The Development of Secondary Market Liquidity for NYSE-listed IPOs

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ABSTRACT

For NYSE-listed IPOs, limit order submissions and depth relative to volume are unusually low on the first trading day. Initial buy-side liquidity is higher for IPOs with high quality underwriters, large syndicates, low insider sales, and high pre-market demand, while sell-side liquidity is higher for IPOs that represent a large fraction of outstanding shares and have low pre-market demand. Our results suggest that uncertainty and offer design affect initial liquidity, though order flow stabilizes quickly. We also find that submission strategies are influenced by expected underwriter stabilization and pre-opening order flow contains information about both initial prices and subsequent returns.

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A liquid secondary market is a critical component in a successful initial public offering (IPO). For investors, a liquid market can reduce transaction costs and lower volatility in the immediate aftermarket. Initial liquidity may also reduce the costs faced by market makers who act as the trader of last resort. Finally, a liquid market may reduce required underpricing and can improve the issuing firm's future access to capital markets by attracting analysts or investors.[1] Despite this importance, little research has examined the development of liquidity in the secondary market. In particular, there are no studies exploring the role of limit orders following IPOs and little analysis of IPOs on a specialist market such as the NYSE.[2]

Using a unique proprietary dataset, we analyze liquidity provision for a sample of 220 IPOs listed on the NYSE between January 1995 and September 1998. The data include all submissions, executions, and cancellations of market and limit orders through the NYSE's electronic SuperDOT system. In conjunction with data on trades and quotes, these data allow us to analyze liquidity provided by public limit orders and to characterize the behavior of limit order traders and floor participants following IPOs. This study provides the first analysis of limit order liquidity and the interactions between limit order submission strategies and the actions of other traders (such as the underwriter) for newly listed securities. Our results are particularly important given the growing role of limit orders on other markets, such as Nasdaq, and the proliferation of order-driven markets worldwide.

We focus on four issues related to the development of secondary market liquidity at the start of IPO trading. First, we analyze the characteristics and determinants of first-day liquidity for NYSE-listed

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[1]In the extreme, insufficient secondary market liquidity can result in the failure or cancellation of the IPO. In 1993, for example, Wilt Chamberlain Restaurants began trading after issuing 1.4 million shares only to cancel the offer after several days of falling prices and failed stabilization activities by the underwriter. Similarly, Claimsnet.com cancelled its IPO in December 1998 after just one day of trading. Ellul and Pagano (2002) and Booth and Chua (1996) discuss the relation between secondary market liquidity and underpricing. The link between liquidity and asset returns is analyzed in Amihud and Mendelson (1986) and Brennan and Subrahmanyam (1996).

[2]IPOs in the U.S. have historically listed on either a regional exchange or the OTC market, and as a result, previous studies of IPO trading generally focus on the role of underwriters and market makers in the Nasdaq dealer market. However, IPO listings on the NYSE increased dramatically in the 1990s (see Corwin and Harris (2001)). See Ritter (1998) and Jenkinson and

IPOs. Because listing firms typically have no prior trading history and limited publicly available information, one might expect the costs of providing liquidity to be high immediately following an IPO. However, liquidity may also be affected by other factors, such as firm characteristics, the offer design choices of the firm, and market conditions. We analyze the ability of these factors to explain the cross-section of liquidity at the start of IPO trading. Second, we examine changes in liquidity over the first 30 trading days and how the unique market conditions associated with IPOs affect trader behavior. In particular, we analyze the evolution of liquidity levels, the relative use of market versus limit orders, and limit order cancellation and execution rates. Third, we examine the relative importance of limit orders and floor participants in providing liquidity and whether limit order submission strategies are affected by underwriter price support. Finally, we examine the information content of pre-opening order flow for first-day prices and long-run returns.

We find that NYSE-listed IPOs are characterized by unusually high limit order book depth and low bid-ask spreads at the start of trading. However, trading volume is also extremely high during this period, and as a result, depth relative to volume is unusually low on the first trading day. At the same time, hot IPOs (those that open more than 15% above the offer price) exhibit significant buy imbalances during the first 30 minutes of trading, while cold IPOs (those that open at or below the offer price) exhibit significant sell imbalances that continue into the second trading day. Notably, though both trading volume and limit book depth are unusually high for several weeks, limit book imbalances and depth relative to volume tend to stabilize within the first two to three days of trading.

Analysis of order submission strategies shows that limit orders represent an unusually low fraction of total submissions on the first day of trading and that limit order cancellation rates are unusually high on day one, especially for hot IPOs. These results suggest that at the start of IPO trading, traders attenuate the potential costs of submitting limit orders by switching to market orders or by monitoring and repositioning their limit orders to a greater extent than usual. Again, however, the results

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Ljungqvist (2001) for recent discussions of the existing IPO literature.

suggest that limit order use and disposition tends to stabilize by the second or third day of trading.

Examining the cross-sectional determinants of initial depth, we find that depth is significantly related to the design choices of the firm and to information revealed during the book-building period. Offers with strong primary-market demand (those priced at or above the maximum of the filing range) exhibit significantly higher bid depth and lower ask depth than other IPOs, while offers with weak demand in the primary market (those priced at or below the minimum of the filing range) exhibit significantly lower bid depth and higher ask depth than other IPOs. These results are consistent with the existence of unsatisfied demand following the IPO allocation and with the partial adjustment phenomenon observed by Hanley (1993). Our results also show that buy-side depth is higher for firms with larger underwriting syndicates and higher quality underwriters, and lower for offers with a large fraction of insider sales. Together, our findings are consistent with the effects of asymmetric information and uncertainty at the start of IPO trading and suggest that firms can influence initial liquidity levels through their choices at the time of the offer.

We find that liquidity provided by limit orders is complemented by liquidity from the trading floor (including the specialist and the underwriter). For hot IPOs, limit orders provide an average of 45% of quoted bid depth and 64% of quoted ask depth on the first trading day, with the trading floor providing the remainder. For cold IPOs, the floor contributes an average of 74% of quoted bid depth on day one, but only 18% of quoted ask depth. These results are consistent with underwriters providing price support through the trading floor for IPOs that exhibit significant selling pressure. Anticipated underwriter price support also appears to affect the order submission strategies of other traders. In particular, we find an unusually large proportion of limit buy orders submitted at exactly the offer price for cold IPOs, and to a lesser extent, for warm IPOs. This pattern is consistent with traders attempting to profit from expected underwriter stabilization by following a quote-matching strategy, as discussed in Harris (1996).

Consistent with previous research, we find that market-clearing prices from pre-opening order flow are good predictors of first-day prices and are reflected in the opening price set by the specialist.

However, order flow is more informative for hot IPOs than for cold, suggesting that underwriter stabilization limits the response of prices to limit book information. In addition, imbalances in pre-opening order flow provide information about future returns. IPOs with large pre-opening buy imbalances have significantly higher market-adjusted returns at the one-year and three-year horizons. This effect is significant even after controlling for underpricing, flipping, and divergence of opinion. Thus, while market-clearing prices from the limit order book are reflected on day one, order flow imbalances appear to contain information that is not immediately incorporated into prices.

Together, our results show that limit orders provide an important and informative source of liquidity for NYSE-listed IPOs. Limit book liquidity develops quickly and is supplemented by the trading floor, especially for offers with significant selling pressure. Initial levels of liquidity appear to be affected by firm characteristics, market conditions, and the offer design choices of the firm. In general, asymmetric information and nonexecution costs appear to outweigh any advantages of using limit orders on the first day of trading, leading to unusually low limit book depth. However, both limit order use and limit book imbalances tend to stabilize within days.

The rest of the paper is organized as follows. Section I discusses the implications of IPO market conditions for limit order use and liquidity provision in a specialist market. Section II describes the data and sample characteristics. In Section III, we analyze the development of the limit order book, the relative importance of various sources of liquidity, and the determinants of initial limit book depth. Section IV examines order submission strategies in the immediate aftermarket and the impact of underwriter stabilization on trader behavior. In Section V, we analyze the information content of the limit order book and the relation between pre-opening order flows and IPO returns. Section VI concludes.

I. Liquidity Provision Following IPOs in a Specialist Market

Like all NYSE-listed securities, IPOs listed on the NYSE are assigned to a single specialist who is responsible for making a market in the stock. Liquidity in this market is provided by public limit orders in addition to the specialist and floor brokers. In this section, we discuss liquidity provision as it relates to

the unique market conditions following IPOs and the roles of limit orders, the underwriter, and the NYSE specialist at the start of IPO trading.

Given the lack of prior trading history and publicly available information associated with newly listed firms, the start of trading for IPOs is likely to be a period of high uncertainty and asymmetric information. Previous research also shows that the start of trading for IPOs is a period of extremely high trading activity (e.g., Ellis, Michaely, and O'Hara (2002)). These unique market conditions may have significant effects on limit order use and liquidity provision following IPOs. First, placing a limit order creates a free option for other traders (see Copeland and Galai (1983), Harris (1998), and Handa and Schwartz (1996)). Because this option may be exercised by traders with better information, the limit order trader faces adverse selection costs that increase when price uncertainty and asymmetric information are high. As a result, we expect limit order use and the resulting limit book depth to be low at the start of IPO trading.

Traders submitting limit orders also face the risk that their order will not be executed if prices move away from their limit price. Thus, the choice of submitting a limit order rather than a market order will depend on the probability of execution (see, for example, Hollifield, Miller, Sandas and Slive (2002)). Given the unusually large initial price moves following IPOs (especially hot IPOs), non-execution risk is likely to be high at the start of trading. This again suggests that limit order use may be low at the start of trading.

On the other hand, a principal advantage of limit orders relative to market orders is that they reduce uncertainty regarding execution price. Thus, investors who wish to minimize execution price risk at the start of trading may choose to submit limit orders rather than market orders. In addition, the high trading volume following IPOs may increase the probability of execution, further encouraging limit order submission. If these effects dominate those discussed above, we would expect more extensive use of limit orders and therefore more depth in the limit order book at the start of IPO trading.

Although the start of IPO trading is expected to be a period of high uncertainty, price fluctuations

in the immediate aftermarket may be limited by underwriter stabilization. Specifically, underwriters typically stand willing to purchase shares during the initial days of trading in order to keep the stock price from falling below the offer price.[3] Unlike on Nasdaq, where the lead underwriter typically becomes the predominant market maker (Ellis, Michaely, and O'Hara (2000)), underwriters providing price support on the NYSE must submit trades to the specialist like any other trader.[4]

Underwriter stabilization affects liquidity in several ways. First, underwriter stabilization provides a direct source of liquidity, but only on the buy side and only in those cases where buying interest from other sources is relatively scarce. Even then, the underwriter is not obligated to provide stabilization and may discontinue support at any time. Since the underwriter trades through a floor broker, we expect underwriter stabilization to result in a high floor contribution to bid depth when other buying interest at the offer price is low.

Stabilization may also have indirect effects on liquidity provided by other traders. If investors are confident that the underwriter will step in to provide price support for IPOs with weak demand, then downward price moves will be limited, and in turn, the costs of submitting limit orders will be reduced. We therefore expect limit order use to be higher in those cases where investors are confident that the underwriter will provide and maintain price support. The willingness of underwriters to buy at the offer price may also affect the order submission strategies of other traders. Specifically, price support may create incentives for other traders to follow a quote-matching strategy by submitting limit buy orders at, or just above, the offer price.[5]

Unlike the underwriter, the NYSE specialist is required to post two-sided quotes and serves as

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[3]Stabilization is allowed under Regulation M of the Securities Act of 1934 as an effective mechanism for fostering the orderly distribution of securities. For recent discussions of underwriter stabilization, see Hanley, Kumar, and Seguin (1993), Ruud (1993), Schultz and Zaman (1994), Benveniste, Busaba, and Wilhelm (1996), Chowdhry and Nanda (1996), Aggarwal (2000), Ellis, Michaely, and O'Hara (2000), Fishe (2002), and Boehmer and Fishe (2003).

[4]To accomplish this, a floor trader representing the underwriter typically interacts with the specialist on the trading floor in order to execute stabilizing trades. Regulation M requires underwriters to notify the specialist and the exchange if a bid is placed for the purpose of stabilization (see SEC (1996)).

[5]This is similar to a quote-matching strategy in the presence of limit orders (Harris (1996)). Downside risk is minimized since traders can sell to the underwriter if prices drop, but profit if prices rise. The risk in this case is that the underwriter will choose either not to support the price or to cease their price support before the trader gets out of her position.

the trader of last resort. The specialist's posted quotes reflect their own trading interests, as well as interest on the trading floor and in the limit order book. A specialist's obligation to maintain orderly markets suggests that he will provide additional liquidity at those times when limit order book and floor liquidity are low. However, market conditions may affect the specialist's willingness to take positions and provide liquidity. For example, high uncertainty following IPOs may increase the specialist's inventory holding costs and therefore decrease the specialist's willingness to take positions (see for example Ho and Stoll (1981) and Bollen, Smith, and Whaley (2003)). In addition, Kavajecz (1999) shows that specialists use quoted depth as a strategic choice variable and set their quotes to reflect only the depth available in the limit order book when they believe informed trading is likely.

Over time, we expect liquidity provision and order submission strategies to stabilize as price uncertainty is resolved and overall trading activity reaches normal levels. We also expect the role of the underwriter to diminish as temporary price support is withdrawn. The length of this transition process and the factors that influence liquidity during the transition remain empirical questions.

II. Data and Sample Characteristics

We identify U.S. IPOs listed on the New York Stock Exchange from January 1995 through September 1998 using the *NYSE Fact Book*. This results in a sample of 304 IPOs. For each IPO, we then collect data on offer characteristics from the Securities Data Corporation (SDC) New Issues database. In addition, we collect trade and quote (TAQ) data and NYSE System Order (SOD) data for the first 60 days of aftermarket trading. The SOD data provide detailed information on all SuperDOT (electronic) orders, including the date and time of order submission, whether the order is a buy or sell, order size, order type (market or limit), order conditions (day order, good-til-canceled, etc.), and the limit price (if applicable).[6] If any portion of the order is executed or canceled, the data also include the time of execution or cancellation, the related number of shares, and the execution price (if applicable).

[6]Sofianos and Werner (2000) find that SuperDOT trades account for an average of 44.9% of total buy plus sell volume. In comparison, the average proportion of volume traded through SuperDOT in our sample ranges from 46.0% on day one to 40.8% on day five.

We exclude 72 closed-end funds and an additional 12 firms due to missing limit order book data. This results in a final sample of 220 NYSE-listed IPOs. For all firms in the final sample, we collect additional financial statement data, inside ownership data, and syndicate characteristics directly from the IPO prospectus. Where possible, data on inside ownership and insider sales are verified using data from Ljungqvist and Wilhelm (2003).[7]

Throughout the paper, we provide separate results for three subsamples of IPOs categorized by initial return. We define hot, warm, and cold IPOs as those that open more than 15% above the offer price, 15% or less above the offer price, and at or below the offer price, respectively. Based on this definition, our sample includes 78 hot IPOs, 106 warm IPOs, and 36 cold IPOs. We expect underwriter stabilization to be most prevalent in the sample of cold IPOs. Consistent with this argument, 33 of the 36 cold IPOs open at exactly the offer price.

Summary statistics for firm and offer characteristics are provided in Panels A and B of Table I, respectively. As shown in Panel A, the average firm in the sample is quite large, with a market capitalization (based on the first day closing price) of $689 million, total assets of $1.8 billion, and total sales of $752 million. In addition, the average firm has a debt-to-assets ratio of 0.60 and a book-to-market ratio of 0.61.

[Insert Table I Here]

Offered shares and offer proceeds for NYSE-listed IPOs average 9.44 million and $183 million, respectively. Not surprisingly, these values are substantially higher than for the typical Nasdaq IPO. For example, Ellis et al. (2002) report average offer proceeds of $37.2 million. On average, NYSE IPOs account for just over 40% of post-IPO shares outstanding (float), and insiders sell an average of 7.2% of offered shares. Commensurate with the relatively large size, the average NYSE-listed IPO is taken public by a highly ranked underwriter and a syndicate comprising more than 27 investment banks. The gross spread and direct expenses for these IPOs average 6.27% and 1.74% of offer proceeds, respectively.

[7]We thank Alexander Ljungqvist for providing this data. To be consistent across IPOs, corporate holdings (sales) are included as

Table II summarizes trading activity (Panel A) and pre-opening order flow (Panel B) for the sample. The average NYSE IPO opens 33.4 minutes after the 9:30 A.M. opening bell. Consistent with Aggarwal and Conroy (2000), opening delays are significantly longer for hot IPOs (41.9 minutes) than for cold IPOs (24.2 minutes). NYSE-listed IPOs are underpriced by 12.5% relative to the opening call-auction price and by 12.8% relative to the first-day closing price, on average.[8] In comparison, Ritter and Welch (2002) report average underpricing of 18.1% for a broad sample of NYSE, AMEX, and Nasdaq IPOs between 1995 and 1998. As expected, underpricing differs significantly across hot, warm, and cold IPOs. Underpricing relative to the opening trade price averages 25.7%, 7.2%, and -0.3% for these three subsamples, respectively.

[Insert Table II Here]

Consistent with previous research, the start of IPO trading is characterized by unusually high trading volume. The mean first-day trading volume in our sample is 4.7 million shares and accounts for an average of 55.5% of offered shares. Trading activity differs significantly across the IPO subsamples, with first-day volume accounting for 72.4% of offered shares for hot IPOs, relative to only 49.9% for warm IPOs and 35.0% for cold IPOs. In contrast, daily volume from days 6 through 30 averages only 159 thousand shares or 1.7% of offered shares.

The opening call-auction trade averages 1.7 million shares and accounts for 20.1% of offered shares.[9] Because sellers in the opening trade are likely to be investors who obtained shares in the original offer, this trade provides a proxy for the amount of flipping that occurs for NYSE IPOs. Consistent with actual flipping documented by Aggarwal (2003), this proxy is increases with initial returns and differs significantly across hot, warm, and cold IPOs. The open averages 2.2 million shares (27.1% of offered shares) for hot IPOs, compared to 1.7 million shares (17.3%) for warm IPOs and 1.1 million shares

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insider holdings (sales). The results are not sensitive to this inclusion.

[8]Consistent with Barry and Jennings (1993), the mean first-day open-to-close return is an insignificant 0.24% suggesting that the benefits of underpricing flow primarily to investors who receive shares in the original offer.

[9]The opening call-auction trade is not always the first trade reported in TAQ. For example, a 100-share inaugural trade executed by a company representative may precede the call-auction trade report on day one. For this reason, we define the opening trade as the largest trade reported during the first 180 seconds of trading.

(13.0%) for cold IPOs. We note, however, that this proxy may overstate flipping, since both the specialist and the underwriter may take short positions at the start of trading. For example, Aggarwal finds that flipping during the first two days of trading accounts for only 15% of offered shares.[10]

We observe substantial differences in order flow across IPO categories (Panel B). As with overall trading volume, pre-opening order flow is highest for hot IPOs and lowest for cold IPOs. While market sell orders typically exceed market buy orders, this sell imbalance is more pronounced for cold IPOs (-48.2%) than for either warm (-16.6%) or hot IPOs (-4.8%). For limit orders, there is a substantial buy imbalance for hot IPOs (32.3%) and a substantial sell imbalance for cold IPOs (-24.3%). Combining market and limit order flow, average pre-opening imbalances are positive for hot IPOs and negative for cold IPOs. The large sell imbalances observed for cold IPOs suggest a potentially important role for the specialist and underwriter in providing liquidity for these issues. The results for hot IPOs suggest that the long opening delays observed in Panel A may reflect difficulties associated with opening a stock in the presence of significant limit order imbalances.

III. Limit Order Book Depth and Sources of Liquidity

We reconstruct the limit order book at 30-minute intervals during the first 60 days of trading using NYSE System Order Data (SOD) and the methodology of Kavajecz (1999).[11] Daily depth measures for each firm are then calculated as the average across intraday periods. Throughout the paper, we analyze both share depth and depth relative to daily volume (adjusted depth). The latter variable controls for the demand for liquidity. We use a variant of standard event study methodology to compare limit book

[10]Our data do not allow us to identify short sales by either the underwriter or the specialist. However, Short sales submitted through the SuperDOT system account for less than 1% of offered shares. Krigman, Shaw, and Womack (1999) calculate an alternative proxy for flipping defined as sell-signed block volume divided by total volume. For comparison to their work, we sign first-day trades using the Lee and Ready (1991) algorithm, where the opening trade is excluded. First-day sell-signed block volume averages 1.25 million shares and does not differ significantly across initial-return subsamples. Our results suggest that the negative relation between flipping and initial returns documented by Krigman et al. may result from variation in total volume rather than variation in sell-signed block volume.

[11]This methodology is especially well-suited for the study of IPOs, since the limit book at the beginning of the period is empty and does not have to be estimated. For IPOs, the methodology involves two steps. We first incorporate the set of limit orders submitted prior to a selected date and time. We then remove any orders that were executed (cancelled) and update orders that were partially executed (cancelled) prior to the date and time of interest. "Day" orders are dropped at the end of each day. To minimize data errors we also delete limit buy (sell) orders at prices higher (lower) than the posted ask (bid) quote.

characteristics at the start of trading to those during normal trading conditions.[12] We create the daily time series of median depth across firms and calculate *t*-statistics based on the mean and standard error of this time series for days 31to 60.[13]

A. The Characteristics of Limit Book Depth

Table III lists median values for share depth, adjusted depth, and depth imbalance based on cumulative limit book depth within $1.00 of the quote midpoint. The table provides intraday results on day one as well as daily results through day 30. Results for hot, warm, and cold IPOs are presented in Panels A, B, and C, respectively. We note that delayed openings affect the number of observations for each period on day one. For example, only 26 (of 78) hot IPOs are opened prior to 10:00 A.M. on day one, while 65 are opened by 10:30 A.M., and all but two are opened by 11:00 A.M.

[Insert Table III Here]

All categories of IPOs exhibit unusually high bid and ask depth throughout the first trading day. For example, at 12:00 P.M. on day one for hot IPOs (panel A), the median ask depth within $1.00 of the quote midpoint is over 64 thousand shares. This is nearly 20 times the median of 3,350 shares on days 31 through 60. This pattern is even more dramatic for bid depth. During the first day, bid depth within $1.00 of the quote midpoint ranges from 63,000 to 141,000 shares compared to a day 31 through 60 median of just over 1,800 shares. Turning to the daily results, we see that bid and ask depth remain unusually high but drift down throughout the first several weeks of trading. For hot IPOs, statistical tests confirm that both bid and ask depth are significantly higher than normal through day 25.

The pattern in share depth mirrors that in trading volume, with very high initial values tapering

[12]Throughout the analysis, we implicitly assume that trading activity reaches normal levels within six weeks (30 trading days). The results suggest that this is a conservative assumption. The normal trading period is defined after the end of the quiet period, which occurs on day 25 (see Bradley, Jordan, and Ritter (2003)), before the end of IPO lock-up period, which typically occurs 180 days after the IPO (see Cao, Field, and Hanka (2003)), and after the end of underwriter stabilization activities.

[13]Statistical tests are based on median depth to account for the highly skewed distribution of share depth. Results based on means are generally similar. As an alternative, we performed statistical tests based on firm-specific measures of abnormal depth relative to the "normal" trading period as in Corwin and Lipson (2000). For each firm, abnormal depth is defined as the percentage difference between limit order book depth at the time of interest and median limit order book depth for that firm at the same time of day across trading days 31 through 60. Cross-sectional significance tests based on this abnormal depth measure provide results similar to those reported above.

off over time. Looking at depth adjusted by volume, we find that both adjusted bid depth and adjusted ask depth on day one are significantly lower than the day 31 to 60 median. For hot IPOs, first-day ask depth ranges from 0.5% to 1.5% of daily volume and first-day bid depth ranges from 1.3% to 2.9% of daily volume. This compares to medians of 5.4% on the ask side and 3.9% on the bid side for days 31 through 60.

Comparing Panels A, B and C, we see that depth levels differ substantially across IPO categories and between the buy and sell sides of the limit order book. Ask depth is significantly higher than normal through the fourth week of trading for all categories of IPOs, though it is lowest for hot IPOs. Bid depth is also significantly higher than normal for all IPO categories, but is lowest and returns to normal more quickly for cold IPOs. In contrast to share depth, adjusted depth for all categories of IPOs is significantly lower on day one than on other trading days and reaches stable levels very quickly. Most statistically significant differences in adjusted depth disappear after the first day or two of trading.

The last column in Table III shows the median depth imbalance, defined as bid depth minus ask depth divided by total bid plus ask depth. For comparison, we note that limit order books on days 31 through 60 are generally characterized by a sell imbalance of roughly 17% to 19%. For hot IPOs, significant buy imbalances exist throughout the first day and continue through day four. For example, the median buy imbalance for hot IPOs at the open is approximately 67% of total depth. Warm IPOs also exhibit a significant buy imbalance at the open but this imbalance diminishes after 10:00 A.M. In contrast, cold IPOs exhibit significant sell imbalances throughout the first trading day, and to some extent, throughout the first week of trading. The median sell imbalance for cold IPOs is at least 62% of total depth throughout day one and reaches as high as 94%. Notably, imbalances tend to stabilize quickly, though not as quickly as adjusted depth.

The results in Table III are based on depth within $1.00 of the quote midpoint. Figures 1 and 2 provide a more detailed illustration of limit book depth. Figure 1 plots depth at various distances from the quote midpoint at 30-minute intervals on the first day of trading. The figure shows that the imbalances

described in Table III are evident throughout the limit order book. Most striking are the large total bid depth for hot IPOs and the near absence of depth on the bid side for cold IPOs. The total depth for hot IPOs is consistent with the presence of traders who attempt to purchase the hot IPO at a relatively low price. As we will see in Section IV, a large number of these limit orders are eventually cancelled after the stock opens well above the offer price. The result for cold IPOs may reflect a lack of demand at the offer price and the resulting need for underwriter price support. We explore the effects of underwriter price support in more detail below. Cold IPOs also differ in the positioning of limit orders on the ask side of the book with much higher ask depth near the quotes than either warm or hot IPOs.

[Insert Figure 1 Here]

Figure 2 plots total share depth (Panel A) and adjusted depth (Panel B) for the first 30 trading days. Consistent with the results for depth within $1.00 of the quote midpoint, total limit book depth is fairly symmetric for hot and warm IPOs after the first few trading days and continues to decrease over the first several weeks of trading. In particular, the large buy imbalance far from the quotes for hot IPOs is much reduced by day two. In contrast, the significant sell imbalance observed for cold IPOs persists throughout much of the first month of trading. Although total share depth is greatest on the first day of trading for all categories of IPOs, adjusted depth is actually lowest on day one.

[Insert Figure 2 Here]

Taken together, the results in Table III and Figures 1 and 2 show that despite high trading volume and overall depth levels that persist for some time, liquidity provision appears to stabilize rapidly on the NYSE specialist market. In fact, most economically significant deviations in adjusted depth and depth imbalances occur during the first day of trading.

B. Sources of Liquidity

On the NYSE, liquidity provided by floor traders (including the underwriter and the specialist) complements that provided through public limit orders. To examine the relative importance of the trading floor and the limit order book, we decompose quoted depth into a component provided by limit orders

and a component provided by the trading floor. The floor contribution is defined as the difference between the specialist's quoted depth and the depth provided in the limit order book at the inside quote.[14] Figure 3 plots the mean floor contribution to depth as a percentage of quoted depth on each of the first 30 trading days. Results are provided separately for bid and ask depth, and for hot, warm, and cold IPOs. The level of quoted depth is provided for comparison.

[Insert Figure 3 Here]

As with trading volume and limit book depth, quoted depth decreases substantially over time. However, quoted depth at the start of trading is actually highest for cold IPOs and lowest for hot IPOs. Combined with the limit book depth results discussed above, this suggests that the trading floor provides substantial bid depth for cold IPOs. This is confirmed by the results for floor contribution to depth. On day one, the trading floor contributes over 73% of quoted bid depth for cold IPOs, compared to only 57% for warm IPOs and less than 55% for hot IPOs. In contrast, the floor contributes only 18% of quoted ask depth on day one for cold IPOs, 27% for warm IPOs, and 36% for hot IPOs. The floor's contribution to bid (buy-side) depth during the first days of trading for cold IPOs is consistent with underwriter price stabilization activities on the trading floor. For other IPOs, the contribution of limit orders appears even more important at the start of trading than during later periods.

As an alternative measure of liquidity, we analyze execution costs using quoted bid-ask spreads and spreads from the limit order book. The limit book spread is defined as the difference between the best ask and bid prices in the limit book. Like the quoted spread, this measure reflects execution costs for small trades.[15] Figure 4 plots mean percentage spreads for each of the first 30 trading days. The results suggest that trading costs are lowest at the start of trading and increase over time. However, the increase

[14]We note that a portion of liquidity provided by floor traders may not be displayed in the specialist's quotes (see for example Bacidore, Battalio, and Jennings (2002)). Our analysis examines only the displayed portion of floor liquidity.

[15]To reflect execution costs for larger trades, we also defined two spread measures based on cumulative depth in the limit book (results not shown). The 5,000-share spread is the difference between the 5,000-share ask and 5,000-share bid, defined as the prices one would have to go up (down) to in order to reach 5,000 shares of cumulative depth on the ask (bid) side of the limit book. The 10,000-share spread is defined similarly for 10,000 shares of cumulative depth. The results based on these measures are consistent with those reported above. For hot IPOs, the average 5,000-share spread rises from 2.2% on day 1 to 7.4% on day 30, while the average 10,000-share spread rises from 3.5% to 14.6%. For cold IPOs, the average 5,000-share spread rises from

in quoted spreads is relatively small compared to the increase in limit book spreads. As depth in the limit book decreases, the specialist (and/or the trading floor) appears to take on a more important role, setting quoted bid-ask spreads at about 25% to 50% of the best limit order spread, on average.

[Insert Figure 4 Here]

C. The Determinants of Liquidity Provision

The results above show that limit book depth differs significantly across IPO categories on the first day of trading. In this section, we analyze more extensively the cross-sectional determinants of initial liquidity provision for NYSE-listed IPOs. We test hypotheses related to firm characteristics, the design of the offer, primary market demand, and IPO market conditions. We also control for overall trading activity by including day one trading volume.

We include three firm characteristics to proxy for the level of asymmetric information and uncertainty associated with IPOs. First, we include firm size, defined as total sales in the year prior to issue. We expect large firms with more publicly available information to have lower levels of uncertainty and asymmetric information than small firms. Second, we include an indicator for technology firms based on SDC's technology definitions. We expect these firms to be associated with more growth options and, therefore, more uncertainty. Third, we include the debt to total assets ratio to capture the effects of leverage. If price uncertainty and asymmetric information increase the costs associated with providing liquidity, we would expect depth to be lower for small firms, technology firms, and firms with high debt ratios.

Initial liquidity levels may also be affected by the offer choices made by the firm and firm insiders. First, the selection of a high quality underwriter may boost investor confidence that stabilization will be provided and maintained in the secondary market. If the promise of underwriter price support encourages liquidity provision, we expect liquidity to be positively related to underwriter quality. Higher quality underwriters may also generate additional demand for an IPO as a result of superior marketing

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4.3% to 10.8% during the first 30 trading days and the average 10,000-share spread rises from 9.1% to 22.5%.

skills or a larger investor base. Similarly, larger underwriting syndicates may be able to generate increased interest in the IPO (Corwin and Schultz (2003)). We therefore expect both underwriter quality and syndicate size to be positively related to buy-side liquidity. We define syndicate size as the total number of underwriters in the IPO syndicate and underwriter quality as the market share of dollars raised in NYSE-listed IPOs during our sample period for each lead underwriter.

Managers of high quality firms may be able signal their quality, and thereby increase demand, by retaining a larger fraction of the firm after the IPO (Leland and Pyle (1977)). However, high inside ownership may also lead to greater asymmetric information problems (Heflin and Shaw (2000)). To test these possibilities, we include three proxies related to inside ownership. The first proxy, float, is defined as offered shares divided by post-IPO shares outstanding and reflects the fraction of the firm sold to the public. The second proxy is insider sales in the IPO as a fraction of offered shares and the third proxy is the percentage of shares owned by insiders after the IPO. If share retention is viewed as a positive signal, we expect buying interest to be positively related to insider ownership and negatively related to float and insider sales. On the other hand, if high inside ownership leads to increased asymmetric information costs, we would expect inside ownership to be negatively related to initial buying interest. This problem may be especially severe following IPOs, since ownership by insiders is much higher than for the typical publicly held firm.[16]

Oversubscription and rationing of IPO shares often lead to unsatisfied demand following IPOs.[17] As a result, demand during the book-building period is likely to carry over to the secondary market. To test whether initial liquidity levels are related to primary-market demand, we include four dummy variables based on the placement of the offer price relative to the initial filing range. The first two variables identify IPOs with strong primary-market demand and are set equal to one if the offer price is equal to or above the maximum of the filing price range, respectively. We expect these variables to be

[16]We note that the median firm in our sample has post-IPO inside ownership of 48.7%, while 25% of the sample firms have inside ownership of more than 70%.

[17]Aggarwal (2000) notes that hot IPOs are often oversubscribed by as much as 20 to 30 times. In addition, Hanley (1993) finds

positively related to bid depth and negatively related to ask depth. The other two variables identify IPOs with weak primary-market demand and are set equal to one if the offer price is equal to or below the minimum of the filing range, respectively. We expect these variables to be negatively related to buying interest.

Initial liquidity levels may be partially determined by IPO market conditions at the time of the offer. Specifically, IPOs issued during hot markets or following other successful IPOs may generate more buying interest than those issued during cold markets. We include two proxies for the state of the current IPO market. The first is the average level of underpricing for IPOs issued during the 60 days prior to the current IPO. The second proxy is the total number of IPOs during this period. If IPOs issued during hot markets generate increased demand, we expect buying interest to be positively related to both the number and underpricing of recent IPOs.

Table IV reports regression results for share depth, adjusted depth, percentage floor contribution to depth, and depth imbalance. We provide separate results for bid (buy-side) and ask (sell-side) depth. To reduce the effects of stale limit orders, dependent variables are defined based on depth within $1.00 of the quote midpoint. For share depth and adjusted depth regressions, the log of depth is used as the dependent variable to limit the effects of outliers and to account for the fact that depth is non-negative by construction. For the percentage floor contribution, a logit transformation of the dependent variable is used. Because IPOs tend to be clustered in time, standard errors are adjusted to allow for clustering by IPO month.

[Insert Table IV Here]

As expected, both bid and ask depth are positively related to total trading volume, though the effect is larger for ask depth than for bid depth. After controlling for volume, we find only weak evidence that cross-sectional variation in depth is related to firm size, leverage, or industry characteristics. The results suggest that ask depth is higher for large firms and adjusted ask depth is smaller for technology

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that underwriters only partially adjust the offer price to information learned during the book-building period.

firms. However, on the bid side, the coefficients on total sales, debt ratio, and the technology dummy are insignificant in all but one case, and in that case, the result is opposite what was expected – larger firms are associated with lower rather than higher bid depth.[18]

Initial liquidity is significantly related to underwriter characteristics. Underwriter market share is positively related to bid depth and negatively related to floor contribution to bid depth, while syndicate size is positively related to both bid depth and adjusted bid depth. Together, these results are consistent with the hypothesis that high quality underwriters and larger syndicates are able to attract more buying interest as a result of better marketing skills or a larger potential client base. The results may also reflect the expectation that high quality underwriters will maintain price support for cold IPOs.[19]

The results for inside ownership are consistent with the effects of increased asymmetric information at high levels of inside ownership, as discussed in Heflin and Shaw (2000). Inside ownership is negatively related to both share depth and adjusted depth on the buy side. In contrast, large insider sales are associated with reduced bid-side depth, a larger floor contribution to depth, and more significant sell imbalances. These findings are consistent with the signaling effects described in Leland and Pyle (1977).[20] Float has no significant impact on buy-side depth, but is positively related to sell-side depth. This result may simply reflect the fact that larger offers result in there being more shares available for trading.

The coefficients on the primary-market demand variables suggest that IPOs priced at or above the maximum of the initial filing price range have higher bid depth, lower ask depth, and larger buy

[18]We also estimated the model including market capitalization and aftermarket standard deviation as alternative proxies. The conclusions are unchanged. The results are also similar if we include dummy variables for industries defined using the SIC classifications from Fama and French (1997). For each specification, we fail to reject the hypothesis that coefficients on all industry dummy variables equal zero.

[19]We also estimated the model including a dummy variable for lead underwriters with a Carter-Manaster rank of nine (see Carter and Manaster (1990) and Carter, Dark, and Singh (1998)). The results are consistent with those presented above, though there is little cross-sectional variation in Carter-Manaster ranks. The minimum rank in our sample is five and more than 95% of the sample have ranks of eight or higher.

[20]To reconcile these somewhat conflicting results on inside ownership and insider sales, we re-estimated the model allowing for separate effects for ownership levels above and below 75% (the 75th percentile in our sample). The coefficient on inside ownership is insignificant for ownership levels below 75%, but negative and significant for ownership levels above 75%. These results suggest that the negative effect of inside ownership is driven by extremely high levels of inside ownership and the resulting asymmetric information and corporate control effects. For a discussion of nonlinear effects related to inside ownership,

imbalances than other IPOs. These IPOs also exhibit reduced floor contribution to bid depth and higher floor contribution to ask depth. In contrast, IPOs priced at or below the minimum of the initial filing range are associated with lower bid depth and higher ask depth. These findings suggest that demand (or lack thereof) during the primary market is carried over into the secondary market and reflected in initial levels of limit book liquidity. However, we find no evidence that hot IPO markets in general are associated with higher liquidity. The number of recent IPOs is insignificant for both buy-side and sell-side depth and periods of high underpricing are associated with lower rather than higher buy-side depth.

In general, the results in Table IV suggest that initial liquidity levels may be influenced by firm characteristics, the offer choices of firms, and demand in the primary market. Buy-side (bid) depth in the limit order book is higher for IPOs with high quality underwriters and larger syndicates, for IPOs in which insiders do not sell a substantial fraction of shares, and for IPO with strong primary market demand. Sell-side (ask) depth is higher for IPOs that represent a larger fraction of total shares outstanding and for IPOs with weak primary market demand. The adjusted R^2 ranges from 4.8% to 47.4% for the ask-side models and from 7.7% to 22.7% for the bid-side models.

IV. Order Submission Strategies and Trader Behavior

As shown above, the limit order book is a significant source of liquidity for NYSE-listed IPOs. To better understand the trader behavior that leads to observed limit book patterns, Figure 5 plots limit order submission, execution, and cancellation rates during the first 30 days of trading. Results are provided separately for buy and sell orders and for hot, warm, and cold IPOs. In general, we note that trading behavior stabilizes very quickly. This is consistent with our earlier result that depth imbalances and adjusted depth reach normal levels within the first few trading days.[21] Although not shown, statistical tests confirm the patterns described below.

[Insert Figure 5 Here]

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see Stulz (1988) and McConnell and Servaes (1990).

[21]The patterns observed over the first few days of trading may reflect a change in the composition of traders during this period. For example, day one may include a high proportion of flipping trades. In addition, unlisted trading privileges for regional

Panel A shows limit order submission rates, defined as limit order submission volume divided by total limit plus market order submission volume. The results provide at least a partial explanation for the low levels of adjusted depth on day one. The limit order submission rate is unusually low on the first day of trading for all IPO types and this effect is more pronounced for sell orders than for buy orders. Thus, traders on day one tend to choose market orders over limit orders to a greater extent than normal. These findings suggest that the costs of submitting limit orders at the start of trading outweigh the execution price risk that traders face when submitting market orders. Except in the case of sell orders for hot IPOs, limit order submission rates tend to reach normal levels by the second or third trading day. For hot IPO sell orders, limit order submissions are lower than normal throughout the first week.

Panel B plots limit order execution rates, defined as total limit order execution volume divided by limit order submission volume. Here the patterns differ markedly between hot, warm, and cold IPOs, and between buy and sell orders. Sell order execution rates are slightly higher than normal for all three categories of IPOs on day one, but again stabilize by approximately the second day of trading. On the buy side, the most striking result is that the execution rate for buy orders in cold IPOs is unusually high at the start of trading, with 82% of buy orders executed during the first day. Although total bid depth is relatively low for cold IPOs, these results suggest that nearly all limit buy orders are executed at the start of trading. In contrast, first-day buy order execution rates are close to normal levels for warm IPOs at approximately 59% and are lower than normal for hot IPOs at 43%. These results likely reflect initial price movements, with prices rising away from buy orders on the first day, especially for hot IPOs. As with sell orders, buy order execution rates tend to stabilize by the second or third day of trading.

Panel C plots limit order cancellation rates, defined as limit order cancellation volume divided by limit order submission volume. With the exception of cold IPO buy orders, we observe very high cancellation rates on the first day of trading. For cold IPO buy orders, the low cancellation rate likely reflects the unusually high execution rates on day one. Since executions are very frequent and prices do

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exchanges begin on day two during most of our sample period (see SEC Rule 12f-2).

not fluctuate much for these IPOs, there is no need to cancel and reposition the limit order. In contrast, for hot and warm IPOs, traders must reposition their limit orders as prices move. In particular, the extremely high cancellation rate for buy orders in hot IPOs is consistent with the large number of (stale) limit buy orders observed far from the quotes at the start of trading (see Figure 1).

As discussed above, the presence of underwriter stabilization may have a direct impact on limit order submission strategies. In particular, stabilization may support profitable quote-matching strategies. To test for the presence of these strategies, Figure 6 presents the mean proportion of limit order shares submitted at the offer price and at prices within $0.25 of the offer price for each of the first 30 trading days. We also include orders submitted prior to the open on day one, labeled as period zero. Results are given separately for buys and sells and for warm and cold IPOs. Results for hot IPOs are not shown since there are very few limit orders submitted near the offer price for these IPOs.[22]

[Insert Figure 6 Here]

Consistent with a quote-matching strategy, we see that a large fraction of limit buy orders for cold IPOs are submitted at exactly the offer price. For these IPOs, roughly 52% of limit buy submissions prior to the open and 47% of limit buy submissions during day one have limit prices equal to the offer price. These results are even more striking given the substantially lower levels of submissions immediately above and below the offer price. For example, only 22.6% of limit buy submissions on day one are submitted within $0.25 above the offer price and only 2.5% are submitted within $0.25 below the offer price. We observe a similar effect for warm IPOs, though to a lesser extent. For these IPOs, 12.5% of limit buy submissions prior to the open and 11.3% during the first day have limit prices equal to the offer price. These results suggest that expected underwriter price support alters the order submission strategies of other traders and attracts order flow from traders who follow a quote-matching strategy.

[22]Even for hot IPOs, with very few limit orders near the offer price, roughly 3% of pre-opening limit buy submissions are at the offer price with less than 0.6% of submissions within $0.25 of the offer price. We note that limit buy orders at the offer price could also result from the underwriter supplementing their floor trading activities with electronic limit orders. However, this is not likely, since Regulation M prohibits placing more than one stabilizing bid in a market at the same time and at the same price (SEC (1996)).

Notably, for cold IPOs we also find that over 50% of limit *sell* submissions prior to the open have limit prices equal to the offer price, though this frequency drops dramatically after day one. These orders reflect traders who are willing to immediately liquidate their position in the cold IPO at the same price they paid for the shares. Such a strategy may be useful to flippers who wish to turn over their holdings but feel an obligation not to put downward pressure on the stock price by using a market order. In the presence of underwriter price support, such an order may also amount to a marketable limit order.

V. The Information Content of Electronic Order Flow

In this section, we examine the information content of pre-opening order flow using two alternative tests. First, we test whether information from pre-opening order flow is reflected in the opening price set by the specialist. Madhavan and Panchapagesan (2000) and Corwin and Lipson (2000) provide similar analyses for regular morning openings and trading halts, respectively. However, the information provided by limit orders may differ in the case of IPOs, since these securities have no prior trading history and may be affected by underwriter stabilization. As a second test, we examine whether imbalances in pre-opening order flow can predict future returns. This analysis is closely related to Krigman et al. (1999) who find that large investors tend to sell (flip) those issues that have the worst future performance and Houge, Loughran, Suchanek, and Yan (2001) who find that excess returns during the first year are significantly related to measures of divergence of opinion. In addition, Affleck-Graves, Hegde, and Miller (1996) find a positive relation between initial returns on IPOs and returns over the first three months of trading, while both Krigman et al. and Houge et al. find a negative relation between initial returns and returns during the first one to three years. We extend these analyses by testing whether information available *prior to* the start of trading can predict future returns. Our measures may also provide a more direct test of investor trading interests since they are based on order submissions rather than executions.

A. First Day Prices

To measure the information content of electronic order flow with respect to first-day prices, we

follow the methodology developed in Madhavan and Panchapagesan (2000). We first define the pre-open market-clearing price as the price that best equates supply and demand across all limit orders. This price is defined for all but one IPO.[23] We then compare the ability of this price and the specialist's opening price to predict the first-day price change, defined as the percentage return from the offer price to the closing price. We employ a two-stage regression approach specified as follows:

$$\text{Stage 1:} \qquad \ln(P_{i,post} / P_{i,pre}) = \alpha + \beta \ln(P_{i,1} / P_{i,pre}) + e_i \tag{1}$$

$$\text{Stage 2:} \qquad \hat{e}_i = \gamma + \delta \ln(P_{i,2} / P_{i,pre}) + u_i \tag{2}$$

The variable $P_{\text{i,post}}$ is the closing quote midpoint on the day firm i goes public, $P_{\text{i,pre}}$ is the offer price, $\hat{e}_i$ are the residuals from the first-stage regression, and $P_{\text{i,1}}$ and $P_{\text{i,2}}$ each either the market-clearing price or the opening call-auction price set by the specialist. The first-stage regression evaluates the quality of a given price ($P_{\text{i,1}}$) and the second-stage regression tests whether incremental information is contained in an alternative price ($P_{\text{i,2}}$). If $P_{\text{i,1}}$ is an unbiased predictor of the future price, then β will equal one and δ will equal zero. If $P_{\text{i,2}}$ provides incremental explanatory power, then δ will be statistically different from zero.

Regression results are shown in Table V. Market-clearing prices from the pre-opening limit book are significant predictors of end-of-day prices. For example, the first-stage regression using market-clearing prices explains 78% of the cross-sectional variation in offer-to-close returns. However, the specialist's opening price provides incremental explanatory power relative to the market-clearing price (i.e., $\delta \neq 0$). In contrast, when the opening price is used in the first-stage regression, the coefficient on opening price explains 87% of the cross-sectional variation in offer-to-close returns and market-clearing prices add no incremental explanatory power (i.e., $\delta = 0$). These results suggest that electronic order flow provides valuable information about future prices, but the specialist's opening price appears to incorporate this information as well as other sources of information such as trading interests from the exchange floor.

[23] We also constructed an alternative market-clearing price based on all pre-opening market and limit orders submitted through SuperDOT (the system-clearing price). Results based on this alternative price are qualitatively similar. However, system-clearing prices exist for only 159 IPOs. Clearing prices are undefined if there is (1) excess demand at the highest limit sell price, (2) excess supply at the lowest limit buy price, (3) market buy volume and no limit sell volume, or (4) market sell volume and no

[Insert Table V Here]

When we analyze opening prices separately by IPO category, we find that market-clearing prices are far less informative for cold IPOs than for hot IPOs. For example, the adjusted R^2 in the first-stage regression equals 58.3% for hot IPOs compared to only 5.3% for cold IPOs. In addition, the coefficients suggest that first-day prices for cold IPOs only partially adjust to limit book information and the specialist's opening price contains significant incremental information beyond that provided in the limit order book. These results are consistent with underwriter price support limiting the adjustment of prices to information on day one and with the effects of expected price support on limit order submission strategies as documented in Section III.

B. Short-Run and Long-Run Returns

To provide an initial look at the aftermarket returns on NYSE-listed IPOs, Panel A of Table VI lists mean values of buy-and-hold returns and market-adjusted returns at various return horizons. Buy-and-hold returns are defined relative to the first-day closing trade price and market-adjusted returns are calculated by subtracting the buy-and-hold return on the value-weighted CRSP index of all NYSE, AMEX, and Nasdaq firms. For the full sample, the mean three-year buy-and-hold return is 26.9% and the mean three-year market-adjusted return is –41.5%. These returns are slightly lower than the 36.0% and –32.3% reported by Ritter and Welch (2002) for the full sample of IPOs from 1995 through 1998. Consistent with previous research, returns at short horizons are in the same direction as initial returns. In contrast, returns at longer horizons do not differ significantly across IPO categories. One-year market-adjusted returns range from –13.2% for hot IPOs to –0.3% for warm IPOs, while three-year market-adjusted returns range from –54.8% for cold IPOs to –37.5% for warm IPOs.

[Insert Table VI Here]

To test whether pre-opening order flow has predictive power for future returns, we provide cross-sectional regressions controlling for other factors that have been shown to affect the long-run returns on

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limit buy volume.

IPOs. The dependent variable is the market-adjusted return on IPOs and regressions are estimated separately for five-day, one-month, one-year, and three-year horizons. Because IPOs tend to be clustered in time, standard errors are adjusted to allow for clustering within IPO month.

The explanatory variables are defined as follows. To control for firm characteristics, we include the log of market capitalization and the log of the book-to-market ratio.[24] Both variables are defined based on the first-day closing stock price from CRSP and negative book-to-market ratios are set equal to 0.01. To allow for differences between hot, warm, and cold IPOs, we include the initial return, defined as the percentage differences between the offer price and the opening trade price. Following Houge et al. (2001), we include the opening spread and opening delay as proxies for divergence of opinion. Finally, we include a proxy for flipping, defined as opening trade volume divided by offered shares.[25]

To test whether pre-opening order flow has significant effects on IPO returns, we define two variables based on the total order flow imbalance immediately prior to the opening trade. The total order flow imbalance is defined as total market plus limit buy order submissions minus total market plus limit sell order submissions, stated as a percentage of total submissions. The positive (negative) total imbalance is then defined as total imbalance if positive (negative) and zero otherwise. Defining separate variables for positive and negative imbalances allows for asymmetric buy and sell effects.

The regression results are presented in Panel B of Table VI. Consistent with previous research, the coefficient on initial return is positive and significant at short horizons and negative and significant at long horizons. These results suggest that hot (cold) IPOs tend to perform well (poorly) during the first weeks of trading, but this pattern is reversed at the one and three year horizons. In contrast to previous research, we find no evidence of a significant relation between long-run IPO returns and flipping, opening delay, or opening bid-ask spread. Although the coefficients on flipping and opening delay are negative and significant at short horizons, neither variable is significant at horizons of one year or longer. In fact,

[24]We also estimated the model including the aftermarket standard deviation measured on days 31 through 60. The inclusion of this variable results in an insignificant coefficient and does not affect the conclusions.
[25]Our results are similar if we use alternative measures of flipping based on sell-signed block volume.

all three variables have positive coefficients at the three-year horizon.

The difference between our results and those of previous studies may reflect differences in sample characteristics. For example, Houge et al. (2001) report mean opening spreads and opening delays of 6.4% and 88 minutes. The comparable numbers in our sample are 1.08% and 33.4 minutes. Our sample also includes substantially larger offers than previous studies. Regardless of the reason, the lack of significance for flipping and measures of divergence of opinion suggest that the predictive power of these variables is not evident in all IPO samples.

The results for order imbalance variables suggest that pre-opening imbalances have little effect on short-run returns. However, pre-opening imbalances do appear to be informative with respect to long-run IPO returns. At both the one-year and three-year horizons, the coefficient on positive order imbalances is positive and significant and the coefficient on negative order imbalances is negative though insignificant. Thus, even after controlling for initial return and divergence of opinion, pre-opening order imbalances are significantly related to long-run market-adjusted returns. These findings suggest that, while the specialist incorporates limit order book information into the opening price, order flow imbalances contain some information that is not immediately incorporated into prices.

VI. Conclusion

Using a unique proprietary dataset, we analyze liquidity provision and the role of limit orders following NYSE-listed IPOs. For all categories of IPOs, we find that limit order book depth is unusually high at the start of trading and approaches normal levels within a few weeks. However, depth as a fraction of trading volume is actually lowest at the start of trading and stabilizes by the second or third trading day. At the same time, limit order submissions are unusually low relative to market order submissions on the first day of trading and limit order cancellation rates are unusually high, especially for hot IPOs. This suggests that limit orders are an important source of liquidity right from the start of IPO trading, though risks related to nonexecution and asymmetric information may attenuate limit order use on day one.

Consistent with underwriter price support, we find that 15% of IPOs open at exactly the offer

price while only 1.4% open below the offer price. These cold IPOs are associated with significant sell imbalances in the limit order book throughout the first day of trading. At the same time, floor participants provide over 73% of quoted bid depth but less than 18% of quoted ask depth on the first trading day. These results are consistent with underwriters providing stabilization for cold IPOs by submitting orders on the trading floor. Underwriter price support also has important effects on the order submission strategies of other traders. Specifically, we find a large proportion of limit buy orders submitted at exactly the offer price both prior to the open and throughout the first few trading days. This suggests that some traders follow a quote-matching strategy in the presence of anticipated price support.

Previous research suggests that both initial returns and first-day trading provide information about future returns on IPOs. We extend this research by testing whether order flow *prior to* the start of trading contains information about future performance. We find that pre-opening order flow provides valuable information about first-day prices and this information is reflected in the opening price set by the specialist. In addition, we find that imbalances in pre-opening order flow are significantly related to market-adjusted IPO returns at the one and three-year horizons. Thus, while market-clearing prices from the limit order book are reflected in trade prices on day one, order flow imbalances appear to contain information that is not immediately incorporated into prices.

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Table I
Summary Statistics for NYSE-Listed IPOs

This table presents summary statistics for a sample of 220 IPOs listed on the NYSE from January 1995 through September 1998. Firm characteristics are described in Panel A and offer characteristics are described in Panel B. The sample is partitioned based on the return from the offer price to the opening call-auction price, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price. For each variable, the table lists the mean value and a *p*-value from a test of the restriction that means are equal across hot, warm, and cold IPOs. Market capitalization is defined as post-IPO shares outstanding times the first day closing stock price. The book-to-market ratio equals post-IPO book value of equity divided by market capitalization and is set to 0.01 when book equity is negative. The debt-to-assets ratio equals total debt divided by total assets. Total debt, total assets, and total sales are based on the most recent fiscal year ending prior to the IPO. Float equals offered shares divided by post-IPO shares outstanding. Insider ownership equals the percentage of post-IPO shares outstanding owned by officers, directors, and corporations. Insider sales equals the proportion of offered shares sold by officers, directors, and corporations. Underwriter market share is defined for each lead underwriter as the proportion of IPO proceeds raised during the sample period. Syndicate size is the number of underwriters in the IPO syndicate. Gross spread and expenses are stated as a percentage of offer proceeds.

		By IPO Category			
	All IPOs	Hot	Warm	Cold	p-value
Panel A: Firm Characteristics					
Number of IPOs	220	78	106	36	-
Market capitalization (millions)	688.93	897.66	635.87	392.90	0.191
Total assets (millions)	1841.85	2838.24	1557.16	521.24	0.266
Total sales (millions)	751.60	955.33	680.16	520.51	0.414
Book-to-market	0.61	0.54	0.64	0.69	0.399
Debt-to-assets	0.60	0.60	0.59	0.61	0.961
Panel B: Offer Characteristics					
Offer price ($)	17.69	18.86	17.91	14.51	0.000
Offered shares (millions)	9.44	8.88	9.69	9.92	0.853
Offer proceeds (millions)	182.74	193.62	186.75	147.34	0.670
Float (%)	40.75	39.21	40.51	44.81	0.551
Inside ownership (%)	45.31	50.38	43.84	38.68	0.091
Insider sales (%)	7.20	5.18	7.66	10.23	0.363
Underwriter market share (%)	13.13	13.68	13.36	11.23	0.453
Syndicate size	27.49	28.31	27.74	24.94	0.561
Gross spread (%)	6.43	6.53	6.36	6.39	0.269
Direct expenses (%)	1.83	1.64	1.69	2.66	0.016

Table II
Trading Activity and Pre-Opening Order Flow for NYSE-Listed IPOs

This table presents summary statistics for a sample of 220 IPOs listed on the NYSE from January 1995 through September 1998. Panel A describes trading activity and Panel B describes pre-opening order flows. The sample is partitioned based on the return from the offer price to the opening call-auction price, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price. For each variable, the table lists the mean value and a *p*-value from a test of the restriction that means are equal across hot, warm, and cold IPOs. Opening delay is the number of minutes from 9:30 to the opening call-auction trade. Aftermarket standard deviation is estimated using closing midpoint returns on days 31 through 60. Opening volume is the number of shares traded in the opening call-auction trade. Market order flows are based on all orders submitted prior to the opening trade. Limit order flows are based on total depth in the limit order book immediately prior to the opening trade. Market order imbalance is defined as market buy submissions minus market sell submissions, stated as a percentage of total market order submissions. Limit order imbalance and total imbalance are defined similarly for limit order submissions and limit plus market order submissions, respectively.

		By IPO Category			
	All IPOs	Hot	Warm	Cold	p-value
Panel A: Trading Activity					
Opening delay (min.)	33.43	41.89	30.32	24.24	0.002
Offer-to-open return (%)	12.52	25.65	7.22	-0.34	0.000
Offer-to-close return (%)	12.81	26.08	7.51	-0.37	0.000
Opening bid-ask spread (%)	1.08	1.00	1.18	0.97	0.040
Aftermarket std. deviation (%)	2.60	2.77	2.45	2.64	0.117
Opening trade volume	1,745,202	2,165,899	1,655,809	1,096,906	0.018
(% of offered shares)	(20.06)	(27.11)	(17.28)	(12.99)	(0.000)
Day 1 volume	4,695,965	5,676,965	4,551,521	2,995,839	0.012
(% of offered shares)	(55.48)	(72.43)	(49.94)	(34.97)	(0.000)
Mean Volume Day 6-30	158,680	181,363	153,927	123,531	0.000
(% of Offered Shares)	(1.71)	(2.04)	(1.60)	(1.33)	(0.000)
Panel B: Pre-Opening Order Flows					
Market buy order shares	532,077	806,500	463,181	140,356	0.000
(number of orders)	(150)	(282)	(94)	(27)	(0.000)
Market sell order shares	580,048	713,889	550,229	377,862	0.000
(number of orders)	(167)	(238)	(144)	(83)	(0.000)
Limit buy order shares	957,192	1,594,370	755,406	170,798	0.000
(number of orders)	(250)	(553)	(103)	(30)	(0.000)
Limit sell order shares	347,238	401,862	344,416	237,191	0.000
(number of orders)	(78)	(107)	(71)	(34)	(0.000)
Market order imbalance (%)	-17.60	-4.82	-16.62	-48.19	0.000
Limit order imbalance (%)	32.28	55.61	34.32	-24.26	0.000
Total imbalance (%)	10.95	30.62	12.59	-36.47	0.000

Table III
Limit Order Book Depth and Imbalance for NYSE-listed IPOs

The table lists medians for cumulative bid and ask depth, depth divided by volume (adjusted depth), and depth imbalance within $1.00 of the prevailing quote midpoint. Depth imbalance equals the difference between buy-side (bid) and sell-side (ask) depth stated as a percentage of bid plus ask depth. Daily volume is median daily share volume in thousands of shares. Intraday results are shown immediately after the opening trade (open) and at 60-minute intervals from 11:00 A.M. to 4:00 P.M. on day one. Daily results are based on the average across intraday periods from the open through the close. The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Results for hot, warm, and cold IPOs are shown in panels A, B, and C, respectively, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price. Limit order book depth is estimated using NYSE System Order Data and the methodology of Kavajecz (1999). For each series, statistical tests are based on the daily time series of the median estimate from days 31 through 60. *t*-statistics are calculated based on the mean and standard error of this time series. For positive (negative) *t*-statistics, ***, ** and * (ˇˇˇ, ˇˇ, and ˇ) indicate statistical significance based at the 1, 5, and 10% levels, respectively.

Day/Time	N	Volume (000)	Bid Depth		Ask Depth		Imbalance (%)
			Share Depth (000)	Depth/ Volume (%)	Share Depth (000)	Depth/ Volume (%)	
Panel A: Hot IPOs							
Day 1 - open	78	-	141.43***	2.90ˇˇˇ	24.16***	0.54ˇˇˇ	67.43***
Day 1 - 11:00	76	-	74.12***	1.74	56.66***	1.29ˇˇˇ	25.77***
Day 1 - 12:00	76	-	84.79***	1.95	64.59***	1.45ˇˇˇ	11.06**
Day 1 - 1:00	77	-	76.25***	2.00ˇˇ	71.69***	1.50ˇˇˇ	16.34***
Day 1 - 2:00	78	-	87.48***	2.00ˇˇ	51.04***	1.37ˇˇˇ	25.77***
Day 1 - 3:00	78	-	73.53***	1.56ˇˇˇ	46.00***	1.31ˇˇˇ	24.82***
Day 1 - close	78	-	63.15***	1.31ˇˇˇ	27.03***	0.79ˇˇˇ	38.01***
Day 1	78	3949.65	97.66***	2.02ˇˇˇ	52.48***	1.27ˇˇˇ	23.18***
Day 2	78	552.60	28.81***	4.13	21.73***	3.09ˇˇˇ	13.88***
Day 3	78	412.80	24.08***	5.55	18.19***	4.04	4.05**
Day 4	78	222.20	17.70***	6.27**	14.76***	4.88	11.97***
Day 5	78	225.50	15.24***	5.49	10.55***	4.62	-9.16
Day 10	78	96.00	9.37***	6.85***	9.01***	7.68	-10.68
Day 15	78	95.30	5.07***	4.36	5.38***	5.61	-10.29
Day 20	78	95.50	5.00***	5.06	6.26***	5.66	-5.17
Day 25	78	66.80	4.85***	5.59	4.51**	4.85	-8.72
Day 30	78	68.05	2.91	4.06	4.11	5.89	-16.62
Day 31-60 med	78	38.70	1.84	3.86	3.35	5.42	-17.95

Table III - Continued

Day/Time	N	Volume (000)	Bid Depth		Ask Depth		Imbalance (%)
			Share Depth (000)	Depth/ Volume (%)	Share Depth (000)	Depth/ Volume (%)	
Panel B: Warm IPOs							
Day 1 - open	106	-	121.45***	3.56$^{\vee\vee\vee}$	32.45***	1.09$^{\vee\vee\vee}$	57.23***
Day 1 - 11:00	103	-	92.08***	2.64$^{\vee\vee}$	105.55***	2.72$^{\vee\vee\vee}$	-2.58
Day 1 - 12:00	105	-	87.85***	2.35$^{\vee\vee\vee}$	104.38***	3.07$^{\vee\vee\vee}$	-9.51
Day 1 - 1:00	106	-	93.10***	2.90$^{\vee\vee\vee}$	97.84***	2.50$^{\vee\vee\vee}$	1.87*
Day 1 - 2:00	106	-	87.39***	2.81$^{\vee\vee\vee}$	84.86***	2.33$^{\vee\vee\vee}$	1.16*
Day 1 - 3:00	106	-	82.88***	2.41$^{\vee\vee\vee}$	79.53***	2.29$^{\vee\vee\vee}$	9.21**
Day 1 - close	106	-	63.40***	1.73$^{\vee\vee\vee}$	53.13***	1.69$^{\vee\vee\vee}$	-0.65*
Day 1	106	3075.95	98.04***	2.76$^{\vee\vee\vee}$	91.60***	2.36$^{\vee\vee\vee}$	4.79**
Day 2	106	572.90	34.58***	5.27	41.54***	6.62	-20.10
Day 3	106	320.60	23.93***	5.82	24.37***	8.99	-23.70
Day 4	106	212.15	16.02***	5.83	22.39***	9.54	-21.26
Day 5	106	218.60	15.67***	7.32	20.66***	10.72	-15.59
Day 10	106	129.95	10.42***	7.97**	12.94***	9.25	-15.50
Day 15	106	90.65	7.67***	6.77	10.31***	10.72	-14.90
Day 20	106	72.05	3.73	4.85	7.58***	13.74**	-33.80
Day 25	106	65.55	4.09	5.93	5.77	8.10	-30.78
Day 30	106	50.75	3.10	5.25	5.79	10.69	-26.91
Day 31-60 med	106	47.18	3.15	5.50	4.76	8.32	-19.16
Panel C: Cold IPOs							
Day 1 - open	36	-	1.00***	0.05$^{\vee\vee\vee}$	40.85***	1.53$^{\vee\vee\vee}$	-94.20$^{\vee\vee\vee}$
Day 1 - 11:00	34	-	11.52***	0.53$^{\vee\vee\vee}$	105.76***	3.85$^{\vee\vee\vee}$	-78.30$^{\vee\vee\vee}$
Day 1 - 12:00	35	-	21.92***	1.04$^{\vee\vee\vee}$	96.20***	4.15$^{\vee\vee\vee}$	-62.53$^{\vee\vee\vee}$
Day 1 - 1:00	36	-	15.65***	0.72$^{\vee\vee\vee}$	97.20***	4.46$^{\vee\vee\vee}$	-78.41$^{\vee\vee\vee}$
Day 1 - 2:00	36	-	16.92***	0.72$^{\vee\vee\vee}$	100.45***	4.50$^{\vee\vee\vee}$	-77.73$^{\vee\vee\vee}$
Day 1 - 3:00	36	-	11.35***	0.47$^{\vee\vee\vee}$	97.50***	4.38$^{\vee\vee\vee}$	-76.92$^{\vee\vee\vee}$
Day 1 - close	36	-	6.70***	0.37$^{\vee\vee\vee}$	57.23***	2.80$^{\vee\vee\vee}$	-75.50$^{\vee\vee\vee}$
Day 1	36	2110.50	23.36***	0.97$^{\vee\vee\vee}$	91.55***	4.02$^{\vee\vee\vee}$	-60.36$^{\vee\vee\vee}$
Day 2	36	354.35	14.65***	5.08	38.79***	14.12	-48.41$^{\vee}$
Day 3	36	210.70	13.26***	7.11	32.16***	15.55	-56.06$^{\vee\vee}$
Day 4	36	193.80	7.11***	4.23$^{\vee\vee}$	29.51***	14.81	-60.36$^{\vee\vee\vee}$
Day 5	36	131.35	13.06***	7.40	23.14***	19.73	-29.90
Day 10	36	87.65	4.80	4.33$^{\vee}$	10.84***	12.40	-33.68
Day 15	36	39.30	6.18**	7.16	12.55***	21.30	-36.76
Day 20	36	65.95	2.46*	4.67$^{\vee}$	9.09*	13.82	-51.60$^{\vee\vee\vee}$
Day 25	36	58.10	4.80	8.40	9.85**	18.87	-21.48
Day 30	36	54.10	4.23	7.40	6.94	11.41	-40.50
Day 31-60 med	36	38.70	3.48	7.73	6.40	14.97	-16.84

Table IV
The Determinants of Limit Order Book Depth

The table lists coefficients from an OLS regression of limit order book depth on offer and firm characteristics. Limit order book depth is estimated using NYSE System Order Data and the methodology of Kavajecz (1999). The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Depth, depth relative to volume (adjusted depth), and imbalance are based on depth within $1.00 of the quote midpoint. Imbalance is the difference between bid (buy-side) depth and ask (sell-side) depth as a percentage of total depth. For share depth and adjusted depth, the dependent variable is in log form. For the percentage floor contribution to depth, a logit transformation of the dependent variable is used. The debt-to-assets ratio equals total debt divided by total assets. Total debt, total assets, and total sales are based on the most recent fiscal year ending prior to the IPO. Underwriter market share is defined for each lead underwriter as the proportion of IPO proceeds raised during the sample period. Syndicate size is the number of underwriters in the IPO syndicate. Float equals offered shares divided by post-IPO shares outstanding. Insider ownership equals the percentage of post-IPO shares outstanding owned by officers, directors, and corporations. Insider sales equals the proportion of offered shares sold by officers, directors, and corporations. Offer pricing dummy variables are defined relative to the minimum and maximum of the initial filing price range. The number and average underpricing of recent IPOs is calculated based on IPOs during the prior 60 days. Standard errors are adjusted to allow for clustering within IPO month. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

	Bid Depth			Ask Depth			
	Shares	Relative to Volume	% Floor Contribution	Shares	Relative to Volume	% Floor Contribution	Depth Imbalance
Intercept	0.114	2.288***	0.920	-3.448***	0.784**	-0.118	1.483***
Ln(day 1 volume)	0.454***	-	-0.000	0.773***	-	-0.010	-0.139***
Ln(total sales)	-0.004	-0.100***	-0.009	0.095***	0.022	-0.032	-0.034
Debt/assets	0.016	0.030	-0.010	0.076	0.026	-0.013	-0.032
Technology firm dummy	-0.014	-0.067	-0.188	-0.179	-0.145**	0.132	0.075
UW market share	1.432*	0.433	-1.877**	0.705	0.256	-0.750	0.317
Ln(syndicate size)	0.255**	0.133**	-0.085	0.049	0.029	-0.159	0.067
Ln(insider sales)	-1.233***	-0.682***	1.701***	0.110	0.015	0.230	-0.410**
Insider holdings	-0.461*	-0.347**	0.425	-0.019	-0.038	-0.094	-0.187*
Float	-0.031	-0.063	-0.423	0.327*	0.218**	-0.536*	-0.109
Below filing price range	-0.231	0.122	0.053	0.261**	0.269***	-0.547*	-0.151
At min of filing price range	0.138	0.386**	0.187	0.260*	0.286**	-0.104	-0.061
At max of filing price range	0.252*	0.048	-0.267*	-0.221	-0.205**	0.221	0.157*
Above filing price range	0.330**	0.062	-0.535**	-0.421***	-0.317***	0.529**	0.292***
Underpricing of recent IPOs	-2.315**	-1.391***	0.626	-0.126	-0.067	0.364	-0.655
Number of recent IPOs	-0.005	0.000	0.008	-0.002	-0.001	0.008	-0.001
N	216	216	213	216	216	213	216
Adj. R^2	0.227	0.081	0.077	0.474	0.210	0.102	0.105

Table V
Informativeness of Limit-Book Prices Relative to Day One Closing Prices

The table lists results from the following two-stage regression analysis:

Stage 1: $\ln(P_{i,post} / P_{i,pre}) = \alpha + \beta \ln(P_{i,1} / P_{i,pre}) + e_i$

Stage 2: $\hat{e}_i = \gamma + \delta \ln(P_{i,2} / P_{i,pre}) + u_i$

where $P_{i,\,post}$ is the closing quote midpoint on the day firm i goes public, $P_{i,\,pre}$ is the offer price, $\hat{e}_i$ are the residuals from the first-stage regression, and $P_{i,1}$ and $P_{i,2}$ equal either the market-clearing price or the opening call-auction price. The market-clearing price is defined as the price that most closely equates supply and demand across all limit orders submitted prior to the open. The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Regressions are estimated using the 219 IPOs for which a market-clearing prices could be defined. Separate results are also shown for the subsamples of hot, warm, and cold IPOs, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price. The limit order book is reconstructed using NYSE System Order Data and the methodology of Kavajecz (1999). ***, **, and * indicate that coefficients are significant at the 1, 5, and 10% levels, respectively.

			First Stage Regression			Second Stage Regression		
$P_{i,1}$	$P_{i,2}$	N	$\hat{\alpha}$	$\hat{\beta}$	*Adj.* R^2	$\hat{\gamma}$	$\hat{\delta}$	*Adj.* R^2
All IPOs:								
Limit-clearing price	Opening price	219	0.002	0.954***	0.777	-0.011**	0.100***	0.035
Opening price	Limit-clearing price	219	0.004	0.993***	0.866	0.000	-0.001	-0.005
Hot IPOs:								
Limit-clearing price	Opening price	78	0.033*	0.860***	0.583	-0.045**	0.202**	0.061
Opening price	Limit-clearing price	78	0.003	0.993***	0.727	-0.002	0.009	-0.012
Warm IPOs:								
Limit-clearing price	Opening price	105	0.019**	0.664***	0.277	-0.029***	0.428***	0.129
Opening price	Limit-clearing price	105	0.004	1.003***	0.536	0.004	-0.059	-0.004
Cold IPOs:								
Limit-clearing price	Opening price	36	-0.002	0.262*	0.053	0.002	0.818***	0.169
Opening price	Limit-clearing price	36	0.002	1.021***	0.255	-0.001	0.082	-0.182

Table VI
The Determinants of Market-Adjusted IPO Returns

The table describes holding period returns on NYSE-listed IPOs. Panel A lists mean values of five-day, one-month, one-year, and five-year holding period returns and market-adjusted returns. Panel B lists coefficients from an OLS regression of market-adjusted returns on offer and firm characteristics. The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Buy-and-hold returns are calculated relative to the first-day closing trade price. Market-adjusted returns are calculated by subtracting the buy-and-hold return on the value-weighted CRSP index of all NYSE, AMEX, and Nasdaq firms. The variable MV is total market capitalization defined as post-IPO shares outstanding times the first day closing stock price. The book-to-market ratio equals the post-IPO book value of equity divided by market capitalization and is set to 0.01 when book equity is negative. Initial return is defined from the offer price to the opening call-auction price. Opening delay is the time from 9:30 until the opening trade in hours. Opening spread is the percentage bid-ask spread based on the specialist's opening quotes. Flipping ratio is defined as share volume in the opening call-auction trade divided by offered shares. Total imbalance is defined as the sum of pre-opening market and limit buy submissions minus pre-opening market and limit sell submissions, stated as a percentage of total market and limit order submissions. Positive (negative) total imbalance equals total imbalance if positive (negative) and zero otherwise. In Panel A, the *p*-value is from a test of the restriction that mean returns are equal across IPO subsamples. In Panel B, ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively. Standard errors are adjusted to allow for clustering within IPO month.

Panel A : Average Holding Period Returns

	5-Day Returns		One-Month Returns		One-Year Returns		Three-Year Returns	
	HPR	Market Adj.	HPR	Market Adj.	HPR	Market Adj.	HPR	Market Adj.
All IPOs	0.35%	-0.24%	2.62%	1.11%	19.21%	-5.00%	26.93%	-41.49%
Hot IPOs	2.03	1.24	5.58	3.62	8.68	-13.23	25.85	-40.77
Warm IPOs	-0.36	-0.84	1.14	-0.27	25.69	-0.34	33.51	-37.50
Cold IPOs	-1.19	-1.68	0.53	-0.23	22.92	-0.88	9.89	-54.81
p-value	0.006	0.015	0.032	0.054	0.109	0.234	0.553	0.716

Panel B: Regressions

	5-Day Returns			One-Month Returns			One-Year Returns			Three-Year Returns		
Intercept	0.095	0.093*	0.097	-0.114	-0.100	-0.119	-0.388	-0.218	-0.359	-3.233*	-3.053*	-3.345*
Log(MV)	-0.007	-0.009**	-0.007	0.010	0.006	0.010	0.035	0.014	0.025	0.207	0.201	0.201
Log(book-to-mkt)	0.011	0.008	0.011	-0.001	-0.008	-0.005	0.064	0.018	0.022	0.068	0.042	0.018
Initial return	0.232***	0.121**	0.231***	0.249***	0.110	0.211**	-0.631	-1.249***	-1.076**	-1.344	-1.324*	-1.702
Flipping ratio	-0.172**	-	-0.172***	-0.177**	-	-0.159*	-0.484	-	-0.306	0.009	-	0.241
Opening delay	-0.010**	-	-0.010**	-0.006	-	-0.006	0.021	-	0.021	0.298	-	0.295
Opening spread	-0.386	-	-0.396	0.158	-	0.298	2.677	-	3.753	9.018	-	11.102
Total imbalance pos	-	0.016	-0.001	-	0.072	0.057	-	0.561***	0.539**	-	0.722*	0.768*
Total imbalance neg	-	0.001	0.004	-	-0.031	-0.031	-	-0.160	-0.165	-	-0.494	-0.506
Adj. R^2	0.147	0.073	0.139	0.030	0.024	0.028	0.025	0.052	0.043	0.030	0.028	0.034

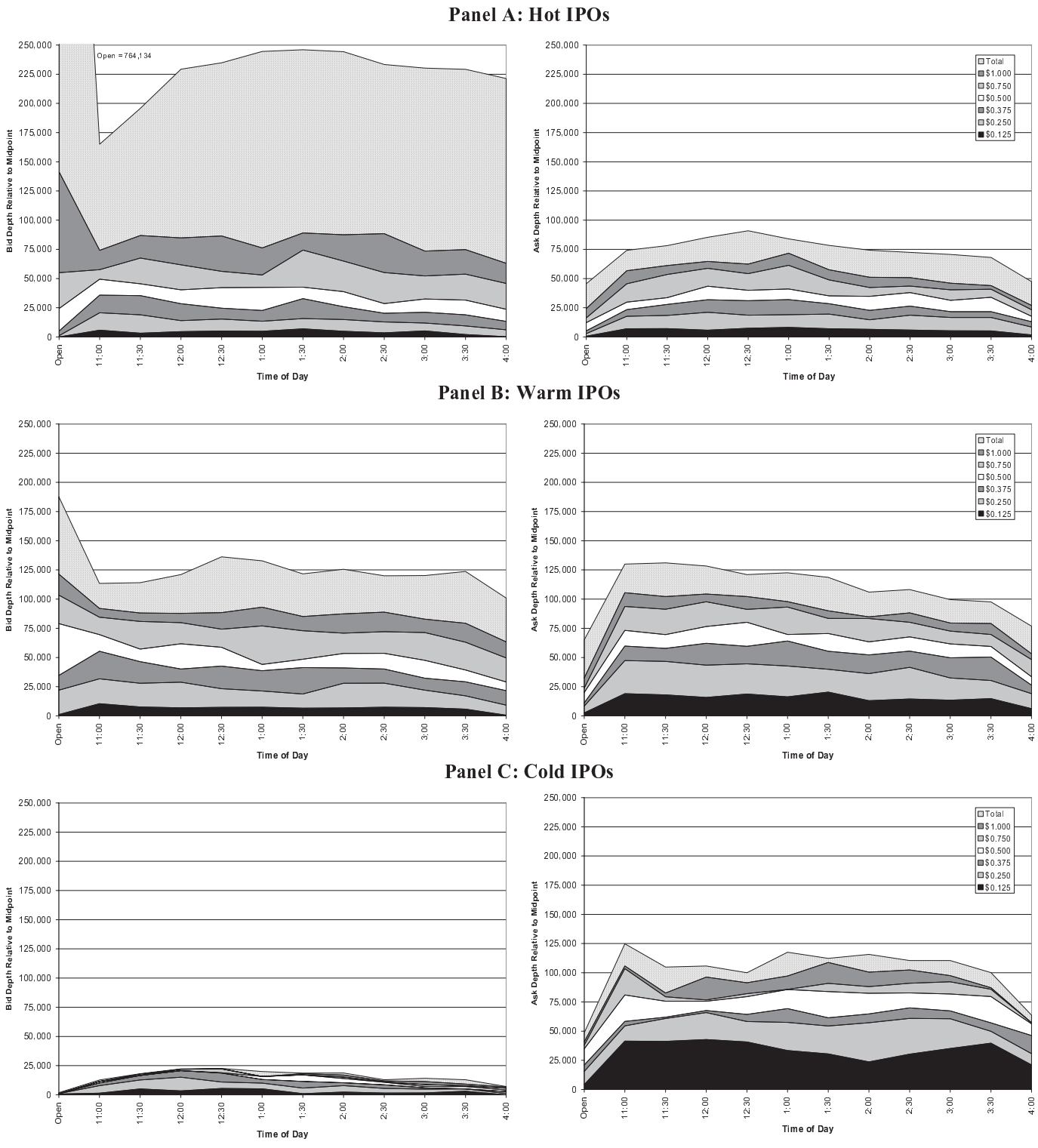
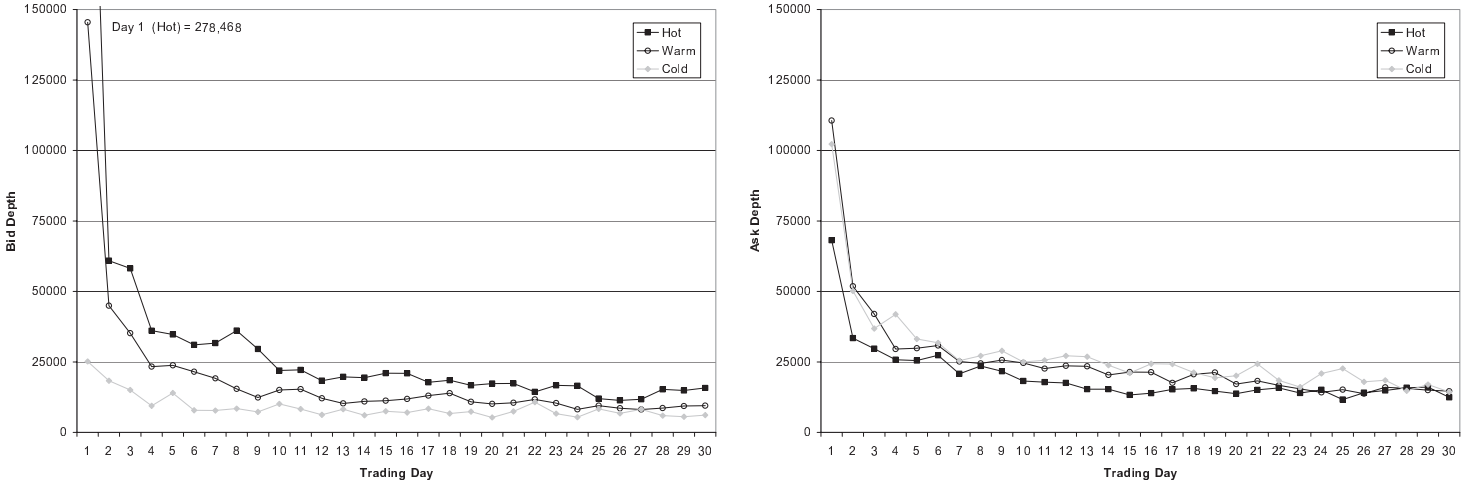


Figure 1. Limit order book depth for NYSE-listed IPOs, day 1. The figure presents median cumulative depth in the limit order book at various distances from the bid-ask midpoint. Depth is shown at the open and at 30-minute intervals during the first day of trading. The limit order book is reconstructed using NYSE System Order Data and the methodology of Kavajecz (1999). The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Results for hot, warm, and cold IPOs are shown in panels A, B, and C, respectively, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price.

Panel A: Share Depth



Panel B: Depth Divided by Daily Volume

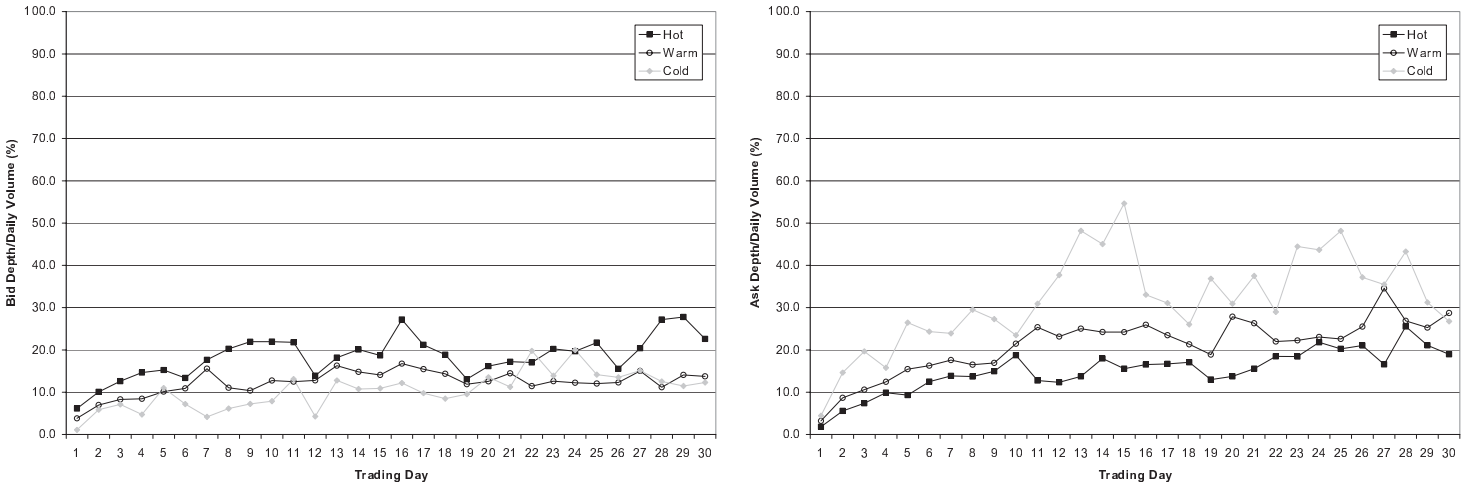


Figure 2. Total limit order book depth for NYSE-listed IPOs, days 1 through 30. The figure plots median limit order book depth on trading days 1 through 30. Panel A shows results for total share depth and Panel B shows results for total depth divided by daily volume. For each firm, daily values are the average across 30-minute periods from the open through the close. The limit order book is reconstructed using NYSE System Order Data and the methodology of Kavajecz (1999). The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Results for hot, warm, and cold IPOs are shown separately, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price.

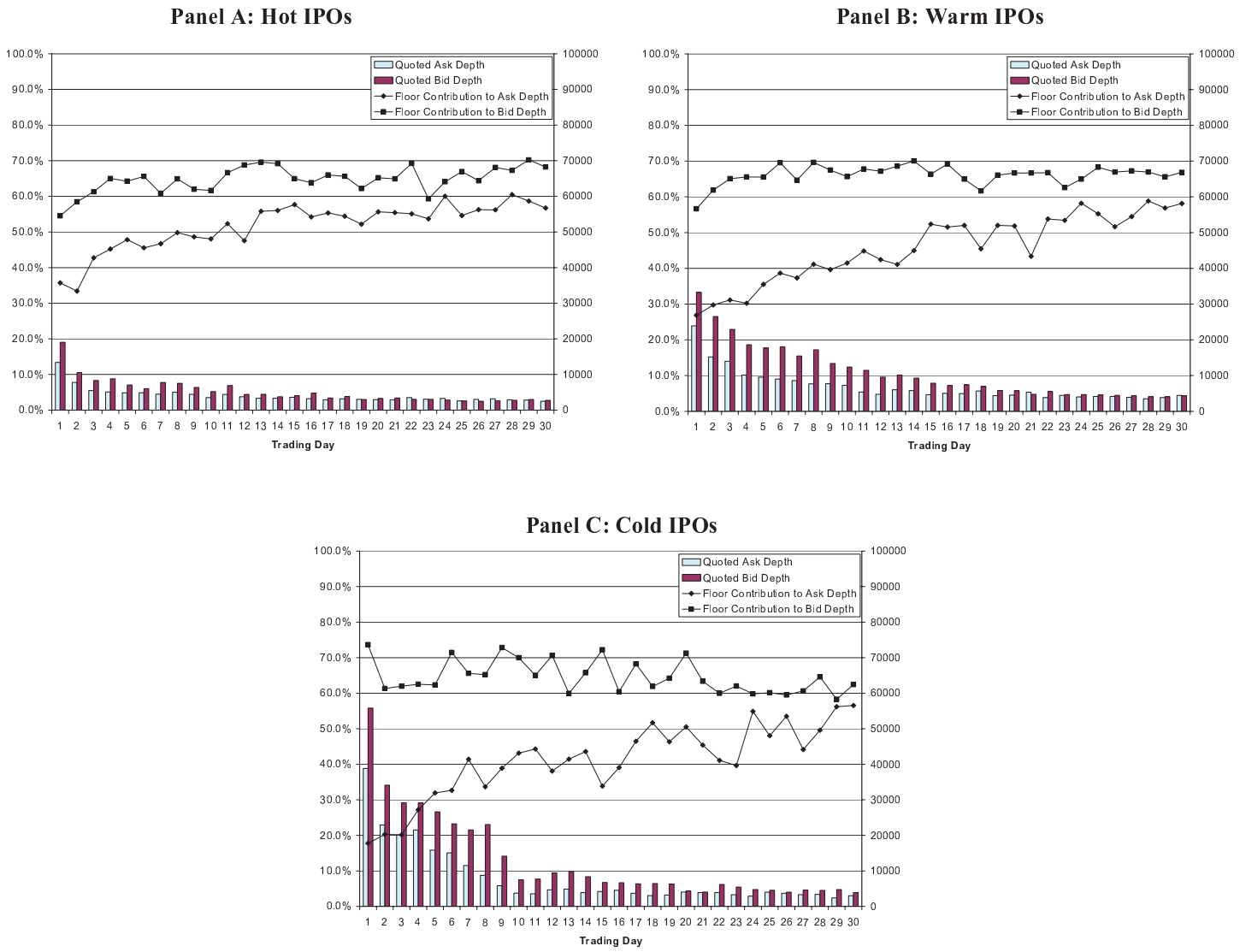


Figure 3. Floor contribution to depth for NYSE-listed IPOs, days 1 through 30. The figure shows mean values of quoted depth (right-hand scale) and the proportion of depth provided by the trading floor (left-hand scale). Floor contribution to depth is defined as quoted depth minus cumulative depth in the limit order book at the inside quote. For each firm, daily values are the average across 30-minute periods from the open through the close. The limit order book is reconstructed using NYSE System Order Data and the methodology of Kavajecz (1999). The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Results for hot, warm, and cold IPOs are shown in panels A, B, and C, respectively, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price.

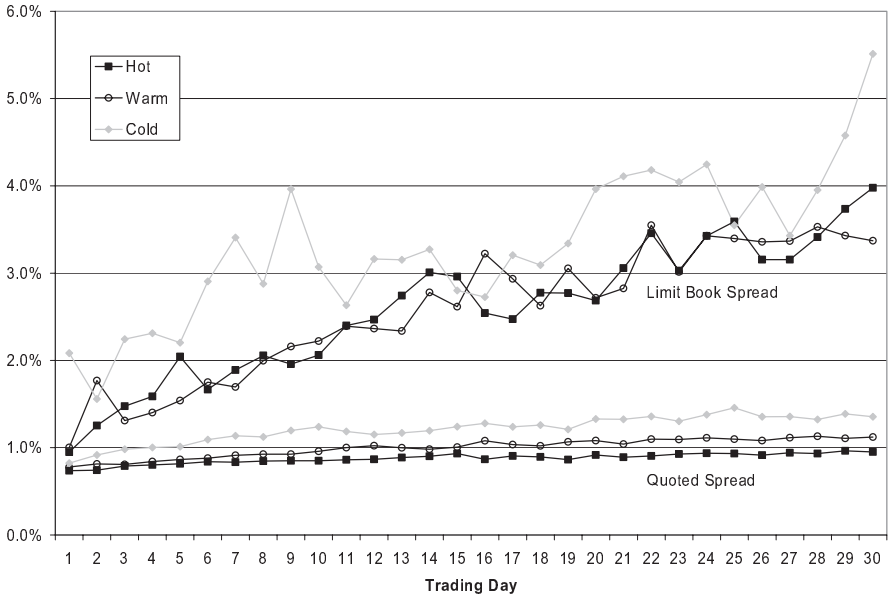


Figure 4. Percentage bid-ask spreads for NYSE-listed IPOs, days 1 through 30. The figure plots mean values of the quoted bid-ask spread and limit book spread for each of the first 30 trading days. The limit book spread is the difference between the best ask and bid prices in the limit order book. Spreads are shown as a percentage of the bid-ask midpoint. For each firm, daily values are the average across 30-minute periods from the open through the close. The limit order book is reconstructed using NYSE System Order Data and the methodology of Kavajecz (1999). The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price.

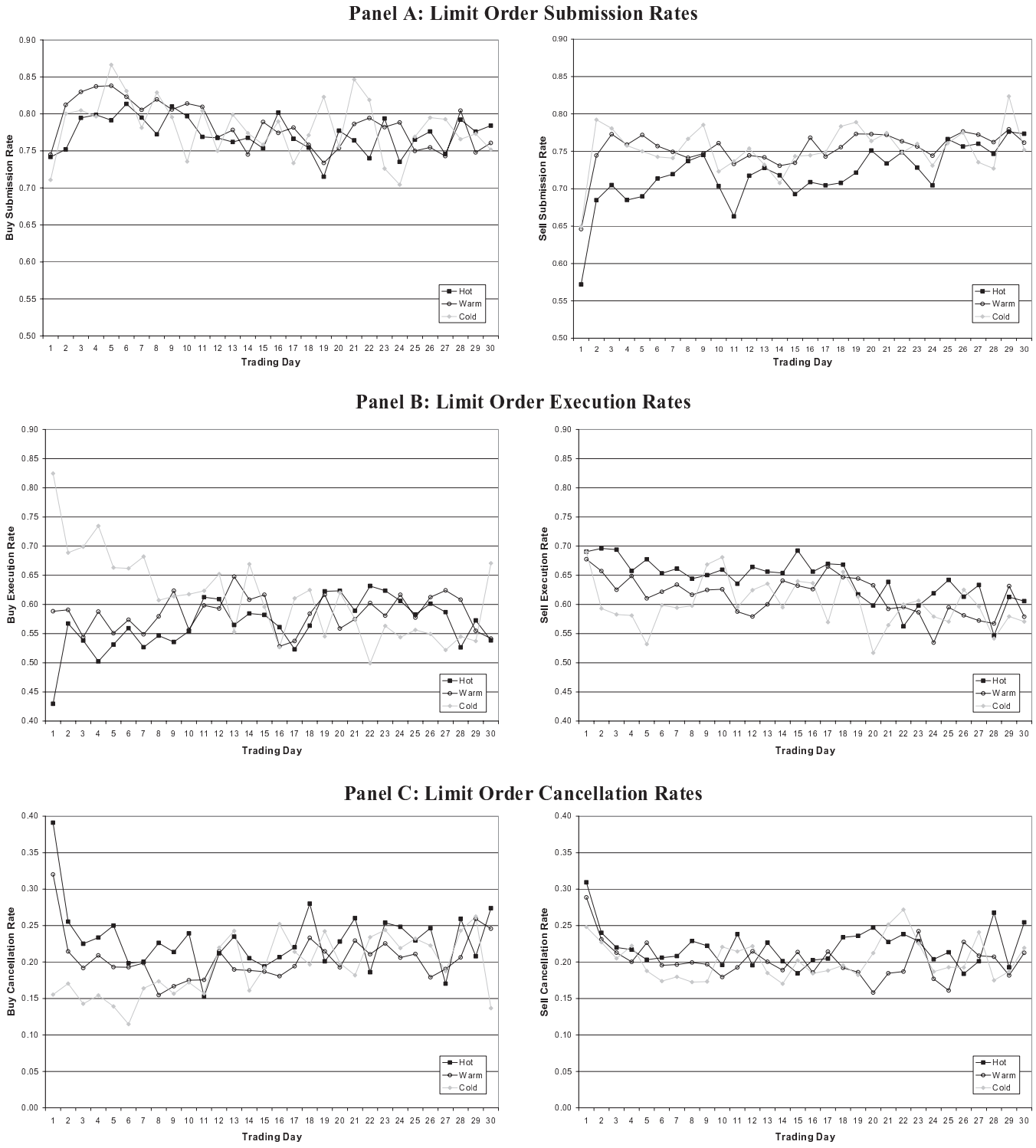


Figure 5. Limit order submission, execution, and cancellation rates. The figures plot mean limit order submission, execution, and cancellation rates for orders submitted through SuperDOT during the first 30 days of trading. Results are shown separately for buy and sell orders and for IPOs categorized by initial return, where hot IPOs are those that open above the offer price by more than 15%, warm IPOs open above the offer price by no more than 15%, and cold IPOs open at or below the offer price. The limit order submission rate is defined as limit order shares submitted divided by limit plus market order submissions. The limit order execution rate is defined as limit order shares executed divided by limit order submissions. The limit order cancellation rate is defined as limit order shares cancelled divided by limit order submissions.

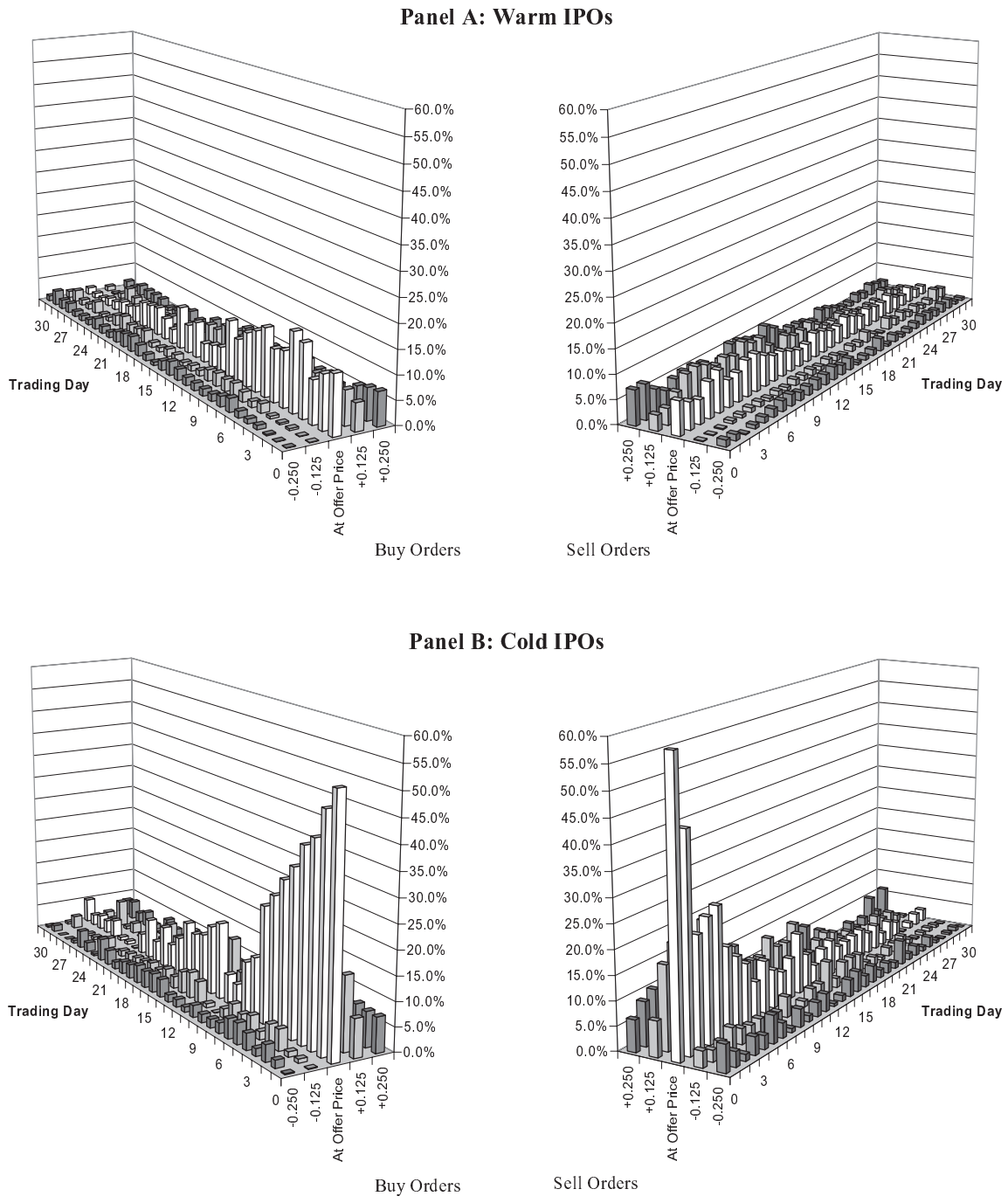


Figure 6. Limit order submissions relative to the offer price. The figure presents the mean proportion of limit order submissions with limit prices at the offer price and at \$0.125 and \$0.250 increments above and below the offer price. Results are shown for the first 30 trading days. In addition, period 0 represents orders submitted prior to the open of trading on day one. The sample includes 220 NYSE-listed IPOs from January 1995 through September 1998. Panel A shows results for IPOs that open above the offer price by 15% or less (warm IPOs) and Panel B shows results for IPOs that open at or below the offer price (cold IPOs). IPOs that open more than 15% above the offer price (hot IPOs) are not shown.