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Abstract

This paper supports an extension of the negotiation hypothesis begun in Harris (1991) and calls into question the evidence of implicit collusion developed in Christie and Schultz (1994). This paper documents the distribution of prices per share for initial public offerings, mergers and acquisitions, and self-tender offers. These markets were selected because they lack the potential for bid-ask collusion. Despite the lack of bid-ask collusion in IPOs, M&As, and self-tenders, prices are often quoted in rounded amounts per share – avoiding quotes ending in odd eighths, odd quarters, and odd halves. Two new hypotheses are offered to explain the lack of odd-eighths quotes and other previously unexplained pricing phenomena.

I. Introduction

Economic phenomena often defy obvious explanation; nonetheless, economists are prone to force an explanation on the unexpected result. Coase (1972) states,

> "The desire to be of service to one's fellows is, no doubt, a noble motive, but it is not possible to influence policy if you do not give an answer. It has therefore encouraged men to become economic statesmen—men, that is, who provide answers even when there are no answers. This tendency has discouraged a critical questioning of the data and of the worth of the analysis, leading the many able scholars in this field to tolerate standards of evidence and analysis which, I believe, they would otherwise have rejected."

One area in which Coase believes this tendency has affected policy is in the area of anti-trust. On the subject of monopoly, Coase (1988) states,

> "One important result of this preoccupation with the monopoly problem is that if an economist finds something—a business practice of one sort or another—that he does not understand, he looks for a monopoly explanation. And as we are very ignorant in this field, the number of ununderstandable practices tends to be rather large, and the reliance on a monopoly explanation is frequent."

More recently, this tendency to find an answer for a phenomenon we do not yet fully understand has affected how financial economists and policy-makers view the pricing practices of the Nasdaq dealers. In a widely publicized and much discussed work, Christie and Schultz (1994) find a lack of odd-eighths pricing of Nasdaq stocks and argue that this lack of odd-eighths pricing is sufficient evidence to accuse Nasdaq market makers of collusive price-fixing behavior. A consequence of the Christie and Schultz work has been scrutiny of Nasdaq dealers by the SEC and others.

1

Few Finance papers in the recent past have received more attention than Christie and Schultz. The American Finance Association selected Christie and Schultz's work as the best paper in Finance last year. In addition to receiving accolades from the Finance academy, Christie and Schultz is one of the very few papers to immediately gain the attention of the lay press. Further, the paper's influence was felt in law offices, courtrooms, and boardrooms throughout the country *quite remarkably, while it was still a working paper*. Their often quoted paper has been described[1] as "an influential 1994 study concluding that Nasdaq dealers tacitly collude to rig prices." Quoting from their working paper's abstract,

> "The lack of odd-eighths quotes cannot be explained by the negotiation hypothesis of Harris (1991), trading activity, or other variables thought to impact spreads. This result implies that the inside spread for a large number of Nasdaq stocks is at least $0.25, and raises the question of whether Nasdaq dealers implicitly collude to maintain wide spreads."

As indicated in their abstract, the principal evidence provided by Christie and Schultz (hereafter CS) is the distribution of share prices of 100 actively traded securities on the National Association of Securities Dealers Automated Quotation System (Nasdaq) when compared to the distribution of prices of 100 securities on the New York Stock Exchange (NYSE) and the American Stock Exchange (AMEX). The principal finding in CS is that the ending fraction in the share prices are not uniformly distributed across all available odd-eighth quotations. Quoting again from CS,

> "We find that spreads of one-eighth are virtually non-existent for a majority of this sample. The lack of one-eighth spreads can be traced to an absence of either inside bid or ask quotes ending in odd-eighths (1/8, 3/8, 5/8, 7/8) for 71 of 100 stocks. In contrast, a sample of 100 NYSE and AMEX firms of similar price and market value to our Nasdaq sample consistently use the full spectrum of eighths."

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[1] "Big Brother Will Be Watching Nasdaq," *Wall Street Journal*, July 15, 1996, page A3.

2

Had CS stopped at this point and presented what they found to be surprising, call it "the odd-eighths puzzle," it seems unlikely that the paper would have received the attention it did. However, CS go on to plainly state that they believe the odd eighths puzzle was sufficient evidence to accuse the Nasdaq market makers of collusive price fixing simply because they, CS, rule out *some* other explanations. The question remains, was the CS list of theories and empirical tests exhaustive? From CS,

> "We believe that this surprising result reflects an implicit agreement among market makers to avoid using odd-eighths in quoting bid and ask prices, and that a large number of market makers per stock is not synonymous with competition."

CS were surprised to find that security prices in a dealer market were not uniformly distributed across odd eighth quotes and concluded that the reason for it must be collusion. It is virtually impossible to prove that collusion does not exist in a market where market makers are frequently in communication with other market makers in the normal course of business. In contrast, a market with a specialist, like the NYSE or AMEX, cannot have bid-ask collusion of the CS type since the market maker has a monopoly[2] in that particular stock. The CS logic is that the lack of odd eighths quotes on Nasdaq must be collusion. But what about controlling for the causes of price concentration seen in other markets? Could these other "non-collusive" causes have contributed to the price concentration on the Nasdaq? Are there markets other than the NYSE and AMEX where bid-ask collusion is not possible or at least *extremely* unlikely? In such collusion-refractory markets, let us ask Christie and Schultz's fundamental question, "How are prices distributed across odd eighths?"

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[2] With the exception of limit orders.

A direct test of the CS premise would be to find other financial markets in which bid-ask collusion does not exist and then examine the ending fraction of the prices quoted in those markets. Grossman, Miller, Fischel, Cone, and Ross (1995), hereafter Grossman, et al, examine the London Stock Exchange, the London gold market, and the international foreign exchange market and find similar clustering in these markets to what CS find for the Nasdaq. Grossman, et al argue that their results "demonstrate that the degree of clustering on Nasdaq is comparable to that observed in other financial markets." Critics of this work, however, may not rule out collusion for Nasdaq, arguing that comparable collusion may exist in the other markets studied by Grossman et al. Here we further the work of Grossman et al, by *examining three markets in which bid-ask collusion cannot exist*, the IPO, merger and tender offer markets, and demonstrate that these non-collusive markets display a degree of clustering far greater than that exhibited by Nasdaq and the markets studied by Grossman et al.

If a number of non-collusive markets show a full distribution of prices while potentially collusive markets avoid odd eighths quotes, then perhaps prices alone are a robust measure of collusion. This is the core of the CS argument. However, if examples of non-collusive markets are found which fail to use a full distribution of odd eighths prices, then CS may have simply failed to completely control for all of the differences, known and yet unknown, between dealer markets and specialist markets. The CS Bid-Ask Collusion Hypothesis argues that odd eighths are avoided to assure wider spreads. The degree of odd eighths aversion is then a direct measure of the extent and efficiency of collusion. CS make a strong point that the collusive dealers must be able to punish a dealer who fails to trade on even eighths. If, as CS propose, collusion is the

4

only reason why price concentration exists in the Nasdaq market, then we would not expect to see price concentration in markets where collusion and retribution is not possible. Furthermore, if new reasons for price concentration are found in non-collusive markets, then these same reasons must be properly analyzed in dealer markets to make certain that the price concentration, thought to indicate collusion, is not in fact of an alternative origin.

Three markets which lack the potential for the CS-type of bid-ask collusion are the [1] initial public offering (IPO), [2] merger and acquisition (M&A), and [3] self-tender markets. Transactions in these markets are characterized as exhibiting a single price, not a pair of simultaneous bid and ask prices. For this reason and a number of other reasons developed in the next section, these three markets specifically lack the potential for CS Nasdaq dealer-based bid-ask collusion, even though these markets are valuing the same underlying assets as those in CS. These very different markets also offer a unique opportunity to examine price concentration in circumstances where the number of shares can be completely variable (IPOs), not altered at all (M&A), and somewhat altered (self-tenders). These markets also differ to the extent that IPOs do not have a trading history, while both self-tenders and M&As have a history of prices. Finally, M&A transactions offer the opportunity to examine hostile versus friendly transactions and the impact of that difference on the distribution of prices.

In the same context as CS, the IPO, M&A, and self-tender markets all demonstrate a very high concentration of prices. In IPOs, M&As, and self-tenders, prices do not exhibit anything close to a uniform distribution of odd eighths quotes. Over half of the IPOs, M&As, and self-tenders occur on the integer dollar quote. Integer and half dollar quotes capture 88% of IPOs,

74% of M&As, and 72% of self-tenders. Furthermore, odd-eighths quotes are avoided in these collusion-refractory markets to a far greater extent than the Nasdaq dealer markets reported by CS. Odd eighth prices account for a mere 2.6% of self-tenders, 2.3% of M&As, and only 1.5% of IPOs. In the CS study, Nasdaq market makers price 15% of securities on odd eighths or *ten times* more frequently than that observed in the IPO market. Thus, these three collusion-refractory markets avoid odd eighths, odd quarter, and odd half dollar quotes to an even greater extent than does the allegedly collusive Nasdaq market.

So as not to be misconstrued, the authors of this paper do not believe there is any bid-ask collusion in the markets for IPOs, nor for M&As, nor for self-tenders. *The authors believe that IPO, M&A, and self-tender transactions are free of bid-ask collusion – yet these markets exhibit much stronger evidence of price concentration than that presented in CS.*

Two New Hypotheses

This paper offers two new hypotheses to explain price concentration in financial markets. The hypotheses are termed the Near Neutral Customs Hypothesis and the Market Coordination Hypothesis. The Market Coordination Hypothesis is an extension of the negotiation hypothesis begun by Harris (1991) and arguments made by Grossman et al. Both papers posit that prices which are rounded off are less costly to communicate and cause fewer errors in trading than do quotes involving odd fractions or several non-zero digits. One only has to imagine a market in which the full distribution of odd 64ths, or 128ths, or 256ths were commonly used to understand the logic in their arguments. For instance, with today's widespread use of highly-accurate

computers one could now call for security prices to be quoted to six decimals. Obviously, this would be more precise. But just as obviously, quotes to six non-zero decimals (e.g. $21.845932 per share) would be subject to higher rates of trading errors than one transacting in integer dollar amounts (e.g. $22 per share). This theory implies that this market might sort itself out with less precision in prices but fewer errors in trading. Costly errors come from the realities of rapid trading, the individuals misreading quotes, misquoting them to buyers and sellers, and incorrectly revising quotes when they are changed based on order flow.

In this paper the authors extend these insights in five ways and argue that markets will tend toward integer and simple fractional quotes when they: [1] have more participants, [2] include less sophisticated traders, [3] transact less often, and/or [4] experience dramatic increases in volume (have less time available per trade). Each of these conditions will increase the need for trading coordination. As a direct result of the greater need for coordinating traders, the Market Coordination Hypothesis poses that these markets will tend to quote prices in simpler numbers, including avoiding finer fractions and extended decimals. Finally, [5] more costly negotiations are more likely to be conducted in simple terms, such as by using rounded price quotes. These extensions are not developed by Harris but seem clear from the core of his argument and some of these points have been discussed in Grossman et al. The fifth extension will lead to a test which discriminates among the hypotheses.

While the Market Coordination Hypothesis provides a positive economic explanation of why a market would trade in integer figures or simple fractions, it is also possible that the price concentration in IPOs, M&As, and self-tenders, as well as that of Nasdaq dealer markets, is

merely a Near Neutral Custom.[3] Near Neutral Customs are conventions, habits, fashions, practices, routines, or procedures which have no economic reason for their existence but are pervasive in a market. Near Neutral Customs abound in all markets; they are so abundant that we don't even notice them, and we don't have theories which describe their existence, function, and nature. Examples include such things as: the preference for navy blue colored suits at business meetings; donuts, eggs, and roses sold in dozens; work weeks being Monday through Friday; stocks reported alphabetically in newspapers; security prices with bids listed before ask prices; some commodity trading in pits; some bonds being quoted in price per hundred with 32nds and sold in thousands while other bonds being quoted in eighths; retail gasoline prices ending in nine-tenths cents; retail prices of consumer non-durables ending in 99 or 95 cents, and so on.

Virtually meaningless customs, conventions, regulations, traditions, and standards exist in all manner of financial, product, and labor markets. Likewise, the lack or abundance of odd eighths quotes in IPOs, M&As, self-tenders, and dealer markets may also serve no significant economic purpose. The decision to quote either a spread, or a buy or sell price is a decision in which both price and volume are considered simultaneously. It has not been demonstrated that maximizing the spread necessarily maximizes profits. It is obvious that by increasing spreads one reduces volume and that dealers certainly have fixed costs. According to Coase (1988),

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[3] The idea of a Near Neutral Custom is new to the literature but was inspired by Miller's (1977) "neutral mutation" argument regarding variations in capital structure. Miller states, "Neutral mutations that serve no function, but do no harm, can persist indefinitely."

"Economists observing the regulations of the exchanges often assume that they represent an attempt to exercise monopoly power and aim to restrict competition. They ignore, or at any rate, fail to emphasize an alternative explanation for these regulations: that they exist in order to reduce transaction costs and therefore to increase the volume of trade."

It is unclear how one constructs an empirical control for a pervasive Near Neutral Custom. Whether quoting in even prices or simple fractions is based on a strong economic rationale as in the Market Coordination Hypothesis or just a Near Neutral Custom is not obvious. But what is clear from the evidence presented here is that the absence of odd eighths quotes, no matter how severe, is certainly insufficient to prove or even imply collusion. Likewise, this evidence does not prove the Nasdaq dealers are innocent. This paper does demonstrate that there are causes of price concentration other than collusion, as shown in the IPO, merger, and self-tender markets. The burden of proof is on CS to prove that the cause of price concentration in dealer and specialists' makers is not in part the same cause of concentration in non-collusive markets and to explain why concentration exists on the NYSE/AMEX.

The remainder of the paper is organized as follows. Section II describes the data and methodology. Section III concludes.

II. Data and Methodology

Figure 1 shows the primary evidence provided by Christie and Schultz (this is a reproduction of their Figure 3).[4] For firms with comparable market capitalization, CS selected

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[4] Note that the CS data are estimated by visual inspection of their Figure 3.

100 high volume stocks from the Nasdaq dealer market system and 100 stocks from the NYSE/AMEX specialist market system. The distribution of price fractions across 544,811 inside quotes from the NYSE/AMEX are shown in the left bars and 372,625 inside quotes from the Nasdaq are shown on the right bars. It is obvious by visual inspection[5] that the Nasdaq odd eighths price fractions, 1/8, 3/8, 5/8, and 7/8, are less common than the Nasdaq even eighths, 0/8, 2/8, 4/8, and 6/8. Following CS, Figure 1 shows eighths in decimal form in multiples of 0.125. Of the Nasdaq quotes occurring on eighths, 15% of prices occur on odd eighths and 85% on even eighths; for NYSE/AMEX, 46% of prices occur on odd eighths and 54% on even eighths. The presumed lack of odd eighths quotes by Nasdaq dealers is the only evidence provided by CS to imply for collusive behavior. CS state, "While this paper does not provide conclusive evidence of tacit collusion among market makers, *we are unable to offer any other plausible explanation for the lack of odd eighths quotes*" (emphasis added). We offer two competing hypotheses to explain the lack of odd-eighths quotes in many financial markets, and we use one test to differentiate between them.

1. The Market Coordination Hypothesis: *Successful markets are coordinated by customs, conventions, and rules which ultimately must benefit both buyers and sellers. Successful markets are markets which grow in the number of buyers and sellers and the volume of transactions at the expense of other less competitive markets.*

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[5] Figures 1, 2, 3, 4 and 4a have the same axes and scales to improve comparisons.

Buyers and sellers gain from using coordinating customs; quickly agreeing on transaction price is one benefit of coordinating customs. Part of price formation involves agreeing ahead of time and complying with common conventions and customs which help to coordinate all traders. Coordination is not *collusion*. When the NYSE chose their trading hours to be 9:30 a.m. to 4:00 p.m. in New York, this action was not collusion; this was market *coordination*. Agreeing to follow those hours benefits buyers and sellers. Likewise, conventions, customs, and sometimes even formal rules regarding price increments are common to organized exchanges. From Harris,

> "Traders use discrete price sets to lower the costs of negotiating. A smaller set limits the number of different bids and offers that can be made. Negotiations may therefore converge more rapidly since frivolous offers and counter-offers are restricted. A small set also limits the amount of information that must be exchanged between negotiating trades. This reduces the time it takes to strike a bargain and it decreases the probability that two traders will believe they have traded at different prices."

Although not discussed by Harris, the Market Coordination Hypothesis extends his insights by noting that more rounded bidding customs are likely to be of greatest benefit when[6] [1] there are a large number of buyers and sellers, [2] the traders trade infrequently, [3] when volume rapidly increases (time available to trade decreases) and [4] when buyers or sellers are less sophisticated. In addition, [5] one would expect that more costly negotiations would be conducted in simpler terms, including a greater use of rounded price quotes. This fifth factor of coordination will allow for a test of the Market Coordination and Near Neutral Custom hypotheses in M&As.

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[6] Some of these arguments are also made in Grossman et el.

2. The Near Neutral Custom Hypothesis: *Near neutral customs have no irreplaceable function and will cease if made costly. (Corollary: Costly customs will exist until less costly alternatives are found.)*

In general, customs are conventions, habits, fashions, practices, routines or procedures. Near neutral customs are those customs which have no significant economic justification but also no downside. Moreover, with some minimal effort a Near Neutral Custom might change. Near Neutral Customs are best understood when contrasted with costly customs. Costly customs are unlikely to change even if perturbed but can be changed at some high cost. Costly customs exist for a reason, if only because of the path of history which has been followed to this point. Costly customs include the almost ubiquitous use of base ten for numbers and the growing use of the English language as the international standard for business, scientific, and navigational communication in the post-WW II era. While any base (e.g., three, sixteen, or two) will do in theory, it is extremely unlikely that we will change from base ten to any other base. To a lesser extent, English is probably going to be the language of choice for scientific communication the foreseeable future.[7] It is costly for people to learn English, assuming it is not their native tongue, and it would be costly for those who speak English to learn a different language if the English-speaking custom were to switch.

Similarly, one might say that people are *more comfortable* with rounded numbers (in base ten); that is not to say that people cannot deal with fractions. It is apparent generally that people

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[7] The failed attempt to convert the United States from the English System to the Metric system is an example of a significant perturbation being unable to upend a costly custom.

show a preference for rounding numbers off. The rounding of prices per share to even eighths[8] is a convention adopted by many Nasdaq dealers but also used by some NYSE/AMEX specialists, as well as by underwriters, takeover artists, and treasurers of undervalued firms. On the Nasdaq in general, or with certain securities on the Nasdaq, this convention may be a Near Neutral Custom. If it is a Near Neutral Custom, then when perturbed, the convention will change, as it was alleged to have changed after CS labeled the behavior "collusive price fixing."[9]

Given these two plausible explanations for a lack of odd eighths quotes on Nasdaq, we test the CS Bid-Ask Collusion Hypothesis by examining price concentration in three markets not examined by CS. The CS Bid-Ask Collusion Hypothesis argues that market makers avoid odd eighths price fractions to assure themselves of wider spreads and presumably higher profits. The degree of odd eighths aversion is then a direct measure of the extent and efficiency of collusive behavior. CS make a strong point that this collusive equilibrium is maintained is through the potential for punishing a dealer who fails to trade on even eighths. If, as CS propose, collusion is the only reason why price concentration exists in the Nasdaq market, then we would not expect to see price concentration in markets where retribution is not possible.

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[8] According to information provided on the NYSE web site, the custom of quoting in eighths is traced to the use of Spanish pieces of eight. "When stock trading began in the late 1700s, the Spanish milled dollar, or doubloon was one of the more plentiful currencies. These gold coins had been literally divided into halves, quarters and bits using a hammer and chisel. The widespread use of the Spanish pieces of eight resulted in all sorts of commodities being bought and sold in fractions of eighths of a dollar. Only in stock trading has this unusual practice continued to the present day." If nothing else, this seems to indicate that some quoting conventions have staying power.

[9] However, if the convention is a costly custom, then it still may change given the threat or realization of new regulations or penalties of sufficient force, but if it is a costly custom then the change is at a cost to all participants.

Markets Free of Bid-ask Collusion

It seems clear that for a market to exhibit bid-ask collusion there must be a bid and an ask price. One market which simultaneously lacks a bid and an ask price is the market for initial public offerings (IPOs). For at least a few days prior to the offering there is but one price, the IPO offer price. The offer price used in this study is the price printed on the final IPO prospectus. Some would argue that the offer price is an ask price, a price asked by the firm, and some would say that the IPO price is a bid, a bid price determined by negotiating with the underwriters for their bid or for the underwriter's expectation of the bid by the public. Which argument is correct is unclear, but what seems indisputable is that for a period there is but one price. At such time, however brief, the IPO market is a "one-sided market." As a one-sided market, there cannot be bid-ask collusion of the CS type.

Another market which seems to defy the potential for bid-ask collusion of the type hypothesized in CS is the M&A market. The M&A market (also known as the market for corporate control) is *extremely* unlikely to fall victim to bid-ask collusion for six reasons: [1] Senior management, including the board of directors, is legally required to be highly involved in every aspect of a takeover. Failing to properly represent the interests of shareholders violates a director's fiduciary responsibilities. It is unlikely directors would allow themselves to be taken advantage of by market makers. [2] During a takeover both sides, the target and the bidder, are often represented by legal counsel and investment bankers which would help monitor the bidding process and the behavior of market makers. [3] Market makers are not the primary source of the takeover bids nor are they the primary source of the target's ask price(s) in a takeover. The

bidders develop their own series of bids, and targets develop their own series of ask prices which are often far different from previous market quotes. [4] The final transaction does not pass through the market maker. The transaction is handled by the bidder's investment banker. [5] Fees for M&A services are negotiated. Fees are rarely (if ever) based on a bid-ask spread. The structure of M&A fees are often fixed fees for legal counsel and for bankers there is a contingent fee based on a percentage of final market valuation. [6] M&A transactions are infrequent for any given firm. This limits the time available to successfully establish collusive agreements and cooperative practices, if for some unknown reason such bid-ask collusion was of some value to management. For any one of these six reasons (and many more), the likelihood of bid-ask collusion of the type hypothesized in CS is extremely remote. Taken together, it seems inconceivable that bid-ask collusion exists in the market for corporate control.

A third market circumstance which is extremely unlikely to suffer CS bid-ask collusion is the occurrence of stock repurchases of firms by self-tender offers. Self-tenders are unlikely to suffer bid-ask collusion for reasons previously developed in the discussions of IPOs and M&A transactions. Like the IPO market, there is but one side to a self-tender, the price offered by the firm for its own shares. And like the M&A market, self-tenders receive significant attention by senior management and by the experts hired by management to assist them with the tender. Likewise, for reasons numbered [3], [4], [5], and [6] discussed in the M&A section above, self-tenders are also unlikely to fall victim to manipulation by market makers. It seems more than safe to say that self-tenders are not subject to CS bid-ask collusion.

Figure 2 shows the distribution of 7,086 eighth-fractions for offer prices across 7,196 IPOs which occurred over the 23-year period between January 1, 1974 and July 30, 1996, and had an offer price of at least one dollar. Not graphed in Figure 2 are 1.5% (n=110) of IPOs occurring on all other fractional amounts. The source of the IPO data was Securities Data Corporation (SDC) On-Line. These data were examined by the method used by CS of examining the odd and even eighths distribution of price fractions. Note the extreme concentration on the whole dollar quote; over two-thirds of all prices are on integer dollars. At 70%, this integer dollar concentration is more than three times higher than the integer dollar concentration exhibited by Nasdaq stocks as shown by CS. The price concentration continues across the other even eighths: an additional 19% of IPOs are quoted on halves and 9% on odd quarters. Thus, taken together, 97% of IPO prices are on even eighths while a mere 1.5% occur on odd eighths. IPO quotes are thus sixty times more likely to occur on even eighths than odd eighths. For Nasdaq, even eighths are six times more common than odd eighths. *Therefore, the IPO market avoids odd eighths at more than ten times the rate of the Nasdaq dealer market.*

Figure 2a shows the distributions of IPO offer prices by exchange. The sample includes 4,754 Nasdaq and 1,108 NYSE/AMEX IPOs which occurred between January 1, 1974 and July 30, 1996, had an offer price of at least $1, and were listed on CRSP within 10 days of the IPO date. The data in Figure 2a demonstrate that price concentration occurs for IPOs listed on either the NYSE/AMEX or Nasdaq exchanges.[10] Over 78% of NYSE/AMEX IPOs have offer prices on the even dollar, compared with 68% of Nasdaq IPOs, while 16% of NYSE/AMEX IPOs and

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[10] Not graphed are 0.5% (n=6) of the NYSE/AMEX and 1.2% (n=58) of Nasdaq IPOs with offer prices occurring on finer than eighth fractions.

16

20% of Nasdaq IPOs have offer prices on the half dollar. Thus, most price concentration takes place on the whole and half dollar for NYSE/AMEX and Nasdaq IPOs: NYSE/AMEX with 94% and Nasdaq with 87% on the whole and half dollar prices alone. IPO offer prices are concentrated on even eighths for 99% of the NYSE/AMEX sample and 97% of the Nasdaq sample.

Figure 3 shows the distribution of 1,525 eighth-price fractions for 1,776 mergers announced during the 16 year period between September 1, 1980 and April 30, 1996, and which had a price of at least one dollar but not more than $100 per share. These data are also from SDC On-Line. Not graphed in Figure 3 are 13.7% (n=241) of mergers which occurred on finer price fractions. The nature of mergers and IPOs differ on three accounts: First, while no prior price exists for IPOs and thus there may be some tendency to begin trading on a integer dollar amount, the same cannot be said of mergers. Merged firms have a price history. Second, IPOs could simply be adjusted by changing the number of shares offered to allow for price concentration; with mergers the number of shares is, of course, fixed. Third, pre-merger prices are well-distributed across even and odd eighths prior to the announcement of takeover (data not shown). One might argue that mergers are priced at a percentage premium to current pre-merger prices. If that were in fact the case, then merger prices would show the full distribution of even and odd eighths quotes. Despite these differences between mergers and IPOs, also notice the high concentration of integer dollar prices shown in Figure 3. Integer dollar quotes account for 57% of all mergers. Half dollar quotes make up 17% and odd quarters are 10% of prices. Together, the even eighths are 84% of all merger prices; the odd eighths are only 2.3% of these quotes. Thus, mergers are 36 times more likely to occur on even than odd eighths. Once again, the

pricing on even eighths is higher with the non-collusive M&A market than on Nasdaq. *Bidders in M&A transactions avoid odd eighths quotes more than six times as often as do the Nasdaq market makers.*

Figure 4 gives the distribution of 668 eighth-price fractions for 802 self-tenders which occurred over the same time period as that used for the merger data. Included are self-tenders with prices of at least one dollar per share. These data are also from SDC On-Line. Not graphed in Figure 4 are 16.7% (n=134) of self-tenders which occurred on finer price fractions. Self-tenders are infrequent, announced repurchases of stock by a firm. Self-tenders often occur at a premium to current prices. Figure 4a shows the previous day quote for 418 eighth-price quotes for 424 self-tenders for which the closing prices data was available on CRSP. The matching quotes one day prior to the self-tender are well-distributed across even and odd eighths, though not uniformly so, as CS might lead one to expect. While 17% of prices were quoted on the integer dollar the day before a tender (Figure 4a), 57% are quoted on the whole dollar at the announcement (Figure 4). The odd eighths quotes drop more than 15 fold from 41% to 2.6% with the announcement of a self-tender. As with the other non-collusive price setters, *firms conducting self-tenders avoid odd eighths quotes over five times more often than do the Nasdaq market makers.*

Beyond Eighths

The anomalous concentration of stock prices does not end with odd fractions. If collusion is the only cause of rounded prices, then we would not observe rounded prices in non-

18

collusive markets. Yet it is common experience that if a firm seeks to raise $10 million in capital, the firm is far more likely to issue one million shares at $10 per share rather than 1,012,658 shares at $9.875 (i.e., 9 7/8). Figure 5 shows the distribution of 4,803 integer-dollar-priced IPOs priced at or below $20. The integer-dollar subset at or below $20 constitutes 66.7% of the total 7,196 IPO sample. As can be seen in Figure 5, the per share price of an IPO is far more likely to be 5, 10, or 15 dollars per share (n = 491, 584, and 489 respectively) than any other single integer dollar price. The mode is a ten dollar price which is more than twice as common as either nine or eleven dollars price per share and six times more common than $9.50 and $10.50 priced shares (the 1,298 half-dollar prices at or below $20.5 from the sample are shown in Figure 6, which has the same scale as Figure 5). Eighteen and nineteen dollars per share are the least likely integer dollar prices, accounting for less than one percent of all IPOs each. The modal half-dollar price is $12.50 per share – but note that 17 of the 20 integer prices are more frequent than this, the most common half-dollar price. These distributions show that when shares can be adjusted, price per share is not arbitrary nor random. There is clearly a strong preference for simple integer prices. This integer pricing convention may be a Near Neutral Custom, or some form of Market Coordination, but it is certainly not bid-ask collusion.

Because average price per share is higher on the NYSE/AMEX than on Nasdaq, one might suspect that integer dollar IPO offer prices are generally higher for firms listing on NYSE/AMEX than for firms listing on the Nasdaq exchange. Figure 5a demonstrates that this is, indeed, the case. For firms listing on NYSE/AMEX, the mode is a $15 price, with 22% of NYSE/AMEX pricing at $15. The next most common price is $10 for NYSE/AMEX firms, with

19

16% of the total. Thus, 38% of NYSE/AMEX IPOs price at either $10 or $15 per share. In contrast, $5 per share is the mode for Nasdaq IPOs, with 8% of the total, followed by a $10 offer price, with 7% of the total. Also note that the distribution of IPO offer prices on dollar integers is much more highly concentrated for NYSE/AMEX firms (which is skewed heavily at $10 and $15) than it is for Nasdaq firms.

Custom or Negotiation Costs?

Evidence from three collusion-refractory markets strongly indicates that a concentration of prices on whole dollar quotes and other even eighths does not prove or even imply collusion. Said differently, *price concentration alone proves a very poor indicator of price fixing.* But the question remains: Is price concentration driven by near neutral or costly custom, market coordination costs, or a yet unknown market force?

Of the three data sets, the M&A transactions offer the clearest test, given one assumption: hostile takeovers are potentially much more costly than friendly mergers (non-hostile takeovers). Minimizing the cost of takeovers is of interest to the management of bidders; they seek ways to reduce those costs once they have decided to acquire a target. Many factors make hostile takeovers potentially more expensive than friendly mergers: [1] legal costs are higher if complex anti-takeover litigation is expected, [2] information costs are higher if targets resist sharing information fully with bidders, [3] massive publicity expenses, [4] loss of valuable reputation, and [5] damage to customer relationships is possible if the battle is waged in the media arena. Any one of these costs is sufficient to support this assumption; with this assumption, it is

possible to test the competing Near Neutral Custom versus the Market Coordination hypotheses. For if Market Coordination, therefore reducing mutual negotiation costs, is a principal motivation causing bidding in rounded prices, then hostile M&A transactions should occur more frequently on integer dollar quotes than non-hostile ones. If bidding in integer amounts is a Near Neutral Custom, then there should be no difference between hostile and non-hostile transactions. A logistic regression analysis follows.

Panels A and B of Table I show the results of stepwise nominal logistic regressions in which a firm is coded 1 if it is priced on the integer dollar and 0 if priced on any fractional amount. A dummy variable (HOSTILE) equals 1 if it is a hostile M&A transaction and 0 otherwise. The attitude classification, hostile or not, is provided for all M&A transactions by SDC On-Line. In addition to controlling for attitude, following CS, Harris, and Godek (1996), price level, market value, return variance and volume are also included in the regressions as continuous variables. The sample used in these regressions ranged from 1,654 to 992 observations based on the availability of data. Average daily volume (VOL) was collected for 22 trading days beginning 22 trading days before the announcement date. The same window was used for variance of daily returns (VAR). Market value (MV) is the total shares outstanding times the price per share (PRICE) offered in the M&A transaction. All continuous independent variables are expressed in natural logarithmic values (LN).

As expected, PRICE is significantly different from zero at the 1% level, alone (Regression 1) or in combination with any other variable. HOSTILE is significant at the 1% level alone (Regression 2), or in combination with PRICE where HOSTILE is significantly

different from zero at the 5% level (Regression 3). HOSTILE also remains significant at the 5% level in the presence of PRICE and MV (Regression 5). While VOL and VAR are significant at the 1% level alone, neither one is significant in the presence of PRICE (Regressions 8 and 9). Interpreting the positive coefficient on HOSTILE, these regressions indicate that hostile takeovers are much more likely to occur on the even dollar quote than non-hostile ones. When controlling for both price level and market value, hostile takeovers are still more likely to be transacted in rounded prices than non-hostile mergers. These data support a hypothesis that bidders in M&A transactions are more likely to quote prices in rounded figures in order to reduce negotiation costs.

In light of these findings, let us compare all three non-collusive markets and also re-examine the CS data. Table II shows the frequency of odd and even eighths across the NYSE/AMEX and Nasdaq transactions from CS, together with the same price distribution data from the IPO, M&A, and self-tender transactions presented here. A non-parametric test (Bernoulli) was performed to test if the observed frequency of even eighths (p) and odd eighths (q) in each market exhibited the hypothesized (D_0) equal distribution ($D_0 = 0.5 = p = q$) of odd and even eighths. The t statistic is given by

$$t = \frac{p - D_0}{\sqrt{\frac{pq}{n}}}.$$

The observed values for p are the number of even eighths observations divided by the total number of observations on eighths, n = sample size. The observed q equals 1−p. Based on

CS and the figures presented here, the authors expected that the NYSE/AMEX specialist system would have an equal distribution of prices across even and odd eighths (i.e., p = q = 0.5); NYSE/AMEX does not, however, have an equal distribution. *Surprisingly, even eighths are statistically significantly favored over odd eighths on NYSE/AMEX.* The null hypothesis in Table II is an equal distribution of even and odd eighths – the t statistic for the NYSE/AMEX of 65 clearly rejects the null hypothesis. Given the sample size which CS studied, they should have found very nearly 50% or about 272,000 on even and roughly the same on odd eighths. However, CS found roughly 296,000 on even eighths and roughly 248,000 on odd eighths in their sample. Given the large sample sizes collected by CS, this is a significant difference. CS do not comment on the significance of the difference in their paper. As can be seen in Table II, the other markets examined, including the Nasdaq, also have significant t-statistics, all rejecting the null hypothesis of equal distribution of even and odd eighths. Thus, all markets examined in this study show a tendency to quote in even eighths whether those markets have the potential for CS bid-ask collusion or not. The rate at which they quote in even eighths varies from 54% for NYSE/AMEX to 98% for IPOs.[11] The Nasdaq market has roughly 85% of eighths prices occurring on even eighths, while mergers and self-tenders have 97% of eighths prices occurring on even eighths relative to odd eighths.

Some would question whether the difference in the NYSE/AMEX distribution of odd and even eighths is "real" or is it simply "caused" by the huge NYSE/AMEX sample sizes? One way to test this is to establish negative control samples. A negative control is a dummy experiment

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[11] Note that for IPOs, mergers, and self-tenders, non-eighths prices have been dropped from the sample to facilitate these tests.

where the expected result is of no significance other than to confirm that the true experiment did not have uncontrolled unknowns which were responsible for the positive results. At least two negative controls are apparent with these data: [1] examine the distribution of the first four eighths (0/8, 1/8, 2/8, 3/8) versus the last four eighths (4/8, 5/8, 6/8, 7/8) and [2] examine the distribution of the "inside" eighths (2/8, 3/8, 4/8, 5/8) versus "outside" eighths (0/8, 1/8, 6/8, 7/8). If the NYSE/AMEX results are "caused" by the huge sample size, then these negative controls should reject the null with the same significance as in Panel A. Panel B shows that the NYSE/AMEX control for "inside" versus "outside" eighths is significant but at a much lesser level than for the odd versus even eighths hypothesis, while the control for the first four eighths versus the last four eighths is not significant. Both Nasdaq controls are significant but at a much lesser level than for the odd versus even eighths hypothesis. The data indicate that some portion difference in the NYSE/AMEX odd versus even eighths is real, and the results are not simply caused by a large sample size. Likewise for the Nasdaq results. Together the results indicate that odd eighths are not as common as even eighths for either the specialist or the dealer market systems. These results support both the Market Coordination Hypothesis and the Near Neutral Custom Hypothesis and reject the CS Bid-Ask Collusion Hypothesis.

III. Conclusions

In defense of the CS work, there was very little in the literature on price concentration or "clustering" at the time of their initial study. Had the data published here on the high price concentration phenomena evident in IPOs, M&As, and self-tenders been well-known before their study, CS may have found other plausible explanations for the price concentration difference

24

they observed between the Nasdaq dealer markets and specialists markets like the NYSE and AMEX. There is little evidence from the IPO, M&A, and self-tender markets to support the CS hypothesis and their use of price concentration as a measure of collusion. *For example, in the IPO market where shares issued can be adjusted, underwriters prefer even eighths at more than ten times the rate of the Nasdaq dealer market. When shares cannot be adjusted, in M&A transactions, bidders avoid even-eighths six times more often than Nasdaq dealers.* Further, IPO price concentration extends beyond odd eighths to a nonuniform use of integer dollar quotes, for which underwriters show a strong preference for $5, 10, and $15 per share prices.

Harris suggested that price clustering increases with price level and volatility and decreases with market value and transaction frequency. Without establishing a cause, Harris observed that clustering is greater in dealer markets than specialist markets. We suggest that coordinating the bid and ask prices to minimize the errors in trading for as many as 50 dealers in a single security is an alternative motivation for competitors agreeing to use rounded numbers as a common convention or custom. There is necessarily less volume per dealer in a market with 50 dealers than in a specialist market which transacts in the stock of an otherwise similar firm. Also, it is well known that at times of very high volume and therefore reduced time per trade, as happened during the Crash of October 1987, even specialist markets migrate toward using integer quotes and simple fractions. This phenomena runs counter to any previous economic argument, especially those relied on in CS, that spreads decrease with increasing volume and decreasing prices.

The Market Coordination Hypothesis predicts the action observed in crashes. Further, the market coordination hypothesis is supported by an empirical finding that the more costly negotiation processes of hostile takeovers are more likely to result in the use of whole numbers and simple fractions than the less costly process of friendly mergers. Empirical tests from M&A transactions support this extension of Harris' costly negotiation hypothesis and, in that particular market circumstance, reject the Near Neutral Custom Hypothesis. However, the broader issue of whether Market Coordination costs or Near Neutral Customs drive the widespread use of even eighths in [1] IPOs, [2] self-tenders, [3] stocks trading on the Nasdaq and [4] the NYSE/AMEX awaits improved empirical tests and better corporate finance and microstructure theories.

Unanswered Questions

Should the taped conversations of traders, or even the confessions of traders, influence scholars who seek the truth about market microstructure? We say no more than the claims of money managers, chartists, or astrologers who believe themselves capable of systematically beating the stock market and repeatedly "confess to same for more transparent reasons." A recapitulation of the Efficient Markets Hypothesis[12] and Roll's (1986) Hubris Hypothesis would lead a scientist to question the testimony of dealers *even if some demonstrated abnormal profits*. This data could simply be misplaced hubris on the part of dealers who over-estimate their own influence combined with sample selection bias on the part of the SEC. The SEC went looking for market power collusion and found market coordination; the SEC did not show collusion was typical nor damaging. In comparison, did the claims of CFOs that they can increase firm value

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[12] See Fama (1991).

via capital structure changes keep the MM Propositions from making their path-breaking contribution? No. Back then, anecdotal information was given little weight in preference to solid theoretical foundations and exhaustive, well-controlled empirical analyses; now science is conducted by press conference. Prudence dictates that the unsubstantiated claims and the unproven testimony of dealers should be given no more weight than that given to dogs howling at the Moon. This "evidence" has no place in the sciences, physical or social.

It is obvious that price concentration exists for reasons other than collusion. Is the concentration on Nasdaq and NYSE/AMEX evidence of collusion or of the other causes developed here? This remains unknown. CS does not construct tests which differentiate, and it is beyond the scope of this paper to redo the CS study here. Certainly, Godek and Grossman, et al have cast doubt on CS methods and sample selection. But in the absence of conclusive empirical data, theory should lead clear-headed economists away from explanations of collusion in a market with a high turnover of participants and virtually free entry. Further, collusion and cartels depend on a restriction in supply. For this final reason alone, it seems unlikely that collusion is typical of the Nasdaq markets given their phenomenal growth. Has collusion ever been attempted? Yes, almost certainly.[13] Is attempted collusion so common and costly as to justify costly SEC intervention? Certainly not based on the evidence presented thus far and especially not until the true costs of that intervention are known.

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[13] As Richard Roll has pointed out, that they should attempt to do so is the general theme of Porter's *Competitive Strategy*.

Why should we expect an equal distribution of eighths in any financial market? Should the SEC require that the NYSE/AMEX, IPOs, M&As, and self-tender prices also begin to show a uniform use of all eighths? If the Nasdaq has been restricted in supply for as long as the even eighths convention has been commonplace, then it is almost inconceivable to imagine just how much bigger Nasdaq would be in 1996 without that decades-long restriction in supply.[14] Nasdaq volume has grown from less than the AMEX to larger than the NYSE in less than thirty years. That single statistic does not ring of supply restriction. The question posed in Christie and Schultz (1994) was, "Why do Nasdaq Market Makers Avoid Odd-Eighths Quotes?" The question may have been equally well asked as, "Why do NYSE/AMEX specialists, underwriters, takeover artists, and treasurers in undervalued firms avoid odd-eighths quotes?"

In this paper, price concentration or clustering was shown to be pervasive and long-lived in three large samples from very different financial markets. The experience of everyday life also shows us that price concentration is common in product, labor, and real estate markets. It remains unclear what causes price concentration in every market where it exists. But what is clear from the results presented here is that there are likely to be several yet unknown non-collusive reasons for price concentration and therefore, *price concentration is a very poor indicator of price fixing.*

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[14] A special thanks to Fred Weston for making this point so clear.

References

Christie, W., and P. Schultz, 1994, "Why do NASDAQ Market Makers Avoid Odd-Eighth Quotes?," *Journal of Finance*, Volume 49, pp. 1813-1840.

Coase, R. H., 1972, "Industrial Organization: A Proposal for Research," *Policy Issues and Research Opportunities in Industrial Organization*, edited by Victor R. Fuchs, Volume 3 of *Economic Research: Retrospective and Prospect*, NBER General Series, Number 96 (Cambridge: National Bureau of Economic Research, 1972), pp. 59-73.

Coase, R. H., 1988, *The Firm, the Market, and the Law*, The University of Chicago Press, p. 9.

Fama, E., 1991, "Efficient Capital Markets: II," *Journal of Finance*, Volume 46, pp. 1575-1617.

Godek, P., 1996, "Why Nasdaq Market Makers Avoid Odd-Eighth Quotes," *Journal of Financial Economics*, Volume 41, pp. 465-474.

Grossman, S., M. Miller, D. Fischel, K. Cone, and D. Ross, 1995, "Clustering and Competition in Asset Markets," A Lexicon Inc. Report.

Harris, L., 1991, "Stock Price Clustering and Discreteness," *Review of Financial Studies*, Volume 4, pp. 389-415.

Miller, M., 1977, "Debt and Taxes," *The Journal of Finance*, Volume 32, pp. 261-275.

Roll, R., 1986, "The Hubris Hypothesis of Corporate Takeovers," *Journal of Business*, Volume 59, pp. 197-216.

TABLE I. Results of Logistic Regressions that Predict
the Probability that Merger Prices are Set on Even Dollars

Table I is constructed in the same format as in CS. The dependent variable takes the value of 1 for merger prices on integer dollar amounts. The independent variables used in the logistic regressions are as follows. PRICE is the merger price. HOSTILE is a dummy variable equal to one if the merger was classified as hostile and equal to zero otherwise. MV is the merger price multiplied by the number of shares outstanding. VOL is the average daily volume of the target stock measured over 22 trading days, starting two months before the merger. VAR is the variance of the target stock returns over the same period as VOL is measured. All continuous independent variables are in natural logarithmic values (LN). The regression estimates are presented in Panel A. The logistic regressions estimate a probability that a merger price will be set on an integer dollar. We define stocks as being correctly classified by the model in Panel B if the merger price is (is not) set on an integer dollar and the model assigns a probability of at least 0.5 (less than 0.5) that the merger price occurs on an integer dollar.

Panel A: Coefficient Estimates
Regression Coefficient and Standard Errors (in parentheses)

Regression	LNPRICE	HOSTILE	LNMV	LNVOL	LNVAR	Constant	Sample Size
1	0.729** (0.062)					-1.938** (0.194)	1,654
2		0.509** (0.122)				0.129* (0.056)	1,654
3	0.708** (0.063)	0.260* (0.128)				-1.931** (0.193)	1,654
4	0.632** (0.073)		0.131** (0.035)			-2.283** (0.211)	1,610
5	0.611** (0.073)	0.271* (0.130)	0.130** (0.035)			-2.277** (0.211)	1,610
6				0.096** (0.036)		-0.809* (0.358)	992
7					-0.279** (0.055)	-1.924** (0.412)	992
8	0.962** (0.098)			-0.024 (0.040)		-2.512** (0.422)	992
9	0.919** (0.101)				-0.043 (0.062)	-2.935** (0.454)	992

Panel B: Classification Accuracy

Regression	Stocks Quoted in Even Dollars		Stocks not quoted in even dollars	
	Correctly Classified	Incorrectly Classified	Correctly Classified	Incorrectly Classified
1	725	201	336	392
2	246	680	598	130
3	725	201	345	383
4	695	200	355	360
5	690	205	360	355
6	427	103	103	359
7	390	140	169	293
8	399	131	263	199
9	396	134	258	204

* Significantly different from 0 at the 5 percent level.
** Significantly different from 0 at the 1 percent level.

TABLE II. Results of Bernoulli Tests of the Distribution of Odd and Even Eighths

Table II shows the observed frequency of even eighths (p) and sample sizes (n). The observed frequency of odd eighths q is 1−p as only odd and even eighths are considered here (so non-eighths prices have been dropped for the IPO, merger and self-tender samples). The null hypothesis D_0 is that even eighths account for one-half of odd and even eighths stock quotes; this implies odd eighths also account for half ($D_0 = p = q = 0.5$). In Panel A, each of t statistics are significant at the 1% confidence level. The null is strongly rejected in all samples including the NYSE/AMEX specialist system. In Panel B, the NYSE/AMEX results for the first four eighths versus last four do not reject the null, while the NYSE/AMEX results for the inner versus outer eighths remain significant but at a lesser level. The Nasdaq results remain significant but at a lesser level. Data from Christie and Schultz begin with CS.

Distribution	Observed Frequency	Sample Size	t-statistic
Panel A: Even versus Odd Eighths (0/8, 2/8, 4/8, 6/8) v. (1/8, 3/8, 5/8, 7/8)			
1. CS NYSE/AMEX	0.5441	544,811	65.4
2. CS Nasdaq	0.8538	372,625	611.3
3. IPO	0.9843	7,086	328.3
4. M&A	0.9731	1,525	114.2
5. Self-tenders	0.9686	668	69.4
Panel B: Negative Controls			
1. CS NYSE/AMEX (0/8, 1/8, 2/8, 3/8 v. 4/8, 5/8, 6/8, 7/8)	0.4998	544,811	-0.3
2. CS NYSE/AMEX (2/8, 3/8, 4/8, 5/8 v. 0/8, 1/8, 6/8, 7/8)	0.4948	544,811	-7.7
3. CS Nasdaq (0/8, 1/8, 2/8, 3/8 v. 4/8, 5/8, 6/8, 7/8)	0.5060	372,625	7.3
4. CS Nasdaq (2/8, 3/8, 4/8, 5/8 v. 0/8, 1/8, 6/8, 7/8)	0.4897	372,625	-12.6

FIGURE 1. Distribution of Price Fractions Across Inside Quotes

Figure 1 is a reproduction of Christie and Schultz' (1994) Figure 3. The left bars show the distribution of price fractions across 544,811 inside quotes for 100 stocks from the NYSE/AMEX specialist market system, while the right bars show the distribution of price fractions across 372,625 inside quotes for 100 high volume stocks from the Nasdaq dealer market system.
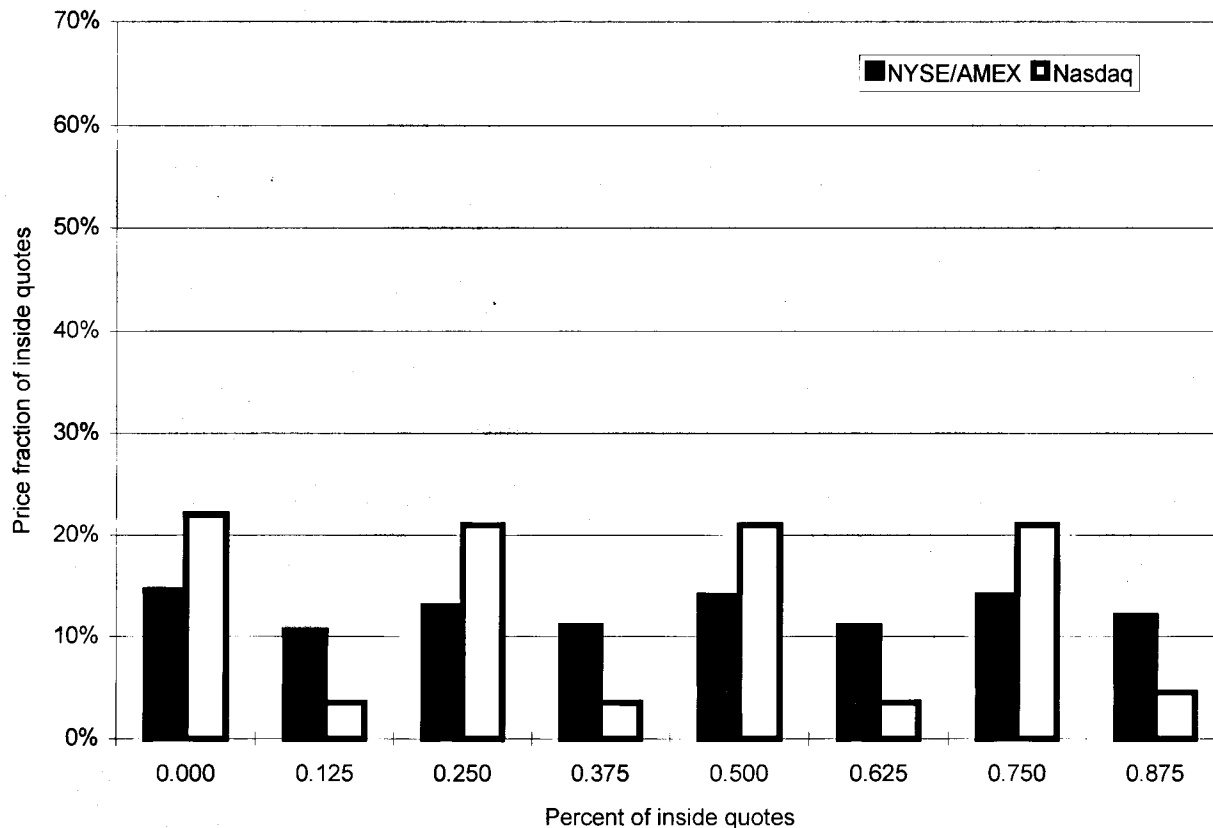
Note: For ease of comparison, Figures 1, 2, 3, 4, and 4a use the same scales.

FIGURE 2. Distribution of Price Fractions Across IPOs

Figure 2 shows the distribution of 7,086 eighth-fractions for offer prices across 7,196 IPOs which occurred between January 1974 and July 1996, and had an offer price of at least one dollar. Not graphed are 1.5% (n=110) of IPOs with offer prices occurring on finer than eighth fractional amounts.
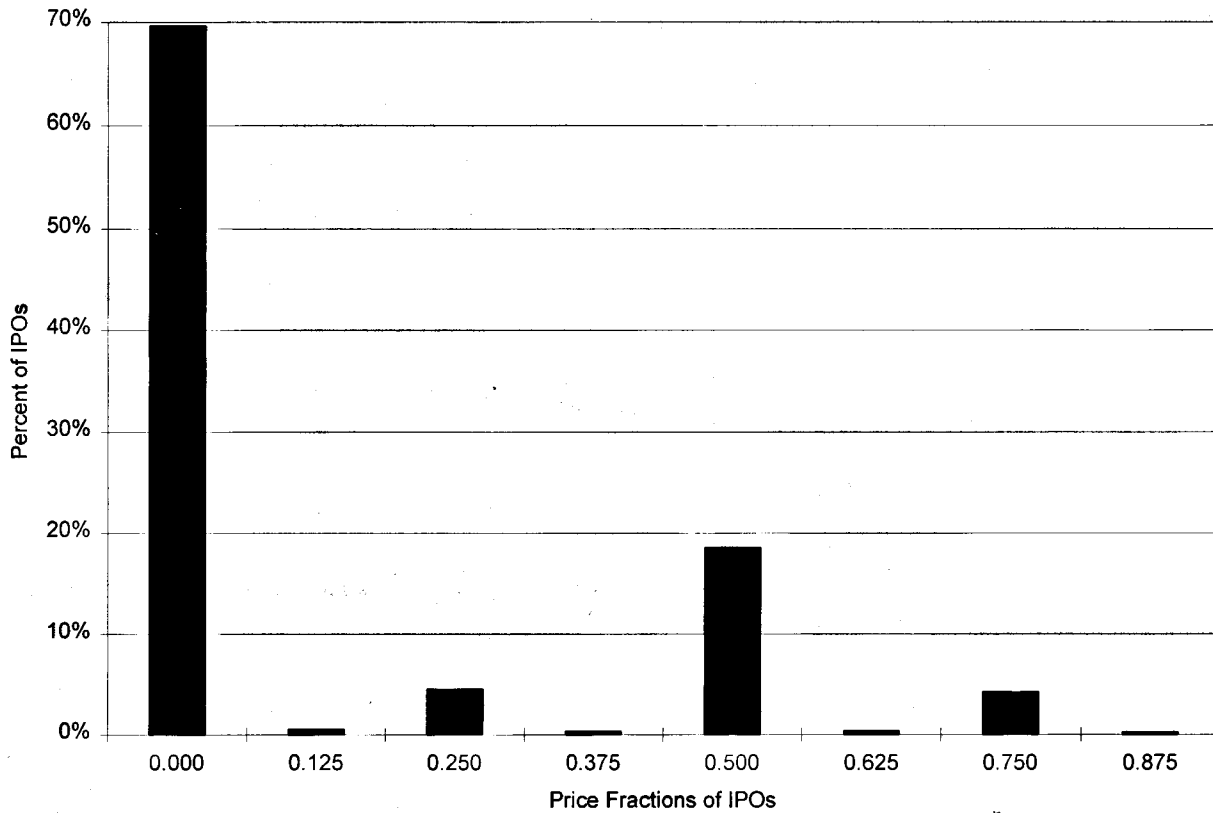
FIGURE 2a. Distribution of IPO Price Fractions Across NYSE/AMEX or Nasdaq IPOs

Figure 2a shows the distribution of 1,102 eighth-fractions for offer prices across 1,108 NYSE/AMEX IPOs and 4,696 eighth-fractions for offer prices across 4,754 Nasdaq IPOs which occurred between January 1974 and July 1996, had an offer price of at least one dollar, and were listed on CRSP within 10 days of the IPO date. Not graphed are 0.5% (n=6) of NYSE/AMEX and 1.2% (n=58) Nasdaq IPOs with offer prices occurring on finer than eighth fractional amounts.
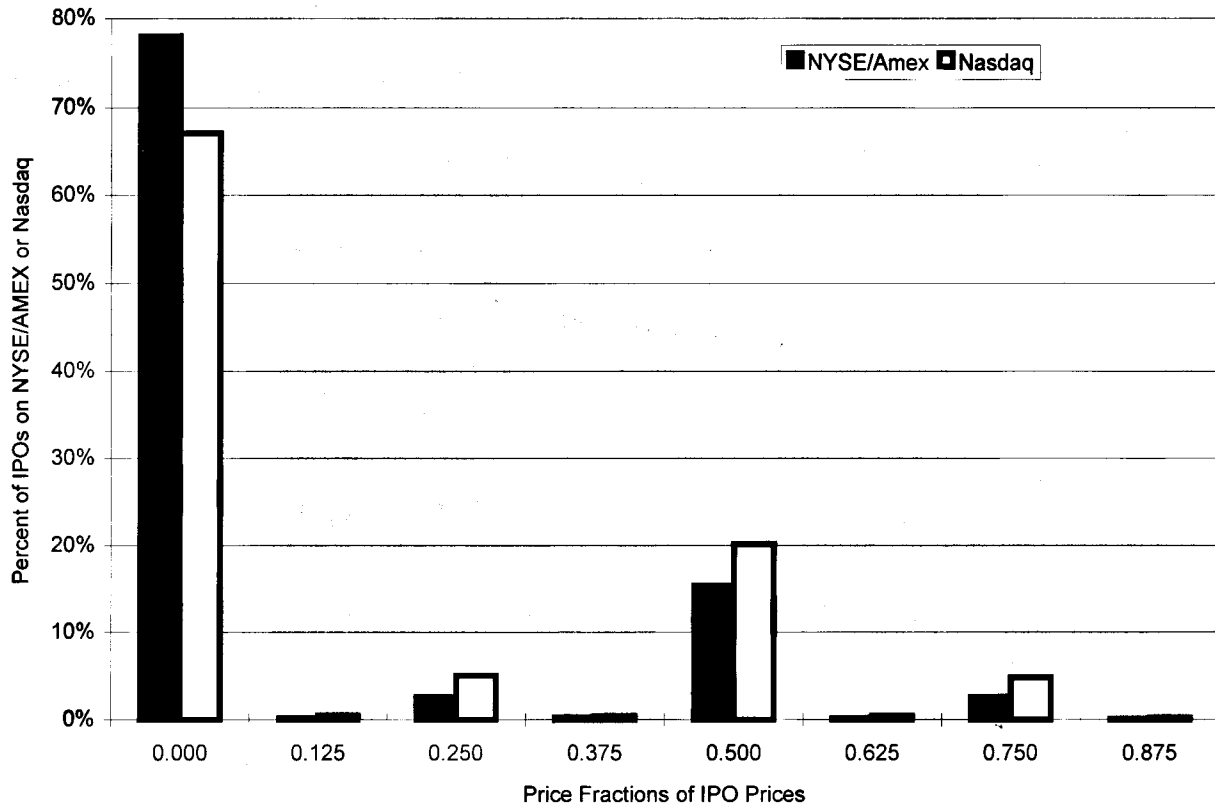
FIGURE 3. Distribution of Price Fractions Across Mergers

Figure 3 shows the distribution of 1,525 eighth-price fractions for 1,776 mergers which were announced between September, 1980 and April, 1996 and had a price of at least one dollar but not more than $100 per share. Not graphed are 13.7% (n=241) of mergers occurring on finer than eighth fractional amounts.
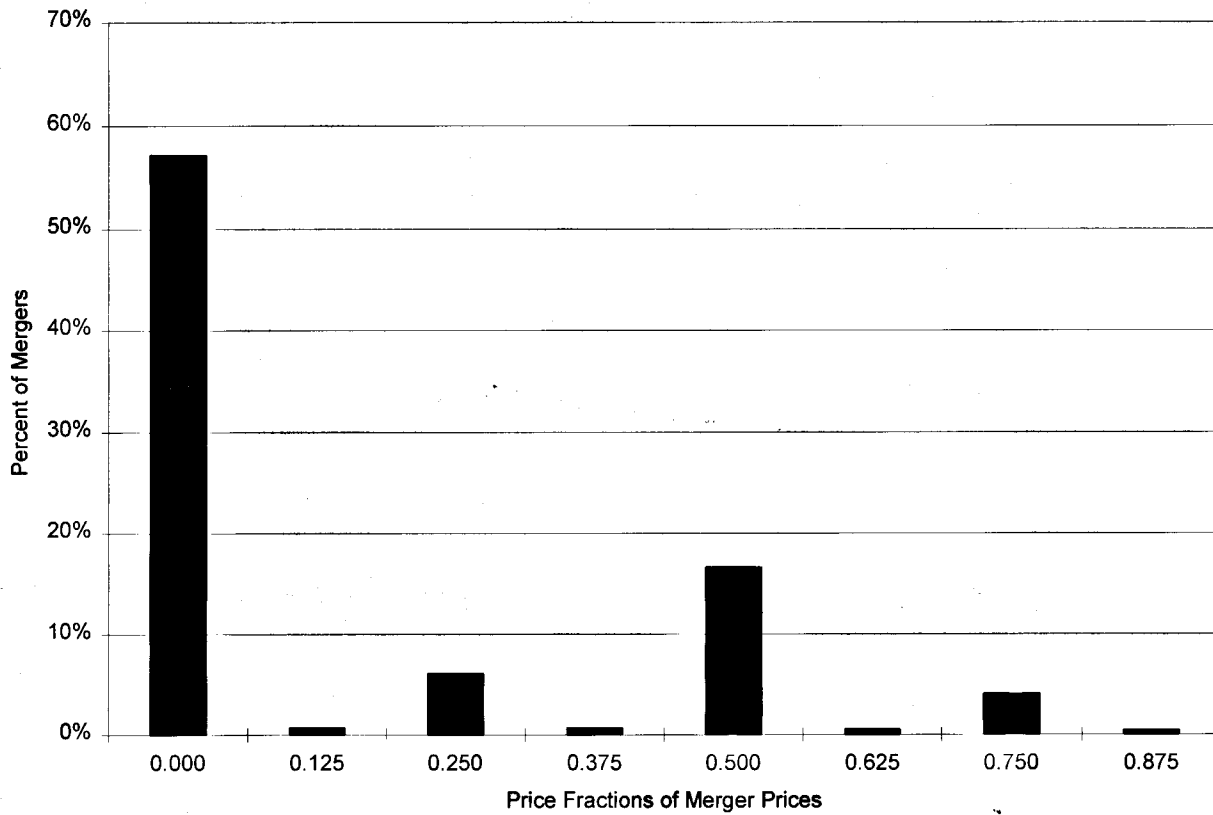
FIGURE 4. Distribution of Price Fractions Across Self-Tenders

Figure 4 shows the distribution of 668 eighth-price fractions of 802 self-tender offers which occurred between September, 1980 and April, 1996 and had a price of at least one dollar per share. Not graphed are 16.7% (n=134) of self-tenders occurring on finer than eighth fractional amounts.
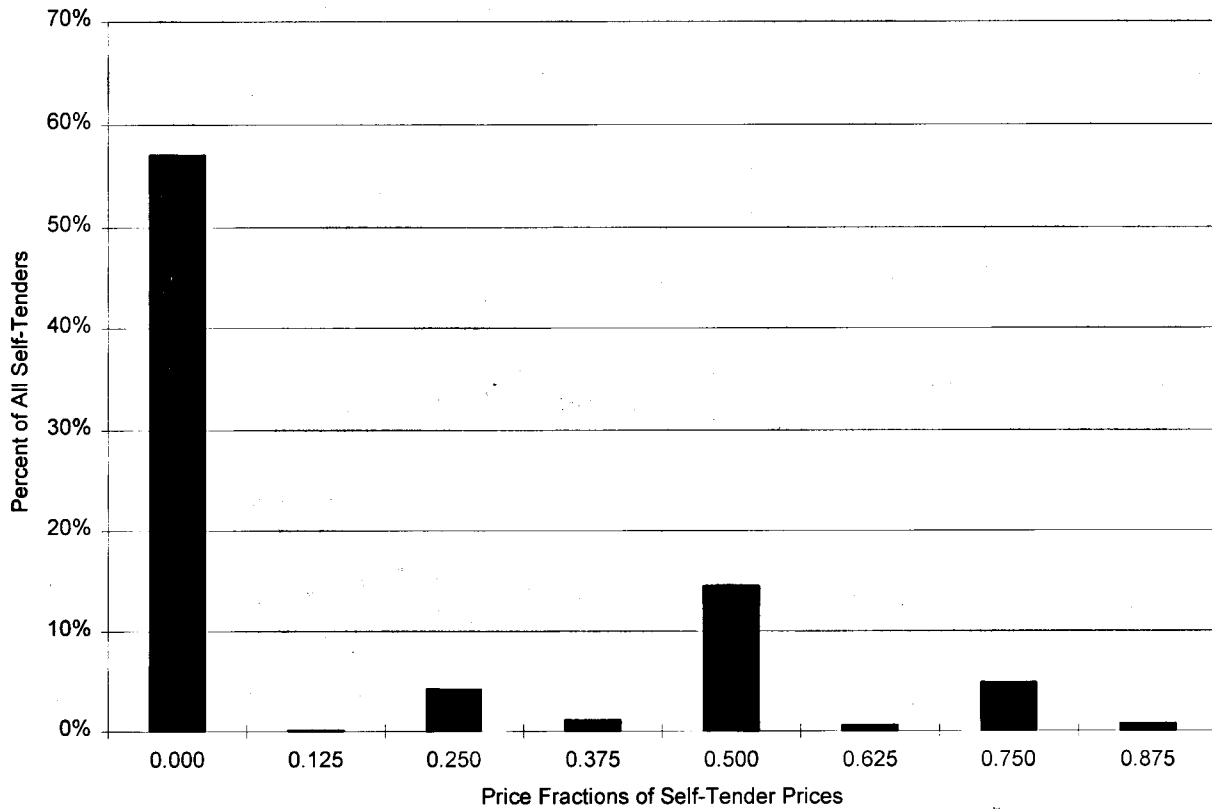

Price Fractions of Self-Tender Prices

FIGURE 4a. Distribution of Prices at Date t-1 for Self-Tender Offers

Figure 4a shows the distribution of the previous day quote for 418 eighth-price quotes for 424 self-tenders for which closing prices at date t-1 were available on CRSP. Not graphed are 1.4% (n=6) of self-tenders (with closing prices at date t-1 available on CRSP) occurring on finer than eighth fractional amounts.
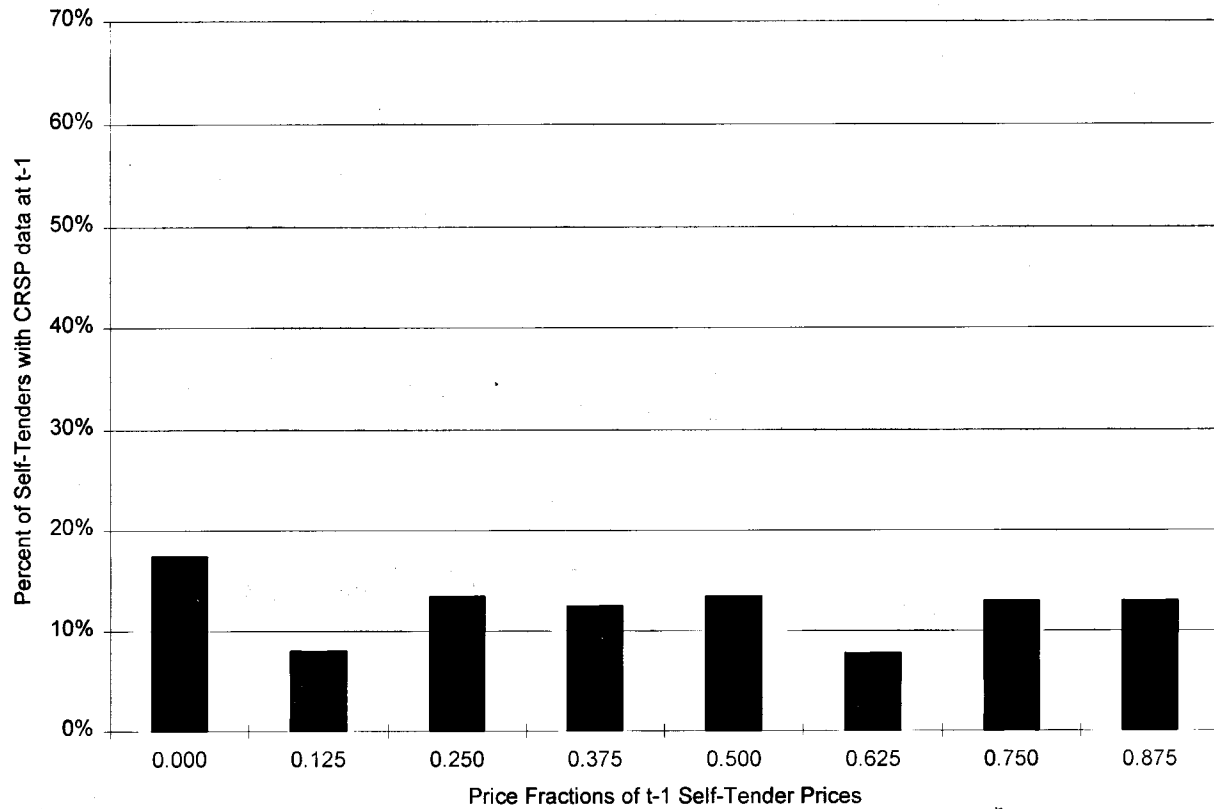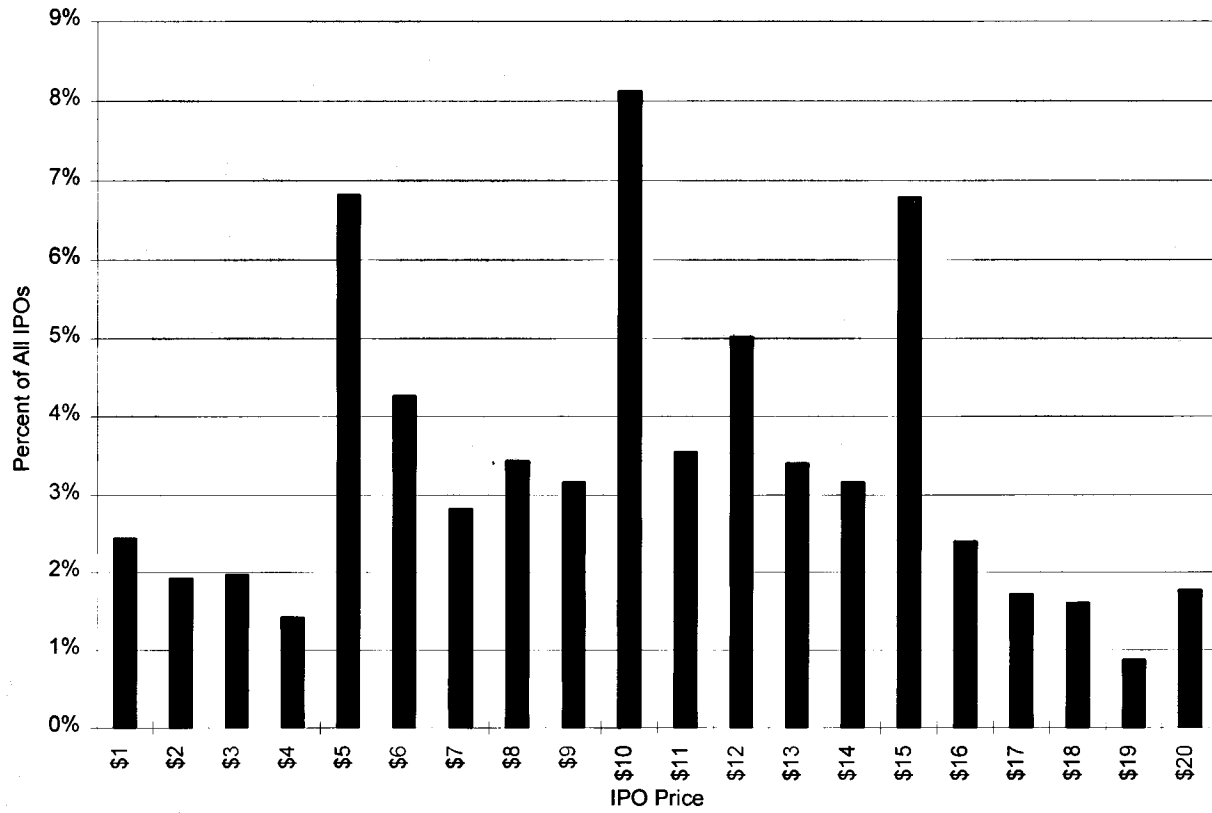
FIGURE 5. Distribution of Even-Dollar Price Increments for IPOs

Figure 5 shows the distribution of 4,803 integer-dollar-priced IPOs priced at or below $20 per share. The integer-dollar subset at or under $20 constitutes 66.7% of the total 7,196 IPO sample.

FIGURE 5a. Distribution of Even-Dollar Price Increments
for NYSE/AMEX or Nasdaq IPOs

Figure 5a shows the distribution of 777 NYSE/AMEX and 3,118 Nasdaq integer-dollar-priced IPOs priced at or below $20 per share. The integer-dollar subset at or under $20 constitutes 70.1% of the NYSE/AMEX sample and 65.6% of the Nasdaq sample.
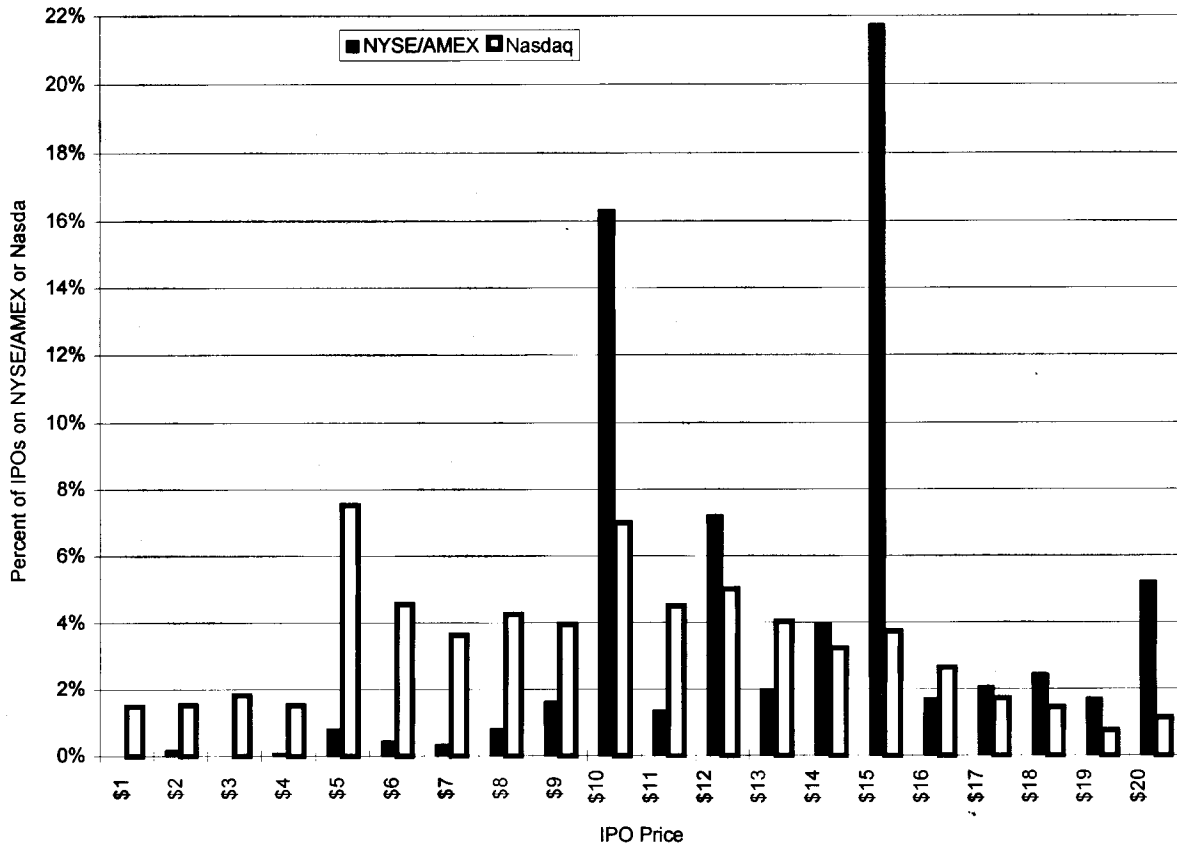
FIGURE 6. Distribution of Half-Dollar Price Increments for IPOs

Figure 6 shows the distribution of 1,298 half-dollar priced IPOs priced at or below $20.5 per share. The half-dollar subset at or under $20.5 constitutes 18.0% of the total 7,196 IPO sample.