Price Discovery from Offer Price to Opening Price of Initial Public Offerings

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Abstract

We examine the preopening process and price discovery from the offer price to the first open price in initial public offerings. The extent of price discovery during preopening is influenced by firm characteristics and preopening attributes, such as volume of shares executed in preopening, canceled orders, order imbalance, and changes in indicative price. Institutional investors cancel four orders for every executed order. Each phase of preopening contributes to incremental price discovery. In "hot" IPOs, almost all price discovery occurs during preopening, whereas in "cold" IPOs, half of the price adjustment occurs after the market opens.

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I. Introduction

On Tuesday, January 25, 2023, the New York Stock Exchange had a glitch and the opening auction did not occur for many stocks, resulting in wide price swings in stocks including Verizon, Nike, and Wells Fargo. Not having an official opening price led some stocks to trade at unusually low or high prices. This affects companies and also investor confidence in the markets. In the case of initial public offerings (IPOs), there is considerable price uncertainty at the opening, which is reflected in order imbalance and volatility, therefore making a smooth preopening even more critical. The orderly opening of secondary market trading after an IPO is of great interest to issuers, investors, exchanges, underwriters, and regulators. However, studies examining the workings of the preopening process and price discovery for IPOs are limited.[1] As discussed by Biais, Hillion, and Spatt (1999), "one of the central issues in economics is how prices are formed, equilibrium is reached, and valuation is discovered." IPOs provide a unique opportunity to examine such a process. This is the only study to examine the preopening process and price discovery from the offer price to the first open price since the introduction of the auction IPO Cross system on Nasdaq.

Over the years, exchanges have made significant changes to the IPO preopening process in order to make price discovery more streamlined. These changes have included greater disclosure and transparency as well as the introduction of an open auction in which all investors can enter orders and contribute to price discovery. The rationale is that a greater number of orders entered prior to the commencement of trading should result in a higher level of order interaction at the open. Other changes, after the Facebook IPO problems, gave a larger discretionary role to underwriters in deciding when to commence trading depending on order imbalance and their other insights. Due to design limitations in the preopening process, the preopening and immediate secondary market trading in Facebook

[1] See Aggarwal and Conroy (2000) and Cao, Ghysels, and Hatheway (2000) for the U.S. and Biais, Hillion, and Spatt (1999) for France.

did not proceed as expected, causing severe disruptions.[2] This high-profile IPO debacle in 2012 brought renewed attention to the opening process. If the IPO preopening process does not work smoothly, as was the case with Facebook, investors can suffer losses, while stock exchanges and underwriters can suffer both reputational and financial consequences. The underwriter and the exchanges are interested in seeing a fair and orderly launch of trading with limited aftermarket volatility. At Nasdaq, underwriters use information from preopening activities and their order book to determine the optimal time to release an IPO for aftermarket trading.

The IPO Cross sets the Official Opening Price and was introduced to benefit both investors and issuers by appropriately reflecting supply and demand in the stock. The preopening process today is completely different and much more important for price discovery than what existed in the earlier periods studied by Aggarwal and Conroy (2000). Before the introduction of the IPO Cross, only market makers could enter quotes during a short window, there was no transparency, and there was no auction to determine the opening price.

We examine factors that contribute to the extent of price discovery during preopening and influence offer-to-open price changes. The first set of factors are firm-level characteristics that include size, age, price revision, venture capital backing, and share overhang. The second set of attributes is specific to the preopening period. The preopening of IPOs allows us to study the role of retail and institutional investors, canceled orders, executed orders, order imbalances, and indicative price in price discovery. We show differences in the extent of price discovery during preopening between hot IPOs, defined as those with the open price being above the offer price, and cold IPOs, defined as those with the open price equal to or below the offer price. The preopening process is analyzed for 824 Nasdaq IPOs during the period 2010 to 2020. The New York Stock Exchange also has an opening auction with the major difference that designated market makers play a critical role in the opening of

[2] https://www.sec.gov/litigation/admin/2013/34-69655.pdf

IPOs. In addition, the order imbalance and indicative clearing price data is disseminated differently and therefore a comparable comprehensive analysis cannot be conducted.

It is well documented (see Ellis, Michaely, and O'Hara (2000); Aggarwal, Prabhala, and Puri (2002); Aggarwal (2000)) that the trading volume on the first day following an IPO is high. We find that a significant proportion of this high volume on the first day is cleared in the IPO Cross based on orders placed during the preopening. The percentage of the day's volume executed in the opening cross is much higher, at 15.3% than the approximate 1% for non-IPO stocks, indicating the importance of price discovery during preopening for IPOs.[3] This volume represents 8.3% of shares offered. The high volume suggests that several market participants are active in this competitive marketplace. The average time spent in preopening has increased from 20 minutes in 2010 to 77.23 minutes in 2020. In contrast, preopening for non-IPO stocks lasts for two minutes, specifically from 9:28 to 9:30 a.m.

IPOs that take a longer time in preopening have higher offer-to-open returns. However, the duration of the preopening period is not related to the open-to-close returns in the secondary market on day 1. The length of preopening does not cause higher offer to open returns, it serves as a proxy for other attributes. This time is longer for IPOs that have a higher volume of shares executed in the preopening auction. Time spent in preopening is also positively associated with firm size, venture capital backed IPOs, share retention, and price revisions.

The Nasdaq preopening process currently has several phases, including System Start-Up, during which orders can be entered; a required minimum Display Only Period (DOP), during which orders can be entered and information about quotes, indicative clearing price, and imbalance is disseminated; the Pre-Launch Period, which can extend the preopening and during which the lead underwriter coordinates with Nasdaq to determine the IPO Cross

[3] https://www.tradersmagazine.com/am/buyers-and-sellers-meeting-earlier-in-the-nyse-opening-auction/

time and the start of trading; and, finally, the IPO Cross, in which an auction is conducted and the official open price determined.

We find that each of the four phases of preopening, including the Pre-Launch Period, contributes to significant incremental price discovery. This indicates that market participants reveal their demand and supply preferences at each stage, rather than waiting until the final phase. The pattern of price discovery for hot IPOs is different from that of cold IPOs. For hot IPOs, almost all the price adjustments from offer-to-close return on day 1 takes place during preopening. In contrast, for cold IPOs, only about half of the offer-to-close return on day 1 takes place during preopening, with the remaining taking place after the IPO starts trading. Cold IPOs are likely to need to be stabilized by underwriters.

The preopening of IPOs also provides an opportunity to examine the role of retail and institutional investors. We assume that orders of less than 100 shares are entered by retail customers and orders of 2,000 or more shares are placed by institutional investors. Retail investors made up 7.42% of all displayable executed orders during preopening in 2014; this increased to 41.44% in 2020. The average number of shares ordered during preopening by all retail investors in an IPO increased from 867.8 shares in 2014 to 13,415.8 shares in 2020. These patterns are consistent with the increased role of retail investors in recent years. We find that even though participation from retail investors has increased during preopening, their role in price discovery is limited mainly because the number of shares transacted by them is very small.

We find that there is a large number of canceled orders and they play a significant role in price discovery. Almost all canceled orders are "out of the money" and are not likely to get executed; therefore, they are canceled and are likely replaced by orders closer to the indicative clearing price. Not surprisingly, most canceled orders are buy orders. On average, for every order executed in the opening auction, two orders are canceled at some point during the preopening period. Institutional investors are much more likely to cancel their

orders than retail investors. For every institutional order executed, more than four orders are canceled.

In the preopening process on Nasdaq, for transparency purposes, information on order imbalance and indicative price is disclosed to market participants. We find that order imbalances, which implies more buy orders than sell orders, predict subsequent increases in the indicative clearing price. This predictability is significant for hot IPOs, but not for cold IPOs. We also use a vector autoregression model (VAR) to examine whether there is a feedback loop between changes in the indicative price and order imbalance. We find that any changes in the indicative clearing price strongly predicts order imbalance in the subsequent period for both hot IPOs and cold IPOs. These results indicate that there is a feedback loop in which both variables affect each other. The transparency provided by disclosing information on order imbalance and indicative clearing price facilitates price discovery. Finally, we use a rule change in 2013 that gave underwriters more discretion to examine the increased role of underwriters in preopening.

Barry and Jennings (1993) and Schultz and Zaman (1994) report that almost the entire initial return (underpricing) is reflected in the opening price; therefore, investors who buy a stock at the open cannot take advantage of the first day's pop. The objective of these studies was not to examine how the IPO price changes from the offer price to the price of the first trade. The five-minute preopening process that existed in 1997 is examined by Aggarwal and Conroy (2000). Almost half of the IPOs had a preopening period that lasted less than three minutes, much shorter than the current duration. Cao, Ghysels, and Hatheway (2000) conclude that quotes during the preopening result in significant price discovery for Nasdaq stocks. Similarly, Biais, Hillion, and Spatt (1999) find that significant learning takes place during the preopening on the Paris Bourse. Our paper studies how the price changes from offer to open in the preopening and the role of the IPO Cross. Several

studies have shown the advantages of consolidating orders during periods of extreme liquidity shocks.[4]

Ellis, Michaely, and O'Hara (2000) discuss the role of the lead underwriter who was always a market maker in Nasdaq IPOs. In its role as a market maker, the lead underwriter decided at what price to start quoting and trading the stock. In contrast, in the current IPO Cross system, there is no quoting by market makers, including the lead underwriter; anyone can place buy and sell orders, and the official opening price is determined using an auction. The role of institutional investors, specifically clients of the lead underwriter, is examined by Griffin, Harris, and Topaloglu (2007). They find net buying by clients of the lead underwriter and suggest that the pattern is consistent with quid pro quo arrangements. Aggarwal (2000) shows that underwriters can stabilize the aftermarket price of an IPO using the over-allotment option and aftermarket short covering. We add to the empirical literature that studies the role of institutional and retail investors in IPOs (see Aggarwal, Prabhala, and Puri (2002); Aggarwal (2003); Field and Lowry (2009); Chemmanur, Hu, and Huang (2010); Ofek and Richardson (2003); and Chan (2010)). Lowry, Michaely, and Volkova (2017) provide a comprehensive review of the theoretical and empirical literature.

II. Preopening Process and IPO Cross Timeline

Nasdaq introduced the IPO Cross on May 30, 2006, after getting approval from the Securities and Exchange Commission (SEC). The IPO Cross is conducted before releasing an IPO for trading. The exchange cited the following benefits in its press release:

- Providing fair executions at a single price that is reflective of supply and demand in the market;
- Maximizing transparency at IPO opens by disseminating timely information to all investors; and by

[4]For example, Barclay, Hendershott, and Jones (2008), Madhavan (1992), Pagano and Schwartz (2005), Ellul, Shin, and Tonks (2005), Jegadeesh and Wu (2022).

- Creating an efficient, open process in which all investors have the ability to enter orders and participate in price discovery.[5]

[INSERT FIGURE 1 HERE]

We categorize the current preopening process into the following four phases as shown in Figure 1: 1) System Start-Up, 2) Display Only Period, 3) Pre-Launch Period, and 4) IPO Cross.

System Start-Up

At 4 a.m. (7 a.m. before 2013) Nasdaq begins accepting orders that are placed in a "holding bin" until the beginning of the next phase, the Display Only Period. Although Nasdaq starts accepting orders at 4 a.m., brokerages typically start sending orders only at 8 a.m.

Display Only Period

The underwriter coordinates with Nasdaq to decide when to start the DOP. During the DOP, members can submit the price and quantity of shares they are willing to buy and sell, entered orders can be canceled or replaced, and no executions occur. Information about quotes, indicative clearing price, paired shares, and imbalance information is displayed to the market during this period. The indicative clearing price is the price at which the opening book would clear based on current orders. Paired shares are the number of shares matched for execution. Imbalance information includes the number of imbalance shares and the side (buy/sell) of imbalance.

In 2006, the minimum DOP was 15 minutes with allowance for up to six five-minute extensions in case of order imbalance or excess volatility immediately before the IPO Cross. Volatility is defined as a movement of 10% or 50 cents (whichever is greater) based on the price immediately prior to the cross and the dissemination 15 seconds prior to the cross. In

[5] http://ir.nasdaqomx.com/news-releases/news-release-details/nasdaq-announces-new-ipo-cross

coordination with the lead underwriter, Nasdaq also has the authority to manually extend the period for five minutes, if needed. Appendix Figures A1-A4 provide an example of the preopening process using Dropbox IPO as an example.

On May 18, 2012, at 7:56 a.m., Nasdaq announced that the DOP for Facebook would begin at 10:45 a.m. and that secondary trading would begin at approximately 11:00 a.m. At 10:45 a.m., indicative price and volume information started to be disseminated. The indicative price showed the price at which Facebook shares would be traded if the IPO Cross occurred at that moment; Additionally, the number of shares (buys and sells) that would be matched were also provided. The criteria for five-minute extensions to the DOP based on volatility and imbalance were not met; therefore, there was no extension to the minimum DOP of 15 minutes. However, due to glitches, the IPO Cross did not take place until 11:30:09 a.m. At 1:50 p.m. Nasdaq became aware that the cross was inaccurate and had not included 19 minutes of orders in the price/volume calculation, resulting in the exchange holding a short position of 3 million shares valued at $129 million[6]

After the many problems with the Facebook IPO, several major changes were made to the preopening process. In 2013, the five-minute extensions to the initial minimum 15-minute DOP were eliminated; instead, a Pre-Launch Period was added. Underwriters were given more say in the timing of the IPO Cross and trading. In an unrelated move, the DOP period was reduced from 15 minutes to 10 minutes in 2017, based on the argument that many IPOs did not need to wait a full 15-minute period to start trading. The reduced length gives the underwriter greater flexibility to initiate trading quickly when needed, while still allowing for a longer preopening when more time is needed.

Pre-Launch Period

Introduced in August 2013, the Pre-Launch Period immediately follows the Display Only Period. There is no specified minimum or maximum time for this phase. The

[6]For details see the SEC Administrative Proceeding File No. 3-15339.

change was designed to facilitate price discovery and promote increased coordination between Nasdaq and the lead underwriter in the timing of releasing a new issue for trading. This change gives the lead underwriter more input and flexibility in the timing of the commencement of the IPO Cross and trading. According to the SEC, the underwriter's involvement in timing the commencement of trading is consistent with current practice. In administering the IPO Cross process since 2006, Nasdaq has found that underwriters have valuable information on the pending IPO given their unique position in the market, including the status of IPO orders on the underwriter's book. Nasdaq believes that it is in the best interest of the markets to give the underwriters input on the timing of the IPO Cross to help ensure the fair and orderly launch of trading in the IPO security.

During Pre-Launch, the lead underwriter coordinates with Nasdaq to determine whether additional time is needed for price discovery before the IPO Cross can occur and trading begins. The lead underwriter can decide when to launch the IPO Cross. However, Cross cannot take place if there is an imbalance or excess volatility requiring additional time for price discovery. The change to allow an underwriter to postpone and reschedule an IPO with the concurrence of Nasdaq gives flexibility in the case of unforeseen market events that make it inadvisable to proceed with the IPO. Orders can also be placed or canceled during this phase.

IPO Cross and Commencement of Trading

After the Pre-Launch Period, IPOs are opened using the IPO Cross, an open auction process in which all orders participate and help determine the opening price. The lead underwriter communicates with Nasdaq when the IPO is ready for the IPO Cross and trading. The IPO Cross auction based on price/time priority sets the official opening price, and a bulk order is sent to the tape. After the IPO Cross takes place, trading begins.

The preopening process for IPOs is different from non-IPO stocks. For Nasdaq, non-IPO stocks conduct the preopening cross from 9:28 to 9:30 a.m. to determine the

opening price. However, the starting time for the preopening process of IPOs is not fixed and varies based on the characteristics of the IPO. The dissemination of information about the order imbalance and indicative clearing price to the market is also an important aspect of preopening. NYSE also has a preopening process for listed stocks that disseminates the opening information, such as order imbalances and indicative clearing price, as early as 8:30 a.m. However, the preopening process for IPOs is still specialist-based and requires a Designated Market Maker (DMM) to facilitate the process. The underwriter works closely with the DMM to open the IPO.

III. Data

We use the Securities Data Company (SDC platinum) new issues database to identify all IPOs that started trading on Nasdaq during the period from March 2010 to December 2020. The key variables obtained from SDC include issuer name, IPO date, issue date, CUSIP, offer price, shares offered, underwriter names, SIC code, and whether the IPO is venture-backed. We also obtain data on the age of issuer firms and underwriter reputation rankings.[7]

The analysis is limited to IPOs that are listed on the Nasdaq because IPO Cross data is only available from the Nasdaq. The NYSE started disseminating auction imbalance information for IPO for a temporary period in 2020. Following the literature, we exclude unit offerings, American Depository Receipts, closed end funds, natural resource limited partnerships, REITs, bank and S&L IPOs, and best efforts offerings. We also exclude stocks with an offer price less than $5. Hot IPOs are defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal

[7] https://site.warrington.ufl.edu/ritter/ipo-data/.

to the first day's closing price. The sample consists of 824 IPOs.[8] The official opening and closing price for IPOs is from millisecond Trade and Quote (TAQ) data.

We obtain disseminated information during preopening from the Net Order Imbalance Indicator (NOII) data from Nasdaq. The NOII shows the supply, demand, and order imbalance information during preopening prior to the opening cross. The components of the NOII include number of paired shares, number of imbalance shares, imbalance side, and the indicative clearing price, and are updated every second.[9] Specifically, the paired shares represent the total number of shares eligible to be matched at the current reference price determined with the goal of maximizing the number of shares paired and minimizing the imbalance shares. Imbalance shares represent the total number of marketable shares that are not matched. The imbalance side indicates the market side for the imbalance where "B" represents the buy side imbalance, "S" represents the sell side imbalance, and "N" represents when the buy side equals the sell side. In the case of non-IPO stocks, the information starts to be disseminated two minutes before the market opens. However, the preopening process for IPOs is very different, and information starts to be disseminated when the Display Only Period starts, and continues until the IPO is released for trading.

We use Nasdaq TotalView ITCH data to obtain orders that are placed for IPO stocks on the first day of trading. Nasdaq TotalView ITCH data displays the full depth of the Nasdaq order book, including every order at every price level. We identify all IPO stock-related orders that were entered into the Nasdaq system. The order message includes a timestamp, the number of shares associated with the order, whether the order is a buy or sell order, and a day-unique order reference number used by Nasdaq to track the order. We exclude orders that are canceled or deleted later based on the order reference number.

[INSERT TABLE 1 HERE]

[8] We examine the preopening process for SPACs on Nasdaq in Appendix Table A1. SPACs provide a useful contrast to traditional IPOs in a number of dimensions.

[9] https://nasdaqtrader.com/content/TechnicalSupport/UserGuides/TradingProducts/noii/noiiguide.pdf

Table 1 provides descriptive statistics by year and also for the full sample of the 824 Nasdaq IPOs during the 2010 to 2020 period. There were fewer IPOs in the years after the 2008-2009 financial crisis. However, activity grew in 2013. The lowest number of IPOs was 32 in 2010 and the highest was 136 in 2020.[10] Mean and median offer prices are $14.63 and $15.00, respectively. The average offer price has been higher in recent years, at 14.68 (2018), 16.83 (2019), and 16.83 (2020). The mean and median issue size are $165.52 million and $89.45 million.

On average, the auction price determined in the IPO Cross is 20.23% higher than the offer price (with a median of 11.11%). For all IPOs, there is only a small change from the open price determined by the IPO Cross to the close price on the first day of trading. The price of hot IPOs rises in the aftermarket, while that of cold IPOs declines. The mean offer-to-close return is 22.03% (median of 12%). These price changes indicate that the preopening process is important for initial price discovery and captures almost all of the first-day return.

IV. Activity during Preopening

Table 2 reports the mean and median trading volume in the IPO Cross as a percentage of shares offered in the IPO and also as a percentage of the first day's trading volume by year. The average trading volume as a proportion of shares offered varies from 7.2% to 10.2%. For the full sample period, the average number of shares executed in the cross is 8.3% of those offered. The mean volume cleared in the IPO Cross relative to the first day's trading volume ranged from 13.8% to 18.8%. For the full sample period, the average shares executed in the preopening is 15.3% of those traded on day 1. The proportion of shares executed in the IPO Cross is significant and far more than what is observed for open or close auctions in non-IPO stocks. It is clear that the IPO Cross system plays an important role in

[10] Dambra, Field, and Gustafson (2015) show that the JOBS Act helped revitalize the IPO market.

the price discovery of IPOs. This pattern holds for both hot and cold IPOs. This preliminary evidence on order executions based on the magnitude of order flow and executions supports the learning hypothesis.

[INSERT TABLE 2 HERE]

An IPO, on average, spends 34.41 minutes in preopening, as shown in Table 3. This is much longer than the minimum Display Only Period required by Nasdaq rules. The time spent in preopening has increased from 20 minutes in 2010 to 77.23 minutes in 2020. Hot IPOs spend more time in preopening than cold IPOs because they need a longer period for price discovery. The highest number of IPOs during our sample period occurred in 2020, as it was a "hot" IPO year.

[INSERT TABLE 3 HERE]

After 2017, the minimum Display Only Period was reduced from 15 to 10 minutes. The rationale for the change was that many IPOs were ready to start trading before the expiration of the 15-minute requirement, and underwriters wanted to have the flexibility to commence trading in these IPOs without having to wait for 15 minutes. The underwriters used this flexibility, as is evident from the drop in the 10th percentile values from 15 to 10 minutes in 2018 and 2019. However, 2020 was a hot year for IPOs with high initial returns, and even IPOs in the 10th percentile, on average, took 25 minutes to start trading. Until August 2013, the minimum Display Only Period could increase only in increments of five minutes and there was no Pre-Launch Period. Therefore, we find the mean, median, 10th percentile, 90th percentile, and maximum to be multiples of five until the change took place.

Figure 2 shows the pattern for cumulative shares ordered during the preopening period for all IPOs and also for hot and cold IPOs separately. To highlight the heightened

activity near the Cross and mitigate the survival bias due to various preopening time across IPOs, the plot shows the averaged cumulative submitted shares divided by executed shares in reverse chronological order. New orders keep coming through out the preopening period and pick up just prior to the IPO Open Cross auction. Buy orders dominate sell orders for both cold and hot IPOs, although cumulative sell shares are relatively higher for cold IPOs.

[INSERT FIGURE 2 HERE]

Given the increasing importance of the preopening process for IPOs, we next examine what factors affect the extent of preopening price discovery. We use the offer-to-open return as a proxy for the preopening price discovery. Although the time spent in preopening seems to be a natural variable to be considered, there are several other key important variables to be considered. Similar to the theory and empirical evidence from the first-day IPO underpricing, firm size is a proxy for investor demand and is an important determinant for price discovery.

$$\begin{aligned} \textit{Ret}_{\text{Offer-to-Open},i} &= a + \beta_2 \textit{ln}(\textit{Additional Time in Preopening})_i \\ &\quad + \beta_1 \textit{VOL}_i + \sum_j \beta_j \textit{Firm Char}_{i,j} + \varepsilon_0, \end{aligned} \tag{1}$$

where $\textit{Ret}_{\text{Offer-to-Open},i}$ is the *(Offer-to-Open)/Offer* for IPO *i* expressed in percentage terms; $ln(\textit{Additional Time in Preopening})_i$ is the natural logarithm of one plus the number of minutes spent in preopening in addition to the minimum required DOP; *VOL* is the preopening total trading volume divided by shares offered. We adjust for the required DOP interval by subtracting 15 minutes from the total time spent in the preopening for IPOs before December 2017 and subtracting 10 minutes for IPOs after December 2017 based on the regulatory change in the minimum required DOP.

[INSERT TABLE 4 HERE]

Column 1 of Table 4 shows that the coefficient of *ln(Additional Time in Preopening)*$_i$ is positive and statistically significant at the 1% level. IPOs that spend more time in the preopening are associated with a larger percentage price change from the offer price to the official open price determined by the IPO Cross. It is not surprising that hot IPOs require more time for price discovery. However, the time spent in preopening does not cause offer-to-open returns and is proxying for other attributes that we examine further. The duration of the preopening period is not related to returns in aftermarket trading. This is again evidence of a well-functioning preopening mechanism that accounts for most of the price adjustment on day one. The volume of transactions executed in the preopening is also associated with offer-to-open returns. We define volume (*VOL*) as the total volume in the preopening auction divided by shares outstanding. The coefficient of *VOL* is positive and significant. However, if price revision is also included as a control variable, as shown in column 2, then *VOL* is no longer significant because price revision and volume have a high correlation of 0.6. These results suggest that relative to shares offered, more volume transacted during preopening is associated with higher offer-to-open returns. The coefficient of time spent in preopening is not significant in explaining open-to-close returns as seen in column 3 of Table 4, however, the open auction volume continues to be positive and significant as seen in column 4. In unreported results, we do not find a significant relation between time spent in preopening and aftermarket volatility.

[INSERT TABLE 5 HERE]

The time spent in preopening does not cause offer-to-open returns and only serves as a proxy for other attributes; therefore, we next examine the determinants of the time spent in preopening. Columns 1 and 2 of Table 5, report the results for all IPOs. The high volume executed during the preopening is positively and significantly associated with longer preopening periods. Firm size, venture capital backing, share retention, and price revision also have positive and significant coefficients. Similar patterns hold for hot IPOs, as

reported in columns 3 and 4. Executed volume and firm size are significant for cold IPOs, as shown in columns 5 and 6, but none of the other attributes are significant.[11] Underwriters are able to use their discretion to extend the preopening period for hot IPOs to achieve a fair and orderly launch, while cold IPOs are released fairly quickly for secondary market trading. These findings lead us to conclude that firm-level attributes play a role in price discovery during preopening.

V. Price Discovery during Different Phases of Preopening

As reflected in the time to preopening, IPOs differ in the time required to reach the new equilibrium price. Some start trading in the secondary market immediately after the end of the required minimum Display Only Period, while at the other extreme, others can spend hours in preopening. The next question is which phases of the preopening process contribute to the price discovery. Therefore, we analyze the extent of price discovery that takes place during the different phases of preopening as the price moves from the IPO offer price to the opening price and finally the first day's closing price. The following regression model is estimated to study whether there is pure learning, pure noise, or noisy learning during each phase of preopening:

$$(2) \qquad (\textit{Close-Offer})/\textit{Offer} = a + \beta_t \left((\textit{Price}_t - \textit{Offer}\ ) / \textit{Offer} \right) + \varepsilon_t$$

where $\textit{Price}_t$, is the indicative price during the preopening period at time t; *Close* is the closing price on the first trading day, and *Offer* is the IPO's offer price.[12] We use the

[11] The observations used in the regressions for subsamples do not equal the number of cold or hot IPOs as the singleton groups are dropped within the industry year fixed effect differently.

[12] We study the noise versus learning hypothesis more precisely by estimating unbiasedness regressions following the approach of Baruch, Panayides, and Venkataraman (2017), Biais, Hillion, and Spatt (1999), and Boguth, Grégoire, and Martineau (2022). The "pure noise" postulates that there is no information during

indicative price to examine price discovery because it reflects supply and demand, and order imbalance. We empirically estimate the cross-sectional regression in equation 2 for each four phases of the preopening period. The regression coefficients in the table are based on one regression with t equal to the end of each phase. (e.g., the end of the Display Only Period). The regression is conducted cross-sectionally across all IPOs, and the statistical inference is based on this cross-sectional regression.

[INSERT TABLE 6 HERE]

Table 6 reports the regression coefficients for the four phases of preopening. The four phases are: 1) offer to first order, 2) first order to DOP start, 3) DOP start to DOP end, and 4) DOP end to official open. DOP end to official open encompasses the Pre-Launch Period and the IPO Cross. Panel A of Table 6 reports the results for all IPOs only in the post-August 2013 period after the introduction of the Pre-Launch period. There is significant price discovery from the offer price to the very first order placed in the system, even though the indicative price is not disseminated at this stage. As discussed earlier, even though the Nasdaq system starts accepting orders at 4 a.m., orders do not start coming in until about 8 a.m. For our sample of IPOs, 17.30% of the change from offer price to close price on day 1 is captured by the first order. This is much less than the information captured in the first quote in the pre-IPO Cross system, as reported by Aggarwal and Conroy (2000). The current system has many more phases, and price discovery continues in these phases. In the second phase, from the first order to the start of DOP, an additional 32.78% of price discovery takes place; the third phase, DOP start to end, contributes an additional 34.55%; and finally, DOP end to official open accounts for 22.34%. The coefficient of the period DOP end to open is 106.96% implying, on average, that the opening price overshoots the closing price by a small amount. The incremental contribution of each phase is significantly

the particular preopening phase, whereas the "pure learning" hypothesis states that preopening orders are informative. The "noisy learning" hypothesis states that because of countervailing incentives, the opening price should reflect a combination of the martingale from pure learning and the noise from pure noise.

different from zero, as indicated by the t-statistic for each phase. Price discovery during preopening accounts for almost 100% of the price movement from offer to close.

The estimate of the slope coefficient increases from the initial phases to the final phase, indicating an increase in informational efficiency as the opening auction approaches. There is considerable price discovery even during phases when transparency is limited. We also find that a lot of orders come in just prior to the opening auction, and yet a lot of the price discovery has already taken place. Each phase of preopening plays a significant role in learning and price discovery. The preopening period offers a process for market participants to progressively learn about pricing by observing the evolution of indicative clearing prices.

Orders placed during preopening and the 15.3% of the first day's volume that clears during preopening play an important role in price discovery on the first day, while the 85.3% of orders executed after trading commences in the secondary market contribute far less to price discovery on day 1. We conclude that investors participate actively in the preopening even though no trades are actually executed until the opening auction. We find that each phase of preopening contributes to price discovery and is not limited to the last few minutes before the market opens.

We repeat the above analysis separately for 506 IPOs that require a Pre-Launch Period and 148 IPOs that do not require one. The existence of a Pre-Launch Period implies that the IPO is not ready to start trading at the end of the mandatory minimum DOP. For this group of IPOs, each of the four phases of preopening plays a significant role in price discovery. However, for IPOs that do not require a Pre-Launch Period, the contribution of phase 1 (offer to first order) to price discovery is not significant, implying that price discovery starts only when the clearing price is disseminated with the start of the DOP.

Next, we examine price discovery for hot and cold IPOs separately. Results are again separated for IPOs that require additional time, and therefore a Pre-Launch Period, versus those that do not require an extension and hence no Pre-Launch Period. Hot IPOs are

defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal to the first day's closing price. As shown in Panel B of Table 6, of the 461 hot IPOs, 367 required additional time in preopening, and 94 did not. Similar to the full sample, 13.96% of the offer-to-close return is accounted for by the offer to the first order; an additional 29.17% of the price change takes place during the first order to start of DOP, 33.09% from DOP start to end and 24.36% from DOP end to official open. All four phases are statistically and economically significant in price discovery. For hot IPOs with no Pre-Launch Period, price discovery from offer to first order is not significant, however, the contribution of the other phases is significant.

Panel C of Table 6 reports the results for cold IPOs. There are a total of 192 cold IPOs; 127 have a Pre-Launch Period and 65 do not. Even for cold IPOs, there is price fluctuation during preopening and the underwriter can decide to extend preopening beyond the minimum DOP. Furthermore, no IPO can commence trading if there is excess volatility or order imbalance, as determined by Nasdaq's rules. Therefore, more than half of cold IPOs have a Pre-Launch Period. The pattern of price discovery in cold IPOs is quite different from that of hot IPOs. In total, 50.96% of the offer-to-close return takes place during preopening, implying that almost 50% of the first day's price discovery takes place after the IPO starts trading. In addition, most of the price discovery during preopening takes place during the minutes just before the opening auction.

[INSERT FIGURE 3 HERE]

We plot the regression coefficients along with the 95% confidence bands in Figure 3 for the 30-minute period after DOP starts. The figure shows price discovery in all IPOs and in hot and cold IPOs every 30 seconds. We run cross-sectional regressions across all IPOs and report the point estimate and confidence interval based on the standard error. Panel A of Figure 3 shows that for the full sample of IPOs, price discovery occurs throughout the period. Toward the end of the preopening, the coefficient is almost close to one,

which implies that 100% of the price movement from offer to closing occurred during the preopening.[13] Panel B of Figure 3 splits the sample into hot and cold IPOs. Price discovery for hot IPOs follows the same pattern as for all IPOs, with the coefficient leveling around one. This implies that most of the price movement from offer to close on day 1 takes place during preopening. However, as seen in Panel C of Figure 3, for cold IPOs, only 50% of the price discovery occurs during preopening, the rest being determined by secondary market activity. On average, cold IPOs need a shorter preopening and significant price discovery continues to take place in the aftermarket. These results suggest that the speed of price discovery varies considerably across different types of IPOs. Our results suggest that the IPO Cross system introduced in 2006 and, particularly, the changes implemented in 2013 that give the underwriter more flexibility in deciding when to release an IPO for trading are beneficial for price discovery.

VI. What Attributes Contribute to Price Discovery?

The evidence from the previous sections shows that each phase contributes to the price discovery, we next examine the activity during preopening that contributes to price discovery. This section examines the role of institutional versus retail investors, canceled orders, order imbalances, and indicative clearing price, in affecting the extent of price discovery. We also examine differences in the price discovery process for cold versus hot IPOs.

The start of the DOP is important because this is when transparency comes into the market and relevant information about quotes, indicative clearing price, paired shares, and order imbalance are displayed by the exchange to the market. Order imbalance is buy

[13]Note that the confidence intervals will not necessarily decrease because, in the case of IPOs, the length of the preopening period varies rather than remaining constant as in Baruch, Panayides, and Venkataraman (2017). IPOs that complete the preopening auctions drop out of the sample. For the same reason, we do not use Root Mean Squared Error (RMSE) as a measure of price discovery.

minus sell orders as a percentage of total orders, and the indicative clearing price is the price at which the opening book would clear based on current orders. During the DOP, members can continue to submit orders with the price and quantity of shares they are willing to buy and sell, entered orders can be canceled or replaced. The Pre-Launch Period extends preopening and gives the underwriter more control in deciding when to release the IPO for trading in the secondary market. Descriptive data on the DOP is provided in Appendix Table A2.

A. Activity of Retail and Institutional Investor

Prior to 2006 only market makers could enter quotes (not orders). However, in the current system, any investor, including retail investors, can enter orders. In recent years, with the introduction of commission-free trading apps, retail investors have started to play an increasing role in the markets. The preopening of IPOs provides an opportunity to examine the role of retail investors in price discovery. We assume that orders of less than or equal to 100 shares are entered by retail customers, and orders of 2,000 or more shares are placed by institutional investors.[14]

[INSERT TABLE 7 HERE]

Panel A of Table 7 shows the activity of retail investors during the preopening. Retail investors, on average, place 24.8 orders per IPO during the preopening period in 2014. However, by 2019 this number increased to 240.5, reaching a peak of 748.5 orders in 2020. Retail investors make up 7.42% of all displayable orders executed before opening in 2014; this increased to 41.44% in 2020. We find a similar increase over time in the number of

[14]As discussed by Cready, Kumas, and Subasi (2014) and others, trade size during secondary market trading is no longer an effective proxy for investor sophistication because large equity traders can execute trades as a series of smaller transactions. However, there is no trading during preopening and, based on our conversation with market participants, algorithmic trading is not an issue during preopening, and small size is a reasonable proxy for retail participation.

shares orders. The average number of shares ordered by retail investors is 868 in 2014 and 13,416 in 2020. The corresponding numbers as a percentage of total shares ordered are 0.16% in 2014 and 1.67% in 2020. These patterns are consistent with the increased role of retail investors in recent years. It is also worth noting that the size of firms going public and the size of IPOs have increased in recent years. Therefore, more information about these firms is available to retail investors. However, retail investors still account for a very small percentage of total orders and have a limited role in price discovery.

The number of large orders (equal to or greater than 2,000 shares) is relatively small with a mean and median of 32.1 and 20 orders, respectively, as shown in Panel B of Table 7. These large orders, on average, account for 13.21% of all orders and make up 75.27% of the total shares ordered in preopening. Assuming that these large share orders are placed by institutional investors, these statistics highlight the important role institutional investors play in price discovery.

B. Canceled Orders

The IPO preopening process allows us to study the role of canceled orders in price discovery.

[INSERT FIGURE 4 HERE]

Figure 4 shows the pattern of order cancelations in the 60-minute window prior to the commencement of secondary market trading. *All Cancelation* equals cumulative orders canceled during preopening divided by all orders executed in the opening auction, and then averaging across all IPOs in the sample. Similarly, *All Buy Cancelation* equals cumulative buy orders canceled during preopening divided by all orders executed in the opening auction, and then averaging across all IPOs in the sample; and *All Sell Cancelation* equals cumulative sell orders canceled during preopening divided by all orders executed

in the opening auction, and then averaging across all IPOs in the sample. A few patterns are evident from Panels A-C of Figure 4: 1) The proportion of canceled orders relative to executed orders is large; 2) Canceled orders come in throught the preopening with the pace picking up just prior to the open auction; 3) Most canceled orders are for buy orders and not for sell orders. This is not surprising given that investors do not get their desired allocation and tend to buy in the aftermarket to build up their position. Also, due to the lockup period, many investors are unable to sell in the immediate aftermarket. Furthermore, underwriters claim that they prefer to allocate IPOs to investors who will not flip shares immediately.

[INSERT FIGURE 5 HERE]

Figure 5 separates out canceled orders by hot and cold IPOs and by small and large orders. Retail investors are much more likely to cancel orders in hot IPOs but not in cold IPOs. For every order, they cancel 0.4 orders in cold IPOs and two orders in hot IPOs, while institutional investors show high cancelation activity in both hot and cold IPOs.

[INSERT TABLE 8 HERE]

As reported in Panel A of Table 8, for every executed order, 2.14 orders are canceled. This is also reflected in the proportion of small orders canceled relative to all executed orders. Large canceled orders far outpace large executed orders as seen in Panel B of Table 8. On average, for every executed order, there are 4.16 canceled orders. There is considerable variation, with the proportion varying from lows of 1.81 in 2017 and 2.27 in 2016 to highs of 7.79 in 2019 and 6.62 in 2015. Large orders are likely placed by institutional investors, including underwriters, market makers, hedge funds, and others. Chiang, Lowry, and Qian (2019) use detailed data from Taiwan and provide evidence that the post-IPO proprietary trades of the lead underwriter banks are superior to those of other market participants. Lead underwriter banks can also enter orders during the preopening and potentially use this period to stabilize an offering.

Next, we examine why investors cancel so many orders. Is it because these orders are not likely to get executed? For example, if the indicative clearing price of a hot IPO keeps moving up, then investors are likely to cancel their old order that was placed at a lower price and replace it with an order at a higher price. Therefore, we identify whether it is "out of the money" orders that are canceled. These are orders that are not likely to get executed. We define an "out-of-money" canceled order as one whose price is at least 5% different from the indicative price. In the case of a buy order, the order would be below the indicative price, while for sell orders it would be above the indicative clearing price. The assumption is that investors do not expect the indicative price to move in a direction that would benefit them. We find that almost all canceled orders are out of the money.

Next, we estimate the following model to examine the role of executed and canceled orders in price discovery.

$$(3) \qquad Ret_{\text{Offer-to-Open},i} = \alpha + \beta_1 \textit{ Type of Canceled Orders } + \sum_j \beta_j \textit{Firm Char}_j + \varepsilon_0$$

The dependent variable $Ret_{\text{Offer-to-Open},i}$, defined as the (*Offer-to-Open*) / *Offer*, captures price discovery during preopening. The main independent variables of interest are: *All Canceled Orders as % of All Executed Orders* and *Large Canceled Orders as % of All Executed Orders* are orders of 2,000 or more shares are assumed to be institutional orders.

[INSERT TABLE 9 HERE]

The results of the model estimate are reported in Table 9. As shown in column 1 of Table 9, the coefficient of *All Canceled Orders as % of All Executed Orders* is positive and significant at 1% in explaining offer-to-open returns. Similarly, the coefficient of *Large Canceled Orders as % of All Executed Orders* is also positive and marginally significant, as shown in column 2 of Table 9. We split the sample into hot and cold IPOs and find that the

two groups behave quite differently. The coefficients of both *All Canceled Orders as % of All Executed Orders* and *Large Canceled Orders as % of All Executed Orders* are positive and significant at the 1% level for hot IPOs, however, the coefficients are negative and significant for cold IPOs. These results indicate that even though canceled orders contribute to the price discovery process, in the case of hot IPOs they are associated with higher returns but in cold IPOs with lower returns. We repeat the analysis using shares instead of orders, the results are similar although less significant.

C. Order Imbalance and Indicative Clearing Price

Nasdaq provides transparency to the market by continually providing information on order imbalances and indicative prices during preopening. We are interested in examining how order imbalance causes the indicative clearing price to change and hence contribute to price discovery. First, we conduct a simple test to examine whether *Order Imbalance* at time t, defined as buy minus sell orders as a percentage of total orders, causes the indicative price to change (ΔP) from t to t+1. Price changes are examined over a 1-minute interval for the last 15 minutes of the preopening period before secondary market trading commences. We use 15 minutes from preopening because the minimum Display Only Period was mandated to be 10 or 15 minutes, and hence this allows us to include the full sample of IPOs. Panel A, Table 10, shows that the coefficient of *Order Imbalance* is not significant for all IPOs, however, it is positive and significant at the 1% level for hot IPOs. The univariate results show that buy order imbalances result in higher prices in the next period for hot IPOs. These results are consistent with our finding that for hot IPOs almost all the price discovery takes place during preopening but for cold IPOs significant price discovery takes place during the first day of aftermarket trading.

[INSERT TABLE 10 HERE]

An order balance can cause the indicative clearing price to change as found above; however, a change in the indicative clearing price may also cause the order imbalance to change. Therefore, we employ a vector autoregression (VAR) model to show the dynamic response of price change and order imbalance. We consider the two-equation VAR model of order 1 as follows:

$$\mathbf{X}_{i,t} = \mathbf{A}\mathbf{X}_{i,t-1} + \mathbf{W}_{i,t-1} \tag{4}$$

Where $\mathbf{X}_{i,t-1} = \begin{pmatrix} \Delta P_{t-1} & OI_{t-1} \end{pmatrix}$ represents the vector of the one-period lagged price change and the order imbalance. To increase the statistical power of the VAR analysis, we use a 10-second interval. Similar to the univariate regression, the VAR results, as shown in Panel B of Table 10, indicate that shocks to order imbalance predict future price movement for hot IPOs, while there is little evidence of order imbalance predicting the price movement for cold IPOs. In this VAR setup, changes in the indicative price strongly predicts order imbalance for both hot and cold IPOs. Price increases cause order imbalance to increase. We conclude that both price increases and order imbalances impact each other, there is a feedback loop. The availability of this information contributes to price discovery.

D. Role of the Underwriter

Underwriters play a different role under the IPO Cross system, relative to the preopening process that existed before the IPO Cross. In our sample, J.P. Morgan led the largest number of IPOs, at 184 during our sample period, followed by Goldman Sachs (165) and Morgan Stanley (144).

Trading cannot begin until the Nasdaq rules on excess volatility and order imbalance are met, as discussed earlier. We take advantage of a rule change in August 2013 to

examine the role of underwriters in the preopening. This rule change gave underwriters a greater role in deciding the length of the preopening period and when to release an IPO for aftermarket trading. Nasdaq eliminated extensions to DOP and instead introduced a Pre-Launch Period. The underwriters were given the flexibility to extend preopening by using this period. This time is also used to coordinate with Nasdaq to conduct the IPO Cross and commence trading. We examine whether lead underwriters use the flexibility provided to them after August 2013. Underwriters possess valuable information about an offering, including information available in their own order book.

We examine the role of the underwriter before and after August 2013 in determining the total time spent in preopening. Top-tier underwriters are more likely to have the resources and expertise to effectively manage the preopening process, therefore, we estimate the following model:

$$ln(\textit{Additional Time in Preopening})_i = \alpha + \beta_1 \textit{DPOST}_i + \beta_2 \textit{TopTierUW}_i + \beta_3\, \textit{DPOST}_i \times \textit{TopTierUW}_i + \sum_j \beta_j \textit{Firm Char}_j + \varepsilon_0 \quad (5)$$

where the dependent variable $ln(\textit{ Additional Time in Preopening})_i$ is the natural logarithm of one plus minutes spent in preopening in addition to the minimum required DOP. The independent variable $\textit{DPOST}_i$ is an indicator variable that is equal to one if the IPO went public after August 1, 2013, and zero otherwise. $\textit{TopTierUW}_i$ is defined as an indicator of whether the lead underwriter's rank is greater than or equal to eight (Carter and Manaster (1990). The interaction between $\textit{DPOST}_i$ and $\textit{TopTierUW}_i$ is included to capture whether, after August 2013, the top-tier underwriters are more likely to extend preopening time. The control variables described above are also included.

[INSERT TABLE 11 HERE]

As shown in Table 11, for the full sample the coefficients of $DPOST_i$ and $TopTierUW_i$ are not significant. However, the interaction term $DPOST_i \times TopTierUW_i$ is positive and significant at the 1% level. This implies that, after being given more flexibility, top-tier underwriters used it to extend the preopening time. We also split the sample based on pre- and post-August 2013 IPOs. We find no relationship between *TopTierUW* and time spent in the preopening before the regulatory change; however, the relationship is significant in the post-August 2013 period. Previously, we showed that in December 2017, when the required DOP changed from 15 to 10 minutes, the underwriters were able to use the flexibility to release some IPOs for trading before the 15-minute window. Some IPOs were released for trading immediately after the required 10-minute period ended. We conclude that the changes introduced in 2013 and 2017 that gave underwriters more flexibility in releasing IPOs for trading were useful and were actually used by them to decide when to release the stock for secondary market trading.

VII. Conclusion

The IPO preopening process provides a unique opportunity to examine the price discovery process. Orders can be placed during the preopening period; they can be modified and canceled at any time until the opening auction takes place. The exchange provides transparency by continuously providing aggregate information on order imbalances and the indicative clearing price. Two regulatory changes allow us to examine the role of underwriters in price discovery.

We find that the extent of price discovery during preopening is associated with firm characteristics such as firm size, venture capital backing, share retention, and price revision. It is also related to preopening attributes including volume of shares transacted during the preopening, canceled orders, information about order imbalances, and indicative clearing

price. There are many more buy orders than sell orders, consistent with IPOs being, on average, oversubscribed, and investors not receiving their desired allocation.

There are several phases in the preopening process, and we find that each of the four phases contributes to significant incremental price discovery. The pattern of price discovery for cold IPOs is quite different from that of hot IPOs. In the case of hot IPOs, almost all of the first day's price adjustment takes place during preopening. For cold IPOs, approximately half of the price discovery takes place during preopening with the remaining half occurring after the IPO starts trading.

Retail investors make up 7.42% of all displayable orders executed before opening in 2014; this increased to 41.44% in 2020. The average number of shares ordered by retail investors in an IPO has also increased over time. However, their role in price discovery is limited because the number of shares transacted by them is much smaller than that of institutional investors.

The volume of shares executed during preopening is large and is positively related to offer-to-open returns. There are a very large number of canceled orders. On average, two orders are canceled in the preopening period for each executed order, with institutional investors canceling more frequently than retail ones. Most canceled orders are "out of the money" and are unlikely to be executed. Canceled orders are positively related to offer-to-open returns; this result is driven by hot IPOs. We find that changes in order imbalance, the difference between buy and sell orders, predict subsequent increases in the indicative clearing price for hot IPOs but not for cold IPOs. We also find that changes in the indicative clearing price predict order imbalances. The dissemination of information about order imbalance and indicative clearing price to the market is one of the important aspects of the preopening process. Finally, we find that the regulatory changes resulted in underwriters effectively using the discretion provided to them to decide when to optimally begin trading an offering in the secondary market. Our findings indicate that the extent of

price discovery during preopening varies considerably across different types of IPOs. The IPO Cross system introduced in 2006 and, particularly, the changes implemented in 2013 that give the underwriter more flexibility in deciding when to release an IPO for trading are beneficial for price discovery.

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Figure 1. Preopening Process and IPO Cross

The figure describes the different phases of the preopening process for IPOs on Nasdaq before the stock is released for trading in the secondary market.

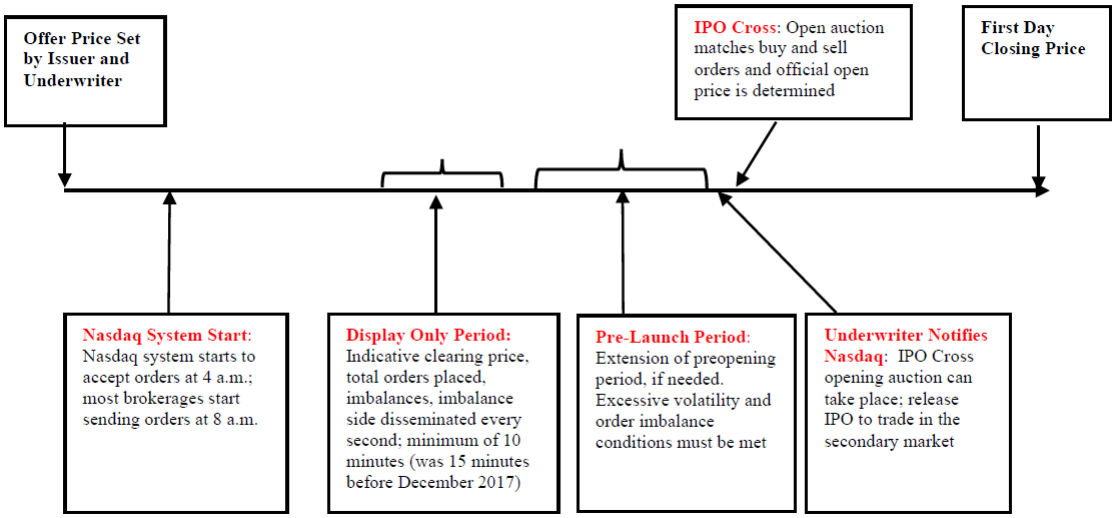
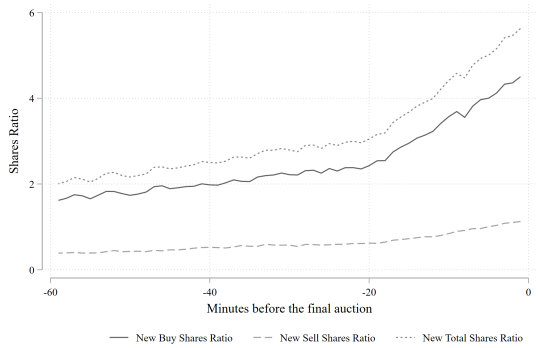


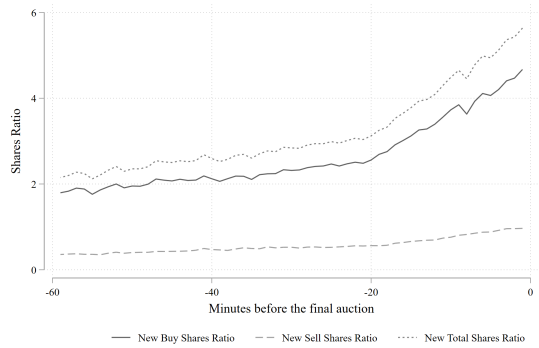
Figure 2. Cumulative Shares Ordered during Preopening

The figure presents the submitted shares during the preopening period for different types of IPOs. Panel A shows the pattern of all cumulative shares for all IPOs. *New Total Shares Ratio* equals cumulative submitted shares divided by executed shares in the opening auction in an IPO, and then averaged across all IPOs in the sample in reverse chronological order. The rightmost point labeled "0" on the x-axis represents the time when IPOs are released to trade in the opening auction. Similarly, *New Buy Shares Ratio* (*New Sell Shares Ratio*) equals cumulative buy (sell) shares divided by executed shares in the opening auction in an IPO, and then averaged across all IPOs. Panel B shows the pattern for Hot IPOs and Panel C shows the pattern for Cold IPOs.

Panel A: All IPOs



Panel B: Hot IPOs



Panel C: Cold IPOs

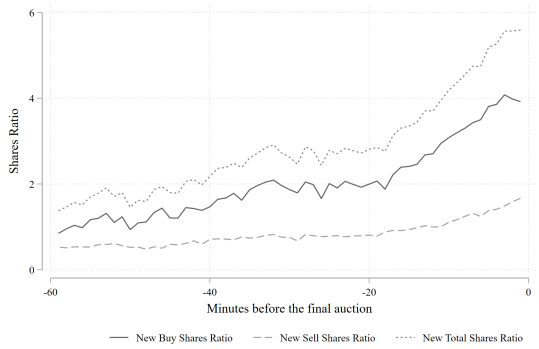
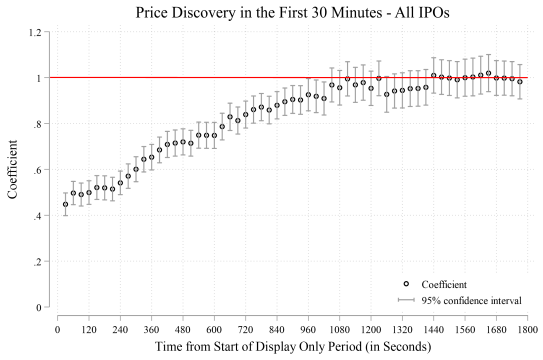


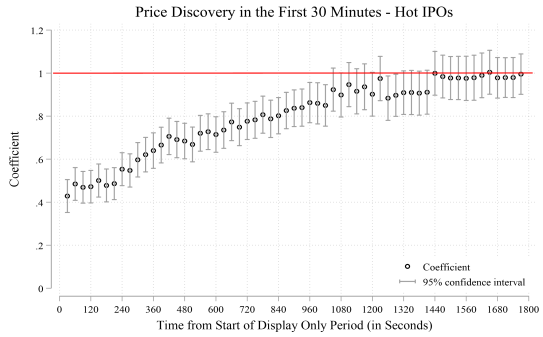
Figure 3. Price Discovery during Preopening

The figure presents the slope coefficients and the 95% confidence interval from the regression $(\textit{Close} - \textit{Offer})/\textit{Offer} = \alpha + \beta_t((\textit{Price}_t - \textit{Offer})/\textit{Offer}) + \epsilon_t$ every 30 seconds during the first 30-minute period after the DOP starts. The new equilibrium value of the stock is proxied by the closing price on day 1, the offer price is the proxy for the previous equilibrium price, and the indicative price at time t is $Price_t$. The indicative price at time t is based on the indicative clearing price from the Nasdaq Net Order Imbalance Indicator data. If the preopening is efficient, then the slope coefficient should equal one (the red horizontal line) by the end of preopening. Panel A shows the pattern for all IPOs, Panel B shows the pattern for Hot IPOs ,and Panel C shows the pattern for Cold IPOs.

Panel A: All IPOs



Panel B: Hot IPOs



Panel C: Cold IPOs

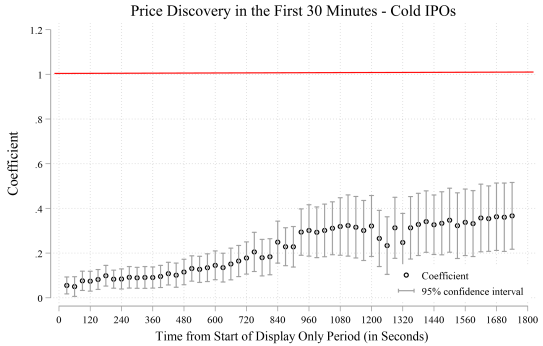
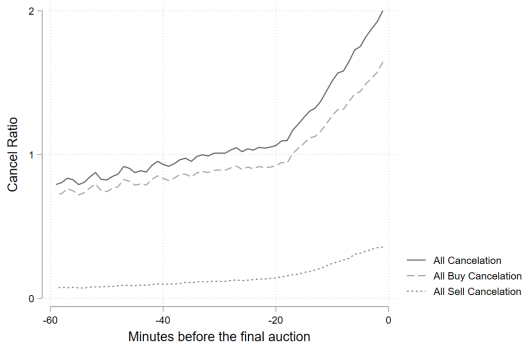


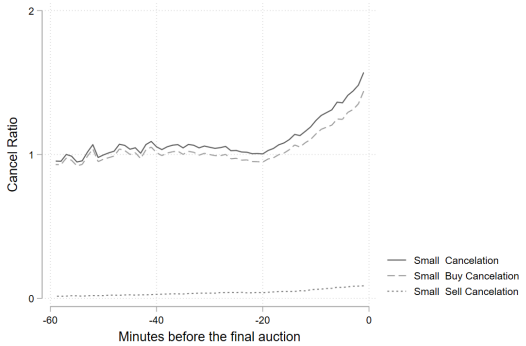
Figure 4. Small and Large Order Cancelations

The figure presents canceled orders during preopening. Panel A shows the pattern of all orders canceled, buy orders canceled, and sell orders canceled during the preopening period. *All Cancelation* equals cumulative orders canceled divided by orders executed in the opening auction in an IPO, and then averaged across all IPOs in the sample in reverse chronological order. The rightmost point labeled "0" on the x-axis represents the time when IPOs are released to trade in opening auctions. Similarly, *All Buy Cancelation* equals cumulative buy orders canceled divided by buy orders executed in the opening auction in an IPO, and then averaging across all IPOs in the sample; and *All Sell Cancelation* equals cumulative sell orders canceled divided by sell orders executed in the opening auction in an IPO, and then averaging across all IPOs in the sample. Panel B shows the pattern for small (<= 100 shares) orders, and Panel C for large (>=2000 shares) orders.

Panel A: All Canceled Orders



Panel B: Small Canceled Orders



Panel C: Large Canceled Orders

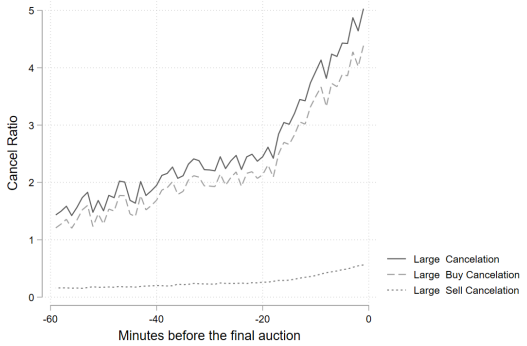


Figure 5. Order Cancelation Pattern during Preopening: Hot vs Cold IPOs

The figure presents canceled orders during preopening. Panel A shows the pattern of all orders canceled, buy orders canceled, and sell orders canceled for Hot IPOs with small (<= 100 shares) orders during the preopening period. *All Cancelation* equals cumulative orders canceled divided by orders executed in the opening auction in an IPO, and then averaged across all IPOs in the sample in reverse chronological order. The rightmost point labeled "0" on the x-axis represents the time when IPOs are released to trade in opening auctions. Similarly, *All Buy Cancelation* equals cumulative buy orders canceled divided by buy orders executed in the opening auction in an IPO, and then averaging across all IPOs in the sample; and *All Sell Cancelation* equals cumulative sell orders canceled divided by sell orders executed in the opening auction in an IPO, and then averaging across all IPOs in the sample. Panel B shows the pattern for large (>= 2000 shares) orders for Hot IPOs, Panel C for small (<= 100 shares) orders for Cold, and Panel D for large (>=2000 shares) orders for Cold IPOs.

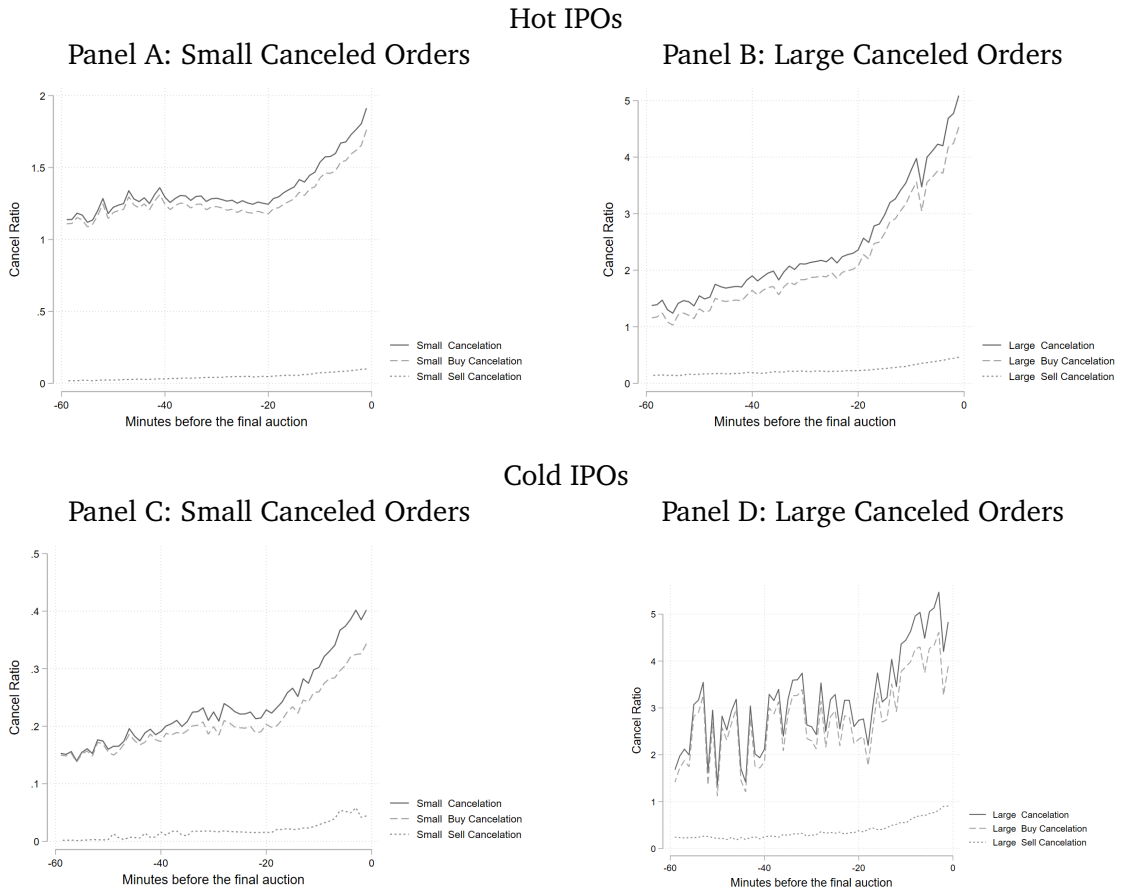


Table 1. Descriptive Statistics for Nasdaq IPOs

The sample consists of 824 Nasdaq IPOs during the period 2010 to 2020. IPOs with an offer price below $5 per share, unit offers, ADRs, closed-end funds, SPACs, natural resource limited partnerships, bank and S&L IPOs, REITs, and best efforts offerings are excluded. The table provides mean and median statistics for the offer price and issue size. N is the number of observations. Offer-to-Open Return is the percentage difference between the opening price on day 1 and the offer price; Offer-to-Close Return is the percentage difference between the closing price on day 1 and the offer price. Issue size does not include the underwriter over-allotment option. Hot IPOs are defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal to the first day's closing price.

		Offer Price ($)		Issue Size (Millions$)		Offer-to-Open Ret		Offer-to-Close Ret	
Year	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median
2010	32	13.17	11.25	129.17	87.05	10.37%	3.35%	13.07%	9.98%
2011	40	13.65	13.00	181.23	106.45	19.16%	10.00%	17.94%	16.58%
2012	40	12.28	11.25	103.97	74.15	10.24%	6.30%	11.55%	5.66%
2013	80	14.08	14.00	138.26	78.00	21.07%	9.33%	25.01%	15.93%
2014	127	12.69	12.00	113.03	65.01	16.20%	7.08%	16.54%	6.82%
2015	80	13.68	14.00	125.60	79.15	16.67%	9.69%	18.51%	6.89%
2016	47	13.29	13.00	89.41	79.00	14.54%	7.86%	16.74%	3.57%
2017	64	13.50	14.00	102.27	79.00	12.83%	8.71%	14.91%	11.46%
2018	91	14.68	15.00	137.96	96.00	18.24%	11.00%	18.24%	8.17%
2019	87	16.83	16.00	225.76	90.00	15.26%	10.00%	20.78%	12.13%
2020	136	18.18	18.00	311.21	190.00	41.15%	27.92%	42.40%	26.29%
All IPOs	824	14.63	15.00	165.52	89.45	20.23%	11.11%	22.03%	12.00%
Hot IPOs	584	15.48	15.00	181.25	98.00	29.85%	21.30%	34.80%	25.00%
Cold IPOs	240	12.69	13.00	127.05	70.00	-2.33%	0.00%	-8.05%	-5.36%

Table 2. Trading Volume during Opening IPO Cross

The table reports the trading volume cleared in the IPO Cross for the 824 Nasdaq IPOs during the period 2010 to 2020. The table shows mean and median statistics for the opening trading volume as a percentage of shares offered and also as a percentage of the first day's trading volume. Opening trading volume is obtained from TAQ data with a sale condition of "O" for the first day of trading, shares offered is from SDC data, and the first day's trading volume is from CRSP daily files. The last two rows show the mean and median statistics of the opening trading volume for hot and cold IPOs separately. Hot IPOs are defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal to the first day's closing price.

	Opening Trading Volume Cleared in IPO Cross			
	as % of Shares Offered		as % of First Day's Trading Volume	
Year	Mean	Median	Mean	Median
2010	8.1%	6.3%	13.8%	12.6%
2011	10.2%	10.1%	17.0%	15.1%
2012	8.1%	6.3%	15.5%	15.2%
2013	9.7%	9.5%	18.8%	14.5%
2014	8.7%	7.7%	13.2%	13.5%
2015	9.9%	8.0%	15.9%	15.0%
2016	8.3%	7.3%	14.3%	15.2%
2017	7.5%	7.3%	14.0%	13.5%
2018	7.2%	6.2%	15.7%	15.9%
2019	7.5%	6.0%	15.8%	16.6%
2020	7.6%	7.3%	15.0%	15.4%
All IPOs	8.3%	7.3%	15.3%	14.7%
Hot IPOs	8.4%	7.4%	14.3%	14.0%
Cold IPOs	7.1%	6.4%	16.2%	15.5%

Table 3. Time Spent in Preopening: Nasdaq IPOs

The table reports the number of minutes spent in preopening. N is the number of observations. Mean, standard deviation, 10th percentile (P10), median (P50), 90th percentile (P90), and maximum minutes are reported. Until August 2013, the minimum preopening period of 15 minutes could change only in increments of 5 minutes. In 2018, Nasdaq reduced the required minimum preopening period from 15 to 10 minutes. Hot IPOs are defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal to the first day's closing price.

Year	N	Mean	Std Dev	P10	Median	P90	Max
2010	32	20.00	5.54	15	20	30	35
2011	40	18.13	4.03	15	15	25	30
2012	40	18.48	3.75	15	20	25	25
2013	80	19.51	7.07	15	15	26	51
2014	127	19.69	7.69	15	17	29	53
2015	80	22.35	11.12	15	17.5	37.5	58
2016	47	24.77	13.73	15	20	49	58
2017	64	27.69	15.41	15	21.5	49	85
2018	91	31.53	21.08	10	26	61	118
2019	87	47.02	31.09	10	40	91	137
2020	136	77.23	41.67	25	79	131	208
All IPOs	824	34.41	30.39	15	20	79	208
Hot IPOs	584	37.10	32.26	15	23	83	208
Cold IPOs	240	28.58	24.78	15	18	60	153

Table 4. Determinants of Preopening Period Price Movement

The table reports coefficient estimates from regressing returns on different attributes. The dependent variable is *Offer-to-Open Return* in the first column and *Open-to-Close Return* in the second column.The key independent variables are *ln(Additional Time in Preopening)* is the log of one plus minutes spent in preopening in addition to the minimum required DOP, and *VOL* is preopening total trading volume divided by shares offered. Other firm characteristics included are: *Size*, the natural logarithm of total assets; *VC Backing*, an indicator for whether the issuer has venture capital backing; *Share Overhang*, the ratio of retained shares to the public float (the number of shares issued); *Price Revision*, calculated as the price change from the middle of the filing price range to the offer price; *Age*, the natural logarithm of one plus the age of the firm in years at the time of the IPO. Year fixed effects based on the IPO year and industry fixed effects based on the 48 Fama-French industries are included. The t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering across year and industry. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Offer-to-Open Return		Open-to-Close Return	
	1	2	3	4
ln(Additional Time in Preopening)	6.607***	5.449***	-0.229	-0.152
	(5.03)	(5.23)	(-0.35)	(-0.25)
VOL	76.930**	-29.320	45.890**	52.970*
	(2.47)	(-0.72)	(2.17)	(1.86)
Size	-1.312	-1.599***	-0.493	-0.474
	(-1.60)	(-2.59)	(-0.76)	(-0.74)
VC Backing	2.656	1.995	0.310	0.354
	(1.53)	(1.37)	(0.23)	(0.26)
Share Overhang	0.882*	0.722	0.269	0.280
	(1.66)	(1.53)	(0.66)	(0.68)
Age	-1.825	0.869	0.413	0.234
	(-1.09)	(0.5)	(0.46)	(0.23)
Price Revision		0.709***		-0.047
		(-6.42)		(-0.57)
N	806	806	806	806
Adj. R-squared	0.21	0.32	0.006	0.006

Table 5. The Determinants of Time in IPO Preopening

The table reports coefficient estimates from regressing time spent in preopening on firm characteristics. The dependent variable, *ln(Additional Time in Preopening* $)_i$, is the log of one plus minutes spent in preopening in addition to the minimum required DOP. The independent variables included are: *VOL*, the preopening total trading volume divided by shares offered; *Size*, the natural logarithm of total assets; *VC Backing*, an indicator for whether the issuer has venture capital backing; *Share Overhang*, the ratio of retained shares to the public float (the number of shares issued); *Price Revision*, calculated as the price change from the middle of the filing price range to the offer price; *Age*, the natural logarithm of one plus the age of the firm in years at the time of the IPO. Hot IPOs are defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal to the first day's closing price. Year fixed effects based on the IPO year and industry fixed effects based on the 48 Fama-French industries are included. The t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering across year and industry. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	All IPOs		Hot IPOs		Cold IPOs	
	1	2	3	4	5	6
VOL	7.095***	5.848***	7.046***	6.000***	6.296***	6.026***
	(6.79)	(4.89)	(6.30)	(4.41)	(3.12)	(2.80)
Size	0.198***	0.193***	0.144**	0.143***	0.273***	0.271***
	(4.77)	(4.79)	(3.25)	(3.26)	(3.90)	(4.03)
VC Backing	0.175**	0.166**	0.256***	0.244***	0.042	0.042
	(2.23)	(2.09)	(2.94)	(2.76)	(0.28)	(0.27)
Share Overhang	0.029*	0.026*	0.043**	0.041**	0.019	0.018
	(1.77)	(1.66)	(2.17)	(2.09)	(0.61)	(0.59)
Age	-0.137*	-0.106	-0.079	-0.059	-0.124	-0.114
	(-1.79)	(-1.34)	(-0.98)	(-0.70)	(-0.91)	(-0.84)
Price Revision		0.008**		0.007**		0.002
		(2.32)		(2.09)		(0.30)
N	806	806	565	565	234	234
Adj. R-squared	0.587	0.592	0.620	0.623	0.509	0.507

Table 6. Price Discovery during Different Phases of Preopening

The table reports the extent of price discovery that takes place during the different phases of preopening for Nasdaq IPOs between August 2013 and 2020 by running the following regression model: $(\textit{Close-Offer})/\textit{Offer} = a + \beta_t\left((\textit{Price}_t - \textit{Offer}\ )/\textit{Offer}\right) + \varepsilon_t$, where the true value of the stock is proxied by the closing price on day 1, the offer price is the proxy for the previous equilibrium price, and the indicative price at time t is Price_t. The indicative price for the first order is based on the displayed price from the first order received by Nasdaq (identified using Nasdaq TotalView ITCH). The indicative price for the DOP start and DOP end is based on the indicative clearing price from the disseminated NOII data. The coefficients are reported for the full sample and for the sample split based on whether a Pre-Launch Period was needed. Panel A reports results for all IPOs, while Panel B and Panel C report the results for hot IPOs and cold IPOs, respectively. Hot IPOs are defined as those with an offer price less than the first day's closing price; cold IPOs are those with an offer price greater than or equal to the first day's closing price.

	Panel A: IPOs								
	All IPOs (N=653)			IPOs with Pre-Launch (N=494)			All IPOs with No Pre-Launch (N=159)		
	Coefficient	Incremental Contribution	t-stat	Coefficient	Incremental Contribution	t-stat	Coefficient	Incremental Contribution	t-stat
Offer to First Order	17.30%	17.30%	7.70	19.78%	19.78%	7.40	4.49%	4.49%	1.49
First Order to DOP Start	50.07%	32.78%	8.64	50.95%	31.17%	7.06	30.77%	26.28%	4.15
DOP Start to End	84.62%	34.55%	7.55	82.03%	31.08%	5.96	118.10%	91.82%	9.32
DOP End to Open	106.96%	22.34%	5.31	106.16%	24.13%	5.08			
	Panel B: Hot IPOs								
	All (N=461)			IPOs with Pre-Launch (N=367)			IPOs with No Pre-Launch (N=94)		
	Coefficient	Incremental Contribution	t-stat	Coefficient	Incremental Contribution	t-stat	Coefficient	Incremental Contribution	t-stat
Offer to First Order	13.96%	13.96%	5.41	16.77%	16.77%	5.66	-0.80%	-0.80%	-0.22
First Order to DOP Start	43.13%	29.17%	6.22	43.49%	26.72%	5.01	22.56%	23.36%	2.86
DOP Start to End	76.21%	33.09%	5.75	73.45%	29.96%	4.63	101.37%	78.01%	5.67
DOP End to Open	100.58%	24.36%	4.57	100.40%	26.95%	4.52			
	Panel C: Cold IPOs								
	All (N=192)			IPOs with Pre-Launch (N=127)			IPOs with No Pre-Launch (N=65)		
	Coefficient	Incremental Contribution	t-stat	Coefficient	Incremental Contribution	t-stat	Coefficient	Incremental Contribution	t-stat
Offer to First Order	2.32%	2.32%	1.93	2.58%	2.58%	1.76	1.85%	1.85%	0.88
First Order to DOP Start	5.72%	3.40%	1.46	6.45%	3.87%	1.45	1.77%	-0.08%	-0.02
DOP Start to End	16.35%	10.63%	2.51	15.14%	8.69%	1.94	70.47%	70.55%	4.02
DOP End to Open	50.96%	34.61%	4.99	48.32%	33.19%	4.48			

Table 7. Retail and Institutional Activity

The table provides information on small and large orders during preopening. Orders of 100 shares or less are classified as small orders to proxy for retail investors, and 2,000 shares or more as large orders to proxy for institutional shares. We only include orders that are not canceled, deleted, or altered based on the message information from Nasdaq TotalView ITCH data. Number Orders is the number of orders placed during the preopening and Number of Shares Ordered is the total number of shares placed during the preopening; mean and median statistics are reported for the number of orders, number of orders as a percentage of total orders, number of shares ordered, and the number of shares ordered as a percentage of total shares ordered. Panel A reports the statistics for small orders and Panel B for large orders.

Panel A: Small (<=100 shares) Orders during Preopening

		Number of Orders		Number of Orders as % of Total Orders		Number of Shares Ordered		Number of Shares Ordered as % of Total Shares Ordered	
Year	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median
2014	89	24.8	9	7.42%	6.18%	868	339	0.16%	0.07%
2015	78	36.1	17	13.23%	11.90%	1,227	582	0.28%	0.18%
2016	45	23.4	17	11.44%	11.11%	789	548	0.27%	0.19%
2017	64	33.8	10	11.70%	10.23%	929	330	0.25%	0.17%
2018	91	62.8	21	19.27%	15.92%	1,724	692	0.47%	0.29%
2019	83	240.5	31	24.79%	22.22%	5,082	919	0.63%	0.49%
2020	130	748.5	96	41.44%	38.54%	13,416	2,339	1.67%	0.84%
ALL	580	226.2	23	20.95%	15.80%	4,466	758	0.65%	0.28%

Panel B: Large (>=2,000) Orders during Preopening

		Number of Orders		Number of Orders as % of Total Orders		Number of Shares Ordered		Number of Shares Ordered as % of Total Shares Ordered	
Year	N	Mean	Median	Mean	Median	Mean	Median	Mean	Median
2014	89	39.3	26	17.57%	16.03%	665,660	336,000	76.92%	82.05%
2015	78	37.4	23	15.22%	13.81%	623,528	265,875	77.23%	81.46%
2016	45	28.7	23	15.63%	14.65%	374,671	206,950	75.02%	79.42%
2017	64	28.1	23	16.19%	15.32%	384,521	238,445	75.42%	78.05%
2018	91	25.4	15	13.50%	12.59%	329,810	159,954	75.40%	79.25%
2019	83	31.8	16	11.17%	10.61%	680,198	180,520	74.45%	77.55%
2020	130	32.2	19	7.83%	6.81%	551,710	231,367	73.42%	78.64%
ALL	580	32.1	20	13.21%	12.35%	530,241	237,566	75.27%	79.20%

Table 8. Role of Canceled Orders in Price Discovery

The table provides information on canceled orders during preopening. Orders of 2,000 shares or more are classified as large orders to proxy for institutional shares. We only include orders that are not canceled or altered based on the message information from Nasdaq TotalView ITCH data. Number of Small (Large) Canceled Orders is the number of small (large) canceled orders placed during the preopening; Panel A reports the mean and median statistics for the number of *All Canceled Orders*, the number of all canceled orders as a percentage of total executed orders, and as a percentage of total executed orders. Panel B reports the mean and median statistics for the number of *Large Canceled Orders*, the number of large canceled orders as a percentage of total executed large orders, and as a percentage of total executed orders.

Panel A: All Canceled Orders

		# of All Canceled Orders		# of All Canceled Order / # of All Executed Orders		# of All Canceled Shares / # of All Executed Shares	
Year	N	Mean	Median	Mean	Median	Mean	Median
2014	89	321.39	183.00	1.39	1.07	3.27	1.98
2015	78	424.65	209.50	1.68	1.19	3.89	1.66
2016	45	236.42	119.00	0.98	0.76	1.77	1.47
2017	64	255.73	121.00	1.42	1.15	2.11	1.70
2018	91	376.26	146.00	1.30	1.10	2.57	1.87
2019	83	1085.64	249.00	1.87	1.43	4.68	2.95
2020	130	3187.41	410.50	2.00	1.40	3.07	2.41
All	580	1083.11	190.00	1.59	1.19	3.16	2.06

Panel B: Large Canceled Orders

		# of Large Canceled Orders		# of Large Canceled Order / # of Large Executed Orders		# of Large Canceled Order / # of All Executed Orders	
Year	N	Mean	Median	Mean	Median	Mean	Median
2014	89	101.48	62	3.44	2.25	0.55	0.38
2015	77	149.64	75	6.62	2.26	0.70	0.34
2016	43	68.74	37	2.27	1.83	0.32	0.30
2017	63	55.13	29	1.81	1.57	0.29	0.22
2018	90	75.47	39	3.35	2.16	0.42	0.32
2019	81	200.05	84	7.79	4.33	0.71	0.37
2020	129	112.42	39	3.28	2.11	0.22	0.14
All	572	112.73	47	4.16	2.14	0.45	0.26

Table 9. Canceled Orders and Price Discovery

The table shows the results from examining the role of canceled orders in price discovery. The dependent variable in each case is *Offer-to-Open Return* captures price discovery during preopening. The main independent variables of interest are: *All Executed Orders as % of All Executed Orders* are canceled orders of 2,000 or more shares scaling by all executed orders and are considered to be large orders placed by institutional investors; *Large Canceled Orders as % of All Executed Orders* are orders of 2,000 or more shares and are considered to be large orders placed by institutional investors; Other variables included are: *Size* is the natural logarithm of total assets, *VC Backing* is an indicator for whether the issuer has venture capital backing, *Share Overhang* is the ratio of retained shares to the public float (the number of shares issued), *Price Revision* is calculated as the price change from the middle of the file price to offer price, and *Age* is the natural logarithm of one plus the age of the firm in years at the time of the IPO. Year fixed effects based on the IPO year and industry fixed effects based on the 48 Fama-French industries are included. The t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering across year and industry. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Offer-to-Open Return					
	All IPOs		Hot IPOs		Cold IPOs	
	1	2	3	4	5	6
All Canceled Orders as % of All Executed Orders	10.020***		10.310***		-1.640**	
	(3.80)		(3.83)		(-2.58)	
Large Canceled Orders as % of All Executed Orders		2.282*		2.981***		-2.237***
		(1.80)		(2.69)		(-2.84)
Size	-1.292**	-0.924	-2.584***	-2.101***	-0.583**	-0.565**
	(-2.22)	(-1.38)	(-4.06)	(-2.69)	(-2.13)	(-2.02)
VC Backing	3.005**	4.397***	1.956	3.821*	1.975	1.915
	(2.53)	(2.96)	(1.40)	(1.94)	(1.29)	(1.27)
Share Overhang	0.326	1.404*	1.870***	3.656***	0.200	0.044
	(0.81)	(1.85)	(3.49)	(4.59)	(1.11)	(0.21)
Price Revision	0.695***	0.863***	0.689***	0.858***	0.190***	0.193***
	(9.78)	(6.49)	(7.57)	(6.49)	(4.16)	(4.38)
Age	1.939	1.242	0.215	-0.936	0.331	0.602
	(1.36)	(0.71)	(0.10)	(-0.36)	(0.31)	(0.56)
N	575	568	393	391	170	165
Adj. R-squared	0.453	0.290	0.489	0.311	0.257	0.248

Table 10. Order Imbalance and Price Discovery During Preopening

The table investigates the relationship between order imbalances and indicative clearing price movement during the IPO preopening. Panel A conducts a two-step Fama-MacBeth approach to compute the parameter estimates and the corresponding standard errors. The t-statistics are in parentheses. Panel B runs a Vector Autoregression (VAR) of order imbalances and price changes during the preopening period. The order of variables is one-period lagged price change and one-period lagged order imbalances, where the first equation's dependent variable is price change and the second equation's dependent variable is order imbalance. The analysis is first estimated at each stock level and then takes the average of the coefficients cross-sectionally for mean and standard errors.

Panel A: Univariate Regression of Price Movement on Order Imbalance						
	All IPOs		Hot IPOs		Cold IPOs	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
ΔP_t on OI_{t-1}	0.01	(0.24)	0.06***	(3.76)	-0.16	(-1.14)

Panel B: Vector Autoregression Estimates for Impulse Functions						
	All IPOs		Hot IPOs		Cold IPOs	
	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
ΔP_t on ΔP_{t-1}	-0.04	(-1.58)	-0.07***	(-4.42)	0.05	(0.62)
ΔP_t on OI_{t-1}	0.36*	(1.78)	0.19**	(2.32)	0.84	(1.12)
OI_t on ΔP_{t-1}	0.42***	(35.44)	0.40***	(29.84)	0.45***	(19.30)
OI_t on OI_{t-1}	-0.74*	(-1.96)	-0.45**	(-2.55)	-1.60	(-1.15)

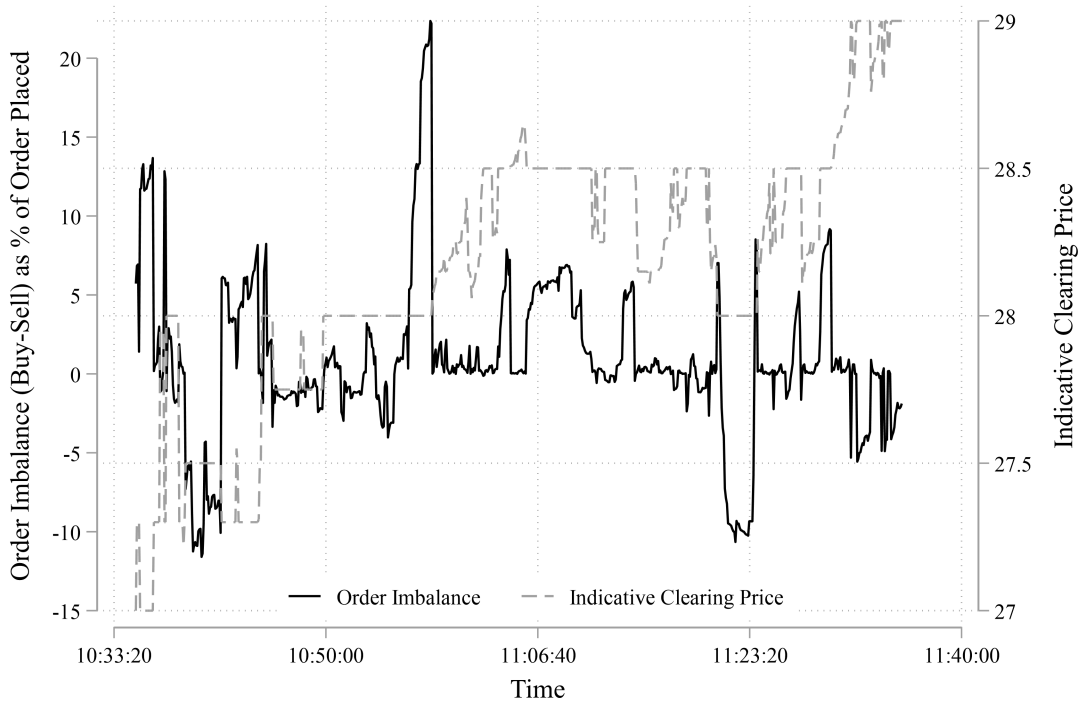
Table 11. Increased Role of the Underwriter in Releasing IPOs for Trading

The table reports coefficient estimates for the determinants of additional time spent in IPO preopening. The dependent variable, $\ln($ *Additional Time in Preopening* $)_i$, is the log of one plus minutes spent in preopening in addition to the minimum required DOP. The independent variable, $DPOST_i$, is an indicator variable that equals one if the IPO went public after August 1, 2013, and zero otherwise. $TopTierUW_i$ is defined as an indicator for whether the lead underwriter's Carter and Manaster (1990) rank is greater than or equal to eight. Other variables included are: *Size*, the natural logarithm of total assets; *VC Backing*, an indicator for whether the issuer has venture capital backing; *Share Overhang*, the ratio of retained shares to the public float (the number of shares issued); *Price Revision*, calculated as price change from the middle of the filing price range to the offer price; *Age*, the natural logarithm of one plus the age of the firm in years at the time of the IPO. Year fixed effects based on the IPO year and industry fixed effects based on the 48 Fama-French industries are included. The t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering across year and industry. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Full Sample		Post-August 2013		Pre-August 2013	
	1	2	3	4	5	6
$DPOST_i$	-0.020 (-0.07)	-0.150 (-0.52)				
$DPOST_i \times TopTierUW_i$	0.932*** (3.33)	0.935*** (3.82)				
$TopTierUW_i$	0.217 (0.98)	-0.165 (-0.83)	1.157*** (7.12)	0.711*** (5.31)	0.271 (1.13)	0.104 (0.45)
Size		0.141*** (4.22)		0.185*** (5.82)		-0.052 (-0.85)
VC Backing		0.148** (1.99)		0.165* (1.81)		0.073 (0.46)
Share Overhang		0.033** (2.45)		0.032** (2.14)		0.063** (2.54)
Price Revision		0.015*** (5.27)		0.014*** (4.60)		0.016*** (3.18)
Age		-0.041 (-0.59)		-0.071 (-0.88)		0.092 (0.64)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes
N	815	815	662	662	147	147
Adj. R-squared	0.529	0.593	0.523	0.581	0.189	0.276

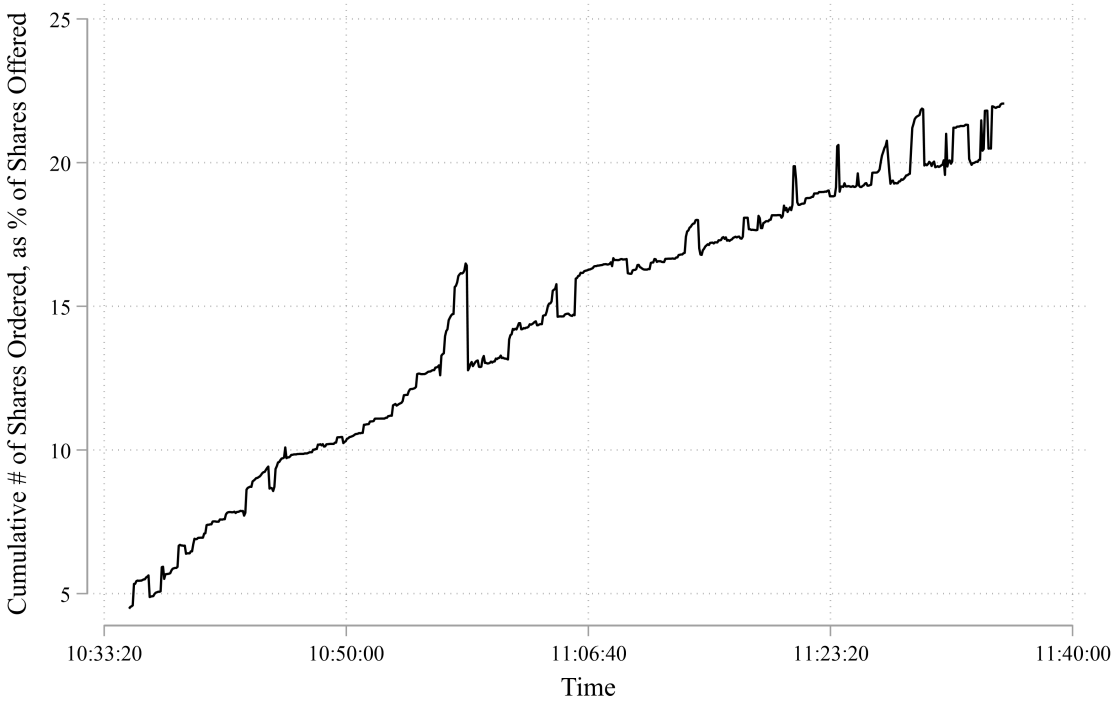
Appendix Figure A1. Example of the Preopening Process: Dropbox IPO

The figure shows the indicative clearing price, order imbalance, and cumulative orders during the preopening process for Dropbox IPO. Indicative clearing price is the price at which the book would clear based on current orders. Dropbox.com went public on March 23, 2018 at an offer price of $21. The Display Only Period started at 10:35:03 a.m. with the first indicative clearing price of $27. The first 10 minutes is the minimum required Display Only Period and the remaining 50 minutes is the Pre-Launch Period. The IPO Cross occurred at 11:35:23 a.m. The order imbalance is defined as buy-minus-sell orders as a percentage of total orders placed.



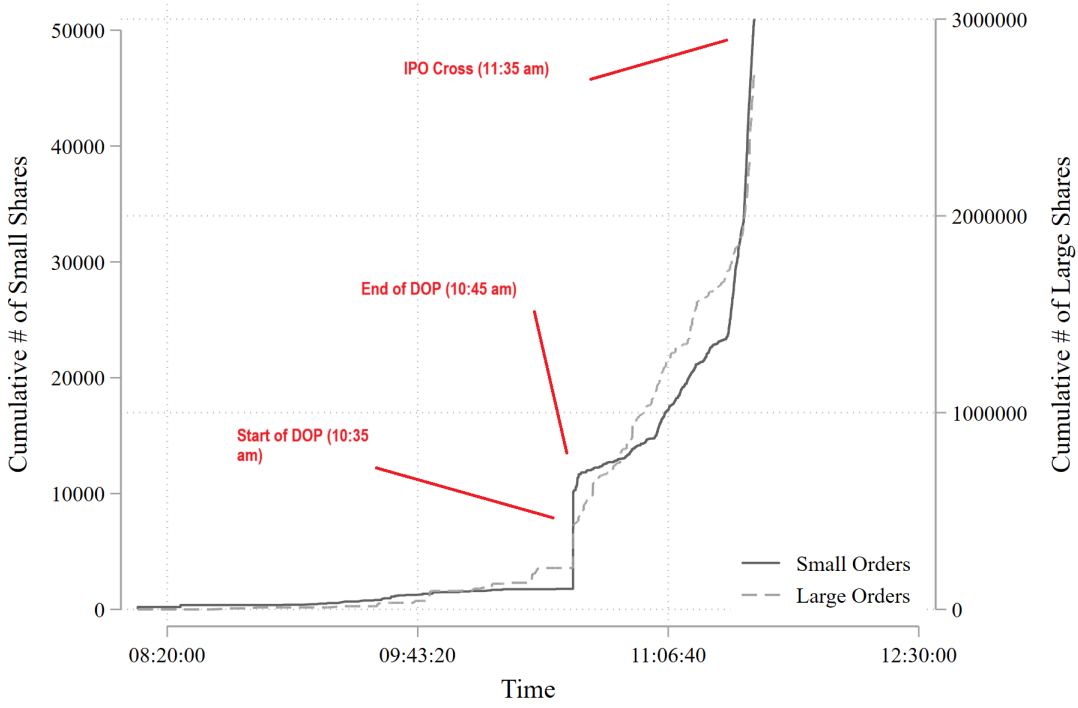
Appendix Figure A2. Price Discovery during Preopening: Dropbox

The plot shows the cumulative number of shares ordered as a percentage of shares offered during preopening for Dropbox. The Display Only Period started at 10:35:03 a.m. with the first indicative clearing price of $27. The first 10 minutes is the minimum required Display Only Period and the remaining 50 minutes is the Pre-Launch Period. The IPO Cross occurred at 11:35:23 a.m.; 36 million shares of Dropbox were offered in the IPO.



Appendix Figure A3. Price Discovery during Preopening: Dropbox

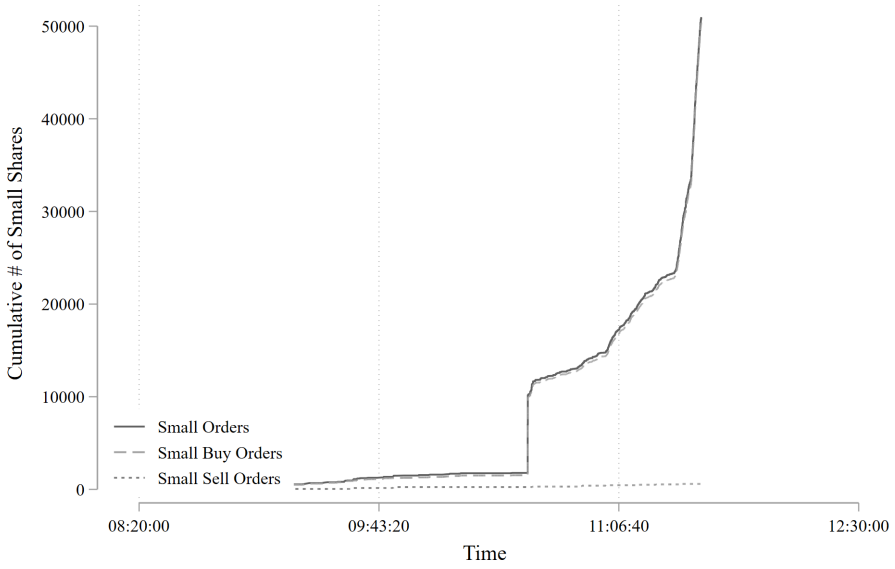
The figure shows the cumulative number of shares ordered in the Nasdaq system during the preopening process for the Dropbox IPO. Dropbox.com went public on March 23, 2018 at an offer price of $21. Orders are received and accepted by the Nasdaq system starting 8:10 a.m. The orders that have less than 100 shares are classified as small orders and those with 2,000 or more shares are classified as large orders.



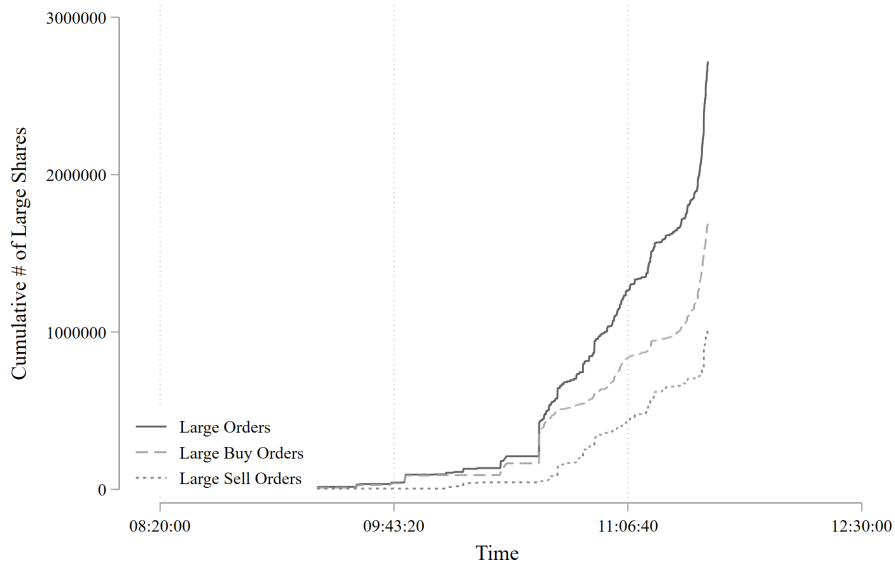
Appendix Figure A4. Buy and Sell Orders during Preopening: Dropbox

The figure shows the cumulative number of shares for buy versus sell orders received in the Nasdaq system during the preopening process for the Dropbox IPO. Dropbox.com went public on March 23, 2018, at an offer price of $21. Orders were received and accepted by the Nasdaq system starting at 8:10 a.m. The orders that have less than 100 shares are classified as small orders and those with 2,000 or more shares are classified as large orders. We assume that retail investors enter small orders and institutional investors enter large orders.

Panel A: The Cumulative Number of Shares in Buy/Sell Orders for Small Orders



Panel B: The Cumulative Number of Shares in Buy/Sell Orders for Large Orders



Appendix Table A1. Time in Preopening: Nasdaq SPACs

The table reports the number of minutes spent in preopening. N is the number of SPACs. There are less than 10 SPACs per year before 2014 and therefore all offerings during the 2010–2013 period have been lumped together. Mean and median statistics are reported for the time spent in preopening, offer price, and offer-to-open return. In December 2017, Nasdaq reduced the required minimum preopening period from 15 to 10 minutes. Therefore, before 2018 the time spent in preopening has to be 15 minutes or more.

		Minutes in Preopening		Offer Price ($)		Offer-to-Open Ret	
Year	N	Mean	Median	Mean	Median	Mean	Median
2010–2013	18	15.44	15.00	9.56	10.00	-0.06%	0.00%
2014	10	17.70	15.00	10.00	10.00	-0.39%	0.00%
2015	17	16.24	15.00	10.00	10.00	0.14%	0.00%
2016	11	19.00	17.00	10.00	10.00	-0.26%	0.00%
2017	22	18.73	16.00	10.00	10.00	0.66%	0.65%
2018	28	11.68	11.00	10.00	10.00	0.39%	0.20%
2019	31	12.74	12.00	10.00	10.00	0.53%	0.50%
2020	126	23.93	20.00	10.00	10.00	1.43%	0.45%
ALL	263	19.35	15.00	9.97	10.00	0.82%	0.20%

Appendix Table A2. IPO Opening Time

The table provides information on IPOs from the start of the Display Only Period and when trading starts in the secondary market. Start time is the half-hour time interval in which the first disseminated information regarding IPO Cross occurs (left panel) and the half-hour time interval in which the IPO Cross occurs (right panel), N is the number of IPOs during the half-hour period, and mean and median are reported for offering size (proceeds) in million dollars, and for Open-to-Offer Returns as a percentage.

	Start of Display Only Period					Start of Trading in Secondary Market				
		Offering Size		Open-to-Offer Return			Offering Size		Open-to-Offer Return	
Start Time	N	Mean	Median	Mean	Median	N	Mean	Median	Mean	Median
9:30–10:00	106	185.99	90.00	24.68%	8.36%	3	67.50	37.50	7.24%	9.21%
10:00–10:30	338	193.95	100.00	23.49%	16.11%	181	100.61	70.45	12.74%	5.00%
10:30–11:00	219	166.60	90.00	19.12%	11.11%	263	130.78	88.00	18.50%	12.50%
11:00–11:30	130	93.53	74.70	13.05%	5.23%	190	171.60	96.65	21.42%	11.79%
11:30–12:00	15	61.09	60.00	11.42%	3.33%	98	261.35	125.00	26.75%	22.97%
12:00–12:30	2	274.55	274.55	37.39%	37.39%	52	299.25	160.50	32.64%	16.45%
12:30–1:00	2	65.00	65.00	0.83%	0.83%	15	245.95	202.00	50.49%	30.00%
1:00–1:30	2	341.95	341.95	-7.18%	-7.18%	9	254.16	178.20	23.30%	8.79%
1:30–2:00	3	15.87	15.10	-0.95%	0.00%	5	734.30	15.10	24.03%	0.00%
2:00–2:30	4	8.60	8.50	1.43%	-1.60%	1	25.00	25.00	0.00%	0.00%
2:30–3:00	3	22.20	12.00	-1.38%	0.00%	4	8.60	8.50	1.43%	-1.60%
3:00–3:30	0					3	22.20	12.00	-1.38%	0.00%