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Abstract

Price clustering in initial public offerings (IPOs) is extreme, pervasive, and long-lived. In a 25 year sample of 7,805 IPOs, offering prices range from one tenth cent to $5,000 per share. However, the price frequency distribution yields a clear triple peak with three discrete values, $5, 10, and $15 per share, accounting for 21.5% of all IPO prices. Clustering pervades every one of the top 20 two-digit SIC code groupings and every year from 1970 through 1994. Firms, underwriters and investors appear to have such consistent preferences for certain nominal prices per share that the mean IPO price per share dropped by 67.7% in real terms during the 25 year period. Additionally, the median IPO price has lagged inflation; it was $10 per share in 1994 as it was in 1990, 1989, 1983, 1977, 1973, 1972, and 1971. Two-day returns are 147 basis points (13%) higher for IPOs priced at $10 per share than otherwise similar firms. These results may indicate that underwriters choose the more highly-rounded prices to signal less precise valuations and that shareholders may earn higher returns for greater uncertainty. These findings build on Harris (1991) concerning clustering in seasoned stocks.

IPO Price Clustering and Discreteness

I. Introduction

The examination of price clustering and discreteness in seasoned stocks has a rich history dating to at least Osborne (1962) and Niederhoffer (1965) but similar studies of initial public offerings (IPOs) are still lacking. Harris (1991), hereafter Harris, examines seasoned stocks and finds that, "Stock prices cluster on round fractions. Clustering increases with price level and volatility, and decreases with capitalization and transaction frequency." Harris does not examine nor make predictions concerning IPOs. IPOs also exhibit price clustering, and do so to an extreme degree, with 94.7% of IPO prices occurring on integers, halves, and quarter dollars.

IPO price clustering extends well beyond integers and round fractions. IPOs also cluster on $5.00 per share increments. Unlike in Harris, price clustering, as measured by the frequency of integer-priced IPOs, does not increase, but rather is unrelated to price level, transaction frequency, and capitalization. Instead of increasing with volatility, as Harris found, IPO clustering declines. Price clustering in IPOs is also negatively related to initial returns but unrelated to insider holdings, dealer versus specialist market listing, and whether an IPO had been a leveraged buyout (LBO). Interestingly, venture capital-backed firms are more likely to have their IPOs on integer prices. Within the IPO literature, there is little or no investigation of price clustering; this paper fills that void.[1]

[1] Ibbotson and Ritter (1995) offers a review of the IPO literature.

This paper examines price clustering in a quarter-century long sample of IPOs, tests the relevance of Harris' assertions with respect to IPO prices, offers a new theory of price clustering in IPOs, and tests it. There are two other areas of research which, while avoiding any reference to IPOs in particular, nonetheless, offer insights into the analysis of IPO price clustering. These are the stock split literature[2] and several papers which discuss price clustering in non-stock markets.[3] These disparate literatures are incorporated immediately.

Figure 1 shows the price frequency distribution for those 7,529 IPOs with prices below \$65 and priced on eighths from the full set of 7,805 IPOs occurring during 1970 through 1994. This price frequency distribution yields a clear triple peak with three discrete values, \$5, 10, and \$15 per share, accounting for 21.5% of all offering prices. Minor price clusters at \$1, 8, 12, and \$20 are also apparent. Integer prices account for 65.7% of IPOs (Figure 1, top line). Prices ending in one-half dollar constitute 19.6% of IPOs and minor half-dollar clusters are apparent at \$2.50, 7.50 and \$12.50 (second line from top of Figure 1).

The choice of price per share is associated with economically and statistically significant differences in the initial returns of IPOs. Empirical evidence shows that IPOs priced at \$10 per share have 147 basis points (or 13.5%) higher two-day returns than other IPOs with equal post-IPO variance, market value, volume, and insider holdings. IPOs with above-average returns are 15.2% more likely to be priced on \$10 than all other prices. Furthermore, the inflation-adjusted price per share declined dramatically over 25

[2] See Brennan and Copeland (1988).
[3] The most relevant of these is Ball, Torous, and Tschoegl (1985).

years. The mean real IPO price per share dropped by 67.7% from 1970 to 1994. The median nominal IPO price also showed little influence of inflation. The median was $10 per share in 1994, 1990, 1989, 1983, 1977, 1973, 1972, and 1971. The remainder of the paper is organized as follows: Section II contains background and relevant literature. Section III analyses price clustering in IPOs. Section IV develops and tests hypotheses concerning clustering. Section V concludes and discusses regulatory implications.

II. Background

For the most part, the selection of a particular price per share for an IPO is of little or no relevance in the current theory of finance. Brennan and Copeland (1988) express this view with respect to seasoned stocks, "It is widely believed that stock splits are purely cosmetic, since the corporation's cash flows are unaffected, each share holder retains his proportionate ownership, and the claims of the other classes of security holders are unaltered." To the extent that this point is true for seasoned stocks, it is all the more correct for IPOs. Ritter (1997) supports the cosmetic nature of splits when he writes, "firms frequently conduct a stock split or reverse stock split to get into the target price range." Thus, it makes no difference, in theory, whether one prices[4] an IPO at $9, 10, or $11 per share, holding valuation constant and adjusting shares accordingly.

But if price per share does not matter, why then has there been such extreme, pervasive and long-lived price clustering in IPOs? Furthermore, why do certain security

[4] In the IPO literature, pricing is increasingly used to mean valuation. To be clear, pricing in this paper means setting the price per share while holding the firm's valuation constant. Valuation means determining the market value for the firm, i.e. price per share times total shares outstanding.

regulations[5], exchange listing requirements[6], and pension fund charters establish rules based upon price per share? While these rules might modestly constrain established firms, with established prices, IPOs by their nature do not have a price history and therefore, it would seem that, new issues can costlessly avoid or even exploit rules based on price per share.[7] Given a persistence in certain nominal prices, and a regulatory focus on same, is this possibly evidence that IPO price per share means something? Does the IPO price per share convey valuable information to investors? If so, how can an informative pricing custom or convention[8] exist in the competitive IPO market? Or alternatively, is the choice of IPO price a nearly neutral custom with no empirical and no regulatory relevance? These research questions are addressed herein.

Literature on price clustering

Price clustering has been examined in a number of markets: corn and soybeans[9], foreign exchange[10], gold[11], houses[12], seasoned stocks (NYSE, AMEX, NASDAQ, and London)[13], and treasury bills[14] to name but a few. These papers are summarized,

[5] Ritter (1997) makes this point, "Stocks with a price below $5.00 per share are subject to the provisions of the Securities Enforcement Remedies and Penny Stock Reform Act of 1990, aimed at reducing fraud and abuse in the penny stock market."
[6] Under the Nasdaq National Market listing requirements, initial price per share must be $5.00 or higher and initial SmallCap listing requirements are $4.00 or higher. Continued listing on either market generally requires a minimum price per share of $1.00. Certain other requirements, minimum levels of assets, share float, market capitalization, can raise the minimum price to $4.00 per share for continued listing. These rules were approved by the SEC and became effective on August 22, 1997.
[7] Existing firms can avoid minimum price rules also by modestly-costly reverse stock splits.
[8] From the American Heritage Dictionary, Custom: A practice followed by a particular group or region. A person's habitual practice. Convention: General usage or custom. An accepted or prescribed practice.
[9] Stevenson and Bear (1970).
[10] Goodhart and Curio (1991).
[11] Ball, Torous, and Tschoel (1985) and Grossman et al. (1995).
[12] Harris (1991) and Grossman et al. (1995) discuss this briefly.
[13] For example see Osborne (1962), Neiderhoffer (1965), Harris (1991), Christie and Schultz (1995), Grossman et al. (1995).
[14] Dale (1981).

highlighting how price clustering is exhibited across markets. First, Harris stresses that the lowering of negotiation costs is the primary motive, observing that, "Price clustering occurs because traders use a discrete set of prices to specify the terms of their trades." Grossman, Miller, Fischel, Cone and Ross (1995) (Grossman et al.) summarizes the decision facing traders by stating, "Finer units of trade allow for more accurate pricing. But this is a mixed blessing. It takes time and effort to obtain more precise valuations of assets, making such valuations more costly." Ball, Torous, and Tschoegl (1985) (BTT) emphasize the importance of examining dynamic price formation thusly, "The degree of price resolution - whether prices are quoted to the nearest 5, 10, 25, 50, or 100 cents - is not constant, but rather is a function of the amount of information in a market, and the level of variability of the price." BTT later add, "The fact that transactions actually occur at eighths (stocks) or twentieths (gold), rather than at some nth place decimal, is important from the point of view of the microeconomics of price formation." Following BTT and others, it is conjectured that careful study of clustering in IPOs may add to the understanding of the microeconomics of IPO markets.

A general theory of price clustering

Building on Harris, BTT and Grossman et al., a general theory of price clustering can be outlined. First, price clustering is only apparent when the minimum unit of pricing, the tick size in stock markets, is less than the coarseness of pricing preferred by traders. It is obvious that, if tick size is large (small) enough, clustering is unobserved (always observed). Second, traders' preference for coarser prices depends inversely upon the frequency with which they trade (one-time, infrequent, frequent or continuous) and the time available for transacting, and directly with the cost of transacting, including, but not limited to, asset valuation and negotiation costs. Repeated transacting in similar assets, or more time to agree on a given transaction, would allow for improved communication between buyers and sellers and therefore, finer prices, ceteris paribus. Third, separate from other costs, the coarseness in prices increases with the uncertainty and volatility of asset prices. Finally, the choice of coarseness is made simultaneously in consideration with all other benefits and costs of trading and coarseness may be altered in response to changes in information, so as to maximize a trader's (or a set of traders') utility, profits, or both for a given trade (or a series of trades).[15]

With any study of clustering, it is important to differentiate the coarseness of prices and quotes. Quotes are necessarily more coarse than prices. This is because quotes are proposed transactions; prices are actual transactions, the result of a quote being accepted. Prices, thus, are a subset of quotes. Grossman et al. emphasize the point that quotes communicate a willingness to trade but have an imbedded free option to "take it or leave it." For this reason and in order to reduce adverse selection, frequent traders (including dealers) will prefer to transact repeatedly with the same customers for, and suppliers of, order flow and to quote in more rounded figures and in the smallest possible quantity. Absent adverse selection, the opposite case holds. Traders prefer precise prices, large quantities, and any source. Finally, the higher the fraction of total order flow a trader maintains, the lower the cost of adverse selection the trader suffers.

[15] Any empirical investigation of clustering faces a constraint identified in BTT, since all prices are rounded, all returns have an "error in variables problem."

Clustering in IPOs is unique

The examination of price clustering in IPOs offers a special case, or limiting circumstance, of price clustering. This circumstance is unavailable for observation in many other asset markets, therefore the study of price clustering in IPOs is valuable. IPOs have neither a price history nor a fixed unit size. The lack of a price history is important in that it increases to the maximum possible limit the uncertainty concerning valuation for an equity asset.[16] While seasoned stocks may trade somewhat infrequently, IPOs in the most exact sense[17] have never traded, and are thus the most uncertain possible valuation circumstance for stocks.

Within wide bounds, shares have no natural, economic or historical unit size. A share can just as easily represent one two hundred millionth of the ownership of the firm or one ten thousandth. In many markets, a natural unit of trade exists. For example, in the retail automobile or the housing market, a natural unit of one exists, due to their price level and utility in use. For shoes, socks, or gloves a pair is the obvious choice. Alternatively, there is no such natural unit size for shares in a firm. Economically, so long as the firm has sufficient float for continued trading, any share size (or price) will do in practice. This means there is little economic rationale between 10% or 20% differences in float and price per share, thus rounding can occur at no great cost. Furthermore, unlike the commodities markets, shares have no physical meaning nor history of prior use, the

[16] Ritter (1997) observes that many IPOs have been pulled from the market the day before their offering for changes in the market conditions which had nothing specifically to do with the firm. Thus, IPOs have all the risks of seasoned equities, because they will become seasoned equities shortly, plus they have risk specific to the "going public event" itself. If the firm fails to go public, current shareholders face a loss of valuation, due to the expense of the process, and the continued illiquidity of the investment.

[17] Some IPOs are in fact LBOs which are coming back to the public market. This circumstance allows for a test of differences in uncertainty which will be developed and tested in the next section.

way a bushel of corn, an ounce of gold, or a barrel of oil has meaning and history. Shares and prices per share, when considered simultaneously, are almost fully arbitrary. For these reasons, the examination of IPOs offers an opportunity to study price clustering absent some of the constraints of other asset markets.

Irrelevance of IPO price per share

Certainly, at the time of the IPO, a firm and its underwriter can agree to set the offering price per share and simultaneously agree on the number of shares to be issued, naturally holding the offering size and valuation roughly constant. For example, if a firm seeks $12 million in equity capital from an IPO, in theory, there is no difference between a firm that issues 1 million shares at $12 per share, a firm which issues 1.2 million shares at $10 per share, or one which chooses 1.5 million shares at $8 per share. Each price-quantity pair results in $12 million in capital. Likewise, the firm could issue at a price of $4, 5, 6, 15, 20, or $24 per share with offering sizes of 3.0, 2.4, 2.0, 0.8, 0.6, or 0.5 million shares, respectively, and achieve the same end. Presumably then, a wide range of prices per share, including fractions, are possible in an IPO. However, if price per share is truly irrelevant, theoretically, it is equally possible that all IPOs could have the same[18] per share price or prices could be randomly distributed about some mean. IPOs do in fact occur over a wide range of prices. In the 7,807 IPO prices examined, prices range over 6

[18] Essentially, the corporate bond markets have adopted this "one unit price" pricing custom for original issues. Virtually all bonds have a $1,000 face value and an original issue price very close to $1,000.00 per bond. Zero coupon bonds, being the exception in that their final unit prices rather than original prices are all close to the same arbitrary value of $1,000 but bearing a zero coupon, initially trade at a deep discount. The point of comparison is that corporate bonds are rarely, if ever, issued with face values and initial unit prices of $100, $10,000, $1,995, $100,000, $500, $2,500, etc.

orders of magnitude from one-tenth cent to $5,000 per share. Yet careful study shows that the distribution of prices per share are neither uniformly distributed, nor random, and certainly a single-unit-price auction for IPOs is not customary.

Underwriters, the firms they represent, and the investors they seek to attract have shown a consistent preference for certain nominal prices per share. Specifically, $5, 10, and $15 per share are frequently chosen but do not constitute a majority of initial prices. One possibility for the existence of price clustering in IPOs is that the casual habits of the underwriters may dictate the underwriter and firm's selection of one particular offering price from an arbitrary set of prices per share. Underwriters may have chosen to issue most of their deals (68.4%) over the past 25 years at $5.00 to $15.00 per share for "no good reason" or simply because "people prefer round numbers." Ritter (1997) emphasizes the irrelevance of particular prices per share with a description of a preferred price range, "...most companies prefer an offer price of between $10.00 and $20.00 per share..." If there is no good reason for choice of a particular price, or if any round number will suffice, for example $10 per share, then in a large sample there will be no difference in initial returns between portfolios of $10 and non-ten dollar price-per-share IPOs when controlled for other determinants of initial return.[19]

Pooling?

An alternative possibility, which also explains the observed distribution of prices, is that firms are pooled by underwriters, who are following a pricing custom or

[19] Brennan and Copeland (1988) use a similar argument with respect to stock splits, "If stock splits are purely cosmetic it would be surprising to find them associated with real events."

convention, and the underwriters select certain per-share prices to signal certain common characteristics. For example, underwriters may use prices to signal the accuracy of their valuation, risk, liquidity, offer size, industry or exchange norms, etc. This prediction, *that firms are pooled by common characteristics based on nominal price per share, and the empirical tests of price per share acting as a signal, differentiates this paper from prior work which makes no prediction concerning signalling or expected returns.* It is hypothesized, more formally to follow, that underwriters use the most coarse[20] or highly-rounded price per share, the $10 price, when the underwriters' valuation is least precise.

If the use of the $10 price per share is in fact signalling, it is an unusual signalling phenomena because the number of shares issued and the price per share can be simultaneously adjusted to accommodate any firm valuation. Thus, there is no verifiable cost to the "rounded-price" signal in the period it is given.[21] The clear benefit is a coordinating convention. If buyers and sellers know that rounded prices mean greater uncertainty, then they can more quickly agree on fair prices, rounded or otherwise. In addition to not being verifiable, another unusual feature is that individual firms bear the cost, but the benefits accrue to the group of investment bankers and investors. The cost of the signal, borne by the existing shareholders, is not "cheap talk." Rather, it is the lower pricing, on average 147 basis points lower pricing, for firms priced on the most-rounded $10 share prices. The entrepreneur with a firm of uncertain valuation has an incentive to encourage the banker to cheat by underpricing less. But the hypothesized

[20] Price per share of $5 and $15 may indicate slightly greater precision than $10 or may serve some other signalling objective. As the precision of valuation increases, underwriters may first use integers, then prices ending in half dollars, then quarter dollar price per share increments. Finer fractions, those beyond one quarter dollar, do not account for a significant part of this pricing convention.

[21] Grinblatt, Masulis and Titman (1984) dismisses stock splits as a signal based on management achieving a certain desired trading range. Their logic is that a split could be costlessly reproduced by a firm interested only in the short term impact on its price.

(and unmeasurable) benefit is efficient and fair dealing for the syndicate and the investors.

It is conjectured that an equilibrium could be maintained in which sufficiently few underwriters defect[22] (mimic higher precision, cheat by pricing off $10 per share and increasing valuation). Defection may be suboptimal due to a viable threat of ex post retribution. In the case of IPOs, retribution for deviates is possible by dropping a deviate underwriter from future syndicates or by refusing to participate in the deviate underwriter's syndicates. Underwriters will retaliate against deviates if the expected value of retaliation, with the hypothesized signalling convention intact, is higher than acquiescence.

While a formal model is left for another paper, some support for this uncommon signalling argument is obvious, and follows directly. The vast majority, if not all, underwriters depend on the strength of mutually beneficial syndicates for rapid and efficient marketing, and initial market making, of IPOs. Assuming a convention exists, when an underwriter deviates, if that underwriter was excluded from future syndicates, it would be severe punishment to the deviate. Deviates, lacking the breadth of the syndicates, would also suffer a loss of their own underwriting business as firms seeking underwriters would go elsewhere. Repeated dealing by IPO syndicates would allow for defectors to be detected. It is presumed that syndicates enforce these pricing customs, if they if fact exist, because it benefits them financially, but the exact mechanism of that benefit and the system of sanctions which support the behavior is left for another paper.

[22] This is defection in the game theory sense. Defection means the underwriter with the low-quality type IPO (highly uncertain valuation) gives a high-quality IPO signal (unrounded price). For example, defection is pricing a highly uncertain IPO at $11.75 or $8.75 or other unrounded price, adjusting shares accordingly, when the underwriter knows his valuation is imprecise and should have been priced at a more rounded, simple $10 price. Normally, for a signal to be robust, the low-quality types must not be able to mimic the high quality types except at a prohibitive cost. Thus, the high-quality signal has validity.

In this paper, the extent and economic significance of IPO price clustering itself is the focus of investigation. The investigation of IPO price clustering and of the relationship between initial returns and price per share is new to the IPO literature. As Ritter (1997) summarized prior empirical work, "the IPO literature has concentrated on the degree of underpricing or the relationship between valuation and such variables as the choice of auditor or underwriter, or the proportion of equity retained by insiders."

III. Analysis of price clustering in IPOs

Data from Securities Data Corporation (SDC) show that from January, 1970 through December, 1994, there were 7,805 IPOs with price-per-share and shares-offered data.[23] Table 1 gives the independent[24] distributional properties of the price, shares, and offer size for these IPOs. The sample mean (median) price is $10.95 ($10.00). Although the mean is $10.95, there were no IPOs offered at $10.95. While one might expect that IPO prices ending on 95 cents or 99 cents might be common, as these prices are common in the retail trade, nothing could be further from the truth. Of the sixty possible prices ending in 0.95 or 0.99 between $0.95 and $29.99, there is only one such occurrence, in the sample of 7,807; it is priced at $14.95. The mean shares value is 3.58 million (M) (1.40 M) and the mean offering size is $36.8 M ($9.7 M). Price, shares, and offer size distributions are left truncated (at zero) and skewed right; the mean price is within the interquartile range of $5.80 to $14.00, whereas, the mean value of shares and offer size

[23] There were only two firms which had shares data but no price data and two which had price data but no shares data. The SDC data is remarkably complete, listing both price and shares data for 7,805 of 7,809 IPOs.

[24] These distributions are independent in the sense that the maximum offer does not result from the maximum price times the maximum shares.

are above the interquartile range. The interquartile range for shares is 675,000 to 2.80 M and offer size is $3.8 M to $30.0 M.

There exists a wide range in prices, shares, and offer sizes. Even though one IPO[25] was offered at just $0.001 (one-tenth cent) per share, and 18 offerings were priced at $0.01 (one cent), all IPOs below one dollar per share account for only 2.5% of offerings. The prices $1.00 through $20.00 account for 92.6% of offerings. Higher prices per share are exceedingly rare, as 99.5% of all IPOs are offered at $30 or less per share. Nonetheless, high prices are possible. In these data, one IPO[26] was offered at $5,000 per share, another at $1,025. Totally, there were only five priced above $100, and just 39 were priced above $30.

Table 2 shows selected distributional properties for offer-size deciles 1 (largest) through 10 (smallest). The largest decile has a mean offer size of $230 M ($157 M) while the smallest is $1.0 M ($1.0 M). Differences in offer size are determined more by number of shares issued rather than price per share. The mean shares issued decreases from 15.4 M (9.85 M) for decile 1 to 2.58 M (0.20 M) for decile 10. This is a six-fold drop in the mean and a 49-fold drop in the median. Price per share is lower for smaller offers but relatively less so than shares issued. Prices range from $17.28 ($15.00) in decile 1 to $11.22 ($5.00) in decile 10. This is a 1.54-fold drop in the mean and a three-fold decline in the median. Harris shows that in seasoned stocks, clustering decreases with capitalization and transaction frequency. In IPOs the opposite seems to hold. In small offers, 59% are priced on integers but in large offers that fraction increases to 76%.

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[25] Quogue Ventures offered 100 million shares of CUSIP 74907210 at $0.001 on May 23rd, 1986.
[26] On May 11th, 1983, Schuchardt Software Systems offered 300 shares at $5,000 for CUSIP 80815010.

The propensity to price on \$5, 10, or \$15 per share is high in each decile. Nine out of ten deciles have a mode of \$5, 10, or \$15 per share. The exception is decile 3, which has a mode of \$12 per share.

Following Harris, Figure 2a is formatted like Figure 1 in his paper. Figure 2a shows the frequency distribution of the fractional portion of IPO prices by integer price level. Harris used a similar relation to Equation 1.

$$Y_i(n) = \frac{N_i(n)}{\sum_{k=0}^{7} N_i(k)} \quad \forall i = 0 \, to \, 30 \qquad (1)$$

The frequency, Y_i (**n**), is the percentage of prices ending with the set of **n** eighths such that **n** contains one or more eighths, 0 to 7, for the integer price levels i = 0 to 30. N_i (**n**) is the number of occurrences of IPOs priced with a particular n-eighth fraction of the total number of IPOs priced on all eighths, k = 0 to 7, at a particular integer price level i.[27] Naturally, the sum of Y_i (k) for k = 0 to 7 equals 100% for all i. Of the 7,771 IPO prices equal to, or below \$30 per share, 7,498 or 96.5% are priced on eighths.[28] If IPOs are offered uniformly across all eighths, one observes 12.5% of prices occurring on integer (n=0) values, with 50% on even eighths, Y_i (0,2,4,6), and 50% on odd eighths, Y_i (1,3,5,7).

$$Y(0) = \frac{\sum_{i=1}^{30} Y_i(0)}{30} \quad and \quad Y(n) = \frac{\sum_{i=0}^{30} Y_i(n)}{31} \; \forall n = 1 \, to \, 7 \qquad (2)$$

[27] $Y_0(0)$ is undefined, but Y_0 (1) is not.
[28] IPO Prices above \$30 are so infrequent that analysis of the distribution of their fraction is meaningless.

The cross-sectional mean of Y(**n**) is given by equation 2.[29] While Y(0,1,2,3,4,5,6,7) is 100%, the mean of Y(0) alone is 67.5% and the mean of Y(4) is another 22.1%. However, unlike Figure 1 in Harris, Figure 2a shows no relation of price level i and integer, $Y_i(0)$, nor half-dollar, $Y_i(4)$, price distributions and certainly nothing approaching a strong positive relation, e.g. $\Delta Y(0)/\Delta i >> 0$. *Price clustering in IPOs is extreme, more so even than reported by Harris, but clustering appears unrelated to price level.* Of all 7,805 IPO prices, for which shares data was available, 5,132 or 65.7% of IPOs have integer prices. This density of integer pricing is 3.8 times the 17.3% frequency reported for seasoned stocks in Harris. Half-dollar prices account for another 19.6% of IPOs. Furthermore, just three discrete IPO prices, $5, 10, and $15 dollars per share, account for 21.5% of all IPO prices.

IPO clustering differs from Harris

To test whether apparent lack of cross sectional clustering in Figure 2a is in fact statistically unrelated to price level in IPOs, two OLS regressions are shown.

$$Y(0) = m_0 INT + b_0 \qquad (3)$$

$$Y(4) = m_4 INT + b_4 \qquad (4)$$

The frequency of integer prices, Y(0), and half-dollar prices, Y(4), is regressed on integer price level, INT = 0,[30] 1, 2 ... 30. This method gives equal weight to each level of integer price, rather than giving equal weight to each observation. This is done so as not to

[29] The divisor is 30 for the mean of the integer distribution because $Y_0(0)$ is undefined.
[30] The integer price level 0 allows for fractional prices below $1 which are also examined.

overly weight the more common price levels but rather to spread the weight evenly across the entire range in INT.[31] This is appropriate because the test is for the *response of clustering to price level.* These OLS regressions, with standard errors in parentheses, are shown below,

Y(0)	=	0.00242 INT +	0.638	$r^2 = 0.027$
		(0.00276)	(0.0491)	F = 0.765.
Y(4)	=	- 0.00332 INT +	0.271	$r^2 = 0.064$
		(0.00236)	(0.0412)	F = 1.98.

The t statistics for the m_0 and m_4 coefficients on INT are t = 0.87 and 1.4, respectively, and are insignificant at the 5% level confirming the lack of a strong relation between IPO price clustering and price level apparent in Figure 2a. And while neither coefficient on price level is significant, the integer relation, Y(0), is slightly positive and the half-dollar relation, Y(4), is slightly negative. The intercepts, b_0 and b_4, are highly significant and correspond to 63.8% and 27.1%, respectively.

In seasoned stocks, Harris observes "Clustering increases with price level." Harris shows this both cross-sectionally (with a graph) and in time series (by regression). As no time series analysis of the type Harris used is possible with IPOs, here the focus is on cross-sectional comparisons. Harris' Figure 1 addresses the cross-sectional relation by showing an obvious and dramatic positive slope for the distributions of stocks priced on integers, Y(0), and stocks with a one-half dollar fraction in their price, Y(4). Estimating

[31] The integer price $2.00 has 147 observations whereas $28.00 has only 8 observations. In the OLS regressions used here, these two integer price levels are given equal weight.

from his figure[32] these (unreported) findings by Harris are

$$Y(0) = 0.00155\ INT + 0.13 \quad (5)$$

and $$Y(4) = 0.00045\ INT + 0.13. \quad (6)$$

Standard errors of the coefficients, through unquestionably small, cannot be estimated from the data given in Harris alone. The intercepts for both linear fits are roughly 13% which is very close to the 12.5% expected in a uniform distribution of eighths. With Equation 5, Harris predicts 16% integers at a $20 price level and Equation 3, for IPOs, predicts 67%.

Finer fractions

Further evidence that clustering in IPOs does not increase, in simple fashion, with integer price level is given in Figure 2b; it shows the distribution of 273 finer-than-eighth price fractions for thirty one price levels - one for each integer price level through $30 and one for zero. If price clustering increases with price level, one would expect that the use of finer fractions would decrease with increasing price; this is not the case for IPOs. Finer fractions, though relatively uncommon above $2, form a U-shaped relation with IPO price level. The use of finer price fractions is less common in the $5 to $15 range than at lower and higher price levels. For example, from the IPO price per share range of 6 5/8ths to $9, there are 1,116 IPOs but none are priced off of an eighth price fraction. At higher price levels, IPOs with finer-priced fractions are rare but relatively more common than in the middle range of IPO prices. By this measure, price concentration increases and then

[32] Neither the slope nor the significance of the slope supporting Harris' claim that "clustering increases with price level" is reported. It is obvious from his figure that the slope of a regression through his zero-eighths and four-eighths distributions would be positive. Furthermore, his sample includes over 14 million data points almost assuring the statistical significance of his results is high.

decreases with price level. The relation of finer fractions and integer price level in seasoned stocks is not reported in Harris.

Analysis of price fractions indicates that fractions below one-quarter dollar are rare. Figure 3 shows the distribution of those 7,605 IPOs (Series 1, cross-hatched bars) priced on eighths of the total 7,807 IPOs with price data. Of these IPOs, 94.8% occur on even eighths (0/8ths, 2/8ths, 4/8ths, and 6/8ths) while just 1.7% occur on odd eighths (1/8th, 3/8ths, 5/8ths, 7/8ths). The slight remainder, 3.5%, constitute all finer price fractions, some with as many as five non-zero decimals. Limiting the sample to IPOs priced from $1.00 to $100 changes the distribution only slightly, with 96.5% on even eighths, 1.7% on odd eighths, and 1.9% on yet finer fractions (Series 2, white bars). This data constitutes the principle evidence of extreme price clustering in IPOs first provided in Bristow and Field (1996).

Clustering is very high in all major SIC code groups

Price clustering is pervasive. Table 3 shows that price clustering, as measured by the integer and even eighths frequency, is high in every one of the top 20 two-digit Standard Industrial Classification code groups (SIC) tested. Of the 4,434 IPOs examined by SIC codes, the top 20 two-digit SIC codes account for 78.6% of these IPOs (N=3,485). This sub-sample is well-distributed across industries, as eight of nine one-digit groups are represented (agriculture is not represented in the top 20). The largest two-digit group is Holding and other investment offices, SIC 67 (N=545). SIC 67 has 89.2% of IPOs offered on an integer dollar, the highest of any group. Furthermore, across top 20 industrial sectors, IPOs are most often offered in integer dollars, ranging down to

45.1% for depository institutions, SIC 60 (N=368). Even when not priced on integers, IPO prices in the most common SIC codes are almost always priced on even eighths. Of IPOs in SIC 51, Wholesale trade - nondurables sector, 100% are priced on even eighths. The lowest use of even eighths in IPOs is 88.5% (N=52) in miscellaneous manufacturing, SIC 39.[33]

Real IPO prices have declined

Price clustering is also long-lived in the sense that the occurrence of particular nominal prices per share are virtually unaffected by inflation. Table 4 shows that of the 7,807 IPO prices per share examined the modal price of $5 per share was the same in 1994 as it was 25 years earlier in 1970. The modal price per share was also $5 in 1972, 1982, 1983, and 1984. The mode jumps rather dramatically (on a percentage basis) independent of inflation or market returns.[34] Further, five discrete IPO prices per share, $1, 5, 10, 12, and $15, all integer values, accounted for all modal values in 20 of the 25 years where there were more than 50 IPOs per year. In five years, 1974 to 1978, there were between 6 and 41 IPOs per year. In 18 of the 25 years, the mode is $5, 10, or $15. The $10 price per share is the 25-year modal value, 638 (8.17%) occurrences, as well the mode in eight years between 1971 and 1989. The frequency of use of the $10 IPO price per share is roughly the same in 1994 as it was in 1970.[35]

[33] This SIC group includes manufacturers of jewelry, sporting goods and office supplies.
[34] In 1972 to 1973 the mode moved from $5 to $15, but in 1993 to 1994 it did the opposite.
[35] In 16 of 25 years, IPOs priced on $10 per share accounted for between 5% to 10% of IPOs. In 1970, 20 of 219 (8.37%) were priced on $10, in 1994 the ratio was 45 of 596 (7.02%); the high was 62 of 228 (21.38%) in 1988, and the low was zero of nine in 1974.

Table 5 shows that the median price of $10 per share also demonstrates extreme intertemporal price clustering; the median is $10 per share eight times over the 25 year period, first occurring in 1971 and most recently in 1994. The mean price increased 27.7% from 1970 to 1994, in nominal terms from $8.97 to $11.46. The CPI[36] increased 296.0% from 37.8 to 149.7 over that same period. The 1970 mean IPO price of $8.97, when inflation-adjusted, equals $35.52 in 1994 dollars. Thus, the mean inflation-adjusted price per share for IPOs fell by 67.7% from $35.52 to $11.46 over the 25 years. The decline in real price per share is not a spurious, single year-specific aberration.[37] The mean IPO price for the first five years, 1970 to 1974, is $10.26 (N = 1,095) while the mean of the last five years, 1990 to 1994, is only slightly larger at $11.30 (N = 2,683). This represents a 10.1% increase in nominal price and a significant decline in real terms over this 20-year period.

IPO price per share differs across industries

Examination of IPO prices per share from 1970 through 1994 by two-digit SIC code groups indicates that the mean, median and mode prices per share differ significantly across industries. The distribution of IPO prices among the three most common prices, $5, 10, and $15 per share also varies markedly by industry. Table 6 shows the number of IPOs, the fraction which occurred on the New York Stock Exchange (NYSE) and American Stock Exchange (AMEX), the mean, median, mode (number of occurrences), and the percentages of IPO prices on $5.00, 10.00 and $15.00 per share by two-digit SIC

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[36] The CPI, used here, is the Consumer Price Index-All Urban Consumers, CPI-U, (1982-84=100) as provided by the Bureau of Labor.
[37] Ibbotson (1975), Table 22, page 267 - 270, shows prices per share for 108 IPOs from 1960 to 1965. These data have a mean price of $11.27, two modal values of $5 and $10, and a median of $10.

code grouping. These 13 two-digit groupings have 100 or more IPOs. The highest-priced SIC code grouping by mean IPO price is SIC 67, Holding and other investment offices (primarily closed-end mutual funds and REITs), with a mean price of $13.96. SIC 67 is the most common grouping with 545 IPOs; it has the highest fraction of NYSE and AMEX listings (% on NY/AM) with 91.9%, the highest median, $15.00, and mode, $15.00, with 203 occurrences. Nearly two-thirds of SIC 67 IPOs are priced on either $10 or $15 per share yet none on $5.

The second most common two-digit SIC code grouping, SIC 73 - Business services, has 398 IPOs but a much more even distribution across $5, 10, and $15 prices. Only 2.8% of SIC 73 IPOs occur on the NYSE or AMEX. The lowest-priced industrial grouping is SIC 50, Wholesale trade - durable goods, with a mean price of $8.65 a median of $8.25 and a mode of $5.00 with 13 occurrences. SIC 50 has the greatest fraction priced on $5.00 at 10.2%; the NYSE and AMEX are used in 5.5% of these IPOs. The SIC code with the second highest fraction of NYSE and AMEX listings (34.0%), SIC 60, also has the second highest mean price $13.74. The mean prices of both SIC 67 and 60 are more than 25% above the mean price per share of all IPOs ($10.95). While cause and effect are not clear, these data do indicate that investment bankers follow customs for industries and for exchanges when selecting the IPO exchange and the IPO price per share.

Shares offered are highly rounded also

One might argue that although prices are concentrated on integer values, the underwriter (or the offering firm) may simply fully adjust the shares offered to accommodate the coarse offering prices. However, as Table 7 demonstrates, shares offered also tend to be highly rounded. Almost 25% of all IPOs offer shares in 1,000,000 increments, 36% offer shares in 500,000 increments, 65% offer shares in 100,000 increments, and 79% offer shares in 50,000 increments. Only 8% of all IPOs offer shares in increments fewer than 1,000. Thus, there is not only a tendency for offer prices to be concentrated on integer values, but most share offerings are concentrated on increments of 1,000,000, 500,000, or 100,000 shares.

Shares cluster on approximate fractions

Since there exists extreme clustering on price per share and shares issued, it seems reasonable to examine if IPOs also cluster on the fraction retained by pre-IPO holders and thus the fraction offered to investors. Table 8 shows that clustering on fractions retained (or issued) indeed occurs, but to a much lesser extent than does clustering in price per share and shares issued. Panel A details the clustering on round decile fractions of those IPOs (56.8%) of all 7,805 IPOs occurring from 1970 to 1994 for which there was volume, variance, shares outstanding, share price and insider holdings data. In this table, 50% means exactly 50% of shares outstanding after the IPO were issued during the IPO. In the case of 50%, 36 of 4,434 IPOs (0.81%) retained (and issued) exactly half of the shares at the IPO. Panel B shows other selected fractions. The issued fraction one third (decimal equivalent 0.333333) is the most common fraction issued with 56 IPOs (1.3%). The fraction retained of 0.714286 is the most common six-digit decimal (having no simple fractional representation) with 13 IPOs (0.30%).

Figure 4 examines whether clusters occur on "approximate fractions" rather than exact fractions. Figure 4 shows the insider holdings (one minus fraction issued) distribution for those 4,434 IPOs analyzed in Table 8. Here insider holdings are rounded to the nearest one percent, 0% through 99%, forming a 100 element histogram approximating a continuous distribution. In this figure, 0% is the most common fraction retained with 405 IPOs (9.13%) essentially selling all outstanding shares at the IPO. None of these IPOs had exactly zero shares retained; those 35 IPOs with exactly zero shares retained were dropped from the sample as they were not distinguishable from missing data. Of the 405 IPOs with nearly zero insider holdings, 398 IPOs are in the two-digit SIC code group 67, which includes closed-end funds and real estate investment trusts (REITs). The significance of this extreme SIC code cluster will be examined in detail in the next section. The fraction 50% has 77 IPOs (1.74%) in this histogram. This frequency is more than twice the number of IPOs with 49% (30 IPOs) or 51% (29 IPOs). The most common percent is 67% which occurred in 180 IPOs (4.06%). Thus, the most common fraction of shares issued in an IPO corresponds to approximately one third.

IV. Hypotheses for price clustering in IPOs

Clearly IPO prices cluster to an extreme degree albeit in a manner different than do seasoned stocks. But the question remains does IPO price clustering matter? There are essentially just two possibilities: The first is that the choice of price per share does not matter in the sense that any reasonable price will suffice and that particular prices convey no valuable information to investors. The second is that clustering does matter and that certain prices per share convey information to investors.[38] Offer prices may cluster as a

[38] Regulators take this presumption a step further by arguing that stocks priced on certain prices per share should be more highly regulated or illegal to sell publicly. In this case, the price per share signals sufficiently to regulators to warrant action or prohibition, but is insufficiently obvious to investors.

reflection of pricing uncertainty by the underwriters, their clients, and investors. The pricing convention may be, "the less certain the valuation the more rounded the price per share." If this is in fact one convention, then the $10 price, the most rounded price in the relevant range of existing prices, would signal the underwriter's greatest uncertainty in valuation. Other priced-based signalling conventions may exist simultaneously, for example, stocks priced below $1.00 (or $5.00) may signal higher default risk. These investigations are left for another paper. But evidence of any convention, based on price per share, opens the possibility of other, perhaps more significant, signalling conventions.

If underwriters are using coarse price per share to signal greater uncertainty in IPO valuation, then rational investors, recognizing the underwriter's uncertainty, would require higher returns for IPOs priced on $10 per share. It follows then, that if the underwriter can more precisely value the offering, he may choose a price that reflects that more accurate valuation by using a non-ten dollar price. For more accurate valuation, the underwriter can underprice less. More accurate IPO valuation estimates might warrant an integer dollar price and the convention may or may not extend to fractions. If this convention is in use, then the underwriter must vary the compensation to investors for the level of uncertainty regarding valuation through higher initial returns (greater underpricing) on stocks offered at $10 per share versus other stocks.

Underwriters do not publish a measure of the accuracy of their valuations and multiple independent security analysts estimates of EPS are seldom available for IPOs. Therefore, a proxy for valuation accuracy must be used. The proxy used here, VAR, is the variance of the CRSP[39] daily returns over the first month (22 days) of trading. The

[39] CRSP is the Center for Research in Securities Prices at the University of Chicago.

assumption behind this choice of proxy is that on average the greater the aftermarket variance then the more uncertain was the underwriter's valuation. Thus, one expects that VAR will be positively related to initial return. The following hypotheses are tested:

Hypothesis 1: Underwriters choose prices per share based on nearly neutral customs which have no economic significance. *Empirical Prediction:* There will be no relation between the $10 offering price and initial returns.

Hypothesis 2: Underwriters compensate investors for greater uncertainty in valuation by greater underpricing on less accurate valuations. To signal greater uncertainty, underwriters use the $10 price per share. *Empirical Prediction:* There is a positive relationship between the offering price of $10 per share and initial return while controlling for variance, volume, market value, and insider holdings.

The exact construction of this hypothesized signalling convention is not presumed to be known. It is possible that in addition to the $10 price, the $9 and $11 or $8 and $12 prices are also part of the rounding convention; likewise, perhaps $5 and $15 are included with the $10 price as "the most rounded prices." But it is not necessary to know the exact convention to test if a convention exists; the empirical implication of all of these variations on the exact convention is that stocks priced on the $10 price will have higher initial returns than comparable firms. Given the distribution of prices in Figure 1, it is difficult to offer any plausible convention, which signals greater than normal uncertainty in valuation, and is based on price per share, that would not include the $10 price. For this reason, the $10 price per share is the focus of seven empirical tests of signalling which follow immediately. The main point of these tests is that in an efficient market with signalling, shareholders will demand a higher return for securities with greater uncertainty. Therefore, if there is a signalling convention involving the $10 price per share, and if IPO markets are informationally efficient, IPOs stocks priced on $10 per share will have a higher return than other securities.[40] This will be measured two ways. Logistic regressions will assess the impact of initial return on the probability of an IPO price being set on $10 per share. Ordinary least squares (OLS) regressions will measure the portion of the initial return, if any, that is explained by a $10 price dummy.

Finally, Leland and Pyle (1977) proposes, and it will be tested here, that higher holdings by insiders signals higher IPO valuation. The fraction of the shares retained by non-selling shareholders, α, is used as the proxy for insider[41] holdings. If Leland and Pyle are correct then α should enter the following regressions significantly.

Regression results

Table 9 contains the results of tests of Hypotheses 1 and 2 with stepwise logistic regressions of one to five exogenous variables wherein the endogenous variable takes on the value of one if the IPO price is $10 per share and zero otherwise. The exogenous variables used in the logistic regressions include (i) RET, the initial return, which is the two-day IPO return calculated as the absolute value of the CRSP price two days after the IPO date divided by the offer price, OPrc, minus one; (ii) VAR, the variance of the CRSP

[40] If price per share is a signal, whether it is penny stocks, or ten-dollar priced stocks, IPO markets could be informationally efficient (use price per share as information) but fail the weak form test of market efficiency.
[41] It is possible that some pre-IPO shareholders are non-insiders as defined by the Securities Act of 1933. However, in Leland and Pyle's model, their insiders are better-informed investors, thus non-selling shareholders are a near perfect proxy. These shareholders were sufficiently well-informed that they chose to

daily returns over the first month (22 days) of trading; (iii) VOL, the average daily volume over the first month (22 days) of trading (and alternative variable to VOL, turnover, TO, which is VOL divided by post-IPO shares outstanding will also be tested[42]); (iv) the firm's market value, MV, calculated as the product of the number of shares outstanding after the IPO multiplied by the IPO price; and (v) the proxy for insider holdings, α, the fraction of the firm retained after the IPO (i.e., one minus the fraction of the firm sold at the IPO). VAR, VOL, and MV are regressed in natural logarithmic transformation (Ln) so as not to give disproportional weight to relatively large or small values.

The full sample of 7,809 IPOs from SDC is reduced to 4,434 IPOs for which there are data on all exogenous variables. The greatest number are lost when daily data are required from the CRSP daily files. For example, when the SDC IPOs are matched to the CRSP header records by CUSIP number, IPOs not listed on the NYSE, AMEX or NASDAQ system and those IPOs before 1973 on NASDAQ are unavailable for further analysis.[43] SDC IPOs for which there was not a CRSP CUSIP match totaled 2,037. Also share volume data are missing on 619 IPOs and 609 unit offerings are excluded because there are no data on returns for the warrant portion of the units. Of the remaining 4,434 IPO sample, 437 IPOs or 9.86% are priced on \$10 per share. The SDC sample has 638 or 8.17% of IPOs priced on \$10 per share. This SDC-CRSP matched sample contains slightly more clustering on \$10 per share than the full SDC sample, as very small firms and low-priced stocks are less likely to be on the CRSP tapes.

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own the stock prior to its offering to the general public.

[42] Michael Brennan is thanked specifically for making this suggestion regarding an alternative variable.

[43] NASDAQ daily data begins on CRSP on December 14, 1972.

The collection of exogenous variables is denoted by $\mathbf{x}'$ = (RET, VAR, VOL, MV, α). The conditional probability that IPO price equals 10 is denoted by $P(Y=1|\mathbf{x}) = \pi(\mathbf{x})$. The logit of the multiple logistic regression is given by equation 7,

$$g(\mathbf{x}) = \beta_0 + \beta_1 RET + \beta_2 VAR + \beta_3 VOL + \beta_4 MV + \beta_5 \alpha \qquad (7)$$

in which case,

$$\pi(\mathbf{x}) = \frac{e^{g(\mathbf{x})}}{1 + e^{g(\mathbf{x})}}.$$

Table 9 shows that IPOs with offer prices of $10 per share are associated with higher initial returns, $\beta_1 > 0$, statistically significant at the p=.01 level. This is true with the addition of stepwise controls for variance, volume, market value, and insider holdings and with all variables present (Table 9, Column 6). In the presence of the other independent variables, higher VOL and α increase the probability, β_3, $\beta_5 > 0$, of a $10-priced IPO and higher MV decreases that probability, $\beta_4 < 0$. Interestingly, the coefficient on VAR, $\beta_2 > 0$, is positive and significant with RET alone, but VAR is insignificant and negative in the presence of RET, VOL, MV, and α. These results reject Hypothesis 1 ("nearly neutral customs") and do not reject Hypothesis 2 ("price-based signalling"). If the scaled variable turnover, TO, is substituted for the unscaled variable volume, VOL, the results change slightly as shown below equation 8. The estimated coefficients are shown with the absolute value of the standard errors, the Chi Squares and the probability of those Chi Squares. The whole model has five degrees of freedom, a Chi Square of 191.6 (p<0.0001) and a pseudo R-square of 0.0671.

$$g(x) = \beta_0 + \beta_1 RET + \beta_2 VAR + \beta_3 TO + \beta_4 MV + \beta_5 \alpha \qquad (8)$$

$$g(x) = 1.543 + 1.238RET - 0.08021VAR + 2.010TO - 0.08318MV + 2.090\alpha$$

Std Error	(0.8826)	(0.4448)	(0.05177)	(0.4410)	(0.04276)	(0.2244)
Chi Sq.	3.06	7.75	2.40	3.78	86.79	20.77
Prob>Chi Sq.	0.0803	0.0054	0.1213	<0.0001	0.0517	<0.0001

The variable TO enters the nominal logistical regression more significantly than does VOL. However, both are significant at the 1% level. In the presence of TO, VAR became slightly more significant, although VAR is still not significant at the 10% level. However, MV is no longer significant with TO in the regression at the 5% level, with VOL, MV is significant at the 1% level. But importantly, the variable of greatest interest in the hypothesis testing, RET did not change appreciably in significance; RET remains significant and positive at the 1% level.

Table 10 contains the results of stepwise OLS regressions of the dependent variable, RET, and the independent variables VAR, VOL, MV, and α with P10 as an independent dummy variable. As before, P10 equals one for IPOs priced on $10 and zero otherwise. In the presence of each independent variable separately, the P10 dummy is significant at the 1% level with a sign that rejects Hypothesis 1 and does not reject Hypothesis 2. With all independent variables as a set, the P10 dummy is significant at the 10% level but not at the 5% with a sign that rejects Hypothesis 1 and does not reject Hypothesis 2. The impact of using TO in place of VOL is shown below equation 9. The estimated coefficients are shown with the absolute value of the standard errors, the t ratios and the probability of those t ratios. This model has an R-square of 0.1369.

$$RET = \beta_0 + \beta_1 P10 + \beta_2 VAR + \beta_3 TO + \beta_4 MV + \beta_5 \alpha \qquad (9)$$

$$RET = 0.4727 + 0.008366P10 + 0.03094VAR + 0.2150TO - 0.01223MV + 0.4721\alpha$$

Std Error	(0.04394)	(0.008366)	(0.002567)	(0.1896)	(0.02165)	(0.01270)
T ratio	10.76	1.87	12.05	11.34	5.65	3.72
Prob>|t|	<0.0001	0.0620	<0.0001	<0.0001	<0.0001	0.0002

The variable TO enters the nominal logistical regression less significantly than does VOL. However, again, both are significant at the 1% level. In the presence of TO, VAR became more significant and MV less significant, although VAR and MV are significant at the 1% level with either TO or VOL in the regressions. The variable of greatest interest in this model, P10, did not change appreciably in significance; P10 remains significant and positive at the 10% level but not at the 5% level. As with VOL, P10 rejects Hypothesis 1 but (weakly) does not reject Hypothesis 2.

In Table 9 and Table 10, α is significant at the 1% level. However, closed-end funds and REITs are included in the sample, and these offerings generally sell *all* shares outstanding at the IPO, retaining zero pre-IPO shareholdings. (Recall Figure 4.) Thus, the finding of a positive relationship between insider holdings and the $10 price per share may be driven by the fact that most closed-end mutual funds and REITs have nearly zero pre-IPO shareholdings. In order to investigate this, in Table 11 and Table 12, the closed-end funds and REITs are excluded.

Elimination of SIC 67 IPOs

Table 11 and Table 12 repeat the regressions from Table 9 and Table 10 but the results in Table 11 and Table 12 exclude those 545 IPOs or 12.3% which have a two-digit SIC code equal to 67. Of the SIC 67 IPOs, 28.3% had IPO prices of $10 per share. This concentration of $10-priced IPOs is nearly four-fold higher than the 7.28% in the resulting sample. The SIC 67 IPOs are primarily mutual funds (N=402) and REITs (N=122). The SIC 67 IPOs have higher than average market values and almost exclusively have nearly zero post-IPO insider holdings.

Table 11 contains a set of stepwise logistical regressions of the same form as those in Table 9. Table 11 shows that excluding these SIC 67 IPOs dramatically reduces the significance of MV and α. VOL is also less significant, but remains significant at the 5% level. However, RET remains significant and positive at the 1% level. This evidence is inconsistent with Hypothesis 1 but does not reject Hypothesis 2. As shown below, substituting the variable TO does not significantly alter the hypothesis tests: Hypothesis 1 is rejected and Hypothesis 2 is not rejected. Without the SIC 67 IPOs, TO does not enter the regression significantly.

$$g(x) = 2.008 + 1.606RET - 0.03213VAR + 0.006950TO + 0.02490MV - 0.4357\alpha$$

Std Error	(1.064)	(0.4687)	(0.06231)	(0.51113)	(0.05528)	(0.4732)
Chi Sq.	3.56	11.74	0.27	0.00	0.20	0.85
Prob>Chi Sq.	0.0591	0.0006	0.6060	0.9892	0.6525	0.3572

In Table 12, stepwise OLS regressions of the form found in Table 10 are also repeated with the exclusion of the SIC 67 IPOs. These results also reject arguments that price per share is irrelevant (Hypothesis 1) but not a price-base signalling (Hypothesis 2). The P10 dummy is significant at the 1% level and the economic interpretation of the coefficient is that IPOs priced on $10 per share have 147 basis points, or 13%, higher returns than otherwise similar IPOs. The mean RET is 10.91% (1091 basis points). The sample size is 3,889 IPOs and 283 are priced on $10 per share. The variables VAR, VOL, MV, and α are also significant at the 1% level and all coefficients have the same signs as in Table 10. This empirical evidence indicates that IPO pricing on $10 per share is associated with surprisingly large real effects.

Testing the alternative variable TO does not alter the results. As shown below, TO enters the OLS regression significantly, though less so than VOL, and slightly increases the significance of the P10 dummy, but does not alter the hypothesis testing. TO will not be examined further.

$$RET = 0.5661 + 0.01873P10 + 0.03868VAR + 0.3050TO - 0.02160MV + 0.1971\alpha$$

Std Error	(0.04857)	(0.005558)	(0.002884)	(0.02222)	(0.002532)	(0.02114)
T ratio	11.65	3.37	13.41	13.73	8.53	9.32
Prob>|t|	<0.0001	0.0008	<0.0001	<0.0001	<0.0001	<0.0001

Elimination of Outliers

Two additional tests will determine if this apparent signalling result, regarding IPOs priced on $10 having higher initial returns, is strongly dependent upon a few outliers. Table 13 shows the principal logit regression from Table 11 (Column 6) with stepwise reductions in sample size. The 3,889 IPO sample was sorted by initial return and then the top 1% of IPOs by initial return were removed. The logit regression was run on the smaller 3,851 IPO sample. This result is Column 2 of Table 13. (Column 1 is repeated from Table 10, Column 6, for the reader's convenience.) Column 3 is the regression result after removing the lowest 1% of initial returns (the sample now excludes both top and bottom 1%). Columns 4 and 5 show the regression results without the top 5% and without the top and bottom 5% of initial returns (total 10%), respectively. In the most restricted sample RET is significant at the 1% level. Table 13 also shows the results of the OLS regression from Table 12 (Column 6 repeated as Column 1 in Table 14). Table 14 has stepwise exclusions on the IPOs with the highest and lowest initial returns. The dummy variable P10 is significant at the 1% level again in the most restricted sample. *These results indicate that the surprising significance of RET in the logistical regressions and the P10 dummy variable in the OLS regressions are not dependent on a few extremely high or extremely low initial returns.* IPO price selection is not based on nearly neutral customs but rather may be a price-based signalling convention.

The last OLS regression involving the P10 dummy includes year dummies for each year 1981 through 1994 since years before 1981 lacked data on one or more of the independent variables. Table 15 shows that of the 15 year dummy variables, only 1983 and 1984 are significant at the 1% level. While 1983 and 1984 were strong years for the number of IPOs (N=1,043), the sign on the coefficient is negative indicating that the average two-day returns were 89 and 59 basis points lower than the overall average of 10.91%. Importantly, in the presence of four independent variables and 15 year dummies, the P10 dummy remains positive and significant at 0.0157 (between the 1% and 5% level).

IPO clustering on integers

One final logistical regression, shown in Table 16, more broadly examines price clustering by determining the relation between the probability of an IPO price occurring on an integer value (IV) and Harris' assertions regarding price level and dealer versus specialist market listing. In addition, two dummy variables control for whether an IPO is venture capital-backed (VC) and whether the IPO was formally a leveraged buyout (LBO). These two dummy variables have the value one in the affirmative case and zero otherwise. The dependent variable, integer value (IV), equals one if the IPO is priced on an integer and zero otherwise.

Contrary to seasoned stocks, price clustering does not increase with price level nor dealer market status. The coefficient on LnOPrc, the natural logarithm of the offer price level, is negative and insignificant even at a 10% confidence interval. The coefficient on NY/AM, the specialist market dummy, is also insignificant at the 10% level, although it is negative, which is the sign Harris found for seasoned stocks. The three independent variables with significant coefficients are RET, VAR, and VC. RET and VAR are significant at the 1% level and VC at the 5% level. The interpretation of the coefficients is that integer-priced IPOs have lower returns and lower variance than IPOs priced on fractional prices. This is a surprising finding given that the IPOs priced on $10, which form a portion of the integer prices, have higher than average returns. Thus IPOs priced on $10 have much higher returns than IPOs priced on all other integers. VC-backed IPOs are roughly 10% more likely to occur on integers. The reason for this is a mystery. These data indicate that LBO status is unrelated to integer pricing.

V. Conclusion

Harris shows that price clustering in seasoned stocks increases with price level and volatility and decreases with market value and transaction frequency. Harris found higher clustering in dealer than specialist markets. Clustering in IPOs differs markedly from clustering in seasoned stocks. This paper demonstrates that price clustering in IPOs is either (1) completely unrelated to price level or (2) forms a U-shaped relation with price level, first increasing and then decreasing, (reaching a minimum at between $6 5/8 and $9 per share) depending upon the manner in which clustering is measured. Unquestionably, IPOs cluster to an extreme degree on $5 price increments with $5, 10 and $15 per share being the most common integer prices and $2.50, 7.50 and $12.50 being the most common half-dollar prices. Furthermore, clustering pervades the top 20 two-digit SIC codes and has been virtually unaffected by 25 years of inflation. Clear cross sectional and exchange differences exist in the mean, median, and mode of IPO prices.

Surprisingly, stocks priced at $10 per share have significantly higher two-day returns than IPOs priced on all other prices. This result was demonstrated in a sample of 3,889 IPOs and is robust to the elimination of the top and bottom 5% of outliers. Price clustering in IPOs, when measured by the probability of a integer value, decreases with initial returns and variance, and is higher for VC-backed firms. IPOs priced on integers have lower returns and lower variance than those ending in fractions. In portfolios which are formed based on offer size, clustering increases with offer size and the modal value of IPO increases with offer size. Clustering on $10 or on integers does not increase with market value if controlled for other determinates of clustering: initial returns, variance, volume, and insider holdings.

Two hypotheses are offered regarding the observed price clustering. These data reject a hypothesis that IPO clustering is a nearly neutral custom but the data *cannot reject a hypothesis that the $10 price per share communicates information regarding expected returns*. Evidence indicates that offerings priced at $10 per share have had higher initial returns. It is argued that this is compensation to investors for greater than normal uncertainty in the value of the offer. Further research should examine price patterns of IPOs in other countries, first determining if discreteness is as extreme as found in the U.S. and also if the most rounded local-currency prices are associated with higher than normal initial returns. The wealth of research on the long-run under-performance of IPOs may benefit from re-examination with controls based on initial price per share.

There are regulatory implications of this "price-per-share-focused" research. Recently, the management of America's largest stock exchanges and regulators from the Securities and Exchange Commission have intensified their efforts to eliminate fraud in low-priced stocks. While laudable actions indeed, this paper raises at least two questions of relevance to this policy action. If price per share is an effective method for communicating information about IPOs, will the elimination of certain ranges in price per share have perverse effects on the signals received by the investing public? Certainly, there is nothing more obvious about a stock, to a potential investor, than its price. If custom or convention dictates that risky stocks are priced below $5.00, or below $1.00 per share, and we eliminate these stocks because they are too risky (including a risk of fraud), will these firms simply not re-emerge as $9, 10, or $11 priced stocks and be just as risky?

On the other hand, if price per share does not matter to any great extent, then there is no compelling reason why regulations based on price per share will, in any meaningful manner, constrain firms or underwriters willing to commit fraud. Furthermore, if price per share does not matter, then selecting firms based on a low price may subject good firms with a low share price to additional, unnecessary regulatory burden. Elimination of penny stocks in this case is simply very expensive window dressing. But in either case, it is not clear that these "price-per-share-focused" regulations have either a theoretical or empirical basis and less clear still that such regulations will result in the improved communication with, or protection of, the investing public.

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