0.73	6.15	9.98	2.15	−4.55
20	−0.04	−6.02	5.04	2.00	−1.17	0.19	−2.42	−0.94	6.37	10.35	2.18	−4.59

is little evidence that prices decline more after stabilization is withdrawn, thus, in the short run, price support appears to raise the equilibrium stock price.

IV. Determinants of Price Support

Price support appears to significantly affect prices and trading in the aftermarket, but there also seems to be large variation in the degree of price support across stocks. This section investigates the cross-sectional determinants of price support. Sections IV.A and IV.B discuss the tests and the hypotheses, and Section IV.C describes the results.

A. Measuring Price Support

The purpose of the cross-sectional analysis is to test how underwriters' ex ante commitment to stabilize varies across stocks. Unfortunately, such commitment is not directly observable, and inferences must be based on the ex post observed stabilization.[15] Stabilization will not be observed for most stocks that trade above the offer price, but this does not mean that the underwriter did not commit to stabilize them had the price declined. Therefore, I limit the sample to overpriced IPOs so that price support can be potentially observed.

The analysis in Section III identifies several measures of price support, each capturing a slightly different aspect of an underwriter's activities. The first measure is marketmaker inventory accumulation on the first trading day (*Inv*). This measure assumes that stabilized stocks exhibit selling pressure as investors take advantage of the inflated price. As discussed in Section III.A, one criticism with this measure is that underwriters could accumulate inventory for reasons unrelated to price support, and that this residual accumulation could bias cross-sectional results. In Section IV.C, I describe several robustness tests that alleviate this concern.

Two alternative measures try to capture an underwriter's commitment to prevent price declines below the offer price. The evidence in Section III suggests that such commitment is an important part of stabilization: Tables III and IV show that bid prices are extremely sticky at the offer price in the sense that it takes, on average, a long time and high selling pressure to induce an underwriter to lower the bid. Although stabilization continues at lower bid levels (inventory accumulation is as strong as at the offer price), prices move much more frequently, which suggests that maintaining a particular bid is far less important. The first measure of price stickiness at the offer price (*Invbid*) captures, for each stock, the average selling pressure on day 1 needed to move a bid, given that the bid is currently at the offer price.[16] Note that this measure is

[15] Note, however, that an underwriter's decision to take a naked short position at the IPO (as documented in Aggarwal (2000)) indicates an ex ante commitment to price support.

[16] More precisely, I compute the average inventory accumulation preceding a bid revision on day 1, given that the initial bid (before the revision) is at the offer price. The inventory accumulation is computed starting from the previous bid revision. The details of the computation are in the Appendix.

defined only for a subset of cold IPOs that trade at the offer price on day 1. The second measure (*Invbid2*) is similar, except that only downward bid revisions are considered. This assumes that prices of stabilized stocks are more likely to decline than to increase when stabilization is withdrawn. I find, not surprisingly, that all three measures are highly positively correlated, with correlations ranging from 66% to 98%. The regression results discussed below are generally consistent across the three measures.

Another measure considered in Section III focuses on the frequency of trading at versus below the offer price. For example, Prabhala and Puri (1999) consider an indicator variable that equals 1 if the IPO closes day 1 at the offer price (stabilized) and 0 if it closes below the offer (not stabilized). That measure assumes, however, that stocks trading below the offer price are not stabilized, which is inconsistent with the evidence in Section III. The measure could also bias the relation between price support and stock characteristics toward finding more price support for less volatile stocks, that is, stabilized stocks that remain at the offer price longer. For this reason, the cross-sectional tests focus only on inventory accumulation and bid stickiness measures.

B. IPO Risk, Information Asymmetries, and Underwriter Reputation

B.1. Information Asymmetries and Risk

The theories of price support introduced in Section I suggest several relations between price support and IPO characteristics. This section tests these predictions. The first hypothesis is based on the models by BBW and CN. Both papers argue that stabilization and underpricing are used to mitigate information asymmetry problems in the IPO market. In the CN model, price support is a form of insurance provided to uninformed investors to reduce the winner's curse. In the BBW model, the underwriter is better informed than investors, and the commitment to repurchase shares at the offer price bonds against deliberate overpricing. Both models suggest that price support should be particularly useful in situations in which information asymmetries among different market participants are severe. Based on this reasoning, a natural empirical prediction is that stocks with more information asymmetry problems should exhibit more price support.

Information asymmetries arise when some market participants have better information about the stock's value than other investors. The degree of information asymmetry is difficult to measure directly, but many authors assume that it is positively related to uncertainty about the value of the stock. (Though, as Beatty and Ritter (1986) discuss, information asymmetry and uncertainty are not equivalent.) Following this reasoning, many previous studies test whether IPO underpricing is higher for risky stocks, that is, stocks with potentially worse adverse selection problems.

In the context of price support, however, the distinction between risk and information asymmetries is more subtle. If risk is viewed as a proxy for information asymmetries, the earlier discussion implies that riskier stocks should

be more strongly supported. However, as CN and Prabhala and Puri (1999) point out, there are reasons to expect an opposite relation. Suppose that investors view price support as an option to sell back a certain number of IPO shares at the offer price. This option is more valuable for riskier stocks, and, consequently, less stabilization, that is, smaller promised share repurchases, might be needed to encourage investors to participate in the IPO.

Prabhala and Puri (1999) and Ellis et al. (2000), among others, make a related point: If stabilization requires underwriters to hold inventories in the stabilized stock, underwriters might be less willing to support riskier and more volatile IPOs. It is difficult to know how important these risk considerations are in practice because underwriters can hedge inventory risk implicitly. Aggarwal (2000) shows that underwriters almost always oversell the issue and start the first trading day with a short position. They have an option to cover this short position in the aftermarket or to purchase up to 15% of shares offered from the issuer. Aggarwal reports that the average short position in her sample is 17.01% of shares offered. I do not have data on short positions, but in my sample inventory accumulation (by day 20) exceeds 17% for 79 out of 280 cold IPOs. It is possible that the inventory buildup rarely exceeds the short position, and that underwriters are able to limit inventory risk for most stocks. Nevertheless, we should observe less willingness to stabilize riskier stocks, as long as inventory risk cannot be completely eliminated.

B.2. Underwriter Reputation

In Section I.C, I argue that underwriter reputation could play a key role in the stabilization decision. First, incidents of overpricing hurt the underwriter's reputation, and price support can be viewed as an ex post action to repair the damage. Second, price support is a discretionary rather than legally binding commitment, and reputation makes it possible for this commitment to be honored. These arguments suggest that price support and underwriter reputation should be related. An obvious hypothesis is that larger and more reputable underwriters are more concerned with losing reputation and, consequently, are more likely to engage in price support. Consistent with this argument, Dunbar (2000) finds evidence that larger underwriters lose significantly more market share as a consequence of inaccurately priced IPOs.

Alternatively, larger underwriters could be better able to diversify inventory risks and absorb potential losses from price support (see, e.g., the discussion by CN). Thus, the risk story also implies a positive relation between underwriter size and price support. However, if underwriters can hedge stabilization risk, as suggested in Aggarwal (2000), risk considerations may not be of first-order importance.

To further explore the reputation hypothesis, I test whether underwriters are more likely to engage in price support when their reputation seems more threatened by the appearance of mispricing. Suppose that a low first-day IPO return coincides with a negative market return, caused, for example, by unfavorable macroeconomic or industry-related news. If the underwriter is not

expected to predict such market-wide events accurately, his reputation may be less severely affected. Alternatively, if the negative initial return appears to be unrelated to overall market movements, it may be more likely interpreted as an avoidable valuation mistake. Following this idea, I test whether the amount of price support associated with a given offering is negatively associated with the overall market's return on the first trading day.

C. Regression Results

The price support regressions are presented in Table VII. The sample consists of 280 cold IPOs, and the dependent variable in the reported regressions is the marketmakers' total inventory accumulation on day 1, measured in percent of shares offered. Results for alternative measures of price support are not reported in the table but are summarized in the text.

C.1. IPO Risk and Information Asymmetries

I use several proxies for IPO risk and the degree of information asymmetries. All variables are described in detail in the Appendix. The common assumption is that larger uncertainty and more information asymmetries are associated with smaller, less mature firms, and firms with a higher fraction of intangible assets. The regressions include IPO proceeds as a proxy for size, and the firm's age and sales-to-assets ratio as proxies for the firm's maturity.[17] To capture the type of firm's operating assets, I use the ratio of fixed to total assets and a dummy variable identifying internet firms.

The variables described above focus on characteristics of an issuer's assets as proxies for IPO risk. The next set of variables tries to capture how events preceding the IPO could affect pricing uncertainty. For example, it may be easier to value an IPO if it follows a large number of similar offerings. To account for this, I include the number of firms with the same two-digit standard industrial classification (SIC) code that went public during the 30 days prior to the IPO. To capture significant market-wide or firm-specific news preceding the IPO, I include the Nasdaq return during the filing period, and the price adjustment from the midpoint of the filing range to the offer price.

Finally, I consider three indirect proxies for IPO risk. If underwriters charge higher gross spreads for IPOs that are more difficult to price, riskier offerings should be associated with higher gross spreads. It is possible that agency conflicts within the issuing firm contribute to the risk and information asymmetries at the IPO. Following Ljungqvist and Wilhelm (2003), I include the fraction of secondary shares sold at the IPO as a proxy for agency conflicts.

The regressions in Table VII provide some evidence that less risky stocks are stabilized more strongly. I report only regressions with total inventory

[17] In unreported regressions, I use book and market value of assets before the IPO as alternative measures of size, with market value measured at the midpoint of the filing range. The results are generally consistent across the different measures (see footnote 18).

Table VII

Regressions of Marketmaker Inventory Accumulation on the First Day after the IPO

The sample consists of 280 cold IPOs from 1996 through 1999 (first two columns have 248 observations because of missing age data). Variable definitions are in the Appendix. An IPO is classified as cold if its initial return is equal to or less than 0. The dependent variable is the marketmakers' accumulation of IPO shares on the first day of trading in percent of shares offered. LGPRO is the logarithm of IPO proceeds ($ mil). LGAGE is the logarithm of 1 plus firm's age, and age is measured in the number of years from the founding year to the IPO. SALES (PPE) is the ratio of sales (PPE plus inventory) to total assets. INTERN is a dummy variable for internet IPOs. URANK is the underwriter's rank. VC is a dummy variable equal to 1 if the IPO is backed by venture capital. GRSP is the gross spread. MARKT (%) is the Nasdaq return during the filing period. UPDATE (%) is the return from the midpoint of the filing range to the offer price. IPONUM is the number of firms with the same two-digit SIC code going public during the 30 days before the IPO. SECOND is the fraction of secondary shares sold in the IPO. NSRET (%) is the Nasdaq return on the first day of trading. INIRET (%) is the initial return measured from the offer price to the closing price on the first day of trading. Year dummies are included in all regressions. *t*-statistics are in parentheses. ***, **, * indicate 1%, 5%, and 10% significance levels, respectively.

LGPRO	3.95***	2.49**	2.15**	1.46	2.22**	2.56***
	(3.78)	(2.31)	(2.30)	(1.48)	(2.40)	(2.77)
LGAGE	0.30	0.27				
	(0.44)	(0.40)				
SALES	0.04*	0.04*	0.04*	0.04**	0.04*	0.04**
	(1.67)	(1.82)	(1.86)	(2.22)	(1.89)	(1.95)
PPE	5.09**	4.42*	4.04*	3.59*	4.22**	3.93*
	(2.10)	(1.88)	(1.91)	(1.75)	(2.01)	(1.89)
INTERN	0.56	0.64	0.39	0.24	0.74	0.46
	(0.29)	(0.34)	(0.22)	(0.14)	(0.42)	(0.27)
URANK		0.70***	0.74***		0.67***	0.64***
		(4.05)	(4.50)		(4.08)	(3.90)
VC	−0.27	−1.13	−0.82	−0.78	−0.70	−0.48
	(−0.22)	(−0.92)	(−0.73)	(−0.70)	(−0.62)	(−0.43)
GRSP	0.14	−0.34	−0.31	−0.57	−0.36	−0.05
	(0.14)	(−0.35)	(−0.40)	(−0.77)	(−0.47)	(−0.06)
MARKT	0.01	0.02	0.02	0.04	0.02	0.01
	(0.15)	(0.47)	(0.33)	(0.88)	(0.40)	(0.11)
UPDATE	0.03	0.02	0.02	0.03	0.03	0.02
	(0.80)	(0.64)	(0.68)	(0.97)	(0.99)	(0.71)
IPONUM	0.10	0.14	0.12	0.15*	0.13	0.12
	(1.09)	(1.56)	(1.40)	(1.88)	(1.56)	(1.42)
SECOND	0.01	0.03	0.03	0.02	0.05	0.05
	(0.21)	(0.47)	(0.55)	(0.42)	(0.89)	(0.92)
NSRET					1.06**	1.04**
					(2.40)	(2.38)
INIRET						−0.22**
						(−2.48)
Lead dummies	No	No	No	Yes***	No	No
Adjusted R^2	0.13	0.18	0.18	0.29	0.20	0.21

accumulation as a measure of price support, although the conclusions are consistent across all measures. The coefficient on IPO size is positive and significant in four out of the five regressions in Table VII. Based on the first column, an increase in total IPO proceeds by one standard deviation at the mean is associated with an increase in the first-day inventory accumulation of 4.1 percentage points. However, the effect diminishes to only 2.6 percentage points when underwriter rank is included in the regression. There is some evidence that firms with more fixed assets or higher sales-to-assets ratios are more strongly supported, although the coefficients are not significant when the alternative stabilization measures are used. There is no evidence that price support is associated with a firm's age, information revealed prior to the IPO or agency conflicts.[18]

C.2. Underwriter Reputation

I use the underwriter's market share as a proxy for its size and reputation (similar to Megginson and Weiss (1991)). Market share is computed based on aggregate proceeds of all IPOs taken public in the 1990s. Controlling for IPO risk, there is a strong positive association between price support and underwriter size, and the result is robust for all three stabilization measures. In the reported regressions in Table VII, the coefficient on underwriter rank is positive with t-statistics between 3.9 and 4.5. The coefficient in column 6 implies that a one-standard deviation increase in an underwriter's market share increases inventory accumulation by 2.3% of shares offered.

Consistent with the reputation hypothesis, I also find that underwriters are less inclined to support weak IPOs on days when the stock market is doing poorly. The coefficient on the Nasdaq return on day 1 is positive for all three stabilization measures and is statistically significant for *Inv* (reported regressions) and *Invbid2*. The coefficient is economically significant: The regression in the fifth column in Table VII suggests that an increase in the Nasdaq return of 1 percentage point increases the inventory accumulation on day 1 by 1.1% of shares offered. As a robustness test, I replace the Nasdaq return with a dummy variable equal to 1 when the return is positive or 0 (the results are not reported). The coefficient on the dummy variable is statistically significant, and it indicates that underwriters repurchase 1.9% of shares offered less on days when the Nasdaq return is negative. Finally, the regression in column 6 of Table VII includes the IPO initial return as an additional control variable. The coefficient on the initial return is negative and significant, consistent with

[18] Unreported univariate regressions present a similar picture. The coefficients on all proxies for size are positive for the three stabilization measures, although only IPO proceeds and total assets (market value measured at the midpoint of the filing range) are statistically significant. Consistent with this pattern, firms with lower gross spreads and higher fixed-assets ratios are more heavily supported, although the coefficients on these variables are significant only when total inventory accumulation is used to measure price support. The coefficient on the Internet dummy is ambiguous across the different stabilization measures, and the coefficients on the remaining proxies for risk and information asymmetries are not statistically significant.

the results in Table III, but its inclusion has no significant impact on the other results.

In sum, the basic regressions provide no evidence that stocks with greater information asymmetries are more strongly supported. There is some indication that riskier IPOs are less strongly stabilized, which is consistent with the stabilization-costs story. Consistent with the reputation hypothesis, less price support occurs on days when the Nasdaq return is low. Finally, the underwriter's size emerges as the strongest determinant of price support; I explore this last result in more detail below.

C.3. Role of the Lead Underwriter

Larger underwriters may be more willing to support IPOs for reputational reasons or because they can better absorb inventory risks. However, it is also possible that an underwriter's rank proxies for other bank characteristics omitted from the regressions. Before discussing this possibility further, Tables VII and VIII provide some indication of whether underwriter heterogeneity, beyond size and reputation, can help explain variation in price support. The regression in column 4 of Table VII includes 20 dummy variables for each of the top-20 lead underwriters; underwriter rank is left out of the regression because it induces multicollinearity. The table shows that the adjusted R^2 jumps substantially, from 18% to 29%, when underwriter rank is replaced by underwriter dummies. The increase is even higher, from 19% to 32%, for the subsample that includes only IPOs underwritten by the top 20 underwriters (this result is not reported). These findings suggest that size alone does not fully capture the important heterogeneity among investment banks.

A closer look at the lead dummies in Table VIII reveals that the underwriter fixed effects are economically highly significant. For example, controlling for IPO characteristics, the average inventory accumulation for stocks underwritten by "Bank 3" is 15.3% of shares offered higher than for smaller (i.e., not top-20) investment banks. For comparison, this estimate is −4.4% for "Bank 18." (The banks are numbered based on the coefficients on the dummy variables.) It seems that the strong differences in price support across banks are to a large extent independent of the underwriter's size and reputation: All top-20 investment banks enjoy substantial fractions of the IPO market, have long traditions as lead underwriters, and seem similarly able to absorb losses from price support. Thus, the interesting question, addressed in Section IV.D below, is what common characteristics of these banks are responsible for the differences in their stabilization decisions.

C.4. Robustness Tests

One concern with the inventory accumulation measure is that it could capture alternative motives for underwriters' share repurchases that are unrelated to price support. Most importantly, underwriters could repurchase cold IPOs to maximize immediate trading profits rather than to support prices. Note that if an IPO trades at a sufficiently deep discount below the offer price (more

Table VIII
Inventory Accumulation by the Lead Underwriter

The left panel shows coefficients and *t*-statistics on top-20 underwriter dummies in the regression of the marketmakers' first-day inventory accumulation (Table VII, column 4). Underwriters are classified as top-20 based on the variable URANK (see the definition in the Appendix). The right panel shows the mean and standard deviation of the marketmakers' first-day inventory accumulation for IPOs underwritten by each of the top-20 underwriters. *N* is the number of IPOs used in the calculation. Underwriters are sorted by the size of the coefficient on the underwriter dummy.

	Table VII Dummies		Inventory Accumulation		
Lead	Coefficient	*t*	Mean	*SD*	*N*
1	32.72	3.90	43.85		1
2	18.94	2.32	26.01		1
3	15.25	4.85	25.15	9.71	8
4	12.25	2.11	19.91	25.38	2
5	10.84	3.33	20.15	8.46	7
6	10.60	3.29	18.98	5.24	3
7	10.10	2.05	17.59	10.35	7
8	7.98	2.10	18.15	5.44	5
9	7.19	1.71	12.46	8.25	4
10	5.50	1.69	13.97	10.31	7
11	3.24	1.16	10.86	10.29	10
12	1.79	0.74	9.34	8.01	13
13	1.62	0.45	9.61	8.73	6
14	1.04	0.27	7.48	5.39	12
15	0.92	0.36	8.41	11.78	5
16	0.05	0.01	7.83	9.95	6
17	−2.36	−0.71	6.82	7.49	7
18	−4.38	−1.37	2.58	2.60	7
19	−5.16	−1.69	3.65	4.75	8
20	−6.31	−1.28	3.39	3.57	3

precisely, at a discount larger than the gross spread), underwriters could prefer not to exercise the overallotment option, but instead to cover the initial short position by purchasing shares in the aftermarket. To address this issue, I repeat the cross-sectional analysis in Table VII for a subset of stocks that never trade at bid prices below −7% (208 out of 280 IPOs in my sample have a gross spread of 7%). Interestingly, the unreported cross-sectional results are very similar to those reported in Table VII for the full sample of cold IPOs, which suggests that the trading-profits motive does not drive the results. As an alternative robustness test, I repeat the results in Table VII for two benchmark samples in which no or less price support should be observed, namely, a sample of hot IPOs on the first trading day and a sample of cold IPOs during the fourth week after the offering.[19] If the cross-sectional results in Table VII are obtained also for

[19] More precisely, the first benchmark sample consists of 849 hot IPOs on the first trading day post-IPO, with IPOs defined as hot if the initial return is greater than 5%. The second benchmark sample consists of 379 cold IPOs on day 19 post-IPO, with IPOs defined as cold if the closing bid on day 19 is at or below the offer price. The analysis is repeated for days 18 and 20 post-IPO with similar results.

the benchmark samples, it would suggest that the results could be caused by a factor unrelated to price support. However, none of the cross-sectional findings in Table VII are present in any of the benchmark samples (the results are not reported).[20] In general, the robustness tests are consistent with inventory accumulation capturing price support.

D. A Closer Look at the Lead Underwriter

Besides size and reputation, several characteristics might explain differences in price support across underwriters. Aggarwal (2003) shows that investment banks with retail brokerage operations distribute larger fractions of IPOs to retail investors.[21] I find supporting evidence by comparing the average trade size in the aftermarket for retail and institutional banks.[22] Investor mix could be important for price support for several reasons. First, BBW and CN suggest that price support is designed to benefit specific types of investors. For example, if price support is targeted at institutional investors (as in BBW), one might expect that "institutional banks," that is, those with a higher fraction of institutional customers, will stabilize more. Second, Hanley et al. (1993) suggest that stabilization is used to conceal overpricing. This strategy should be more successful with unsophisticated investors, so price support could be more valuable to "retail" banks. Finally, one could make the case that unsophisticated investors rely more heavily on underwriter reputation when making their decision to participate in an IPO (I discuss this possibility further below). Thus, reputation concerns could also induce more price support for retail banks.

In addition, I include a number of control variables that capture other potentially important differences among investment banks. Recent accounts in the financial press suggest that underwriters use IPO allocations to compensate favored clients for high brokerage commissions and other services. These anecdotes suggest that complementarities (or conflicts of interest) among various business segments of an investment bank could affect its IPO-related decisions,

[20] For example, IPO size and underwriter rank are the strongest determinants of price support in the "stabilization sample" in Table VII, but the coefficients on both variables are insignificant (and in one case have the wrong sign) in the benchmark samples. The only variable significant at the 1% level is the initial return in the sample of hot IPOs. This result is actually consistent with price support: Stocks with less positive initial returns are more likely to trade at or below the offer price on day 1, and, thus, are more likely stabilized.

[21] Underwriters might favor their own customers in IPO distributions for several reasons. First, it may simply be cost-efficient for an underwriter to approach existing customers. Second, anecdotal accounts in the financial press suggest that underwriters allocate IPOs to their own customers in exchange for brokerage commissions and other services (e.g., Smith and McGee (2000)). Recently, Reuter (2004) shows that mutual funds that direct brokerage business to underwriters receive favorable IPO allocations.

[22] In particular, I find that the average size of an investor's sale on the first day of trading after the IPO is significantly lower for retail banks than for other top-20 investment banks, and the difference is significant at the 1% level.

including price support. For example, the value of IPO allocations as means to reward brokerage customers is probably small for banks with no significant brokerage operations. Alternatively, banks with smaller brokerage divisions may use price support more extensively if they try to attract additional customers. Although the sign of these relations is difficult to predict a priori, I use several proxies for an investment bank's "type" as control variables. I measure the relative importance of the bank's business segments by each segment's contribution to total revenues.

D.1. Sample and Descriptive Statistics

The analysis focuses on IPOs underwritten by top-20 investment banks. The banks are publicly traded, so their financial statements are available during my sample period; in some regressions, I drop three banks because the financial data is incomplete.[23] Table I compares IPOs underwritten by the top investment banks to other IPOs. The top banks account for 52% of all IPOs in the sample and 74% of aggregate sample proceeds. Consistent with previous literature, the 20 largest banks underwrite larger IPOs, raise higher proceeds, and charge lower gross spreads than their competitors. Also, IPOs taken public by the top underwriters are more likely to have venture capital backing and to come from the internet sector. Finally, Table I shows that the cold IPOs taken public by large underwriters experience higher first-day inventory accumulation than the cold IPOs in the total sample (11.8% and 9.03% of shares offered, respectively).

D.2. Regression Results

Table IX shows first-day inventory accumulation regressed on various characteristics of the lead underwriter and a set of control variables. As discussed earlier, the fraction of retail versus institutional customers of the investment bank could influence the bank's commitment to price support. To capture this bank characteristic, I create a dummy variable that identifies investment banks with retail brokerage operations.[24] In addition, I search the investment bank's annual reports and 10-K filings for information about the composition of the bank's assets under management. Although some banks disclose what fraction of total assets is managed for institutional and retail customers (or at least what fraction is managed in separate customer accounts versus mutual funds), many financial statements contain no details about asset composition. Consequently, I combine financial statement data on total assets under management with information on aggregate net asset value of all mutual funds managed by

[23] I do not find consistent data on total assets under management for Lehman Brothers, Montgomery Securities, and Robertson Stephens & Co.

[24] More precisely, the dummy variable is equal to 1 if I find a reference to retail brokerage in the bank's annual reports or 10-K filings.

Table IX

Regressions of Marketmaker Inventory Accumulation on Day 1 for Top Underwriters

The full sample consists of 122 cold IPOs underwritten by the top-20 underwriters from 1996 through 1999 (some regressions have fewer observations because of missing data). Variable definitions are in the Appendix. The dependent variable is the marketmakers' accumulation of the IPO shares on the first day after the IPO in percent of shares offered. An IPO is classified as cold if its initial return is equal to or less than 0. LGPRO is the natural logarithm of the IPO proceeds ($ mil). SALES (PPE) is the ratio of sales (PPE plus inventory) to total assets. INTERN is a dummy variable for internet IPOs. VC is a dummy variable equal to 1 if the IPO is backed by venture capital. URANK is the underwriter's rank. RETAIL is equal to 1 if the underwriter has major retail brokerage operations. MF/AM is the ratio of mutual fund assets to total assets under management for the lead underwriter. MF/IPO is the ratio of mutual fund assets managed by the underwriter to the volume of IPOs taken public by the underwriter in the 1990s. MANAGE, COMMIS, PRINC, and INVBANK is the fraction of the underwriter's revenues derived from asset management, commissions, principal transactions, and investment banking, respectively. All regressions include year dummies. *t*-statistics are in parentheses. ***, **, * indicate 1%, 5%, and 10% significance levels, respectively.

LGPRO	0.61	0.20	0.61	0.87	1.13	1.42	1.14	1.44
	(0.39)	(0.11)	(0.38)	(0.55)	(0.70)	(0.85)	(0.68)	(0.89)
SALES	0.06	0.06	0.06	0.06*	0.07*	0.06	0.07*	0.05
	(1.59)	(1.32)	(1.42)	(1.68)	(1.87)	(1.57)	(1.78)	(1.34)
PPE	−0.85	−1.12	−0.16	−3.52	−3.47	−3.57	−3.79	−3.59
	(−0.25)	(−0.30)	(−0.05)	(−1.07)	(−1.04)	(−1.05)	(−1.09)	(−1.08)
INTERN	−3.22	−2.90	−2.34	−5.71**	−5.92**	−5.97**	−5.58**	−5.83**
	(−1.27)	(−1.00)	(−0.89)	(−2.26)	(−2.28)	(−2.26)	(−2.11)	(−2.27)
VC	0.31	−0.74	−0.35	2.20	2.56	1.61	1.91	1.98
	(0.17)	(−0.35)	(−0.19)	(1.16)	(1.30)	(0.81)	(0.96)	(1.01)
URANK	0.75***	0.73***	0.73***	0.41**	0.53***	0.63***	0.58***	0.38*
	(3.93)	(3.44)	(3.75)	(2.10)	(2.79)	(3.33)	(2.93)	(1.88)
RETAIL	6.51***			12.73***	12.60***	9.99***	8.62***	11.52***
	(3.73)			(5.57)	(4.99)	(4.75)	(4.00)	(3.30)
MF/AM		6.50						−1.59
		(1.49)						(−0.21)
MF/IPO			0.14***					0.17
			(2.86)					(1.09)
COMMIS				−42.82***				−69.40***
				(−2.96)				(−2.76)
MANAGE					−41.95**			24.25
					(−2.19)			(0.77)
PRINC						14.47		23.97**
						(1.37)		(2.09)
INVBANK							−4.24	1.93
							(−0.83)	(0.34)
Adjusted R^2	0.27	0.20	0.25	0.40	0.37	0.36	0.35	0.42
N	122	107	119	100	100	100	100	100

the investment bank that can be found in the CRSP Mutual Funds Database.[25] I assume that the ratio of mutual funds to total assets under management proxies for the relative importance of retail versus institutional customers of the bank's asset management division. Alternatively, the relative importance

[25] Total net assets of a mutual fund is the market value of all securities owned by the mutual fund, plus all assets minus all liabilities. The net asset value is measured at the end of year 1999 or the last year in which the bank appears in the sample. A mutual fund is considered as "managed" by an investment bank if the investment bank is responsible for electing the fund manager.

of the bank's retail operations is measured by the bank's mutual fund assets scaled by the aggregate IPO proceeds underwritten by the bank in the 1990s. To capture the relative importance of the bank's various business segments, I collect information on the bank's revenue sources from the annual 10-K filings and annual reports.

Table IX suggests that underwriter type is an important determinant of price support, beyond the effects of size and reputation. Controlling for rank and IPO characteristics, all variables that measure the importance of retail customers have positive coefficients, and two out of three are statistically significant. When all retail proxies are included, only the retail dummy remains significant (the t-statistic in column 8 is 3.3). The coefficient in the regression in column 8 implies that when an IPO performs poorly on the first trading day, retail banks repurchase 11.5% of shares offered more on day 1 than other top investment banks.

Interestingly, the variables describing an investment bank's revenue composition add explanatory power in the price support regressions after controlling for retail proxies: the R^2 in a regression with underwriter rank, retail dummy, and other IPO characteristics is 36% (for the unreported regression for 100 IPOs with available revenue proxies), compared to 42% when the revenue measures are included. Finally, to be consistent with the full-sample regressions, I include the first-day Nasdaq return and the initial return in the regression in column 8 of Table IX (to save space, this regression is not reported). The coefficients on these variables are similar in magnitude to those reported for the full sample, but they are no longer significant.[26]

D.3. Why Do Retail Banks Stabilize More?

One of the most striking results in Table IX is that retail banks repurchase larger fractions of cold IPO shares than other investment banks. Below, I suggest three potential explanations for this finding.

Are retail banks more concerned about their reputation with investors? I have argued that price support can be viewed as an ex post action by the underwriter to protect its reputation with investors. An underwriter that sees the IPO's price decline in the aftermarket can choose to reduce the losses to initial investors through price support, and thereby mitigate any negative reputational effect associated with negative initial returns. Taking this perspective, one could conclude that retail banks are more negatively affected by the ex post overpricing, which gives them a stronger incentive to stabilize.

Suppose that institutional investors know more about the IPO's value at the time of the offering than retail investors. Consequently, the institutional investors are also better equipped to evaluate the underwriter's performance in

[26] The results in Table IX are similar when measures of bid rigidity (i.e., *Invbid* and *Invbid2*) are used as measures of price support. These measures are positively and significantly associated with retail dummy, but the variables measuring the composition of revenues are not significant determinants of price support.

pricing the IPO. In particular, they can better assess whether the aftermarket price decline is a consequence of deliberate overpricing, insufficient due diligence in the pre-offering stage, or simply bad luck. In contrast, the less informed investors must rely more on the observed history of initial returns to infer the underwriter's true ability and effort in pricing the IPO. If this reasoning is correct, underwriters that market IPOs more extensively to retail investors may be more concerned with the effects of overpricing on investors' perceptions and on the demand for future IPOs. Such underwriters may be more inclined to intervene in the aftermarket to prevent price declines. This story seems consistent with the finding in this paper that retail banks engage more heavily in price support.

Do retail banks manipulate prices to deceive small investors? Hanley et al. (1993) suggest that investment banks use price support to conceal the true market price from investors. They argue that price support temporarily inflates the stock price. By delaying a price decline for several days after the IPO, the underwriter makes it more difficult for naïve investors to identify overpriced stocks. Similar to the reputation story, the Hanley et al. argument suggests that price support could be more important for retail banks, assuming that retail customers are less sophisticated investors. The evidence here is inconsistent with this view. First, I find little evidence that prices decline once stabilization is withdrawn, so banks do not seem to pursue the naïve camouflage strategy. Second, I test whether retail investors are more confused about the price effects of price support than institutional investors. In particular, I test whether more extensive retail net buying on day 1 relative to institutional net buying predicts more negative future returns for cold IPOs. I find only weak support for this hypothesis.[27]

A related idea is that retail banks try to prevent positive-feedback trading. Anecdotal accounts in the financial press suggest that unsophisticated investors behave like momentum traders, tending to buy IPOs after the stock price increases.[28] Such momentum trading could give rise to price stabilization if underwriters try to prevent selling pressure by concealing the weakest IPOs. Again, however, this theory is inconsistent with the data: I find no evidence of retail selling pressure, even for the weakest IPOs.[29] Also, anecdotal evidence suggests that investment banks can prevent investors from flipping cold IPOs

[27] For each stock, I measure the average size of an investor purchase to the average size of an investor sale on the first trading day. High ratios suggest higher institutional net buying volume relative to retail net buying volume. In unreported tests, I find weak evidence that higher ratios predict more positive cumulative returns during the 20 days after the IPO. Specifically, I find that an above-median ratio predicts significantly positive cumulative returns for 4 out of 20 days after the IPO. This result holds only in a subsample of cold IPOs with above-median marketmaker inventory accumulation on day 1. There is no predictability in the subsample of cold IPOs with below-median accumulation.

[28] See, for example, Lucchetti (1999) and Prial (1999).

[29] I assume that an average trade by retail investors is smaller than an average trade by an institution. Thus, as a proxy for retail trading, I examine separately trades above and below 1,000 shares. I find that net selling volume for cold IPOs is caused by large and medium trades. In fact, small trades induce a net buying volume for IPOs that open below the offer price.

by threatening exclusion from future offerings. If investment banks can control flipping directly, they may not need to use price support for the same purpose. In short, there is little evidence that retail banks stabilize more to disguise market prices from retail investors.

Do retail banks use price support to discriminate among investors? Retail banks generally provide brokerage and other services to retail and institutional customers, whereas institutional banks tend to focus on the latter group.[30] Customer heterogeneity might be reflected in the investor mix that receives IPO allocations. If retail banks distribute IPOs to a more heterogeneous investor group, it might be more important for these banks to discriminate among investors by offering some investors more favorable terms than others. Price support is one way to achieve such discrimination: A promise to repurchase IPO shares in the aftermarket can be offered selectively to a specific investor group. The literature suggests two reasons why discrimination could be important. First, CN argue that price support is a put option given specifically to uninformed investors to compensate them for the winner's curse. Second, BBW suggest that price support is offered selectively to institutional investors in exchange for information in the pre-offering period.

The evidence in this paper, combined with the direct evidence on flipping in Aggarwal (2003), is consistent with both types of discrimination. Aggarwal documents that institutions flip larger fractions of their IPO allocations than retail investors, as predicted by the BBW hypothesis. However, two pieces of evidence point toward the alternative view. First, retail investors receive relatively high allocations of overpriced IPOs, consistent with the winner's curse. Second, in Section III.D, I find only weak evidence that the withdrawal of price support causes significant price declines. Thus, it is possible that price support benefits all initial investors, including retail investors who do not immediately flip their shares. In short, both theory and empirical evidence suggest that price support allows underwriters to discriminate among different investor groups. This could explain why retail banks, who face a more heterogeneous investor mix, use price support more extensively.

V. Conclusions

Researchers have proposed a wide range of explanations for price support, but there have been relatively few empirical studies, in part because of the limited availability of precise measures of stabilization. This paper provides a comprehensive study of price support for a large sample of IPOs. It explores both the variation of price support across stocks and the effects of price support on prices and trading volume in the aftermarket.

[30] The composition of assets under management provides an indication of customer heterogeneity. For example, J.P. Morgan reports in 2000 that it manages $270 billion assets for institutions and $79 billion assets for high net worth individuals. There is no mention of retail customers. In contrast, Prudential Financial reports in 2001 that it manages $96.5 billion assets for retail customers and $89.1 billion assets for institutions. According to the annual statement, retail accounts include individual mutual funds, variable annuities, and variable life insurance.

I find that price support is substantial for poorly performing IPOs. Underwriters accumulate large inventories of IPO stock at prices close to and below the offer price in an apparent attempt to stabilize the price. It appears that underwriters are committed to prevent prices from falling below the offer price. When a stock trades at the offer price on day 1, it takes extreme selling pressure to induce the underwriter to lower the bid. The strongest share repurchases occur within the first few minutes of trading on day 1 and at the first quoted bid, although stabilization continues throughout day 1 and, to a lesser degree, during the following 2 weeks. It appears that stabilization has a long-lasting effect on prices: There is no clear evidence that prices fall after stabilization ends. Moreover, for a disproportionate number of stocks, bid prices stay exactly at the offer price for many days after IPO, in spite of strong selling pressure on day 1.

There is large variation in the degree of price support across stocks. BBW and CN argue that price support, similar to underpricing, helps reduce adverse selection problems in the IPO market. This suggests that stabilization is particularly useful in circumstances in which information asymmetries are most severe. However, I find no evidence that riskier stocks or stocks with more potential information asymmetry problems are stabilized more strongly. Instead, stabilization appears stronger for larger and less risky IPOs and for IPOs underwritten by more reputable underwriters. One potential explanation for this finding is that underwriters avoid stabilizing risky IPOs to limit their risk exposure from taking inventory positions in the IPO stock.

Risk considerations could also explain why large underwriters stabilize more. It is possible that larger underwriters are more skilled at predicting IPO performance, or are better able to absorb inventory risks. Alternatively, underwriter reputation could play a key role in stabilization decisions. First, price support is an implicit rather than legally binding commitment, and it is possible that only reputable underwriters are able to make this commitment credibly. Second, price support could be viewed as an ex post action designed to protect an underwriter's reputation with investors, and larger underwriters could be more concerned with losing reputation. Consistent with this hypothesis, I find that price support is weaker on days when the stock market is doing poorly, that is, when the underwriter's failure in pricing the IPO is less apparent.

Interestingly, I find that other characteristics of the lead underwriter, in addition to size and reputation, help explain the variation in price support. The most robust result is that retail banks, that is, banks with significant retail brokerage operations, stabilize more. On average, these banks repurchase 11.5% of shares offered more on day 1 (for cold IPOs) than other top-20 investment banks. This surprising finding seems at odds with most prior studies, which suggest that price support is targeted primary at institutional investors. The paper puts forward two potential explanations for the finding. First, retail banks could suffer larger reputational damage from ex post overpriced IPOs, and thus they use price support to protect their reputations. Second, retail banks could value price support to discriminate among investors: A promise to repurchase shares

at the offer price can be targeted to a specific investor group. The preliminary evidence in this and previous studies is consistent with both hypotheses.

Appendix: Variable Definitions

LGPRO	LGPRO = log(PROC). PROC are IPO proceeds defined as the offer price times the number of shares offered ($mil).
LGAGE	LGAGE = log(1 + AGE). AGE is the number of years from the founding year to the year of the IPO. The age data are provided by Laura Field and Jay Ritter. Detailed descriptions of the data are in Field and Lowry (2004) and Loughran and Ritter (2004).
SALES	Ratio of revenues to total assets in the last fiscal year before the IPO.
PPE	Ratio of property, plant, and equipment plus inventory to total assets before the IPO.
INTERN	Dummy variable for internet IPOs (see Demers and Lewellen (2003)).
URANK	Underwriter rank equal to total proceeds of IPOs underwritten by the underwriter during the 1990s in percent of total proceeds of all IPOs in the 1990s.
VC	Dummy variable for IPOs backed by venture capital.
GRSP	Gross spread (%).
MARKT	Return on the Nasdaq Composite Index from the filing date to the offer date (%).
UPDATE	Return from the midpoint of the filing range to the offer price (%).
IPONUM	Number of firms with the same two-digit SIC code as the IPO going public during 30 days before the IPO.
SECOND	Secondary shares offered in the IPO in percent of total shares offered.
NSRET	Return on the Nasdaq Composite Index on the first day after IPO (%).
INIRET	Initial return from the offer price to the closing price on the first day after IPO (%).
RETAIL	Dummy variable equal to 1 if the underwriter has major retail brokerage operations.
MF/AM	Ratio of mutual fund assets to total assets under management for the lead underwriter (%).
MF/IPO	Ratio of mutual fund assets managed by the underwriter to the volume of IPOs taken public by the underwriter in the 1990s (%).
COMMIS	Fraction of the lead underwriter's revenues derived from commissions (%).
MANAGE	Fraction of the lead underwriter's revenues derived from asset management fees (%).
PRINC	Fraction of the lead underwriter's revenues derived from principal transactions (%).

INVBANK Fraction of the lead underwriter's revenues derived from investment banking (%).

INV Marketmakers' accumulation of the IPO shares on the first day after IPO in percent of shares offered.

INVBID Bid stickiness at the offer price on day 1, where the stickiness is measured as the average marketmaker inventory accumulation preceding a bid change, if the current bid is at the offer price (% of shares offered). The variable is constructed as follows. First, I select all bids on day 1 equal to the offer price. Second, I compute inventory accumulation for each bid from the time the bid is quoted (or from the beginning of trading for the first bid) to the next bid change (or to the end of trading on day 1 for the last bid). Finally, I average the accumulations across bids for each stock to compute *Invbid*. If the bid stays at the offer price throughout day 1, total inventory accumulation on day 1 is counted.

INVBID2 Bid stickiness at the offer price on day 1. The variable is computed similarly to *Invbid*, except that only a subset of bids is counted, for which the next quote is a decrease. Last bid change for a stock is classified as a decrease or an increase based on the first bid change after day 1.

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