International Journal of Economics, Finance and Management Sciences
2021; 9(6): 285-296
http://www.sciencepublishinggroup.com/j/ijefm
doi: 10.11648/j.ijefm.20210906.19
ISSN: 2326-9553 (Print); ISSN: 2326-9561 (Online)

The Stock Price Response to the Resolution of Stock Distributions, Order Imbalances, and the Market Maker

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To cite this article:
Rong Guo, Kristian Rydqvist. The Stock Price Response to the Resolution of Stock Distributions, Order Imbalances, and the Market Maker. *International Journal of Economics, Finance and Management Sciences*. Vol. 9, No. 6, 2021, pp. 285-296.
doi: 10.11648/j.ijefm.20210906.19

Received: November 19, 2021; **Accepted**: December 20, 2021; **Published**: December 31, 2021

Abstract: We re-examine the abnormal stock return over the ex-right day of stock splits, stock dividends, and rights offers. The average abnormal stock return for stock splits equals 0.45%, for stock dividends equals 0.83%, and for rights offers equals 1.74%. These abnormal returns suggest that stock distributions incur handling costs that we refer to as nuisance. Regression analysis of the abnormal stock return on the bid-ask spread suggests that an underlying nuisance cost in the amount of 0.57% (across stock distribution types) of the stock price and a bid-ask bounce that occurs with a probability of 23% capture the essential cross-section (across stock distribution types) and time-series variation in the abnormal stock return. However, further analysis of the behavior of bid and ask quotes questions the bid-ask-bounce interpretation. Specifically, the bid-ask midpoint changes one-to-one with the changes in the bid and ask quotes, respectively, which suggests that market makers do not eliminate the nuisance cost from stock distributions. The nuisance cost of stock distributions decreases over time, and it vanishes entirely with high-frequency trading. Presumably, stock distributions are not nuisance for computers. With the development of the internet, share price management largely falls out of fashion, and stock distributions are no longer a concern.

Keywords: Integer Stock Splits, Fractional Stock Splits, Rights Offers, Abnormal Stock Return, Market Making, Share Price Management

1. Introduction

Several papers estimate the stock price response to the ex-day of stock distributions. In a stock split, new securities replace old securities, and following a stock dividend or rights offer, the number of securities increases through the issuance of additional shares. The average stock market reaction is positive, which indicates that the completion of the stock distribution is welcome, and trading can revert to normal. Many capital market frictions contribute to explaining the abnormal stock return: fractional shares, trading restrictions, odd-lot fees, and before the time of computers, mailing and receiving paper ownership certificates. For rights offers, costs associated with financing the purchase price may also enter investors' calculations. We shall refer to all those costs as nuisance. For any or all these reasons, the market maker may adjust his midpoint quote, prospective buyers may postpone their purchases to the ex-day, and sellers may accelerate their sales to before the ex-day. As a result of the midpoint quote adjustment and order imbalances, prices are depressed before the ex-day and respond positively to the completion of the stock distribution.

Frank and Jagannathan [7] construct a model of price formation over the ex-day in the absence of income tax and adverse selection. They focus on explaining the abnormal stock return over the ex-dividend day in Hong Kong, where cash dividends are tax-free. They also analyze a small sample of 37 stock dividends in Hong Kong. Their model has four sets of agents: a market maker, noise traders who trade no matter what, and buyers and sellers who time their transactions in response to the stock distribution. The model delivers the predictions that the (excess) stock return over the ex-day is positive and that the abnormal stock return is proportional to the bid-ask spread. In order to derive a parsimonious model of the abnormal stock return that is entirely driven by order imbalances, Frank and Jagannathan [7] assume that the market maker is not bothered by the stock distribution and, therefore, does not incur any nuisance cost. We extend their model by assuming that the market maker adjusts his midpoint quote in response to the stock distribution. The first contribution of our paper is to show that the extended model captures the essential cross-section and time-series variation in the abnormal stock return.

We compute abnormal stock returns on the ex-day for stock splits, stock dividends, and rights offers by companies listed on the NYSE from 1926 to 2016. In accordance with the previous literature, which we review below, we find that average stock returns exceed the market return. We regress the abnormal stock return on the bid-ask spread. We estimate the underlying nuisance cost to be 0.57% of the stock price and a bid-ask bounce that occurs with a probability of 23%. There is a strict ordering of average abnormal stock returns across distribution types: the average abnormal return is the smallest for integer stock splits (0.45%) that result in an even number of new securities; the abnormal return is higher for fractional stock splits or stock dividends (0.83%) that are likely to result in fractional shares that need to be purchased and sold to result in new shares; the abnormal return is the highest for rights offers (1.75%), which in additional to the nuisance of fractional shares also require that investors finance the purchase cost. There is also time-series variation. The abnormal stock return vanishes with high-frequency trading that follows the introduction of electronic matching of buy and sell orders from the year 2000, and we find some evidence that the abnormal return decreases after the removal of odd-lot fees.

After these initial positive results, we investigate the behavior of bid and ask quotes. The bid-ask-bounce theory predicts that the stock return exceeds the midpoint-quote return by the amount of the bid-ask bounce. The second contribution of our paper is to demonstrate that the midpoint-quote return is a near perfect predictor of the stock return, the average midpoint-quote return equals the stock return, and the coefficients from regressing the midpoint-quote return on the bid-ask spread are indistinguishable from those of the stock return regression. These results suggest that nuisance costs also matter for the market maker and that the abnormal stock return is related to liquidity, the cost of executing a trade, and the process by which arbitrage puts a cap on price inefficiencies.

Dolley [5] is the first to notice that stock distribution ex-day prices are higher than expected. The first papers to estimate abnormal stock returns over the ex-right day are Eades, Hess, and Kim [6], who find 0.387% for a sample of stock splits and stock dividends, and Grinblatt, Masulis, and Titman [10], who present raw returns of 0.69% for stock splits and 1.10% for stock dividends. Grinblatt, Masulis, and Titman [10] hypothesize that the abnormal return equals half the spread, but they do not test this conjecture. Maloney and Mulherin [12] find that post-split prices are more likely to occur at the ask, and Conrad and Conroy [3] study order flow imbalances after stock splits. Following some stock splits, market makers organize when-issued trading in post-split shares. Choi and Strong [2] find that when-issued stock prices systematically exceed pre-split stock prices adjusted for the split, which they offer as an alternative measure of the nuisance cost of a stock split. Nayar and Roze [14] point out that the existence of a when-issued market is evidence of inconvenience. They stress the importance of a trading restriction on pre-split shares. Nelson [15] finds that ex-day prices of rights offers tend to be larger than expected, but he does not perform any statistical tests. Smith [16] studies the ex-day return of rights offers. He concludes that there are no abnormal returns associated with the ex-right day, but his calculations are limited to monthly stock price data before daily stock returns become available from CRSP. Graham, Michaely, and Roberts [9] find that abnormal stock returns over the ex-dividend day do not regress toward zero after the general reduction in the bid-ask spread after decimalization. Their result also speaks against the bid-ask bounce theory.

The rest of the paper is organized as follows: Section 2 derives testable implications, Section 3 describes the data set and the mechanics of a stock distribution, Section 4 reports our empirical results, and Section 5 concludes the paper.

2. Theory and Implications

We review and modify the model by Frank and Jagannathan [7] with a focus on deriving testable implications. There are four sets of agents: a market maker, buyers, sellers, and noise traders. In the original model, buyers and sellers are averse to the stock distribution, which imposes a nuisance cost on them, while the market maker and noise traders do not pay attention to the stock distribution. Under the assumptions of the original model, an abnormal stock return arises from a bid-ask bounce that occurs with probability π over the ex-right day. Then, we consider an alternative model with a market maker and noise traders, but no buyers and sellers. An abnormal ex-right day return arises because the market maker factors in a nuisance cost into his bid and ask quotes. Finally, we combine the two models into one with market maker nuisance and bid-ask bounce. The combined model has a rich set of testable implications.

2.1. The Frank-Jagannathan Model

Market maker. The market maker does not change his bid and ask quotes in response to the stock distribution:

$$P_{Bid,0} = E(\hat{P}_{Bid,1}), \tag{1}$$

$$P_{Ask,0} = E(\hat{P}_{Ask,1}). \tag{2}$$

Subindex 0 and 1 refers to bid and ask quotes before and after the stock distribution, respectively. We adjust time 1 quotes through multiplication by the split factor: $\hat{P}_{Bid,1} = S_1 \times P_{Bid,1}$ and $\hat{P}_{Ask,1} = S_1 \times P_{Ask,1}$.

Buyers. A buyer is an agent who purchases the stock at the market maker's ask quote. He incurs a nuisance cost c from participating in the stock distribution. As a result of this additional transaction cost, the buyer prefers to postpone the trade:

$$P_{Ask,0} + \mathrm{c} > E\left(\hat{P}_{Ask,1}\right). \quad (3)$$

We assume that the inequality is satisfied.

Sellers. A seller is another agent who trades at the market maker's bid quote. The seller also incurs the nuisance cost *c*. By accelerating the trade, the seller avoids the cost:

$$P_{Bid,0} > E\left(\hat{P}_{Bid,1}\right) - c. \quad (4)$$

We assume that the inequality is satisfied.

Noise traders. Noise traders do not pay attention to the stock distribution, and they are indifferent between trading before or after the ex-right date. On average, noise traders transact at the midpoint of the market maker's bid and ask:

$$P_{Mid,0} = \frac{P_{Bid,0}+P_{Ask,0}}{2} = \frac{E(\hat{P}_{Bid,1})+E(\hat{P}_{Ask,1})}{2} = E\left(\hat{P}_{Mid,1}\right) \quad (5)$$

Equilibrium. Consider the last day when the stock includes the right to the new shares. The probability that the market maker transacts with a seller is π, and the expected transaction price equals the weighted average of the price that results from trading with a seller and from trading with a noise trader:

$$E(P_0) = \pi P_{Bid,0} + (1-\pi)P_{Mid,0}. \quad (6)$$

Next, consider the ex-day. The probability that the market maker transacts with a buyer is π , and the expected transaction price is:

$$E\left(\hat{P}_1\right) = \pi\hat{P}_{Ask,1} + (1-\pi)\hat{P}_{Mid,1}. \quad (7)$$

We subtract the cum-day price (6) from the ex-day price (7), and we make use of the assumptions that the market maker and noise traders are neutral with respect to the distribution:

$$E\left(\hat{P}_1\right) - E(P_0) = \pi(P_{Ask,0} - P_{Bid,0}). \quad (8)$$

The expected price change over the ex-right day equals the bid-ask spread multiplied by the probability π that the market maker trades with a seller before the distribution and a buyer after the distribution. Accordingly, the abnormal stock return over the ex-right day equals a bid-ask bounce that occurs with probability π.

2.2. Market Maker Nuisance and Bid-ask Bounce

The nuisance cost enters the equilibrium prices indirectly through the inequalities (3) and (4), which by assumption are satisfied. As a result, the model does not allow us to impute the nuisance cost *c* from the abnormal return, which implies that the model does not offer any predictions with respect to cross-section and time-series variation in the nuisance cost. We want to modify the model such that *c* enters. To meet this objective, we relax the assumption that the market maker can handle the distribution of securities at zero cost. First, we ignore buyers and sellers and focus on the interaction between the market maker and noise traders. Then, we introduce buyers and sellers.

The market maker modifies his bid and ask quotes with respect to the stock distribution as follows:

$$P_{Bid,0} + \mathrm{c} = E\left(\hat{P}_{Bid,1}\right), \quad (9)$$

$$P_{Ask,0} = E\left(\hat{P}_{Ask,1}\right) - c. \quad (10)$$

The nuisance cost *c* makes it less attractive to buy securities before the distribution, and it reduces the value of selling securities ex right. The bid-ask spread remains the same before and after the stock distribution:

$$P_{Ask,0} - P_{Bid,0} = E\left(\hat{P}_{Ask,1}\right) - E\left(\hat{P}_{Bid,1}\right), \quad (11)$$

but the market maker adjusts his midpoint quote such that:

$$E(\hat{P}_{Mid,1}) = \frac{E(\hat{P}_{Bid,1})+E(\hat{P}_{Ask,1})}{2} = \frac{P_{Ask,0}+P_{Bid,0}+2c}{2} = P_{Mid,0} + c. \quad (12)$$

On average, noise traders transact at the midpoint of the market maker's bid and ask, which results in an expected price change over the ex-right day, which is equal to the nuisance cost:

$$E(\hat{P}_1) - E(P_0) = c. \quad (13)$$

As the final step, we combine the market maker nuisance with the bid-ask bounce. As before, we compute the price change over the ex-day by subtracting the ex-right price given by Equation (7) from the ex-right price stated in Equation (6), but this time, we replace the midpoint quotes without market-maker nuisance from Equation (5) with the midpoint quotes with market-maker nuisance from Equation (12):

$$\begin{aligned} E\left(\hat{P}_1\right) - E(P_0) &= \pi\left(\hat{P}_{Ask,1} - P_{Bid,0}\right) + (1-\pi)\left(\hat{P}_{Mid,1} - P_{Mid,0}\right) \\ &= \pi\left(\hat{P}_{Ask,1} - P_{Bid,0}\right) + (1-\pi)\times c = \pi\left(P_{Ask,0} - P_{Bid,0}\right) + c. \end{aligned} \quad (14)$$

In the extended model, the price change over the ex-right day has two terms, one that captures the bid-ask bounce and another that reflects the underlying nuisance cost.

2.3. Implications

Cross-section. We replace the expected price change over the ex-day from Equation (14) with the realized stock return from close (P_0) to close $\left(\hat{P}_1\right)$, we subtract the rate of return on the stock market r_m, and we add a residual term *u* that represents everything else that might influence the stock return over the ex-right day:

$$\frac{\hat{P}_1-P_0}{P_0} - r_m = \frac{c}{P_0} + \pi\left(\frac{P_{Ask,0}-P_{Bid,0}}{P_0}\right) + u. \quad (15)$$

The left-hand side of Equation (15) is the excess stock return over the market, and the right-hand side captures the underlying nuisance cost and the effect of the bid-ask bounce. We estimate the regression model:

$$AR = \gamma_0 + \gamma_1 \left(\frac{P_{Ask,0} - P_{Bid,0}}{P_0}\right) + u, \quad (16)$$

where AR denotes the abnormal ex-day stock return, the intercept term is $\gamma_0 = c/P_0$, and the slope coefficient is $\gamma_1 = \pi$. The model implies that *(i)* the average abnormal stock return is positive, $\overline{AR} \geq 0$, *(ii)* the regression intercept is positive, $\gamma_0 \geq 0$, and *(iii)* the regression slope coefficient is a number between zero and one, $\gamma_1 \in [0,1]$.

In addition, we explore the data for cross-section variation in the nuisance cost by estimating the extended regression model:

$$AR = \gamma_S I_S + \gamma_F I_F + \gamma_N I_N + \gamma_3 \left(\frac{P_{Ask,0} - P_{Bid,0}}{P_0}\right) + e, \quad (17)$$

where I_S, I_F, I_N are indicator variables for integer stock splits, fractional stock splits, and rights offers, respectively. We hypothesize that:

$$\gamma_S \leq \gamma_F \leq \gamma_N. \quad (18)$$

An integer split replaces one old share with multiple new shares. A fractional split, on the other hand, is likely to result in fractional shares that must be traded and combined to result in full shares. A rights offer is also likely to result in fractional shares, and it has the additional disadvantage that it requires financing of the purchase cost.

Time-series. We expect that the nuisance cost decreases over time because of technological improvements. Before 1970, shares are paper ownership certificates. Dealing with paper certificates may involve more nuisance than managing electronic book entry. Before 1991, brokers charge an odd-lot fee for transacting with blocks of less than 100 shares. Finally, before 2000, buy and sell orders are matched manually as opposed to electronic matching. Algorithmic, high-frequency trading develops after matching becomes electronic. Odd lots and fractional shares involve less or zero nuisance for computers.

Quote adjustment. We define the market maker's midpoint adjustment (from Equation (12)):

$$AR_{Mid} = \frac{P_{Mid,1} - P_{Mid,0}}{P_0} - r_m. \quad (19)$$

A bid-ask bounce as captured by the slope coefficient from Equation (16), $\gamma_1 \in [0,1]$, implies that the average abnormal stock return exceeds the regression intercept, which must equal the average abnormal midpoint adjustment:

$$\overline{AR} \geq \gamma_0 = \overline{AR}_{Mid}. \quad (20)$$

3. Data & Institutional Background

Data. We retrieve data from CRSP for companies listed on the NYSE from 1926 to 2016. Table 1 reports the number of observations along with an explanation for missing data. After deleting reverse stock splits, we estimate average abnormal returns for 94% of the data set with closing prices and no confounding events within plus/minus five business days around the ex-day. [1] For the regression analysis of Equations (16) and (17), we also need bid-ask spreads, which reduces the data set to 79% of the number of stock distributions. Finally, we analyze how the market maker adjusts his midpoint quote in a subset that covers only 19% of the stock distributions, where we observe bid and ask quotes and simultaneously can estimate the bid-ask spread.

Bid-ask spread. CRSP contains daily bid and ask quotes from 1926 to 1941 and again from 1993 to 2016. For the missing years, we estimate the bid-ask spread using the method by Corwin and Schultz [4]. It derives an estimate of the bid-ask spread as a function of high and low transaction prices over two consecutive days. During periods of higher-than-average volatility, the spread estimate can turn negative. The number of positive spread estimates on the last day before the completion of the stock distribution is 8,290.[2] To increase coverage, we estimate the bid-ask spread for both day -2 and day -1, we delete negative spread estimates, and we average non-deleted estimates. This procedure raises coverage to 10,351 observations.[3] We have also considered extended search-back periods up to five days before the ex-day, but the subsequent analysis does not change in any interesting way.

Time-series distribution. We classify stock distributions into integer stock splits, fractional stock splits (stock dividends), and rights offers. We also distinguish between large stock dividends with a split ratio above or equal to 10% and small stock dividends with a split ratio of less than 10%. Figure 1 plots the annual frequency of each stock distribution type in percent of the number of companies listed on the NYSE. The annual frequency of integer splits averages to about three percent. More than 80% are two-for-one stock splits. The time-series of fractional splits exhibit a similar time-series path. The most frequent split ratio is 50% (one new share for two old shares), but other common split ratios are 33% (one for three), 25% (one for four), and 10% (one for ten). Both integer splits and fractional splits fall out of fashion in recent years (Minnick and Raman [13]). There are many small stock dividends with a split ratio below 10%. The time-series plot at the bottom left corner reports only the first year a company initiates a sequence of stock dividends that we refer to as programs. Companies initiate stock dividend programs in the 1920s and the 1950s. The most frequent split ratios are full percentage points, 1%, 2%, 7%. Rights offers decrease from a high in the 1920s to virtual disappearance in the 1980s.

The primary purpose of integer splits and large fractional splits is to manage the share price within a targeted price range. The fact that integer splits and fractional splits are less

1 Curiously, reverse stock splits experience an average negative abnormal stock return over the ex-day. Nuisance cannot explain negative abnormal returns.

2 According to Table IA.I in the Internet Appendix of "A Simple Way to Estimate Bid-Ask Spreads from Daily High and Low Prices by Corwin and Schultz [4]," there are negative bid-ask spreads for 30% of the business days of NYSE listed stocks on CRSP.

3 This method follows Corwin and Schultz [4].

common in recent years suggests that the level of the price per share is less important. Figure 2 plots the average raw price per share for NYSE-listed companies 1926-2018 along with plus and minus two standard errors around the mean. The average price begins around \$100, where it has been since the inception of the NYSE in 1815 (Goetzman, Ibbotson, and Peng [8]). Subsequently, after the October crash of 1929, the average price drops to \$30 per share, where it remains until the mid-1990s. The stable average price and the visible absence of cross-section volatility around the average is the result of share price management through stocks splits. From the mid-1990s, the average share price increases and cross-section volatility explodes as management abandon the old, targeted price range. Two standard errors falls below the horizontal axis, while the actual distribution is truncated at zero. We notice that share price management ends with internet and electronic trading. Accordingly, the nuisance of stock distributions is a disappearing problem.

Stock splits. Figure 3 exhibits the time line of a stock split. The Board of Directors declares a record date and a distribution date, which occur about three weeks apart. The distribution date determines the ex-day to one business day before the distribution date. The new shares must be issued before they can start trading. The buyer of old shares between the record day and the ex-day receives old shares plus a due bill that obligates the owner of the shares on the record day to pass on his new shares to the buyer after the record day. The exchange of old for new securities takes place on the redemption day, which occurs about one week after the ex-day. During the one-week period between the ex-day and the redemption day, the buyer of the old shares plus the due-bill cannot trade his package. Nayar and Roze [14] point out that this trading restrictions can explain why there is a positive abnormal return associated with integer stock splits that do not result in odd-lot fees and fractional shares.

Rights offers and stock dividend programs. Figure 4 provides the corresponding timeline for rights offers and small stock dividends. The procedure is the same as for cash dividends. The Board of Directors set a record date and a distribution date. Shareholders on the record day are entitled to receive the new shares. The record day determines the ex-day, which occurs one business day before. The distribution of the new shares takes place about three weeks later. The three-week period provides the issuing company with ample time to verify the shareholder record and register the new shares with SEC.

Brokerage commission. Brokerage commission consists of a round-lot fee per share, an odd-lot fee per share, and a variable component in percent of the transaction amount. Before May 1, 1975, NYSE sets the minimum brokerage commission. The history of minimum commission schedules is conveniently summarized by Jones [11]. To illustrate, as of 1924 to 1938, the round-lot fee is 12.5c per share, the odd-lot fee is also 12.5c per share, and the variable fee is 0.1% of the transaction amount for stock prices between \$10 and \$100. Figure 5 expresses the excess brokerage commission from buying or selling 100 pre-split shares after the stock distribution. The horizontal axis varies the split factor. Brokerage commission increases after the stock distribution because the number of shares increases and, for fractional splits, the stock distribution also results in odd-lot charges. Sellers have an incentive to accelerate their sales to avoid the higher commission, and buyers have an incentive to postpone the purchase of a round lot to after the stock distribution, although the purchase of a round lot after the stock distribution is a smaller investment than purchasing before. The quantitative effect increases with the split factor, which implies that the incentive for sellers to accelerate and for buyers to postpone increase with the split factor. From May 1, 1975, brokerage commission is individually negotiated and not subject to a minimum commission schedule, and following decimalization from April 9, 2001, and electronic matching of buy and sell orders, brokerage commission shrinks to a bare minimum.

4. Results

As an introduction, we plot the time-series of the average cumulative abnormal return from 30 days before the announcement day of a stock distribution to 15 days after the ex-day. Figure 6 summarizes three well-known facts about stock distributions and stock returns: *(i)* the stock price runs up before the announcement, *(ii)* the stock price responds positively to the announcement, and *(iii)* the stock price increases on the ex-day. We are interested in the positive stock price reaction on the ex-day. The plot emphasizes that the full valuation effect of a stock distribution equals the sum of the announcement effect and the ex-day effect. The valuation effect is approximately $3\% + 1\% = 4\%$ across all stock distributions.

4.1. Cross-section Analysis

We bring out three results. *(i)* Average abnormal stock returns are positive, *(ii)* abnormal stock returns are correlated with the bid-ask spread, and *(iii)* abnormal stock returns are sorted by stock distribution type from integer splits (low) to fractional splits (medium) and rights offers (high).

Table 2 reports average one-day abnormal stock returns for integer splits, fractional splits, and rights offers, respectively. Average abnormal returns over the ex-day are positive and statistically different from zero for all stock distributions. The averages are ordered from integer splits (0.450%) to fractional splits (0.829%) to rights offers (1.746%). Similar estimates of abnormal returns can be found in numerous previous articles, but we are not aware of any paper that reports the average abnormal return for rights offers.

Table 3 reports the results from regressing abnormal returns on bid-ask spreads. The intercept is positive and statistically different from zero, and the slope coefficient is statistically different from both zero and one. The parameter estimates imply that the average nuisance cost equals 0.57% of the cum-right price and the probability of a bid-ask bounce is 23.39%. A large portion of the data set (1942-1992) rests on estimated bid-ask spreads, and estimation errors induce a negative bias in the slope coefficient. We estimate the regression on data from 1926-1941 and 1993-2016, when we simultaneously observe and estimate the bid-ask spread. The slope coefficient in the regression with observed bid-ask spreads is indistinguishable from that of the regression with estimated bid-ask spreads. We conclude that the bias is negligible.

Finally, in Table 4, we control for stock distribution type. We recover the strict ordering of the nuisance parameter according to Equation (18): integer splits (0.34%), fractional splits (0.61%), and rights offers (1.44%). The strict ordering mimics that of the univariate analysis in Table 2. The slope coefficient, which we interpret as the probability of a bid-ask bounce, remains statistically different from both zero and one.

4.2. Time-series Analysis

The time-series of abnormal returns and bid-ask spreads generate three additional results: *(i)* the two time-series are correlated, both time-series begin high, they decrease after World War II, and they approach zero after the year 2000, *(ii)* there is no visible effect of the transition from paper ownership certificates to electronic book entry in the 1970s, and *(iii)* abnormal stock returns decrease around the removal of the odd-lot fee in 1991, but only for large fractional splits (split ratio 10% or higher) and not for small fractional splits (split ratio below 10%).

Figure 7 plots five-year average abnormal stock returns and bid-ask spreads on the last day before the ex-day. Each average is complemented by a confidence interval of plus and minus two standard errors around the mean. The time-series of abnormal returns and bid-ask spreads are visibly correlated. Both time-series begin high, then they fall to a medium level after World War II, and they vanish after the introduction of electronic matching of buy and sell orders and algorithmic trading. [4] Casual analysis suggests that neither the transition from paper ownership certificates to electronic book entry in the 1970s nor the removal of odd-lot fees in February 1991 influence abnormal stock returns. However, as suggested by the cross-section distribution of the increase in brokerage commission after a stock distribution (Figure 5), Table 5 demonstrates that the average abnormal stock return decreases significantly for large fractional stock splits (split ratio above 10%), while it does not decrease statistically for small fractional stock splits (split ratio below 10%). These results suggest that the odd-lot fee contributes to the nuisance cost of stock distributions in the past.

4.3. Midpoint-quote Adjustment

Up to this point, our findings support the theory of an underlying nuisance cost enhanced by a bid-ask bounce. In this section, we report results that cast doubts on the bid-ask-bounce interpretation. Specifically, we analyze how the market maker adjusts his midpoint quote in response to a stock distribution within the smaller subset of stock distributions where we observe bid and ask quotes. We add three new results: *(i)* The average midpoint return is approximately equal to the average stock price return, *(ii)* the average midpoint return is much larger than the regression intercept, and *(iii)* the midpoint return is positively correlated with the bid-ask spread; the regression coefficients from the midpoint return regression are indistinguishable from those of the stock return regression. These three observations speak against the bid-ask-bounce theory, and they raise the question of why the abnormal stock return increases with the bid-ask spread. To shed light on this positive correlation, we regress stock returns and midpoint returns on the Amihud measure of illiquidity (Amihud [1]). Both return measures are positively correlated with illiquidity, and the coefficients from the two regression models are very similar. The reason why those regression results are so similar is that the abnormal midpoint-quote return is almost a perfect predictor of the abnormal stock return. Finally, and not surprisingly, we notice that the time-series pattern of the Amihud measure is like that of both the abnormal stock return and the bid-ask spread.

We want to test the prediction that the average stock price return exceeds the average midpoint-quote return (20) as implied by the positive regression intercept in Table 3. However, we find that the average abnormal stock return is approximately equal to the average midpoint-quote return (Table 6). We also want to test whether the average midpoint quote return equals the intercept from the stock return regression in Table 3. The average midpoint-quote return is statistically larger than the regression intercept at the 10% level. Both results speak against the bid-ask bounce theory.

In Table 7, we compare the coefficients from regressing abnormal stock returns on the bid-ask spread with those from regressing the midpoint-quote return on the bid-ask spread. The regression coefficients from the price regression are indistinguishable from the coefficients of the midpoint regression (Panel A). We also regress abnormal stock returns and midpoint-quote returns on Amihud's measure of illiquidity (Panel B). Both variables are positively correlated with the illiquidity measure, and the coefficients from the two regressions are very similar. We conclude from these results that the positive correlation between abnormal stock returns and the bid-ask spread is not the result from a bid-ask bounce but rather reflects a correlation between abnormal stock returns and stock price illiquidity.

The reason why the regression results with the abnormal

4 The reduction of the average bid-ask spread around 1940 coincides with the switch from observed to estimated spreads, which raises the suspicion that the reduction has something to do with the switch of the measurement method. However, we observe the same reduction in estimated bid-ask spreads; when measured over 1936-1940, the estimated bid-ask spread decreases from 1.42% to an average of 0.79% from 1941-1945. We repeat the experiment around the switch from manual to electronic trading on April 9, 2000. The observed spread decreases from 1.21% in 1991-2000 to 0.25% from 2001-2016, while the estimated spread remains approximately the same: it increases slightly from 0.95% in 1991-2000 to 0.97% from 2001-2016. We do not know why the estimation method fails to mimic the level of observed bid-ask spreads after decimalization.

stock return as the dependent variable are so like those with the abnormal midpoint-quote return is that the latter is almost a perfect predictor of the former. Table 8 reports the results of estimating Equation (21). The goodness of fit is very high: $R^2 = 0.9020$, the intercept is close to zero, and the slope coefficient is close to one.

The time-series behavior of Amihud's measure of illiquidity is like that of abnormal stock returns and bid-asks spreads (Figure 8). Initially, illiquidity is high, it decreases after World War II, and it goes to zero in recent years. The time-series behavior of the illiquidity measure is telling about the source of the abnormal ex-day stock return: the liquidity restriction between the distribution date and the redemption date does not matter when liquidity is abundant, and odd lots and fractional shares are not nuisance for computers that eliminate all price inefficiencies.

5. Conclusions

This paper re-examines the positive abnormal stock return over the ex-day of stock distributions. Regression analysis of abnormal stock return on the bid-ask spread are consistent with the theory that the abnormal stock return can be decomposed into an underlying nuisance cost that affect the market maker's midpoint quote and a bid-ask bounce that results from sellers who accelerate their sales and buyers who postpone their purchases. The underlying nuisance cost is smaller for integer stock splits than for stock dividends that result in fractional shares, and it is larger for rights offers that in addition to fractional shares require that subscribers finance the purchase cost of the new shares. The underlying nuisance cost and the bid-ask bounce effect disappear altogether in recent years after the introduction of electronic matching of buy and sell orders and algorithmic trading. Liquidity restrictions on trading pre-split shares, odd lots, and fractional shares are not a nuisance for computers.

Abnormal stock returns decrease over time as the number of shareholders and demand for brokerage services increases. Abnormal stock returns also decrease as the cost of executing a trade goes down. The development computers eliminate price inefficiencies at next to zero cost. With the development of the internet, share price management also appears to lose its importance, and the nuisance of stock distributions become part of the past.

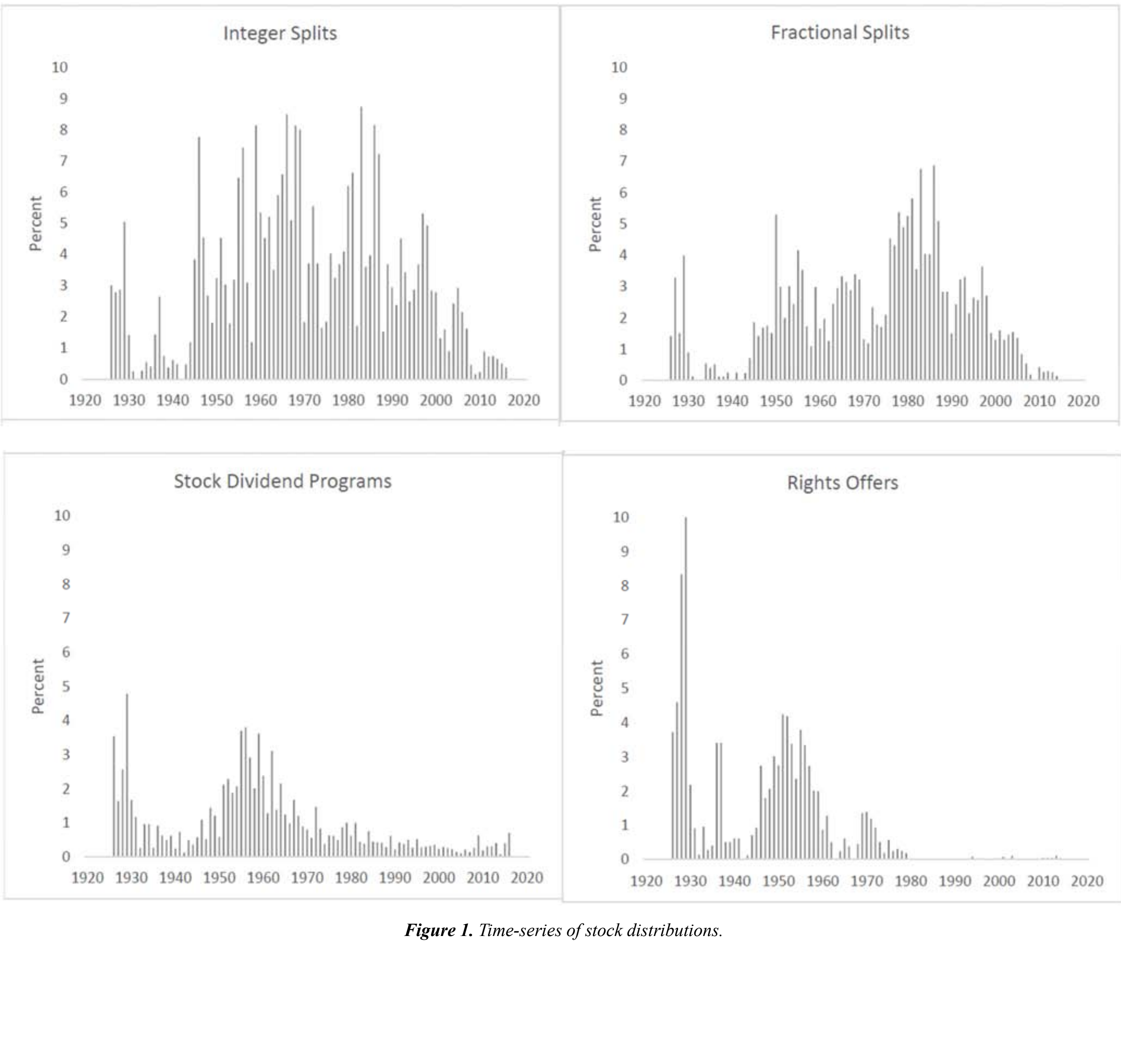

Figure 1. *Time-series of stock distributions.*

The figure displays the annual number of stock distributions in percent of the number of NYSE listed companies at the end of each year from 1926 to 2016. Stock splits includes all increases where the number of new shares is an integer multiple of the number of old shares; reverse splits are not included. Stock dividends are all increases in the number of shares where the increase is a fraction of at least 10% of the number of old shares. Stock dividend programs are the year of the first occurrence of a stock dividend with a split factor of less than 10%; all subsequent stock dividends have been eliminated from the plot. Rights offers are sales of new shares through pre-emptive rights to old shareholders. The number of observations 12,921.

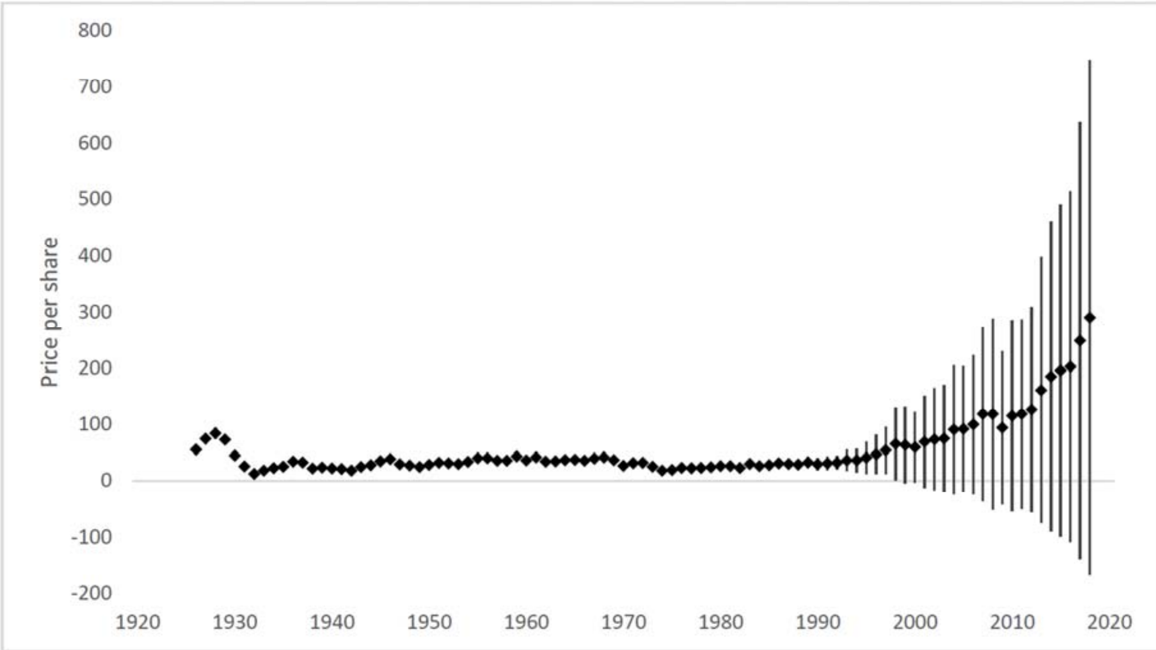

Figure 2. *Time-series distribution of price per share.*

The figure plots the annual average price along with plus and minus two standard errors of the average for NYSE listed stocks. For each stock, we compute the average within the year, and for each year we compute the equal-weighted average across companies.

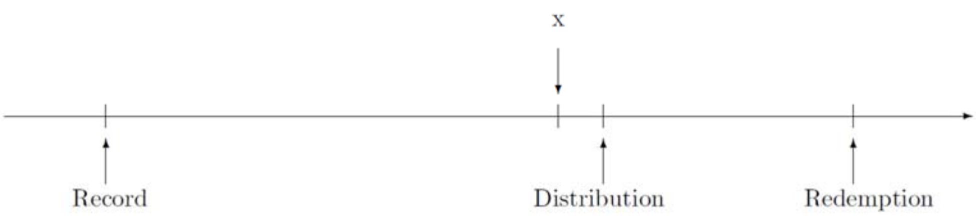

Figure 3. *Time-line of stock splits.*

Shareholders on the record date are entitled to receiving the new shares on the distribution date. The ex-date occurs one business day before the record date. Buyers of old shares between the record date and the ex-date receive a due-bill, which entitles them to receive the new shares on the redemption date. Buyers of new shares on the ex-date avoid the stock distribution.

Figure 4. *Time-line of rights offers and stock dividend programs.*

Shareholders on the record date are entitled to receiving the new shares on the distribution date. The ex-date occurs one business day before the record date.

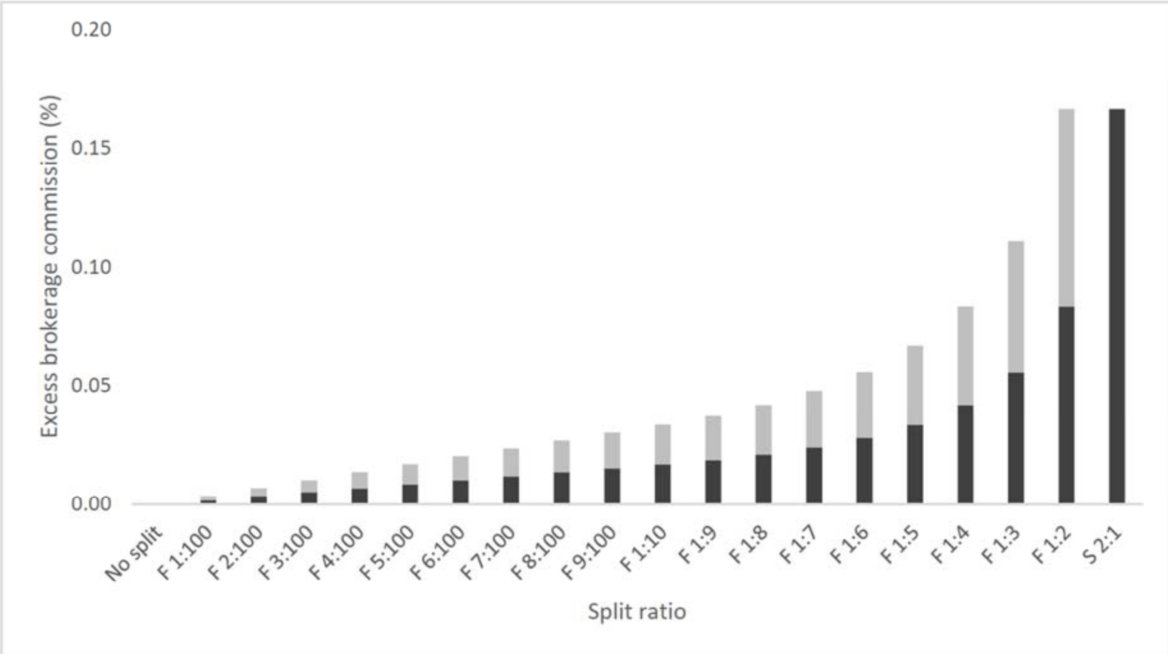

Figure 5. *Excess brokerage commission by split factor.*

The figure reports the excess brokerage commission for the sale of a round lot of 100 shares after a stock distribution as a function of the split ratio. The numbers represent the minimum commission schedule as of 1924-1938. We decompose the excess brokerage commission into the effect from selling a larger number of shares (dark grey below) and the effect of the odd-lot fee (light grey portion above).

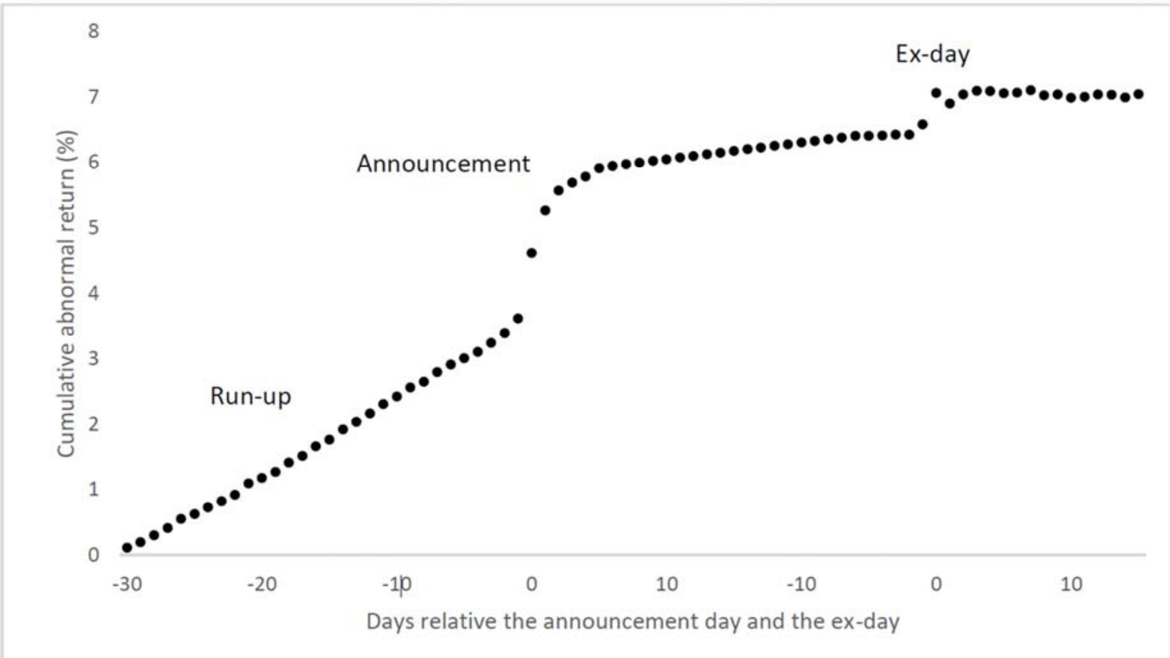

Figure 6. *Stock distributions and stock returns.*

The figure displays two time series that we merge. The time-series to the left is the cumulative abnormal stock return from 30 days before the announcement of a stock distribution to 15 days after, and the time-series to the right is the cumulative stock return from 15 days before the ex-day of the stock distribution to 15 days after. The number of observations is 12,344.

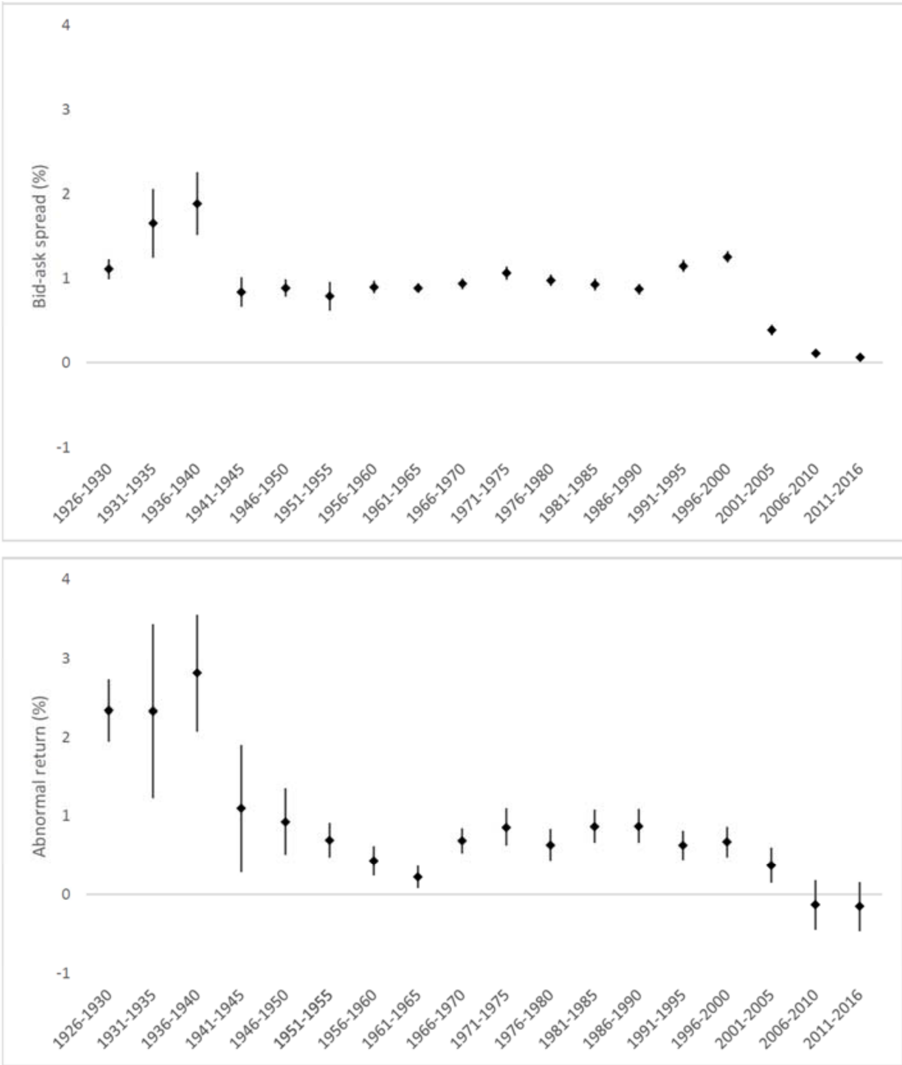

Figure 7. *Bid-ask spreads and stock returns.*

The figure displays two time series that we merge. The time-series to the left is the cumulative abnormal stock return from 30 days before the announcement of a stock distribution to 15 days after, and the time-series to the right is the cumulative stock return from 15 days before the ex-day of the stock distribution to 15 days after. The number of observations is 12,344.

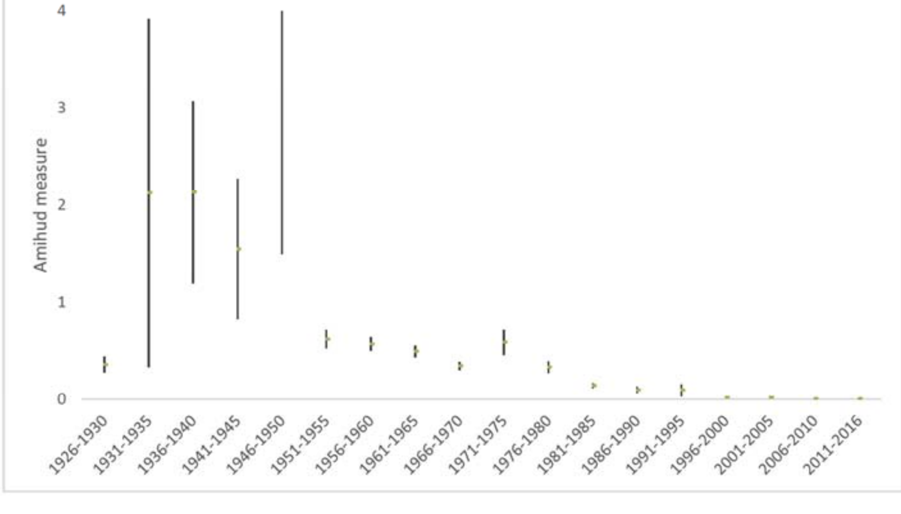

Figure 8. *Time-series behavior of illiquidity.*

The figure displays average of Amihud's measure of illiquidity (diamonds) for each five-year period along with a 95% confidence interval (thin lines). The plot is truncated at 4%. The number of observations is 10,351.

Table 1. *Data set.*

	# Observations	Percent
Stock distributions	13,176	
Reverse splits	-255	
Increasing distributions	12,921	
Confounding news	-510	
No closing prices	-67	
Abnormal returns	12,344	
No spread estimate	-1,993	
Regression analysis	10,351	
Period 1942-1992	-7,253	
No spread estimate	-632	
Quote analysis	2,466	

The table reports the number of observations along with an explanation for missing data for each step of the analysis.

Table 2. *Abnormal stock returns.*

	Integer splits	Fractional splits	Rights offers
A. Announcement day			
Average (%)	1.133	0.887	2.633
Standard error (%)	0.050	0.047	1.770
# Observations	2,628	4,132	8
B. Ex-right day			
Average (%)	0.450	0.829	1.746
Standard error (%)	0.082	0.035	0.197
# Observations	4,177	7,331	836

The table reports average one-day stock returns in excess of the market over the announcement day and the ex-day, respectively. The benchmark is the return on the CRSP value-weighted index. Standard errors have been estimated with ordinary least squares. Announcement dates are taken from CRSP.

Table 3. *Regression of abnormal return on bid-ask spread.*

Intercept	Slope	R^2	# Obs.
0.0057	0.2339	0.0038	10,351
(0.0005)	(0.0367)		

The table reports the results of regressing abnormal return on bid-ask spread in the pooled sample for which we have transaction prices and bid-ask spreads (observed or estimated). Standard errors are reported below in parentheses.

Table 4. *Controlling for stock distribution type.*

Interger splits	Fractional splits	Rights offers	Slope coefficient	R^2	# Obs.
0.0034	0.0061	0.0144	0.2164	0.0409	10,351
(0.0008)	(0.0007)	(0.0016)	(0.0370)		

The table reports the results of regressing abnormal return on bid-ask spread in the pooled sample for which we have transaction prices and bid-ask spreads (observed or estimated). Standard errors are reported below in parentheses.

Table 5. *Abnormal stock returns around the removal of the odd-lot fee.*

	Large fractioanl splis			Small fractioanl splis		
	Before	After	Difference	Before	After	Difference
Mean (%)	1.270	0.780	-0.487	1.090	1.050	-0.040
Standard error	(0.164)	(0.141)	(0.215)	(0.293)	(0.184)	(0.331)
# Observations	255	302		108	142	

The table reports average stock returns in excess of the market over the ex-day for fractional stock splits that occur five years before the removal of the odd-lot fee in February 1991. Large fractional splits have a split ratio of F 1:10 or larger.

Table 6. *Midpoint-quote adjustments.*

	Abnormal return (a)	Regression intercept (b)	Midpoint quote adjustment (c)
Average (%)	1.099	0.712	1.022
Standard error (%)	0.139	0.180	0.153
T-test (a)=©	1.13		
F-test (b)=©			
# Observations	2,466	2,466	2,466

The table reports the average spread adjustment and midpoint quote adjustment in the subset of the data where we observe transaction prices and bid and ask quotes before and after the stock distribution. The spread adjustment is defined as the change in the bid-ask spread from the last day cum-right to the first day ex-right in percent of the last cum-day transaction price, and the midpoint quote adjustment is defined as the change in the midpoint from the last day cum-right to the first day ex-right in percent of the last cum-day transaction price.

Table 7. *Midpoint-quote regressions.*

	Intercept	Slope	R^2	# Obs.
A. Bid-ask spread				
Stock return	0.0071	0.3923	0.0046	2,466
	(0.0018)	(0.1167)		
Midpoint return	0.0060	0.4230	0.0044	2,466
	(0.0020)	(0.1287)		
B. Illiquidity measure				
Stock return	0.0100	0.0043	0.0116	2,466
	(0.0014)	(0.0008)		

	Intercept	Slope	R^2	# Obs.
Midpoint return	0.0091 (0.0015)	0.0046 (0.0009)	0.0112	2,466

Panel A reports the results of regressing abnormal stock returns and midpoint-quote returns on the bid-ask spread in the subset of the data where we both observe and estimate the bid-ask spread. Panel B reports the corresponding results of regressing stock returns and midpoint-quote returns on Amihud's measure of illiquidity. Standard errors are reported below in parentheses.

Table 8. *Stock returns versus midpoint-quote returns.*

	Intercept	Slope	R^2	# Obs.
Stock return	0.0009 (0.0002)	0.9646 (0.0062)	0.902	2,457

The table reports the results of regressing abnormal stock returns on abnormal midpoint-quote returns. The number of observations is 2,457 after deleting nine observations that appear with errors in CRSP. Standard errors are reported below in parentheses.

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