Financial Management

The Impact of Market Structure on Ex-Dividend Day Stock Price Behavior

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We explore the impact of market structure on the ex-day price anomaly. Measuring the price-drop ratio (PDR) as the ratio of the price change on the ex-day to the dividend amount, we find that the average NASDAQ PDR is significantly less than one and significantly less than the New York Stock Exchange (NYSE) PDR. We then investigate a subset of firms that voluntary switch from NASDAQ to the NYSE and find that the PDR significantly increases after the switch, suggesting that market structure affects PDRs. We also create a matched sample and find that the NASDAQ PDR converges toward its matched NYSE counterpart, particularly after the introduction of SuperMontage. Our evidence is consistent with significant NASDAQ market structure changes reducing execution cost differences between the two exchanges and, in turn, reducing the PDR difference. Overall, our results highlight the important role market structure can play in understanding anomalies.

We investigate the effect of NASDAQ and New York Stock Exchange (NYSE) market structure on ex-dividend day stock price behavior. In a frictionless market, stock prices should fall by the dividend amount on the ex-day. However, for more than half a century academics have noted that, on average, stock prices fall by less than the dividend amount; that is, price-drop ratios (PDRs) are significantly less than one.[1] The literature focusing on the US evidence has been NYSE centric with almost every prominent study exclusively using NYSE-listed firms.[2] However, the market structure literature highlights the importance of trading platform on price efficiency (see, e.g., Affleck-Graves, Hegde, and Miller, 1994; Huang and Stoll, 1996; Barclay, Hendershott, and Jones, 2008). Although NASDAQ has traditionally been a dealer market and the NYSE an auction market, over the years there has been a convergence in the way stocks trade across the two markets. Thus, given the historical market structure differences, a natural question that arises is whether the ex-day price behavior of NASDAQ-listed firms is similar to that of NYSE-listed

We are grateful to Shreesh Deshpande, Murali Jagannathan, Dennis Lasser, Tongshu Ma, Ryan McKeon, Vikram Nanda, Biljana Nikolic, Kristian Rydqvist, Steven Schwartz, Marko Svetina, Hui-Ju Tsai, and seminar participants at Binghamton University, the University of San Diego, the Financial Management Association annual meeting (2014), and the Midwest Finance Association annual meeting (2014) for helpful comments. We are grateful to the editor and especially to Michael Goldstein (the referee) whose comments greatly improved the paper. We retain sole rights to all errors. This article was previously entitled "Ex-Dividend Day Stock Price Behavior—The NASDAQ Evidence." Sabatino (Dino) Silveri gratefully acknowledges the support of a summer research grant from the Fogelman College of Business and Economics at the University of Memphis. This article is based on the second chapter of Shishir Paudel's Ph.D. dissertation.

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[1] See Campbell and Beranek (1955) and Barker (1959) for early studies on this issue.

[2] Throughout this article, when we refer to NYSE-listed firms we include firms listed on the American Stock Exchange (AMEX) (the NYSE acquired the AMEX in 2008). The results are unaffected if we exclude these firms. The one exception to the NYSE-centric focus is Karpoff and Walkling (1990) who use the bid-ask spreads of NASDAQ-listed firms to explore the relation between ex-day abnormal returns and transaction costs.

firms. Moreover, if there are differences, are the differences changing over time? We attempt to answer these questions and in the process hope to shed light on the ex-day price anomaly.

The two most prominent explanations of the ex-day behavior are taxes and execution costs.[3] Elton and Gruber (1970) point out that as long as capital gains are taxed more favorably than dividends, PDRs will be less than one. Many studies have found support for this tax explanation (a partial list includes Barclay, 1987; Graham, Michaely, and Roberts, 2003; Whitworth and Rao, 2010). Not all investors, however, have a tax preference for capital gains over dividends. Thus, in the absence of execution costs, an expected PDR of less than one presents profit opportunities to some market participants. Consequently, another major strand of the literature argues that PDRs less than one reflect the execution costs faced by tax-neutral or tax-advantaged entities employing "dividend capture" strategies (see, e.g., Kalay, 1982; Boyd and Jagannathan, 1994).[4] As Karpoff and Walkling (1988, 1990) point out, these two explanations are not necessarily mutually exclusive. For stocks in which dividend capture is too costly, PDRs may reflect the marginal tax rate of retail investors with longer holding periods.

Execution costs can significantly reduce the profitability of dividend capture strategies. Perold (1988) argues that the "implementation shortfall" of a trading strategy, the difference between a paper portfolio and a real portfolio, can be substantial, due in large part to execution costs. In a paper portfolio it is possible to transact at the prevailing quotes instantly, costlessly, and in unlimited quantities. However, implementing a real portfolio can take considerably longer and cost considerably more. Execution costs include not only the more explicit trading costs such as commissions and bid-ask spreads but also the price impact of trades, that is, the unfavorable price moves that may occur after a trader decides to implement a trading strategy. These costs can be difficult to measure. Recently, Henry and Koski (2017) use a proprietary data set that allows them to accurately measure execution costs and find that dividend capture strategies are not profitable on average, though skilled investors do profitably pursue dividend capture strategies on targeted ex-days. Henry and Koski (2017) exclude NASDAQ-listed firms from their sample and focus on NYSE-listed firms to "control for variation in microstructure across exchanges that might affect ex-day returns" (p. 465). We take advantage of NASDAQ and NYSE market structure differences to explore the role of market structure on the ex-day price anomaly.

The mid-1990s and early 2000s saw many changes in the way of (and cost of) trading stocks, particularly for the NASDAQ market.[5] Before the mid-1990s, NASDAQ dealers avoided odd-eighths price quotes (Christie and Schultz, 1994). The resulting controversy led the US Securities and Exchange Commission (SEC) to mandate new "order handling rules," which in turn increased the demand for and led to the proliferation of electronic communication networks (ECNs). In response to the competition from ECNs, at the end of 2002 NASDAQ introduced its own electronic trading mechanism, SuperMontage, a fully integrated quotation and execution system that completely automated the trading process (essentially a hybrid system combining dealer and ECN quotes). It allowed, for the first time, quoting, order handling, and execution to be processed

[3] We use the term "execution costs" to refer to all costs associated with implementing a trading strategy. These costs include not only explicit costs such as the bid-ask spread and trading commissions (which we refer to as trading costs throughout our article) but also implicit costs such as the price impact of trades employed in a trading strategy.

[4] For a tax-neutral or tax-advantaged investor, the dividend capture strategy involves buying the stock cum-dividend, receiving the dividend, and selling the stock ex-dividend.

[5] Although we focus on NASDAQ changes, we note that there were also significant NYSE changes. For example, at the end of 2000 the NYSE introduced Direct+, an automatic execution service, and in 2002 introduced OpenBook. Nonetheless, several studies document that NASDAQ trading costs are higher than those of the NYSE (e.g., Huang and Stoll, 1996; Bessembinder, 1999) and that the difference in trading costs between the two exchanges narrowed at the turn of the millennium (e.g., Bessembinder, 2003; Boehmer, 2005; Jain and Kim, 2006).

in a single transaction and it enabled traders to see the aggregate trading interest of all market participants on a real-time basis. Chung and Chuwonganant (2009) find that SuperMontage increased execution speeds, increased fill rates, and reduced realized spreads. They note that the dispersion of the pricing error was significantly reduced, consistent with SuperMontage reducing execution costs and return volatility due to improved price efficiency.[6] In addition to the introduction of SuperMontage at the end of 2002, there were major ECN consolidations around this period. Both Stoll (2006) and Fabozzi (2008) report that there were a dozen ECNs in 2000 but this number reduces to less than a handful just a few years later.

As a result of structural and regulatory changes, the distinction between NASDAQ as a dealer market and the NYSE as an auction market has become less pronounced over time. This is borne out by the number of firms that switch from NASDAQ to the NYSE through time. In the 20 years before the introduction of SuperMontage, the yearly average number of NASDAQ firms switching is 67. In the decade or so following the introduction of SuperMontage, the yearly average number of NASDAQ firms switching is eight, a reduction of almost 90%. To the extent that execution costs and price efficiency affect PDRs, we expect NASDAQ PDRs to increase through time and any difference between NASDAQ and NYSE PDRs to reduce over time.

After imposing various restrictions, we have a NASDAQ sample of more than 55,000 dividend observations during 1983 to 2014. Even though the corresponding NYSE sample has a little more than 99,000 observations, the NASDAQ sample is nonetheless nontrivial. Notably, we find that the average NASDAQ PDR is 43%, significantly smaller than the corresponding average NYSE PDR of 92%. As firm characteristics of the average NASDAQ firm are different from that of the average NYSE firm, we attempt to control for these differences. Using each firm as its own control, we explore a subset of firms that voluntarily switch from NASDAQ to the NYSE and find that the average PDR significantly increases from 51% before the switch to 87% after the switch, suggesting market structure differences affect PDRs.

To circumvent potential self-selection issues that arise from the switching sample, we further explore the impact of market structure by creating a matched sample of NASDAQ and NYSE firms on the basis of criteria that the prior literature deems important in explaining PDRs. These criteria include the stock price, dividend amount, firm size, bid-ask spread, and stock return volatility (see, e.g., Karpoff and Walkling, 1988). As bid-ask spread data for NYSE firms are only available beginning in 1993, the sample is restricted to 1993 to 2014 for this analysis. We find that the difference in average PDRs between the two exchanges for the matched sample remains substantial. Whereas the average NYSE PDR is 72%, it is only 47% for NASDAQ firms (the medians are 81% and 50%, respectively). We also find that for firms in which dividend capture is presumably more difficult, that is, firms that are relatively small in size, firms with relatively large bid-ask spreads, and firms with relatively small trading volume, the NASDAQ PDRs are substantially smaller than the corresponding NYSE PDRs. This possibly reflects the relative benefit of the NYSE specialist system for trading such firms.[7]

Although we find that the NASDAQ PDRs are significantly smaller than the matched NYSE PDRs, this difference is driven by the period preceding the implementation of SuperMontage at the end of 2002. In 2003 we find a dramatic drop in the PDR difference, and from 2003 onward, the

[6] Price efficiency is the ability of a market to absorb order imbalances that reveal little or no information about fundamental values without unduly moving prices, that is, the ability of a market to absorb liquidity shocks and minimize temporary price changes. Price efficiency is presumably important for investors trading around the ex-day solely to trade the dividend.

[7] Both Bessembinder (2003) and Chung, Van Ness, and Van Ness (2004) find that the NYSE specialist system is valuable in terms of lower execution costs for trading small, low-volume stocks. Moreover, Barclay, Hendershott, and McCormick (2003) and Goldstein, Shkilko, Van Ness, and Van Ness (2008) find that ECNs, which account for relatively more of the NASDAQ trading volume, are best suited to stocks that have high trading volume and large market capitalization.

PDRs are not significantly different across the two exchanges. Notably, the significant difference in PDRs between the two exchanges in the earlier period and the subsequent convergence of PDRs in the latter period cannot be explained by differences in stock attributes as we control for these differences when forming the matched sample and for any residual differences in the regressions.[8] Rather, our results are consistent with significant NASDAQ market structure changes reducing the difference in execution costs between NASDAQ and the NYSE.[9] That is, the reduction in the PDR difference through time is associated with a convergence in the way stocks trade across the two exchanges.

We make several contributions to the literature. First, we document that PDRs for NASDAQ firms are half those observed for NYSE firms, implying that PDRs are statistically and economically smaller than previously documented (or, equivalently, ex-day abnormal returns are statistically and economically larger than previously documented). To the best of our knowledge, we are the first to do so. Second, our results highlight the significant role that market structure can play in an arbitrageur's ability to take advantage of dividend capture strategies. The significant convergence in PDRs between the two exchanges stems from market structure changes in the early 2000s that reduce differences in execution costs and price efficiency between the two markets. Although studies such as Bali and Hite (1998) argue that price discreteness imposed by minimum tick sizes can induce PDRs of less than one and studies such as Frank and Jagannathan (1998) argue that bid-ask bounce can induce PDRs of less than one if dividends are a "nuisance" to collect for retail investors, we keep these factors constant and continue to find large differences in PDRs across the two exchanges. Finally, we do not find support for the tax hypothesis using the NASDAQ sample. Prior studies that find support for the tax hypothesis by focusing on NYSE-listed firms ignore a nontrivial number of dividend payers and skew the sample toward firms in which execution costs are likely smaller. Thus, the inferences drawn from these studies can be misleading. Incorporating NASDAQ firms, which represent more than one-third of all dividend payers, suggests that taxes cannot explain PDRs. Overall, our results highlight the impact market structure can have on asset prices and, thus, on our understanding of anomalies.

I. Literature Review, NASDAQ Market Changes, and Hypotheses Development

As the ex-day literature dates back over half a century, we provide only a brief description here and lay out our hypotheses. An excellent summary of the literature can be found in Kalay and Lemmon (2008).

A. Tax Hypotheses

In their seminal paper on the ex-day anomaly, Elton and Gruber (1970) point out that a dollar of capital gains is worth more than a dollar of dividends whenever capital gains are taxed more favorably than dividends. As investors care about after-tax returns, in equilibrium investors will

[8] The second half of our matched sample period corresponds to a period when dividends and capital gains are taxed at the same rate. As we show later, this zero tax differential does not drive our results.

[9] The latter half of our sample period saw the introduction of Regulation NMS (National Market System), which includes an order protection rule that requires a market receiving an order to send the order to any other market that has better posted prices if those prices are automated and immediately accessible (Rule 611). This was a major change for NASDAQ because, unlike the NYSE, NASDAQ did not have such a rule. For many active NASDAQ stocks, the SEC estimated before the rule change that 1 of every 11 shares traded was a significant "trade-through," that is, executed at prices inferior to those offered by displayed and accessible limit orders. See Regulation NMS at http://www.sec.gov/rules/final/34-51808.pdf.

be indifferent between selling on the cum-day or the ex-day if:

$$P_{cum} - (P_{cum} - P_{cost}) \times t_g = E(P_{ex}) + D \times (1 - t_d) - (E(P_{ex}) - P_{cost}) \times t_g, \quad (1)$$

where P_{cum} and $E(P_{ex})$ are the cum-day and expected ex-day prices, P_{cost} is the price initially paid for the stock by an investor, D is the dividend amount, and t_d and t_g are the dividend and capital gain tax rates, respectively. The left-hand side of Equation (1) represents the after-tax proceeds from selling the stock cum-dividend and the right-hand side represents the expected after-tax proceeds from selling the stock ex-dividend. Equation (1) can be rewritten as:

$$\frac{P_{cum} - E(P_{ex})}{D} = \frac{1 - t_d}{1 - t_g}. \quad (2)$$

Equation (2) is also the equilibrium outcome if one repeats the analysis from the viewpoint of a prospective buyer (Elton and Gruber, 1970). The left-hand side of Equation (2) is the expected PDR. We follow Elton and Gruber (1970) and use the right-hand side of Equation (2) to impute the dividend tax rate of the marginal investor. If capital gains are taxed more favorably than dividends for the marginal investor (i.e., if $t_d > t_g$, as has historically been the case for retail investors), the PDR will be less than one. If the marginal investor is indifferent between dividends and capital gains (i.e., if $t_d = t_g$, as is the case for short-term traders, pension funds, etc.), the PDR will equal one.[10] If the marginal investor has a tax preference for dividends over capital gains (i.e., if $t_d < t_g$, as is the case for corporations), the PDR will be greater than one.

Using NYSE data from 1966 and 1967, Elton and Gruber (1970) find that the PDR is, on average, around 80%. Moreover, they find that the imputed tax rates are consistent with the top marginal rates observed during the period. Many others have since found support for the Elton and Gruber (1970) tax hypothesis (e.g., Barclay, 1987; Graham et al., 2003; Graham and Kumar, 2006; Whitworth and Rao, 2010). To the extent that NASDAQ firms are held by retail investors or that the ownership structure of NASDAQ firms is similar to that of NYSE firms, the Elton and Gruber (1970) tax hypothesis is applicable in the NASDAQ setting. We thus have:

H_{Taxes}: The PDR for NASDAQ-listed firms is $\frac{1 - t_d}{1 - t_g}$.

B. NASDAQ Market Changes

An alternative to the tax hypothesis is that PDRs reflect the execution costs faced by tax-neutral or tax-advantaged investors employing dividend capture strategies (e.g., Kalay, 1982; Karpoff and Walkling, 1988; Boyd and Jagannathan, 1994). Thus, variation in execution costs affects PDRs.

The 1990s and early 2000s saw several changes in the way NASDAQ stocks trade. Before the mid-1990s, NASDAQ dealers avoided odd-eighths price quotes (Christie and Schultz, 1994). The resulting controversy led to the 1997 SEC order handling rules, which in turn led to the proliferation of ECNs and to a reduction in bid-ask spreads (Stoll, 2006; Fabozzi, 2008).[11] In response to the competition from ECNs, at the end of 2002 NASDAQ introduced its own

[10] We note, as does the ex-day literature, that although the nominal tax rates may be equal, the tax rate on dividends is effectively greater than that on capital gains because of the deferral and tax timing options associated with capital gains. Chay, Choi, and Pontiff (2006) estimate a dollar of realized capital gains is equivalent to \$0.93 of unrealized capital gains.

[11] The late 1990s and early 2000s also saw NASDAQ (along with the NYSE) reduce the minimum tick size from one-eighth of a dollar to decimalization. Studies such as Boehmer (2005), Van Ness, Van Ness, and Warr (2005), and Fink, Fink, and Weston (2006) find that NASDAQ spreads continued to decline in the early 2000s largely independently of tick-size reductions. This is consistent with the prominent role ECNs have had on the NASDAQ market. Stoll (2006) also

electronic trading mechanism, SuperMontage, a fully integrated quotation and execution system that completely automated the trading process.[12]

SuperMontage allowed, for the first time, quoting, order handling, and execution to be processed in a single transaction and it enabled traders to see the aggregate trading interest of all market participants at five price levels on a real-time basis.[13] Chung and Chuwonganant (2009) find that the significantly increased pretrade transparency and the integrated, more efficient quotation and trading system resulting from SuperMontage's introduction led to increased liquidity and execution quality. In particular, Chung and Chuwonganant (2009) find that SuperMontage increased execution speeds, increased fill rates, and reduced realized spreads. Moreover, they find that the dispersion of the pricing error reduced significantly, consistent with SuperMontage reducing execution costs and return volatility due to smaller transitory price movements. Presumably then, as SuperMontage improved price efficiency, dividend capture became more profitable and feasible for a larger set of dividend observations.

Although the literature provides evidence that auction markets such as the NYSE have greater price efficiency and lower execution costs compared to dealer markets such as NASDAQ (e.g., Benveniste, Marcus, and Wilhelm, 1992; Huang and Stoll, 1996; Madhavan and Panchapagesan, 2000; Barclay et al., 2008), the structural and regulatory reforms encountered by NASDAQ has reduced the differences. As mentioned earlier, over the 20 years spanning 1983 to 2002, the yearly average number of NASDAQ firms voluntarily switching to the NYSE is 67. This number reduces to just eight during 2003 to 2014, a reduction of almost 90%. Given the reduction in NASDAQ execution costs, the improvement in price efficiency, and the reduction in the differences between the two exchanges, we have the following hypothesis:

$H_{\text{Execution Costs}}$: To the extent that NASDAQ execution costs are higher than NYSE execution costs, NASDAQ PDRs will be smaller than NYSE PDRs. Moreover, as NASDAQ execution costs decrease and NASDAQ price efficiency improves, NASDAQ PDRs will increase and any difference between NASDAQ and NYSE PDRs will attenuate.

II. Data Description and Testing the Tax and Execution Costs Hypotheses

A. Full Sample

We obtain our data from the Center for Research in Security Prices (CRSP). We begin with domestic dividend-paying firms (CRSP share codes 10 and 11) and focus on regular taxable cash

notes that although regulatory action has led to a decline in spreads for NASDAQ firms, electronic trading has been a continuing factor in reducing costs.

[12] While the new order handling rules led to a fragmented marketplace for trading NASDAQ stocks in the late 1990s and early 2000s, this period was followed by a wave of consolidation that began with two prominent ECNs—Instinet and Island—agreeing to merge their books in 2002 to form INET (the books actually merged in 2004). In 2004, NASDAQ bought Brut, an ECN that was as large as SuperMontage at the time and bought INET in 2005. After purchasing the Pacific Stock Exchange in 2005, Archipelago merged with the NYSE in 2006. During 2004, Stoll (2006) estimates that 21% of the volume in NYSE stocks is traded in markets other than the NYSE (14% of the share volume is traded on the NASDAQ market, 4% is traded on the regional exchanges and 3% is traded on ECNs). In contrast, the NASDAQ market traded only 51% of the volume in stocks it lists. Moreover, the two largest ECNs at that time, Archipelago and Instinet/Island traded 42% of the volume in NASDAQ stocks.

[13] Before SuperMontage, NASDAQ collected and displayed only the single best bid and offer from each market participant. The inability to observe trading interest below a single price level made it difficult for investors to determine the collective willingness of market participants to trade.

dividends, that is, CRSP distribution types 12N2 for $N = 1$ to 9 (Michaely and Vila, 1996). In cases where a firm pays more than one taxable cash dividend on an ex-date, we follow Bali and Hite (1998) and combine the dividends into a single dividend. To ensure that measures of ex-day price changes are meaningful, we require a trade on both the cum-day and the ex-day. Because there is no trading volume information for most NASDAQ firms before 1983, our sample period spans 1983 to 2014. We ensure that there is no change in the number of shares outstanding from the cum-day to the ex-day and that there are no other distributions within four days of the ex-date (Whitworth and Rao, 2010). In addition, we ensure that there are no dividend announcements within four days of the ex-date (Eades, Hess, and Kim, 1984). If a firm has multiple distribution types on the same ex-date, we exclude that observation (Boyd and Jagannathan, 1994; Jakob and Ma, 2004). We also exclude cases where the dividend yield is greater than 10% (Kadapakkam, 2000; Whitworth and Rao, 2010). We eliminate observations when there are more than 365 days between ex-days (Eades et al., 1984; Whitworth and Rao, 2010) and when the cum-price is $5 or less (Jakob and Ma, 2004; Elton, Gruber, and Blake, 2005). As the PDR is affected more by a given price fluctuation for smaller dividends, we eliminate cases where the dividend is $0.05 or less (Elton et al., 2005; Whitworth and Rao, 2010) and adjust for outliers by truncating at the top and bottom PDR percentiles (Graham et al., 2003). We follow Whitworth and Rao (2010) in obtaining top marginal tax rates for dividends and capital gains.

We follow Graham et al. (2003) and compute *PDR* as the ratio of the difference between the cum-day (P_{cum}) and ex-day price (P_{ex}) to the dividend (D), that is:[14]

$$PDR = \frac{P_{cum} - P_{ex}}{D}. \tag{3}$$

The final sample consists of 55,005 taxable cash distributions from NASDAQ-listed firms and 99,099 taxable cash distributions from NYSE-listed firms.

B. Descriptive Statistics and the Tax Hypothesis

In Table I we report summary statistics for the NASDAQ and NYSE samples over 1983 to 2014. In Panel A we find that the mean NASDAQ PDR is 43%, about half the mean NYSE PDR of 92%. Moreover, the average NASDAQ PDR corresponds to an imputed dividend tax rate of 66%, which is more than double the observed tax rate over the sample period. In contrast, the imputed dividend tax rate of 28% obtained from the mean NYSE PDR is consistent with the observed tax rate over the sample period. Thus, although the NYSE evidence appears consistent with the tax hypothesis, the NASDAQ evidence is not. In untabulated results, we also investigate nontaxable distributions (i.e., stock dividends and stock splits). The tax hypothesis predicts a zero ex-day excess return for nontaxable distributions. However, we find a statistically and economically significant NASDAQ average ex-day excess return for nontaxable distributions. This provides further evidence against the tax hypothesis.

In Panel A of Table I we also find that although the average *Dividend Yield* is similar between the two exchanges (0.78% for NASDAQ and 0.77% for the NYSE), the average level of *Dividend* is not ($0.17 for NASDAQ and $0.25 for the NYSE). There are significant differences in other

[14] We note that using the ex-day closing price to compute the PDR understates the true PDR by the daily expected return. The benefit of the PDR measure we use, though, is that it avoids the noise created when estimating expected returns. We thank the referee for making this suggestion. We follow Michaely (1991) and account for heteroskedasticity by weighting the PDRs by the ratio of the dividend yield squared to the variance of daily returns. The results we report and the inferences we make are robust to adjusting the ex-day closing price by the expected daily return.

Table I. Summary Statistics

Panel A reports summary statistics for various firm characteristics. The sample comprises domestic dividend-paying firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1983 to 2014. Price-drop ratio (*PDR*) is the price change from the cum-day to the ex-day expressed as a percentage of *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). We truncate the PDR at the top and bottom percentiles. *Dividend* is the per share dividend amount. In cases where a firm pays more than one taxable cash dividend on an ex-day, we combine the dividends into a single dividend. We ensure that there are no other distributions within four days of the ex-date and that there are no dividend announcements within four days of the ex-date. We require that the *Dividend* be greater than $0.05. *Dividend Yield* is the *Dividend* to *Share Price* ratio. *Share Price* is the price per share on the cum-day, and we require that the *Share Price* is greater than $5. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a seven-day period centered on the ex-day. *Relative Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes divided by the midpoint of the quotes, averaged over a seven-day period centered on the ex-day. As NYSE bid-ask spread data are only available in CRSP beginning in 1993, the numbers we report for both *Bid-Ask Spread* and *Relative Bid-Ask Spread* encompass the 1993 to 2014 period. *Firm Risk* is the standard deviation of stock return over days [−50, −6] U [+6, +20] relative to the ex-day. *Firm Size* is the product of the cum-day price and the number of shares outstanding on the cum-day (in billions of dollars). Diff. is the NASDAQ value less the corresponding NYSE value. *Panel B* reports the relative frequency of the *Dividend* sorted into dividend buckets separately for NASDAQ and the NYSE.

Panel A. Summary Statistics

Variables	**Statistic**	**NASDAQ**	**NYSE**	**Diff.**
PDR	Mean	43%	92%	−49%***
	Median	46%	100%	−54%***
Dividend ($)	Mean	0.17	0.25	−0.08***
	Median	0.14	0.20	−0.06***
Dividend Yield	Mean	0.78%	0.77%	0.01%***
	Median	0.68%	0.65%	0.03%***
Bid-Ask Spread ($)	Mean	0.40	0.24	0.16***
	Median	0.29	0.15	0.14***
Relative Bid-Ask Spread	Mean	1.96%	0.84%	1.12%***
	Median	1.38%	0.46%	0.92%***
Share Price ($)	Mean	25.20	36.52	−11.32***
	Median	21.28	30.63	−9.35***
Firm Size ($billion)	Mean	1.28	6.68	−5.39***
	Median	0.21	1.30	−1.09***
Firm Risk	Mean	2.25%	1.84%	0.41%***
	Median	2.02%	1.65%	0.37%***
Observations		55,005	99,099	

Panel B. Relative Frequency of Dividends

Dividend range	**NASDAQ**	**NYSE**	**Diff.**
($0.05, $0.125]	45%	32%	13%***
($0.125, $0.25]	38%	32%	6%***
($0.25, $0.50]	15%	27%	−12%***
($0.50, $1.00]	2%	8%	−6%***
Over $1.00	<1%	1%	−0.4%

***Significant at the 0.01 level.

firm characteristics. We find that both *Share Price* (the closing price on the cum-day) and *Firm Size* (*Share Price* multiplied by the cum-day shares outstanding) are significantly smaller for NASDAQ firms. In addition, we find that *Bid-Ask Spread*, the difference between the CRSP closing ask quote and the CRSP closing bid quote averaged over the seven-day interval centered on the ex-day (Michaely and Vila, 1996), is significantly larger for NASDAQ firms. Finally, we find that *Firm Risk*, measured as the standard deviation of security returns over days $[-50, -6] \cup [+6, +20]$ relative to the ex-day (Michaely and Vila, 1996; Whitworth and Rao, 2010), is significantly larger for NASDAQ firms.

In Panel B of Table I we report the distribution of dividends for various dividend buckets. Consistent with the mean numbers in Panel A, NASDAQ firms tend to pay smaller dividends. Around 45% of the dividends are between \$0.05 and \$0.125, whereas on the NYSE it is 32%. For dividends between \$0.125 and \$0.25, the corresponding proportions are 38% (NASDAQ) and 32% (NYSE), and for dividends between \$0.25 and \$1, the corresponding proportions are 17% (NASDAQ) and 35% (NYSE). Dividends larger than \$1 are uncommon for both exchanges. In unreported results, we find that on average, 20 days elapse between the announcement day and the ex-day for NASDAQ firms compared to 23 days for NYSE firms. The frequency of ex-days across days of the week and months of the year are similar across both exchanges. Thus, although there does not appear to be a substantial difference in *Dividend Yield*, day of the week or month of the year for dividend payments across the two exchanges, there are differences in the level of the *Dividend*, *Share Price*, *Firm Size, Bid-Ask Spread,* and *Firm Risk*. As these factors influence PDRs (Karpoff and Walkling, 1988), in Section II.D we create a matched sample based on these characteristics to enable a better comparison of PDRs between the two exchanges.

Before moving on to a matched sample analysis, in the next section we investigate a subset of firms that voluntarily switch from NASDAQ to the NYSE.

C. NASDAQ Switchers

One explanation for the difference in PDRs across the two markets is the difference in execution costs. Higher execution costs on NASDAQ make dividend capture more difficult and may result in lower PDRs. A way to test the impact of execution costs is to investigate PDR changes for a subset of firms that voluntarily switch from one exchange to another. A benefit of investigating such firms is that each firm acts as its own control. The literature examining switching behavior focuses on firms switching from NASDAQ to the NYSE as relatively few firms switch from the NYSE to NASDAQ.[15] Firms that switch from NASDAQ to the NYSE generally experience improvements in stock liquidity, lower execution costs, and greater investor recognition (Cowan et al., 1992; Christie and Huang, 1994; Kadlec and McConnell, 1994; Jain and Kim, 2006). We use CRSP to identify NASDAQ switchers and impose all of the previous data requirements.

The resulting sample comprises 291 firms that switch from NASDAQ to the NYSE. Table II reports the results, focusing on the year before and the year after the switch. In Panel A we report the results for the full sample and find that the average *Dividend* before the switch is similar to the average *Dividend* after the switch, indicating no significant change in dividend policy after the switch. We find, however, that the average *PDR* increases from 51% before the switch to 87% after the switch, an increase of more than 70% in relative terms. This increase is statistically significant at the 1% level. To see whether the increase in PDRs is prevalent for larger dividends, in

[15] Before a 1999 NYSE rule change, it was difficult for NYSE-listed firms to switch exchanges. As Kalay and Portniaguina (2001) note, before March 2000 no firm had voluntarily switched from the NYSE to another exchange. The first firm to voluntarily switch from the NYSE to NASDAQ was Aeroflex in March 2000.

Table II. Average Dividend and Price-Drop Ratio for Firms Switching from NASDAQ to the NYSE

This table reports the average *Dividend* and *PDR* for a subset of firms that voluntarily switch from NASDAQ to the NYSE. The sample comprises 291 domestic dividend-paying NASDAQ-listed firms on the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), that voluntarily switch to the NYSE during 1983 to 2014. The numbers reported are the means before the switch (Before Switch) and the means after the switch (After Switch). *Dividend* is the per share dividend amount. Price-drop ratio (*PDR*) is the price change from the cum-day to the ex-day expressed as a percentage of *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). Diff. is the After Switch value less the Before Switch value. Panel A reports the results for all observations, Panel B reports the results for observations with *Dividend* greater than $0.125, and Panel C reports the results for observations with *Dividend* greater than $0.25.

Variables	Observations	Before Switch	After Switch	Diff.
		Panel A. All dividends		
Dividend	928	0.20	0.20	0.00
PDR	928	51%	87%	36%***
		Panel B. Dividend > $0.125		
Dividend	599	0.27	0.27	0.00
PDR	599	55%	89%	34%***
		Panel C. Dividend > $0.25		
Dividend	241	0.40	0.39	<0.01
PDR	241	65%	91%	26%**

***Significant at the 0.01 level.
**Significant at the 0.05 level.

Panels B and C we restrict the sample to dividends greater than $0.125 and $0.25, respectively. Again, we find a statistically significant increase in PDRs in both panels, suggesting that even for larger dividends there is a significant increase. Although we acknowledge that there are self-selection issues for this subset of voluntary NASDAQ switchers, it is difficult not to attribute part of this PDR increase to a market structure effect. We investigate this further with our matched sample analysis.

D. Matched Sample

We create a matched sample by following the methodology employed in the market microstructure literature (e.g., Huang and Stoll, 1996; Van Ness, Van Ness, and Warr, 2002). The advantage of a matched sample is that it allows for a tighter control of key firm characteristics that may affect PDRs. We match each NASDAQ observation with a NYSE counterpart on the basis of the following attributes the prior literature finds important in explaining PDRs: *Dividend*, *Share Price, Firm Size*, *Bid-Ask Spread,* and *Firm Risk* (e.g., Karpoff and Walkling, 1988).[16] As we can see from Table I, NASDAQ dividends tend to be smaller in absolute terms than NYSE dividends. Thus, for each *Dividend* observation in the NASDAQ sample, we match, with replacement, NYSE

[16] Davies and Kim (2009) recommend a one-to-one match rather than a one-to-many match as one-to-one matching outperforms one-to-many matching in both the size and the power of statistical tests.

firms that pay the same *Dividend* in the corresponding year (rounded to the nearest cent).[17] We then require *Share Price* to satisfy the following inequality:

$$\left| \frac{P^Q - P^Y}{(P^Q + P^Y)/2} \right| < 1, \tag{4}$$

where P^Q and P^Y are the NASDAQ and NYSE cum-day prices, respectively. As Huang and Stoll (1996) point out, this screen eliminates observations for which price levels are extremely far apart. Next, for each remaining match we compute the following composite match score (CMS):

$$CMS = \sum_{i=1}^{3} \left[\frac{X_i^Q - X_i^Y}{\left(X_i^Q + X_i^Y\right) / 2} \right]^2, \tag{5}$$

where X_i represents one of the following attributes—*Firm Size*, *Bid-Ask Spread,* or *Firm Risk*—and the Q and Y superscripts refer to NASDAQ and NYSE, respectively.[18] Following Huang and Stoll (1996) and Van Ness et al. (2002), we eliminate observations with bid-ask spreads greater than \$4 or less than \$0 and observations with an ex-day return in excess of 10%. As NYSE bid-ask spread data are available in CRSP only from 1993 onward, the matched sample spans 1993 to 2014. Following Huang and Stoll (1996) and Davies and Kim (2009), we do not impose a tolerance level on the CMS. Finally, for each NASDAQ observation we pick the NYSE observation with the smallest CMS.

As NASDAQ-listed firms are on average smaller than NYSE-listed firms, there is the possibility that we will match multiple NASDAQ observations to a single NYSE observation in a given year. To ensure that this does not have an undue influence on our results, we also report regression results from matching without replacement. As Davies and Kim (2009) note, when matching without replacement, the order of matches can matter as each match reduces the set of potentially available remaining firms. We thus choose firms that are likely more difficult to match first (Rubin, 1973). Accordingly, we match the smallest firms with the largest bid-ask spreads and greatest volatility first. As the matched firm cum-day may occur at a different time in the year, when forming the matched samples we scale *Firm Size* by the value of the CRSP value-weighted portfolio on the cum-day and scale *Firm Risk* by the corresponding standard deviation of the CRSP value-weighted market portfolio (Michaely and Vila, 1996; Whitworth and Rao, 2010).

We report descriptive statistics for the matched sample in Table III. As one of our matching criteria requires *Dividend* to be the same, there is no difference in dividends between the exchanges in this sample. Although *Bid-Ask Spread*, *Share Price*, *Firm Size,* and *Firm Risk* in Table III are much closer compared to Table I, there still are some differences. For example, even though the difference in the average *Bid-Ask Spread* reduces from \$0.16 in Table I to \$0.04 in Table III (the corresponding difference in the medians reduces from \$0.14 to \$0.01), the difference is statistically significant. It is important to note, however, that NASDAQ dealers in the early 1990s avoided odd-eighths price quotes and much of this difference is attributable to that period. Moreover, in

[17] As we match by year, we implicitly control for tax rates and any other marketwide factors throughout the year.

[18] We measure dividend and bid-ask spread in absolute terms (rather than relative terms) because these are more relevant for an investor employing a dividend capture strategy. We thank the referee for this suggestion.

Table III. Matched-Sample Summary Statistics

This table reports summary statistics for various firm characteristics for the matched sample. The sample comprises domestic dividend-paying NASDAQ firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. For each dividend observation in the NASDAQ sample, we match, with replacement, NYSE firms that pay the same dividend in the corresponding year. We follow Huang and Stoll (1996) to compute composite match scores using *Share Price*, *Bid-Ask Spread*, *Firm Size,* and *Firm Risk*. For each NASDAQ observation, we pick an NYSE match with the lowest match score (see Section II.D for a detailed description). Price-drop ratio (*PDR*) is the price change from the cum-day to the ex-day expressed as a percentage of *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). *Dividend* is the per share dividend amount. *Share Price* is the price per share on the cum-day and we require that *Share Price* is greater than \$5. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a seven-day period centered on the ex-day. *Relative Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes divided by the bid-ask midpoint, averaged over a seven-day period centered on the ex-day. *Firm Risk* is the standard deviation of stock return over days $[-50, -6]$ U $[+6, +20]$ relative to the ex-day. *Firm Size* is the product of the cum-day price and the number of shares outstanding on the cum-day (in billions of dollars). Diff. is the NASDAQ value less the corresponding NYSE value.

Variables	Statistic	NASDAQ	NYSE	Diff.
PDR	Mean	47%	72%	−25%***
	Median	50%	81%	−31%***
Dividend	Mean	0.17	0.17	0.00
	Median	0.14	0.14	0.00
Bid-Ask Spread (\$)	Mean	0.29	0.25	0.04***
	Median	0.19	0.18	0.01***
Relative Bid-Ask Spread	Mean	1.48%	1.35%	0.13%***
	Median	0.92%	0.84%	0.08%***
Share Price (\$)	Mean	24.83	25.11	−0.28**
	Median	21.25	21.48	−0.23
Firm Size (\$billion)	Mean	1.53	1.43	0.10*
	Median	0.24	0.29	−0.05***
Firm Risk	Mean	2.24%	2.08%	0.16%***
	Median	2.01%	1.87%	0.14%***
Observations		38,060	38,060	

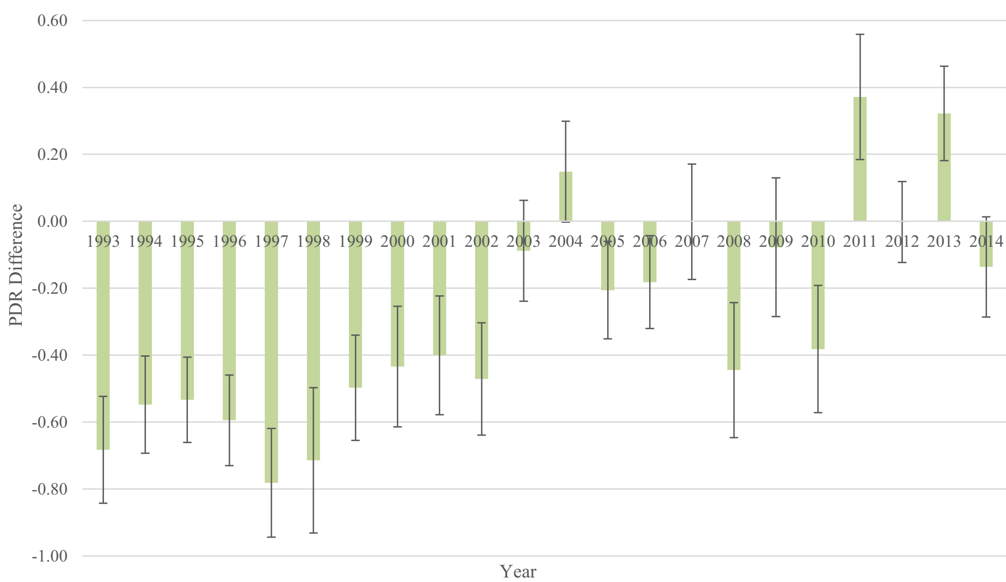
***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

our regression analysis we control for any residual differences in our matching criteria variables, and in robustness tests we restrict the sample to observations where the difference in bid-ask spreads is less than a penny.

In Table III we continue to find that the average PDRs across the two exchanges are different. The average NASDAQ PDR is 47% whereas it is 72% for the NYSE (the corresponding medians are 50% and 81%, respectively). Once again, the NASDAQ evidence does not accord with the NYSE evidence. Even though these are univariate results, the difference is unlikely driven by firm attributes. Nonetheless, later we undertake regression analysis and control for any residual differences between the matched pairs along with additional control variables.

Figure 1. Matched Sample Price-Drop Ratio Difference through Time

This bar chart (with error bars) plots the price-drop ratio (PDR) difference between NASDAQ and the NYSE for the matched sample through time. The sample comprises domestic dividend-paying NASDAQ firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. *PDR* is the price change from the cum-day to the ex-day expressed as a fraction of *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). *Dividend* is the per share dividend amount. In cases where a firm pays more than one taxable cash dividend on an ex-day, we combine the dividends into a single dividend. We ensure there are no other distributions within four days of the ex-date and that there are no dividend announcements within four days of the ex-date. We require that the *Dividend* be greater than \$0.05. The bars represent the mean *PDR Difference* (NASDAQ *PDR* less NYSE *PDR*) and the lines represent the 95% confidence interval centered on the mean *PDR Difference*.



III. PDRs through Time and in the Cross-Section: Matched-Sample Evidence

A. PDRs through Time

As we describe in Section I.B, the early 2000s was a period of transition for the NASDAQ stock market that saw execution costs significantly reduce and price efficiency increase. In Figure 1 we plot the difference in PDRs between the two exchanges through time (NASDAQ PDR minus NYSE PDR). The PDR difference is negative and significant each year before 2003, indicating that the NASDAQ PDR is consistently and significantly less than the corresponding NYSE PDR during this time. However, from 2003 onward, the difference in PDRs is often statistically indistinguishable from zero. Moreover, when it is significantly different from zero, the difference is just as likely to be positive as it is to be negative. Thus, the PDR difference between the two exchanges appears to behave differently from the earlier period to the later.

Table IV. Comparing Price-Drop Ratios across Two Periods

This table compares the average price-drop ratio (PDR) for NASDAQ and the NYSE for 1993 to 2002 and 2003 to 2014 in Panel A, and 1988 to 1990 and 2003 to 1014 in Panel B. Panel A presents results for the matched sample described in Section II.D. In Panel B, the matched sample is formed in a similar fashion with the following exception: As NYSE bid-ask spread data are not available in the Center for Research in Security Prices (CRSP) before 1993, we substitute NYSE spreads with the 300- to 500-share print size spreads given in table 9 of Blume and Goldstein (1992) during 1988 to 1990. The sample comprises domestic dividend-paying NASDAQ firms listed in CRSP (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9). *PDR* is the price change from the cum-day to the ex-day expressed as a percentage of the *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). Diff. is either the difference between NASDAQ and NYSE PDRs for a given period or the difference in PDRs from the earlier period to the later period for a given exchange. The bottom right cell of each panel represents the difference in differences.

Variables	NASDAQ	NYSE	Diff.
	Panel A. PDR 1993-2002 vs. 2003-2014		
$PDR_{1993\text{-}2002}$	16%	76%	−60%***
$PDR_{2003\text{-}2014}$	66%	68%	−2%
Diff.	50%***	−8%***	58%***
	Panel B. PDR 1988-1990 vs. 2003-2014		
	NASDAQ	**NYSE**	**Diff.**
$PDR_{1988\text{-}1990}$	36%	90%	−54%***
$PDR_{2003\text{-}2014}$	66%	68%	−2%
Diff.	30%***	−22%***	52%***

***Significant at the 0.01 level.

In Table IV we confirm the results from Figure 1. Panel A shows that the PDR difference between the two exchanges during 1993 to 2002 is a statistically significant 60% in absolute terms. However, this difference reduces to just 2% in absolute terms during 2003 to 2014 and is not statistically significant. The difference in differences of 58% in absolute terms is both statistically and economically significant. Moreover, much of the reduction in the PDR difference between the two exchanges is driven by the significant increase in the NASDAQ PDR between the two periods. The results from Figure 1 and Table IV provide support for the execution costs hypothesis.

During the post-2002 period dividends and capital gains are taxed at the same rate. If the tax rate of the marginal investor of NASDAQ firms differs from that of NYSE firms, the convergence in PDRs may simply reflect the tax differential between dividends and capital gains converging between the two groups of investors. For example, retail investors face a heavier tax burden on dividends relative to capital gains before 2003 and this tax differential disappears during 2003, whereas short-term traders face the same tax rate on dividends and capital gains both before and after 2003. We thus compare PDRs from two periods when dividends and capital gains are taxed at the same rate: 1988 to 1990 and 2003 to 2014.[19] We find that the difference in PDRs

[19] Dividends and capital gains are taxed at the same rate in the later period beginning in May 2003. We obtain similar results to those we report if we begin the later period in 2004. The lack of NYSE bid-ask spread data in CRSP before 1993 means we exclude this attribute when forming the matched sample. Instead, we replace this attribute with the effective spread as given in table 9 of Blume and Goldstein (1992). In particular, we use the numbers corresponding to the 300- to

across the exchanges is a statistically significant 54% in absolute terms in the earlier period but reduces to just 2% in the later period. Most of the reduction in the difference is again driven by the significant increase in NASDAQ PDRs between the two periods. As the tax differential is the same across the two periods, taxes cannot explain the increase in NASDAQ PDRs or the convergence in PDRs we document. Rather, the results are consistent with significant NASDAQ market structure changes reducing the difference in execution costs between NASDAQ and the NYSE.

In sum, the results from Figure 1 and Table IV support the execution costs hypothesis but not the tax hypothesis. As trading structures become more alike between the two markets and the difference in execution costs attenuates, so too does the PDR difference. The results suggest that market structure can have a significant effect on investors' ability to arbitrage market imperfections and thus provide evidence of the effect market structure can have on asset prices and our understanding of anomalies.

B. PDRs by Stock Attribute Quartiles

We next examine the average PDRs across the two exchanges for the following stock attribute quartiles: *Bid-Ask Spread*, *Firm Size, Firm Risk,* and *Trading Volume* (the median PDRs are not reported for brevity but display the same basic pattern). *Trading Volume* is defined as the 60-day average of daily trading volume divided by total shares outstanding over days [−50, −6] U [+6, +20] relative to the ex-day (Michaely and Vila, 1996). As NASDAQ trading volume has been overstated in the past relative to NYSE trading volume, we follow Gao and Ritter (2010) and adjust NASDAQ trading volume.[20] We form the quartiles each year and report the results in Table V. We find that for NYSE firms there is relatively little variation in PDRs going from the bottom quartile to the top quartile of stock attributes, but there is a substantial increase for NASDAQ firms.

In particular, we find that for NYSE firms there is relatively little variation in PDRs when moving from the bottom to the top quartile for *Firm Size*, *Bid-Ask Spread,* and *Trading Volume*. This is in stark contrast to the NASDAQ evidence where the difference between the bottom and top quartiles is relatively large. The result is that for firms where dividend capture is presumably more difficult (small firms, large bid-ask spreads, and low volume), the difference in PDRs across the two exchanges is much larger. In addition, we report the mean PDRs for each quartile for the two subperiods 1993 to 2002 and 2003 to 2014. Although we find that the mean NASDAQ PDR is significantly smaller than its matched NYSE counterpart across all quartiles for each stock attribute we report in the 1993 to 2002 period, the difference reduces in the 2003 to 2014 period and is often not significant. Moreover, much of the reduction in the difference is driven by NASDAQ PDRs increasing from the earlier period to the later period in every quartile and across every stock attribute. The difference in NASDAQ PDRs across the two subperiods is substantially larger than the difference in NYSE PDRs, and the difference between these differences is statistically significant across all attribute quartiles (see the last three columns of Table V).

With regard to *Firm Risk*, we find relatively little variation in PDRs when moving from the bottom to the top quartile. The finding that the PDR is not as sensitive to risk quartiles as compared

500-share print size as a proxy for bid-ask spreads when forming a matched sample for the 1988-1990 period. We thank the referee for this suggestion. Alternatively, replacing the bid-ask spread with the reciprocal of the stock price (Karpoff and Walkling, 1998) yields similar results.

[20] In particular, before February 1, 2001, we divide NASDAQ volume by 2; from February 1, 2001 to December 31, 2001, we divide NASDAQ volume by 1.8; for 2002 and 2003, we divide NASDAQ volume by 1.6; and beginning 2004, we do not make any adjustments (see appendix B of Gao and Ritter, 2010, for details).

Table V. Average Price-Drop Ratios by Firm Attribute Quartile

This table reports average price-drop ratios (PDRs) by various firm attribute quartiles for the matched sample. The sample comprises domestic dividend-paying NASDAQ firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. *PDR* is the price change from the cum-day to the ex-day expressed as a percentage of *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). *Dividend* is the per share dividend amount. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a 7-day period centered on the ex-day. *Firm Risk* is the standard deviation of stock return over days [−50, −6] U [+6, +20] relative to the ex-day. *Firm Size* is the product of the cum-day price and the number of shares outstanding on the cum-day (billions of dollars). *Trading Volume* is the average daily proportional trading volume. It is measured as the 60-day average of daily trading volume as a percentage of total shares outstanding over days [−50, −6] U [+6, +20] relative to the ex-dividend day. We follow Gao and Ritter (2010) and adjust NASDAQ trading volume to make it comparable to NYSE trading volume. We use the NASDAQ sample to define the quartile (Q) breakpoints each year. Diff. is the difference between NASDAQ and NYSE PDRs, and DID is the difference in differences.

		Entire Sample			Pre-SuperMontage: 1993–2002			Post-SuperMontage: 2003–2014			Post- vs. Pre-SuperMontage		
Firm attributes	Quartiles	(1) NASDAQ	(2) NYSE	(1)–(2) Diff.	(3) NASDAQ	(4) NYSE	(3)–(4) Diff.	(5) NASDAQ	(6) NYSE	(5)–(6) Diff.	(5)–(3) NASDAQ	(6)–(4) NYSE	[(5)–(3)]–[(6)–(4)] DID
Bid-Ask Spread	Q1 (Low)	66%	75%	−9%***	24%	68%	−44%***	88%	81%	7%**	64%***	13%***	51%***
	Q2	44%	69%	−25%***	19%	80%	−61%***	61%	55%	6%	42%***	−25%***	67%***
	Q3	37%	73%	−36%***	12%	80%	−68%***	52%	63%	−11%***	40%***	−17%***	57%***
	Q4 (High)	34%	72%	−38%***	3%	76%	−73%***	47%	69%	−22%***	44%***	−7%*	51%***
Firm Size	Q1 (Low)	33%	74%	−41%***	2%	84%	−82%***	46%	65%	−19%***	44%***	−19%***	63%***
	Q2	45%	67%	−22%***	19%	75%	−56%***	59%	58%	1%	40%***	−17%***	57%***
	Q3	54%	69%	−15%***	9%	69%	−60%***	79%	68%	11%**	70%***	−1%	71%***
	Q4 (High)	61%	79%	−18%***	31%	77%	−46%***	81%	81%	0%	50%***	4%	46%***
Firm Risk	Q1 (Low)	47%	74%	−27%***	17%	78%	−61%***	62%	69%	−7%**	45%***	−9%**	54%***
	Q2	45%	75%	−30%***	11%	74%	−63%***	64%	75%	−11%**	53%***	1%	52%***
	Q3	48%	68%	−20%***	17%	74%	−57%***	64%	60%	4%	47%***	−14%***	61%***
	Q4 (High)	54%	70%	−16%***	16%	78%	−62%***	73%	64%	9%*	57%***	−14%***	71%***
Trading Volume	Q1 (Low)	31%	70%	−39%***	10%	74%	−64%***	41%	65%	−24%***	31%***	−9%**	40%***
	Q2	43%	74%	−31%***	17%	84%	−67%***	59%	62%	−3%	42%***	−22%***	64%***
	Q3	56%	73%	−17%***	21%	77%	−56%***	75%	69%	6%	54%***	−8%**	62%***
	Q4 (High)	67%	72%	−5%	14%	66%	−52%***	90%	77%	13%***	76%***	11%***	65%***

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

to the other firm attributes we report seems surprising at first glance. However, as Kalay and Lemmon (2008) point out, any risk exposure for someone employing a dividend capture strategy is relatively short in duration. Moreover, the risk is diversifiable as there are several thousand ex-dividend events in a calendar year and the risk associated with these events should be temporally independent. Consistent with this, Henry and Koski (2017) find that bid-ask spreads and firm size (and investor execution skill) are more important than firm risk in determining the profitability of dividend capture strategies. Most important, and consistent with our partitions for other firm attributes, we find that the NASDAQ PDRs significantly increase across all risk quartiles (the NASDAQ PDRs more than triple from the earlier period to the later period), resulting in the PDR difference substantially reducing across all risk quartiles.

To focus on dividends where dividend capture is likely more profitable or more likely to occur, in Table VI we examine the average PDRs across the two markets for quartiles of the ratio of *Dividend* to *Trading Costs.* We measure *Trading Costs* as the sum of the bid-ask spread and trading commissions. Although retail investors face a flat fee commission structure (e.g., many brokers currently charge retail investors less than $10 to trade shares), institutional investors face a per share commission fee structure. Goldstein, Irvine, Kandel, and Wiener (2009) find a bimodal distribution of one-way per share commissions for institutional investors during 1999 to 2003, with one mass at five cents and another mass at two cents. Stoll (2006) estimates round-trip commissions decline from more than 35 cents per share in 1980 to a little more than 6 cents per share in 2001. Chemmanur, Hu, and Huang (2015) find that for 1999 to 2009, institutions incur one-way per share commissions of a little more than two cents. As trading commissions have decreased through time, we impose round-trip trading commissions as follows: eight cents for 1993 to 1997, six cents for 1998 to 2002 and four cents for 2003 to 2014. We note, though, that dealer markets such as NASDAQ and auction markets such as the NYSE can differ in the way charges are levied to provide trading services. As Huang and Stoll (1996) and Weston (2000) note, trading on the NYSE incurs a commission whereas trading on NASDAQ is often "net," that is, without a commission, particularly when the customer is an institution.[21] If NASDAQ firms in our sample trade net, then matching on the *Bid-Ask Spread* as we do likely biases against finding that NASDAQ PDRs are smaller than NYSE PDRs. This is because we are matching to NYSE firms that are likely to have higher trading costs than their matched counterparts. To the extent that such firms have smaller PDRs, this makes it more difficult to find lower PDRs for NASDAQ firms.

Larger values for the ratio of *Dividend* to *Trading Costs* correspond to more profitable or viable dividend capture strategies. We see in Table VI a pattern emerging similar to that from Table V. For NYSE firms there is much less variation going from the bottom to the top quartile in comparison to NASDAQ firms. Moreover, for the top quartile where the ratio is the largest, the difference in PDRs is a statistically significant 19% in absolute terms for the 1993 to 2014 period. However, this difference is driven by the 1993 to 2002 subperiod. In the second half of our sample period, the difference in PDRs for the top quartile is not significant. To investigate this further, in the last rows of Table VI we split the sample into two subsamples based on whether the ratio of *Dividend* to *Trading Costs* is above or below one. Observations with a ratio above one are those in which dividend capture is profitable given our measure of trading costs. We find

[21] The bid-ask spreads and trading commissions we use are likely overstated for dividend capture traders. For a start, trades can and do occur inside the bid-ask spread. In addition, as dividend capture trades are not information based, the bid-ask spread may also be lower for such trades (Karpoff and Walkling, 1990). Moreover, with the rise in discount brokerage and the proliferation of ECNs, commission costs are likely lower than we estimate. For example, Jarrell (1984) estimates that the discount broker share for NYSE firms in 1980 is only 6%, whereas Goldstein et al. (2009) find that by 2003, more than 40% of institutional volume is executed at discount prices.

Table VI. Average Price-Drop Ratios Sorted by the Ratio of Dividend to Trading Costs

This table reports the average price-drop ratios (PDRs) for various cutoffs of the dividend to trading costs ratio for the matched sample. The sample comprises domestic dividend-paying NASDAQ firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. *PDR* is the price change from the cum-day to the ex-day expressed as a percentage of *Dividend* and is adjusted for heteroskedasticity as in Michaely (1991). *Dividend* is the per share dividend amount. *Dividend/TC* is the ratio of *Dividend* to *Trading Costs*. *Trading Costs* (*TC*) is the sum of *Bid-Ask Spread* and trading commissions where trading commissions are levied at eight cents for 1993 to 1998, six cents for 1999 to 2002, and four cents for 2003 to 2014. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a seven-day period centered on the ex-day. We use the NASDAQ sample to define the quartile (Q) breakpoints each year. Diff. is the difference between NASDAQ and NYSE PDRs, and DID is the difference in differences.

		Entire Sample			Pre-SuperMontage: 1993–2002			Post-SuperMontage: 2003–2014			Post- vs. Pre-SuperMontage		
Ratio	**Quartiles**	**(1) NASDAQ**	**(2) NYSE**	**(1)–(2) Diff.**	**(3) NASDAQ**	**(4) NYSE**	**(3)–(4) Diff.**	**(5) NASDAQ**	**(6) NYSE**	**(5)–(6) Diff.**	**(5)–(3) NASDAQ**	**(6)–(4) NYSE**	**[(5)–(3)]–[(6)–(4)] DID**
Dividend/TC	Q1 (Low)	24%	64%	−40%***	1%	75%	−74%***	31%	58%	−27%***	30%***	−17%***	47%***
	Q2	37%	65%	−28%***	1%	70%	−69%***	53%	60%	−7%	52%***	−10%**	62%***
	Q3	38%	69%	−31%***	5%	72%	−67%***	59%	64%	−5%	54%***	−8%*	62%***
	Q4 (High)	60%	79%	−19%***	27%	81%	−54%***	80%	78%	2%	53%***	−3%	56%***
Dividend/TC	≤1	21%	71%	−50%***	13%	77%	−64%***	35%	54%	−19%***	22%***	−23%***	45%***
	>1	71%	75%	−4%*	36%	71%	−35%***	74%	76%	−2%	38%***	5%	33%***

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

that the PDR difference when the ratio is above one is a statistically significant 35% in absolute terms during 1993 to 2002 but it is statistically indistinguishable from zero during 2003 to 2014. These results provide further support for the execution costs hypothesis.

Overall, the results from Tables V and VI are consistent with the NYSE specialist system, making dividend capture more viable for firms in which dividend capture is likely more difficult. For example, both Bessembinder (2003) and Chung et al. (2004) find that the NYSE specialist system is relatively valuable for trading small, low-volume stocks and that it is in such firms that dividend capture is presumably more difficult. Moreover, the results from Tables V and VI suggest that the PDR difference has decreased across all quartiles from the 1993 to 2002 period to the 2003 to 2014 period, consistent with the difference in execution costs decreasing through time. Dividend capture has become feasible for a larger set of dividends after the NASDAQ changes.

C. Regression Results

The results thus far suggest two things. First, there is a significant difference between the NASDAQ and NYSE PDRs. Second, through time there is a convergence in PDRs across the two exchanges. Given the large difference between the PDRs in the first half of the sample period and the subsequent convergence, one question is whether residual differences in stock attributes between the matched NASDAQ and NYSE firms drive the results. Another possibility is that trading characteristics not included in the matching procedure, such as trading volume, can explain the difference in PDRs. We thus estimate the following regression for our matched sample (time subscripts suppressed):

$$PDR_i^Q - PDR_i^Y = \beta_0 + \beta_1 \left(DT_i^Q - DT_i^Y\right) + \beta_2 \left(S_i^Q - S_i^Y\right) + \beta_3 \left(R_i^Q - R_i^Y\right) + \beta_4 \left(V_i^Q - V_i^Y\right) + \varepsilon_i, \quad (6)$$

where for observation i, PDR_i represents the price-drop ratio, DT_i represents the ratio of *Dividend* to *Trading Costs* where trading costs are measured as the sum of the *Bid-Ask Spread* and round-trip trading commissions as discussed in the previous section, S_i represents *Firm Size*, R_i represents *Firm Risk*, V_i represents *Trading Volume*, ε_i represents the error term, and the Q and Y superscripts refer to NASDAQ and NYSE, respectively. We estimate the regression using weighted least squares following Michaely (1991) and Whitworth and Rao (2010).[22]

In Table VII we report the regression results for the 1993 to 2014 period along with the 1993 to 2002 and 2003 to 2014 subperiods. In Panel A we report the results for the matched sample with replacement. The statistically significant intercept of −25% for the 1993 to 2014 period in Model 1 represents the PDR difference across the two exchanges after controlling for any residual differences in the matching criteria and differences in trading volume (recall that when forming the matched sample we require the dividends to be equal so there are no residual differences in dividends). In particular, the NASDAQ PDR is 25% smaller in absolute terms, on average, than the NYSE PDR. Confirming our earlier results, the significant difference in PDRs is driven by the first half of the sample period and disappears in the second half. The NASDAQ PDR is 58% smaller in absolute terms than the NYSE PDR in the first half of the sample period (Model 2)

[22] Michaely (1991) highlights the importance of adjusting for heteroskedasticity. Observations in the regressions are weighted according to the ratio of the dividend yield squared to the variance of stock returns estimated over days [−50, −6] U [+6, +20] relative to the ex-day.

Table VII. Regressions Explaining the Difference in Price-Drop Ratios

This table reports weighted least squares regression results of the price-drop ratio (PDR) difference on various firm attribute differences for the matched sample. We compute the paired difference between matched firms as the NASDAQ less the NYSE variable of interest. Δ symbolizes the paired difference. The sample comprises domestic dividend-paying firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. The dependent variable in the regressions is Δ*PDR*, the difference in PDRs. *PDR* is the price change from the cum-day to the ex-day expressed as a fraction of *Dividend*. *Dividend* is the per share dividend amount. *Dividend/Trading Costs* is the ratio of *Dividend* to *Trading Costs*. *Trading Costs* is the sum of *Bid-Ask Spread* and trading commissions where trading commissions are levied at eight cents for 1993 to 1998, six cents for 1999 to 2002, and four cents for 2003 to 2014. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a 7-day period centered on the ex-day. *Firm Size* is the product of the cum-day share price and the number of shares outstanding on the cum-day. *Firm Risk* is the standard deviation of stock return over days [−50, −6] U [+6, +20] relative to the ex-day. *Trading Volume* is the average daily proportional trading volume, measured as the 60-day average of daily trading volume as a percentage of total shares outstanding over days [−50, −6] U [+6, +20] relative to the ex-dividend day. We follow Gao and Ritter (2010) to adjust NASDAQ trading volume to make it comparable to NYSE trading volume. $I_{1998\text{-}2002}$ is an indicator variable that equals one if the ex-day occurs in 1998 through 2002, inclusive. $I_{2003\text{-}2014}$ is an indicator variable that equals one if the ex-day occurs in 2003 through 2014, inclusive. Observations in the regressions are weighted according to the ratio of the dividend yield squared to the variance of stock returns estimated over days [−50, −6] U [+6, +20] relative to the ex-day. Panel A reports regressions results using a matched sample with replacement. Panel B reports regressions results using a matched sample with replacement and requires that the difference in *Bid-Ask Spread* between the matched firms is within a penny. Panel C reports results using a matched sample without replacement. The *t*-statistics are in parentheses below each coefficient.

Regressors	**(1) 1993–2014**	**(2) 1993–2002**	**(3) 2003–2014**	**(4) 1993–2014**
Panel A. Matched sample with replacement				
Intercept	−0.25***	−0.58***	−0.02	−0.61***
	(−13.40)	(−19.53)	(−0.72)	(−16.99)
Δ(*Dividend/Trading Costs*)	−0.01	0.14*	0.02	0.02*
	(−0.97)	(1.81)	(1.45)	(1.74)
Δ*Firm Size*	−0.00	0.00*	−0.00**	−0.00
	(−1.52)	(1.79)	(−2.01)	(−1.63)
Δ*Firm Risk*	−0.08***	−0.00	−0.02	−0.01
	(−4.62)	(−0.09)	(−0.56)	(−0.46)
Δ*Trading Volume*	0.01*	−0.04***	0.01	0.00
	(1.85)	(−2.62)	(1.46)	(0.79)
$I_{1998\text{-}2002}$				0.13**
				(2.29)
$I_{2003\text{-}2014}$				0.59***
				(13.80)
F-stat	6.40***	3.30***	2.19*	41.38***
Observations	38,060	17,378	20,682	38,060

(Continued)

Table VII. Regressions Explaining the Difference in Price-Drop Ratios *(Continued)*

Regressors	(1) 1993–2014	(2) 1993–2002	(3) 2003–2014	(4) 1993–2014
Panel B. Matched sample with replacement and bid-ask spreads within a penny				
Intercept	−0.15***	−0.48***	0.03	−0.50***
	(−6.84)	(−11.93)	(1.14)	(−10.80)
Δ(*Dividend/Trading Costs*)	−0.01	2.33**	0.06	0.06
	(−0.31)	(2.08)	(1.18)	(1.39)
Δ*Firm Size*	0.00*	0.00	0.00	0.00
	(1.86)	(1.12)	(0.72)	(1.22)
Δ*Firm Risk*	−0.04**	0.03	−0.01	0.01
	(−1.97)	(0.90)	(−0.34)	(0.28)
Δ*Trading Volume*	−0.00	−0.07***	−0.00	−0.01
	(−0.70)	(−3.64)	(−0.44)	(−1.43)
$I_{1998\text{-}2002}$				0.12
				(1.63)
$I_{2003\text{-}2014}$				0.53***
				(9.84)
F-stat	2.14*	4.86***	0.58	20.83***
Observations	27,298	11,832	15,466	27,298
Panel C. Matched sample without replacement				
Intercept	−0.28***	−0.61***	−0.03	−0.62***
	(−12.99)	(−17.31)	(−1.00)	(−15.90)
Δ(*Dividend/Trading Costs*)	−0.01	0.25***	0.03**	0.03***
	(−1.25)	(3.33)	(2.19)	(2.71)
Δ*Firm Size*	0.00	0.00	0.00	0.00
	(−0.75)	(0.12)	(−0.55)	(−0.40)
Δ*Firm Risk*	−0.08***	0.01	−0.03	−0.02
	(−4.86)	(0.21)	(−1.22)	(−1.02)
Δ*Trading Volume*	0.01*	−0.01	0.01**	0.01**
	(1.81)	(−0.57)	(2.49)	(2.21)
$I_{1998\text{-}2002}$				0.07
				(1.08)
$I_{2003\text{-}2014}$				0.59***
				(12.73)
F-stat	6.43***	2.98**	3.85***	37.10***
Observations	36,111	16,818	19,293	36,111

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

but is not significantly different from the NYSE PDR in the second half of the sample period (Model 3). These results are consistent with the execution costs hypothesis.

As discussed earlier, during 1997 the SEC introduced new NASDAQ order handling rules in response to NASDAQ dealers avoiding odd-eighths price quotes, and this led to a reduction in bid-ask spreads. The late 1990s and early 2000s also saw a reduction in the minimum tick size from one-eighth of a dollar to decimalization for both exchanges. Thus, in Model 4 we investigate whether the PDR difference reduces during the 1998 to 2002 period. In particular, we run a regression over the entire sample period and include two indicator variables, one for the 1998 to 2002 period and another for the 2003 to 2014 period to capture the change in the PDR difference from the earlier period to each of these two later periods. We find some evidence of a reduction in the PDR difference during the 1998 to 2002 period (13% in absolute terms) but the reduction is moderate compared to the 2003 to 2014 period (59% in absolute terms).

In Panels B and C of Table VII we test whether the regression results are robust to alternative matching requirements. In Panel B we restrict the sample to observations where the difference in bid-ask spreads between the two exchanges is less than a penny.[23] Again, in Model 1 we find a statistically significant PDR difference between the two exchanges for the 1993 to 2014 period that is driven by the first half of the sample period (Model 2) and disappears in the second half of the sample period (Model 3). In Model 4 we again include two indicator variables to examine changes in the PDR difference for the 1998 to 2002 and 2003 to 2014 subperiods. The indicator variable is positive for both subperiods but statistically significant only in the later period. To ensure the results are not sensitive to matching with or without replacement, in Panel C we report the results from creating a matched sample without replacement. We again find a statistically significant difference in PDRs across the two exchanges that is driven by the first half of the sample period.

The regression results from Table VII suggest that differences in stock attributes are not driving the results as we control for these differences in the regressions. Moreover, the results are robust to alternative ways of forming the matched sample. The results also confirm our earlier results investigating the subset of firms that switch from NASDAQ to the NYSE (where we use each firm as its own control). Overall, the results from Table VII are consistent with the execution costs hypothesis.

We next explore whether the convergence in PDRs is concentrated in a subset of firms. In particular, we investigate the difference in PDRs for the top and bottom quartiles for *Bid-Ask Spread* and *Firm Size*.[24] Table VIII reports the results using the matched sample with replacement (similar results emerge using the other samples from Table VII). We find that the difference in PDRs reduces for both the top and bottom quartiles for both stock attributes. For example, in Panel A where we focus on *Bid-Ask Spread*, the PDR difference reduces from a statistically significant 72% in absolute terms in the 1993 to 2002 period to a marginally significant 11% in the 2003 to 2014 period for firms in the top quartile (i.e., firms with the largest bid-ask spreads). For firms with the lowest bid-ask spreads, the PDR difference reduces from a statistically significant 40% in absolute terms in the earlier period to a statistically insignificant 6% in the later period.

As we do in the previous section, to focus on dividends where dividend capture is likely more profitable or more likely to occur, we split the sample into observations where the ratio of *Dividend* to *Trading Costs* is above and below one. We report the results in Table IX. We find that the PDR difference reduces from a statistically significant 38% in absolute terms in the 1993 to 2002 period to a statistically insignificant 1% in the 2003 to 2014 period for observations where the ratio is above one. For observations where the ratio is below one, the PDR difference reduces from a statistically significant 60% in the earlier period to a statistically insignificant 3% in the later period. Thus, there is a reduction in the PDR difference from the earlier period to the

[23] As we use the average of the bid-ask spread over a seven-day period centered on the ex-day, the differences in bid-ask spreads between the two exchanges are almost always nonzero.

[24] For brevity, we report the results only for these attributes. In untabulated analysis we investigate the PDR difference for the top and bottom quartiles for two additional stock attributes—*Firm Risk* and *Trading Volume*—and find patterns similar to those we report.

Table VIII. Regressions Explaining the Price-Drop Ratio Difference for Top and Bottom Firm Attribute Quartiles

This table reports weighted least squares regression results of the price-drop ratio (PDR) difference on various firm attribute differences for the top and bottom quartiles of *Bid-Ask Spread* and *Firm Size*. We compute the paired difference between the matched firms as the NASDAQ less the NYSE variable of interest. Δ symbolizes the paired difference. The sample comprises domestic dividend-paying firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. The dependent variable in the regressions is ΔPDR, the difference in PDRs. *PDR* is the price change from the cum-day to the ex-day expressed as a fraction of *Dividend*. *Dividend* is the per share dividend amount. *Dividend/Trading Costs* is the ratio of *Dividend* to *Trading Costs*. *Trading Costs* is the sum of the *Bid-Ask Spread* and trading commissions where trading commissions are levied at eight cents for 1993 to 1998, six cents for 1999 to 2002, and four cents for 2003 to 2014. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a 7-day period centered on the ex-day. *Firm Size* is the product of the cum-day share price and the number of shares outstanding on the cum-day. *Firm Risk* is the standard deviation of stock return over days [−50, −6] U [+6, +20] relative to the ex-day. *Trading Volume* is the average daily proportional trading volume, measured as the 60-day average of daily trading volume as a percentage of total shares outstanding over days [−50, −6] U [+6, +20] relative to the ex-dividend day. We follow Gao and Ritter (2010) and adjust NASDAQ trading volume to make it comparable to NYSE trading volume. $I_{1998\text{-}2002}$ is an indicator variable that equals one if the ex-day occurs in 1998 through 2002, inclusive. $I_{2003\text{-}2014}$ is an indicator variable that equals one if the ex-day occurs in 2003 through 2014, inclusive. Observations in the regressions are weighted according to the ratio of the dividend yield squared to the variance of stock returns estimated over days [−50, −6] U [+6, +20] relative to the ex-day. We use the NASDAQ sample to define the quartile breakpoints each year. Panel A reports regression results for Quartile 4 (i.e., largest) and Quartile 1 (i.e., smallest) of firms sorted by *Bid-Ask Spread*. Panel B reports regression results for Quartile 4 and Quartile 1 of firms sorted by *Firm Size*. The *t*-statistics are in parentheses below each coefficient.

	Quartile 4 (Largest)				**Quartile 1 (Smallest)**			
Regressors	**(1) 1993–2014**	**(2) 1993–2002**	**(3) 2003–2014**	**(4) 1993–2014**	**(5) 1993–2014**	**(6) 1993–2002**	**(7) 2003–2014**	**(8) 1993–2014**
				Panel A. Bid-ask spread				
Intercept	−0.33***	−0.72***	−0.11*	−0.76***	−0.12***	−0.40***	0.06	−0.39***
	(−6.81)	(−7.90)	(−1.78)	(−7.49)	(−3.82)	(−7.48)	(1.33)	(−6.25)
Δ(*Dividend/Trading Costs*)	−0.04*	−0.12	0.01	−0.00	−0.04	−0.01	−0.04	−0.04
	(−1.72)	(−0.60)	(0.20)	(−0.09)	(−1.14)	(−0.08)	(−1.05)	(−1.12)
Δ*Firm Size*	−0.00	0.00	−0.00**	−0.00	−0.00*	0.00	−0.00	−0.00*
	(−0.80)	(1.44)	(−1.99)	(−1.22)	(−1.76)	(0.74)	(−1.66)	(−1.69)
Δ*Firm Risk*	−0.09***	0.00	−0.08	−0.02	0.00	0.00	0.14*	0.04
	(−2.92)	(0.01)	(−1.47)	(−0.41)	(−0.01)	(0.00)	(1.90)	(0.96)
Δ*Trading Volume*	0.03**	−0.01	0.03*	0.03	0.01	−0.05**	0.01	0.01
	(2.10)	(−0.20)	(1.86)	(1.6)	(1.54)	(−2.00)	(0.96)	(0.67)

(Continued)

Table VIII. Regressions Explaining the Difference in Price-Drop Ratios *(Continued)*

Regressors	Quartile 4 (Largest) (1) 1993–2014	(2) 1993–2002	(3) 2003–2014	(4) 1993–2014	Quartile 1 (Smallest) (5) 1993–2014	(6) 1993–2002	(7) 2003–2014	(8) 1993–2014
Panel A. Bid-ask spread								
$I_{1998\text{-}2002}$				0.21				0.00
				(1.59)				(0.04)
$I_{2003\text{-}2014}$				0.63***				0.44***
				(5.92)				(5.91)
F-stat	3.56***	0.57	2.18*	8.94***	1.75	1.19	2.49**	8.97***
Observations	9,269	4,108	5,161	9,269	9,723	4,521	5,202	9,723
Panel B. Firm size								
Intercept	−0.21***	−0.43***	−0.03	−0.50***	−0.35***	−0.71***	−0.13**	−0.76***
	(−6.35)	(−8.22)	(−0.62)	(−9.07)	(−8.98)	(−11.51)	(−2.55)	(−8.41)
Δ(*Dividend/Trading Costs*)	0.00	0.25**	0.01	0.01	−0.01	−0.42*	0.03	0.03
	(0.03)	(2.45)	(0.28)	(0.39)	(−0.49)	(−1.87)	(1.06)	(1.16)
Δ*Firm Size*	−0.00**	0.00	−0.00**	−0.00**	0.00*	0.01***	0.00	0.00
	(−2.26)	(0.76)	(−2.12)	(−2.09)	(1.87)	(2.62)	(0.76)	(1.63)
Δ*Firm Risk*	−0.13**	−0.09	−0.02	−0.08	−0.08***	−0.05	−0.03	−0.01
	(−2.56)	(−1.36)	(−0.20)	(−1.48)	(−2.81)	(−1.24)	(−0.53)	(−0.43)
Δ*Trading Volume*	0.02**	0.00	0.01	0.02*	0.01	−0.12***	0.02	0.01
	(2.30)	(0.02)	(1.58)	(1.88)	(0.90)	(−2.91)	(1.53)	(0.71)
$I_{1998\text{-}2002}$				0.31***				0.13
				(3.00)				(1.16)
$I_{2003\text{-}2014}$				0.47***				0.62***
				(6.70)				(6.15)
F-stat	3.88***	2.44**	1.86	10.12***	3.08**	4.27***	1.83	10.63***
Observations	9,506	4,340	5,166	9,506	9,525	4,348	5,177	9,525

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

Table IX. Regressions Explaining the Price-Drop Ratio Difference Sorted by the Ratio of Dividend to Trading Costs

This table reports weighted least squares regression results of the price-drop ratio (PDR) difference sorted by the ratio of *Dividend* to *Trading Costs*. We compute the paired difference between the matched firms as the NASDAQ less the NYSE variable of interest. Δ symbolizes the paired difference. The sample comprises domestic dividend-paying firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9), over 1993 to 2014. The dependent variable in the regressions is Δ*PDR*, the difference in PDRs. *PDR* is the price change from the cum-day to the ex-day expressed as a fraction of *Dividend*. *Dividend* is the per share dividend amount. *Dividend/Trading Costs* is the ratio of *Dividend* to *Trading Costs*. *Trading Costs* is the sum of *Bid-Ask Spread* and trading commissions where trading commissions are levied at eight cents for 1993 to 1998, six cents for 1999 to 2002, and four cents for 2003 to 2014. *Bid-Ask Spread* is the dollar difference between the closing bid and ask quotes averaged over a 7-day period centered on the ex-day. *Firm Size* is the product of the cum-day share price and the number of shares outstanding on the cum-day. *Firm Risk* is the standard deviation of stock return over days [−50, −6] U [+6, +20] relative to the ex-day. *Trading Volume* is the average daily proportional trading volume, measured as the 60-day average of daily trading volume as a percentage of total shares outstanding over days [−50, −6] U [+6, +20] relative to the ex-dividend day. We follow Gao and Ritter (2010) and adjust NASDAQ trading volume to make it comparable to NYSE trading volume. $I_{1998\text{-}2002}$ is an indicator variable that equals one if the ex-day occurs in 1998 through 2002, inclusive. $I_{2003\text{-}2014}$ is an indicator variable that equals one if the ex-day occurs in 2003 through 2014, inclusive. Observations in the regressions are weighted according to the ratio of the dividend yield squared to the variance of stock returns estimated over days [−50, −6] U [+6, +20] relative to the ex-day. We use the NASDAQ sample to determine whether *Dividend/Trading Costs* are larger than or smaller than one. The *t*-statistics are in parentheses below each coefficient.

	***Dividend/Trading Costs* > 1**				***Dividend/Trading Costs* ≤ 1**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Regressors	**1993–2014**	**1993–2002**	**2003–2014**	**1993–2014**	**1993–2014**	**1993–2002**	**2003–2014**	**1993–2014**
Intercept	−0.04	−0.38***	0.01	−0.34**	−0.42***	−0.60***	−0.03	−0.61***
	(−1.34)	(−4.05)	(0.37)	(−2.16)	(−15.81)	(−18.56)	(−0.64)	(−16.08)
Δ(*Dividend/Trading Costs*)	0.00	−0.06	0.01	0.01	0.02	0.20	0.11***	0.12***
	(−0.03)	(−0.55)	(0.78)	(0.73)	(0.46)	(1.66)	(2.59)	(3.23)
Δ*Firm Size*	0.00	0.01**	−0.00	−0.00	−0.00	0.00	−0.00**	−0.00
	(−1.10)	(2.03)	(−1.48)	(−1.24)	(−0.60)	(0.97)	(−2.27)	(−1.26)
Δ*Firm Risk*	0.02	0.11	0.03	0.04	−0.06***	0.00	−0.07	−0.02
	(0.69)	(1.06)	(0.91)	(1.11)	(−2.80)	(−0.01)	(−1.62)	(−0.68)
Δ*Trading Volume*	0.01	−0.05	0.00	0.00	−0.00	−0.05**	0.02	−0.01
	(0.85)	(−1.35)	(0.65)	(0.52)	(−0.23)	(−2.38)	(1.28)	(−0.43)
$I_{1998\text{-}2002}$				−0.07				0.10*
				(−0.39)				(1.72)
$I_{2003\text{-}2014}$				0.35**				0.56***
				(2.19)				(9.74)
F-stat	0.72	1.54	1.08	4.13***	2.18*	2.39**	4.06***	17.92***
Observations	12,369	1,010	11,359	12,369	25,691	16,368	9,323	25,691

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

Table X. Regressions of the Percentage Price Drop on Dividend Yield

This table reports regressions based on Boyd and Jagannathan (1994) for the matched sample. The sample comprises domestic dividend-paying NASDAQ firms listed in the Center for Research in Security Prices (CRSP) (share codes 10 and 11) paying regular taxable cash dividends, that is, distribution types 12N2 ($N = 1$ to 9). The dependent variable in the regressions is the percentage price drop: the price change from the cum-day to the ex-day expressed as a fraction of the cum-day price. *Dividend Yield* (*DY*) is the ratio of the dividend amount to the cum-day share price. *NASDAQ* is an indicator variable that equals one if the observation comes from a NASDAQ-listed firm. The *t*-statistics, based on standard errors that are clustered by the ex-dividend date, are in parentheses below each coefficient.

Regressors	(1) 1993–2014	(2) 1993–2002	(3) 2003–2014	(4) 1988–1990
DY	0.98***	0.82***	1.09***	1.03***
	(11.30)	(9.25)	(7.97)	(7.57)
DY × *NASDAQ*	−0.25***	−0.57***	−0.15	−0.53***
	(−2.77)	(−5.66)	(−1.11)	(−3.41)
NASDAQ	0.00	0.00***	0.00	0.00
	(0.21)	(0.42)	(1.18)	(0.46)
Constant	−0.00***	−0.00	−0.00**	−0.00*
	(−3.86)	(−1.37)	(−3.65)	(−1.90)
F-stat	185.53***	66.27***	193.05***	56.28***
Observations	76,120	34,756	41,364	12,068

***Significant at the 0.01 level.
**Significant at the 0.05 level.
*Significant at the 0.10 level.

later period for both subsamples. Overall, the results from Tables VIII and IX suggest that the reduction in PDR difference is not confined to a subset of firms.

D. An Alternative Test of the Execution Costs Hypothesis versus the Tax Hypothesis

An alternative way to test the execution costs and tax hypotheses is to employ regressions based on Boyd and Jagannathan (1994). The possibility that nonunitary PDRs represent a trading opportunity for investors that do not face a tax differential between capital gains and dividend income is known as the “short-term trading hypothesis.” In regressions of the ex-day percentage price drop on dividend yield for NYSE firms, Boyd and Jagannathan (1994) find a slope coefficient largely indistinguishable from one. Within their framework, this suggests that short-term traders are the marginal price setters around ex-days, consistent with the short-term trading hypothesis. We run regressions of the ex-day percentage price drop on dividend yield for the matched sample.

The results are reported in Table X. In Model 1 we find that although the NYSE dividend yield (*DY*) slope coefficient is not statistically different from one [$t = (0.983 - 1)/0.0869 = -0.20$], the NASDAQ dividend yield slope coefficient of 0.73 ($= 0.98 - 0.25$) is significantly smaller than the corresponding matched NYSE sample over the 1993 to 2014 period (i.e., the coefficient on the interaction term *DY* × *NASDAQ* is negative and significant) and significantly less than one (*t*-statistic is −7.78). However, in Models 2 and 3 it becomes apparent that this difference is driven by the first half of the sample period (1993 to 2002). In Model 2 the coefficient on the NASDAQ interaction term *DY* × *NASDAQ* is negative and significant, whereas in Model 3 it is statistically indistinguishable from zero; that is, the NASDAQ dividend yield slope coefficient is not significantly different from its matched NYSE counterpart in the 2003 to 2014 period. This evidence is consistent with our earlier findings and supports the execution costs hypothesis.

As the 2003 to 2014 period corresponds to the period where the tax differential between capital gains and dividend income is zero, it can be argued that it is not surprising that the dividend yield slope coefficients is statistically indistinguishable between NASDAQ and the NYSE during this period. We thus compare the difference in slope coefficients across two subperiods where the tax differential is zero: 1988 to 1990 and 2003 to 2014.[25] In Model 4 we find that the NASDAQ dividend yield slope coefficient is significantly smaller than its matched NYSE counterpart (i.e., the coefficient on the interaction term $DY \times NASDAQ$ is negative and significant). In terms of magnitude, the NASDAQ dividend yield slope coefficient is about half that of the NYSE dividend yield slope coefficient during the 1988 to 1990 period. Thus, although the tax differential is zero during both the 1988 to 1990 and 2003 to 2014 periods and the NYSE dividend yield slope coefficient remains relatively constant, the NASDAQ dividend yield slope coefficient increases in the later period and becomes statistically indistinguishable from its matched NYSE counterpart. This evidence is not consistent with the tax hypothesis. Rather, this evidence is consistent with our earlier findings and provides further support for the execution costs hypothesis.

IV. Conclusion

Although the stylized fact that prices drop by less than the dividend amount on the ex-day has been noted for more than half a century, the focus has been almost exclusively on NYSE-listed firms. We compare NASDAQ ex-day price behavior to that of the NYSE. The NASDAQ sample is nontrivial as more than a third of all dividend observations come from NASDAQ. Is the ex-day price behavior of NASDAQ-listed firms similar to that of NYSE-listed firms? We find that it is not. The average NASDAQ PDR is significantly smaller than its NYSE counterpart. This is true for both the full sample and a matched sample based on characteristics that the prior literature deems important in explaining PDRs. Our results also hold for a subsample of firms that switch from NASDAQ to the NYSE. We do not find support for tax-based explanations of the PDR.

There have been many changes in the way stocks trade on NASDAQ. We find that the NASDAQ PDR increases through time and converges toward its matched NYSE counterpart, consistent with significant NASDAQ regulatory and structural reforms greatly reducing execution costs and improving price efficiency. Moreover, we find that the convergence in PDRs is across the board, occurring, for example, in both small and large firms, in firms with small bid-ask spreads and in firms with large bid-ask spreads. It appears that as the distinction between NASDAQ as a dealer market and the NYSE as an auction market becomes less pronounced, so too has the PDR difference between the two markets. Our results underscore the impact market structure can have on arbitrageurs' ability to employ dividend capture strategies.

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[25] We use the same matching criteria as we do in Table IV for the 1988-1990 subperiod.

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