



6-14-2018

# Are the stock markets "rigged"? An empirical analysis of regulatory change

Stephen Diamond

*Santa Clara University School of Law*

Follow this and additional works at: <https://digitalcommons.law.scu.edu/facpubs>



Part of the [Law Commons](#)

## Recommended Citation

Diamond, S.F., Kuan, J.W., 2018. Are the stock markets "rigged"? An empirical analysis of regulatory change. *International Review of Law and Economics* 55, 33–40. doi:<https://doi.org/10.1016/j.irle.2018.03.002>

This Article is brought to you for free and open access by the Faculty Scholarship at Santa Clara Law Digital Commons. It has been accepted for inclusion in Faculty Publications by an authorized administrator of Santa Clara Law Digital Commons. For more information, please contact [sculawlibrarian@gmail.com](mailto:sculawlibrarian@gmail.com), [pamjadi@scu.edu](mailto:pamjadi@scu.edu).



# Are the stock markets “rigged”? An empirical analysis of regulatory change<sup>☆</sup>

Stephen F. Diamond<sup>a,\*</sup>, Jennifer W. Kuan<sup>b</sup>

<sup>a</sup> Santa Clara University, United States

<sup>b</sup> Tulane University, United States



## ARTICLE INFO

### Article history:

Received 21 February 2018

Accepted 16 March 2018

Available online 22 March 2018

### Keywords:

Stock market  
High frequency trading  
Flash crashes  
Non-profit  
SEC

## ABSTRACT

Volatile events in the stock market such as the 2010 Flash Crash have sparked concern that financial markets are “rigged” in favor of trading firms that use high frequency trading (“HFT”) systems. We analyze a regulatory change implemented by the SEC in 2007 by examining its effect on a key market metric, the bid-ask spread, an investor cost, and find that the regulatory shift, indeed, disadvantages investors. We link the implementation of this change to a shift in the volume of trades from a low-cost venue to a high-cost venue. We argue that this outcome is predicted by the incentives of the venues, non-profit stock exchanges owned by different types of members. The less-volatile, lower-cost New York Stock Exchange was owned by underwriters and included a specialist system that is less vulnerable to HFT tactics that can disadvantage investors.

© 2018 Elsevier Inc. All rights reserved.

## 1. Introduction

On May 6, 2010, a dramatic price drop, now known widely as the “Flash Crash,” shocked major stock indices in the United States. Within five minutes nearly 1000 points had been wiped off the Dow Jones Index – approximately \$1 trillion or 9% of its value. Yet, within the following fifteen minutes, the Index regained the bulk of those losses. Such an extreme volatility event should be exceptionally rare, if not impossible, and yet it happened. Smaller versions of the Flash Crash now occur on a regular basis in the capital markets, typically hitting individual stocks. One study discovered more than 5000 such “mini flash crashes” during a four-month period (Golub et al., 2012). Coincident with the appearance of extreme market volatility is the new dominance of so-called high frequency trading (“HFT”) systems. Firms deploying these computerized order systems are now responsible for more than 60% of the trading volume in U.S.-listed stocks. HFTs engage in a range of complex trading tactics that take advantage of the new equally complex structure of the

capital markets. There is some evidence that the mechanisms used by HFTs contribute to flash crashes. This has led some to charge that the stock markets are now “rigged” (Lewis, 2014). We trace the emergence of extreme volatility and concerns about HFTs to an important regulatory change implemented by the Securities and Exchange Commission (“SEC”) in 2007. We measure the impact of this change empirically by examining its effect on a key market metric, the bid-ask spread, and find that the regulatory shift, indeed, disadvantages investors.

Until relatively recently, U.S. stock exchanges shared much in common with other regulated utilities. Exchanges were private firms that served an important public function but could have monopolistic tendencies. Indeed, from its founding in the late 18th century until approximately 2007, the New York Stock Exchange (NYSE) enjoyed near-monopoly status, listing a set of stocks and executing the vast majority of trades for those stocks. The Nasdaq, once it emerged in the 1970s, also achieved a near monopoly for a separate set of stocks that it listed.

Now, however, less than one-fourth of the trades of NYSE-listed stocks take place on the NYSE floor. The bulk of trading is now spread across as many as a dozen different trading venues, including so-called “dark pools” which do not share pricing data with other venues. This complex trading architecture enables HFTs to jump ahead of other investor orders or to create a false impression about the level of demand for certain stocks that can lead to trading profits for the HFT firms.

<sup>☆</sup> The authors wish to express their appreciation for comments received from Ran Abramitsky, Emek Basker, Janet Bercovitz, Shane Corwin, Kira Fabrizio, Deepak Hegde, Ha Hoang, Peter T. DeMarzo, Albert J. Menkveld, Minh T. Ngo, Joanne Oxley, Robert Seamans, David N. Smith, Lawrence Wu, Rosemarie Ziedonis, and Arvids Ziedonis, and from participants in conferences and workshops at Berkeley, Harvard, The New School, Northwestern, Santa Clara, Stanford, Tulane, and Yale.

\* Corresponding author.

E-mail address: sdiamond@scu.edu (S.F. Diamond).

However, stock exchanges differ from typical regulated utilities in two ways that have important implications for regulation beyond this narrow context. Specifically, both were member-owned nonprofit organizations and both contained self-regulatory functions. Nonprofit ownership raises analytical challenges in characterizing the incentives of an organization (Hansmann, 1980), and self-regulation complicates the effect of public regulation, which could either be a complement or a substitute for private ordering (DeMarzo et al., 2005). More broadly, while nonprofits might seem rare targets of regulation, they appear surprisingly often in such diverse settings as energy markets, health care, education, professional sports, industry trade groups and more.

How does nonprofit ownership affect self-regulation and public regulation? The stock market and a 2007 regulatory change, Regulation NMS (Reg. NMS), provide an opportunity to show how nonprofit incentives can be analyzed and understood in a regulatory context. Previous studies have explored the nonprofit organization of stock exchanges<sup>1</sup> but focused on their stock-trading function, such that the NYSE and Nasdaq were assumed to have identical objectives. However, an important finding of the nonprofit literature is that nonprofits can have heterogeneous objective functions even within the same industry or market (Hansmann, 1980; Gertler and Kuan, 2009). Existing models also overlook the fact that exchanges are two-sided markets (Parker and Van Alstyne, 2005; Rochet and Tirole, 2003), serving not just investors but also firms that list their shares. Combining these two observations, we posit an NYSE owned by underwriters who service listing firms (and therefore service investors who buy shares in those firms), and a Nasdaq owned by broker-dealers who profit from investor activity.<sup>2</sup>

The incentives of two such exchanges differ substantially from each other. The agency problem between a broker-dealer and investors in a broker-dealer-owned exchange is modeled in the literature (DeMarzo et al., 2005). By contrast, an underwriter-owned exchange involves vertical integration (Kuan, 2001), in which underwriters operate a marketplace to increase the value of their underwriting services. (Below, we describe in some detail how orderliness in trading can attract investors, who are the customers of underwriters' clients). The resulting incentive difference thus leads to a predictable performance difference between the two exchanges. A broker-dealer-owned exchange would maximize profits from investors' trades, while a vertically integrated exchange would offer trading services at a lower cost, possibly even below cost in a two-sided market (Rochet and Tirole, 2003). In short, the Nasdaq would provide higher-cost services than the NYSE.

Reg. NMS allows for a test of this hypothesis. Before 2007, a "best price rule" required brokers to route trades to the venue with the best posted price. For NYSE-listed stocks, this was typically the NYSE, so 80% or more of NYSE-listed stock trades took place on the NYSE, with the other 20% performed by smaller, regional exchanges

and the Nasdaq.<sup>3</sup> Reg. NMS replaced this rule and allowed brokers to route orders to the Nasdaq despite a better price on the manual trading floor of the NYSE.<sup>4</sup> Only orders placed on automated exchanges would now be protected against "trade throughs."

This regulatory change accommodates a difference-in-differences analysis. In the pre-change period, any Nasdaq trading of NYSE-listed stocks had to be at the NYSE price or better. Thus, prices were constrained by regulation to be equal, while post-change prices are de-constrained. We predict higher investor costs for the de-constrained, post-Reg. NMS Nasdaq trades in NYSE-listed stocks. Using stock trade data from a sample of over 200 NYSE-listed stocks 30 days before and after Reg. NMS, we show that spreads, a commonly used measure of investor cost, increase for trades on the Nasdaq relative to the NYSE.<sup>5</sup>

The literature offers several alternate hypotheses about the impact of Reg. NMS. First, regulators predicted that competition would lead to lower costs for investors (SEC, 2005b). Second, "cream-skimming" could occur in which an entrant, the Nasdaq, siphons off high-profit, uninformed, trades leaving lower-profit trades with the incumbent NYSE. This would raise investor costs at the NYSE (Bessembinder and Kaufman, 1997; Easley et al., 1996; Battalio et al., 1997).<sup>6</sup> Third, auction (dealer) markets might be better than dealer (auction) markets, in general (Huang and Stoll, 1996; Affleck-Graves et al., 1994; SEC, 2004). Our test does not quite address this last hypothesis because the design details of any auction or dealer market influence performance so significantly that we cannot claim to compare these two mechanisms in the abstract. Rather, we argue that owners make design choices based on their incentives and our analysis compares two realized sets of design decisions.

The dramatic changes in stock market structure since our period of analysis might suggest that this analysis is of historical interest only. Exchanges have proliferated, technology has made floor trading seem more archaic than in 2007, and neither the NYSE nor the Nasdaq is still a nonprofit. However, while a complete analysis of the current industry structure is beyond the scope of this paper, we would argue that our analysis actually helps explain today's often bewildering stock market by reinterpreting the institutional design and self-regulation of the NYSE as part of a vertically integrated system where private incentives generated a low-cost, orderly market that attracted investors and listings. More broadly, our study suggests that the incentives of nonprofits should be carefully considered because they may differ from those of for-profits and even other nonprofits in the same market, and that these incentives,

<sup>3</sup> The best price rule explains, in large part, why the NYSE so long dominated trading of NYSE stocks. Nasdaq had a monopoly in trading Nasdaq stocks because the NYSE did no trading of Nasdaq stocks.

<sup>4</sup> Specifically, the trade-through provisions of Reg. NMS require brokers to route orders to the automated venue posting the best price. The floor of the NYSE is not automated unlike the Nasdaq and the newest entrants, electronic communications networks (ECNs). The rule change was intended to give investors a choice, allowing them to choose the faster trade execution enabled by automation even though the execution price might be worse.

<sup>5</sup> An important question is why investors would choose a high-cost venue over a low-cost venue. While some of the shift in volume was perhaps due to investors choosing faster execution over better prices, earlier "cream-skimming" studies predict that volume would shift to electronic trading venues that pay brokers to route uninformed trades to their higher-cost venues, i.e., "payment for order flow." An "arms race" among HFTs emerged to profit from this "cream," contributing additional trading volume to the automated venues (Budish et al., 2015).

<sup>6</sup> SEC Rule 19c-3 allowed dealers to pay to shift profitable "uninformed" trades to non-NYSE venues but only applied to certain NYSE stocks. This restriction makes a difference in differences comparison possible. Battalio et al. (1997) find that after the profitable, small-sized, uninformed trades moved to alternative venues, spreads increased for the NYSE stocks that were included in the Rule, but the analysis did not decompose the trades by venue to identify which trades had caused the increase.

<sup>1</sup> Pirrong (2000) and Hart and Moore (1996) examine the reasons for nonprofit organization; and a literature on demutualization explores the role of technology in exchanges demutualization (Aggarwal, 2002; Steil, 2002; Stoll, 2002).

<sup>2</sup> Institutional details are informative. Prior to its 2006 IPO, underwriters dominated the NYSE (Gasparino, 2007; Harris, 2010; NYSE, 2006) and listed only those firms that met stringent, formal listing requirements. Long before the federal regulation of disclosures to investors, the NYSE mandated disclosures by their listed firms, following the "due diligence" practices developed by underwriting banks (Loss and Seligman, 2006; Carosso, 1970). By contrast, the Nasdaq – an acronym for the National Association of Securities Dealers Automated Quotation system – is a computer network that knits together a loose confederation of broker-dealers. The Nasdaq evolved out of the older over-the-counter market, which traded unlisted securities. Once established as a venue for listing, its culture of trading weaker firms continued, with minimal listing standards.

which are susceptible to analysis, can affect self-regulation and the effectiveness of public regulation.

## 2. Background

The NYSE formed over 200 years ago when traders began gathering informally on Wall Street. [Michie \(1987\)](#) and [Geisst \(1997\)](#) detail the long historical process of institutional change at the Exchange, which included moving trading activity indoors, formal incorporation, competition with a variety of formal and informal exchanges, and the adoption and adaptation of mechanisms, rules, and procedures, including restrictive membership and listing requirements. Thus, trading on the Exchange was limited to the carefully vetted owners of 1366 “seats,” a number that was set in the mid-20th century and remained the same until the Exchange’s demutualization in 2006. Its listing standards meant that only a limited subset of publicly traded firms could sell their shares on the Exchange.

Emerging from a longstanding but informal over the counter (“OTC”) trading market, the Nasdaq began formal operation in 1971 with the expectation that it could compete with the NYSE if the barriers between OTC and exchange-listed securities were removed. The Nasdaq comprises broker-dealers connected initially by telephone and later by a computer network. It was immediately more inclusive than the clubby NYSE. Thus, even unprofitable firms could trade on this market, and dealers needed only be members of the NASD to participate in that trading. By the mid-1990s the NASD had 5400 firms with more than 57,000 branch offices and “nearly 500,000 registered securities professionals” (NASD Report cited in [Loss and Seligman, 2006](#) at 703). With more than 5500 listed companies, Nasdaq dealers in the mid-1990s traded in the stocks of more than twice as many firms as the NYSE. The Nasdaq’s listing standards were far laxer than those at the NYSE, which reflected the entity’s origins in the weakly regulated OTC market. One study, for example, found the Nasdaq’s standards to be “partially responsible for the influx of poorly-performing IPOs during the Nasdaq market bubble of the late 1990s” ([Klein and Mohanram, 2005](#)).

While the original goal of the Nasdaq to engage as a direct competitor in trading of NYSE listed securities was long delayed, the Nasdaq served as a useful complement to the NYSE. The two exchanges differed in several ways, in addition to the significantly larger number of listings on the Nasdaq. Quality seemed to be lower at the Nasdaq, where the total market capitalization was less than that of the NYSE despite the much greater number of listed firms. Different trading mechanisms were chosen by each exchange. Using the computer network that is the foundation of the Nasdaq, dealers take part in both sides of every trade, buying from sellers and selling to buyers. The NYSE employs a manual floor trading process that *appears* to be the outdated holdover of a centuries-old institution. However, our proposition that trading is a complement to underwriting calls for a closer examination of this key institutional feature.

For each listed firm, the NYSE assigns a specialist who conducts all of the trades of a firm’s shares at a single trading post. The specialist (called a “designated market maker” in the post-Reg. NMS environment) is subject to rules that ensure an orderly price discovery process. Under the NYSE’s continuous “double auction” mechanism, the specialist repeatedly gathers all buy and sell orders and sets a quote for bids and asks. This quote, by rule, must be close to the previous bids and asks (NYSE, Rule 104). Buyers are then matched to sellers by the specialist acting as a broker (or agent). Any unmatched residual is bought (sold) by the specialist acting as a dealer (or principal), if necessary, to maintain a “fair and orderly” market (Exchange Act Sec. 11(b) and Rule 11b-1; NYSE Rule 104). Note that the NYSE’s *sauction mechanism* differs from the Nasdaq’s pure *dealer mechanism*, in which the dealer is the counter-party on

both sides of every transaction. The Nasdaq dealer buys from third party sellers, resells to third party buyers, and thus profits from a wider spread while not being required to enter the market to ensure orderliness.

While the privileged information that a specialist enjoys is potentially valuable, rules and enforcement minimize its exploitation ([Mann and Seijas, 1991](#); [Dutta and Madhavan, 1995](#); [Battalio et al., 2007](#); [Madhavan and Panchapagesan, 2000](#), 655; but see [SEC 2005a](#)). If trading is viewed as a complement to underwriting, specialists are best understood as having been, prior to the implementation of Reg. NMS, agents of the underwriter-owners of the NYSE, and rule enforcement can be modeled as the outcome of a principal-agent relationship. This is notably different from the self-regulation by Nasdaq of its members, who are peers ([SEC, 1996](#)).

An empirical literature has tried to measure the effects of different exchange features. Bid-ask spreads, for example, a measure of investor cost and disorderliness, are higher for Nasdaq stocks, but this could be the result of the underlying riskiness of the stocks or of the Nasdaq’s dealer mechanism. Because each exchange monopolized trading of (an almost) disjoint sets of stocks, direct comparisons of trading mechanisms have been impossible.<sup>7</sup> Reg. NMS allows for a better test, as NYSE stocks now trade freely at different prices on both exchanges.

In replacing the old “best price” rule with what is now known as the “trade through” rule, Reg. NMS initiated substantial structural changes to the stock market. But even before Reg. NMS was implemented, change had already begun. The final regulation was adopted in August 2005; six months later, the NYSE demutualized via a merger with the publicly-traded Archipelago, an ECN ([Diamond and Kuan, 2006](#)). NYSE members thereby agreed to convert their nonprofit into a publicly traded, investor-owned for-profit corporation. While Reg. NMS and demutualization might seem to be two unrelated events, our model of vertical integration suggests otherwise. If underwriters who were vertically integrated with trading could no longer produce orderliness, they would sell their trading operation. And loss of control over orderliness was predictable; the NYSE’s share of trading volume in NYSE listed stocks began a steep decline to 25% (see [Fig. 1](#)) so that prices of those stocks were no longer set solely by the NYSE.

Final implementation of Reg. NMS took an additional year and a half after NYSE demutualization so that the NYSE and Nasdaq were both for-profit firms at the time of our empirical study.<sup>8</sup> We nevertheless interpret our results as reflecting the incentives of two different ownership interests, each of which instituted long-lasting mechanisms and structures that take time to dismantle. So, while a merger might reduce the NYSE’s self-regulatory activity, the dealer and auction mechanisms, which are of particular relevance for our study, remained. Moreover, if the NYSE’s low-cost mechanism degraded toward a higher-cost mechanism, it would only work against our hypothesis and weaken our results.

## 3. Hypotheses

The interpretation of the bid-ask spread as an investor cost is well established in the literature, but is particularly appropriate in

<sup>7</sup> Empirical strategies for comparing mechanisms include using matched pairs of stocks from the NYSE and Nasdaq. This is challenging because NYSE-listed firms have much bigger market capitalizations, which is a match dimension ([Huang and Stoll, 1996](#); [Affleck-Graves et al., 1994](#)). An alternative approach uses the relatively few firms that move their listings from the Nasdaq to the NYSE as the basis of comparison ([Christie and Huang, 1994](#); [Barclay et al., 1998](#); [SEC, 2004](#)). The studies find lower bid-ask spreads at the NYSE but are problematic because of selection issues, as those stocks might be less risky, for example.

<sup>8</sup> The NASD began the process of divesting and demutualizing the Nasdaq in 2000, well before Reg. NMS, and finally completed that process at the end of 2006.

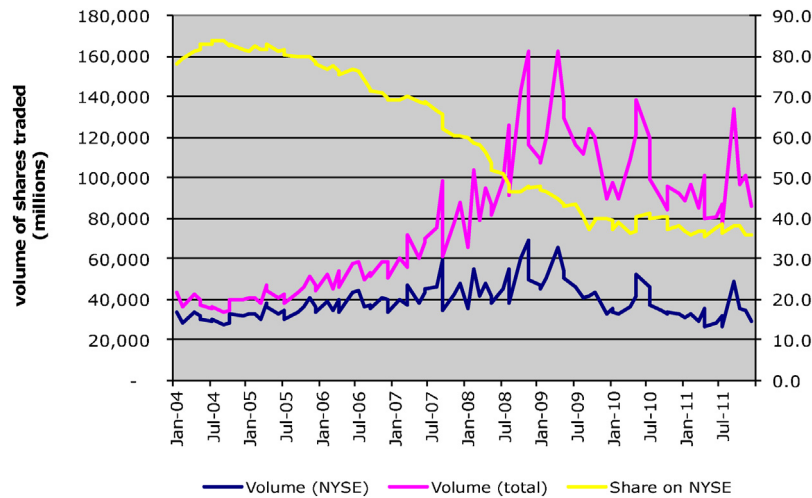


Fig. 1. Trading Volume for all NYSE-listed stocks (Jan 2004–Dec 2011).

our case because heterogeneous ownership generates a hypothesis about differential spreads. Dealers profit directly from spreads, buying low and selling high from their customers, while underwriters have the opposite incentive, to reduce spreads to attract investors for their underwriting clients. Thus, we hypothesize that before Reg. NMS, spreads for NYSE-listed stocks are the same on both exchanges by rule, but increase for trades on the Nasdaq after Reg. NMS. Competing hypotheses are presented in the literature, as mentioned above.

We estimate a fixed effects difference-in-differences model using panel data:

$$s_{ijt} = a + b_1 \text{nasdaq}_{ijt} + b_2 \text{after}_{ijt} + b_3 \text{trend}_{ijt} + b_4 \text{nasdaq}_{ijt} * \text{after}_{ijt} + b_5 \text{trend}_{ijt} * \text{after}_{ijt} + e_{it} \quad (1)$$

where the dependent variable,  $s_{ijt}$ , is the bid-ask spread for stock  $i$  on exchange  $j$  at time  $t$ . *Nasdaq* is 1 for Nasdaq spreads and the omitted category is NYSE. *After* is 1 if time  $t$  is after Reg. NMS implementation. The explanatory variable is the interaction between *nasdaq* and *after*. We hypothesize that this interaction will be positive, as spreads on Nasdaq trades increase relative to NYSE trades.

As a robustness check, we include a time-trend variable, *trend*, the time period in days. The interaction term *trend\*after*, interacts the time-trend with “after Reg. NMS” to detect whether our results are driven by a general time trend or only begin after the regulation.

#### 4. Data

We follow the literature on several dimensions of our empirical strategy. In addition to measuring daily bid-ask spreads (Corwin and Schultz, 2012) in a differences-in-differences design, we also use a broad cross section of stocks, decompose the spread by venue (Bessembinder and Kaufman, 1997), and use a 30-day event window. Also, we use transaction data from the Wharton Research Data Services (WRDS) Trade and Quote (TAQ) dataset, which provides the timing and size of each trade, the price for each transaction, and the exchange where the trade took place.

##### 4.1. Sample

We restrict our attention to NYSE-listed stocks because Reg. NMS affects the NYSE’s monopoly position in trading, not the Nasdaq’s. Recall that the Nasdaq’s monopoly in trading is the result of the NYSE’s organizational design, which provides no mechanism for trading Nasdaq-listed stocks. We selected a sample of 222 stocks

from a variety of industries in the top quartile of trading volume and market capitalization. Together, they account for about 15% of the industrial firms listed on the NYSE.

We selected actively traded stocks because of the endogeneity of trading volume and spreads: on the one hand, liquidity is associated with smaller spreads; on the other hand, lower spreads might encourage people to trade, thus increasing liquidity. So, if Reg. NMS caused spreads to decrease, as some of the alternate hypotheses predict, we might worry that the measured decline in spreads was conflating the effect of Reg. NMS with increased liquidity as lower spreads attracted more investors. By restricting our attention to stocks that always trade heavily, we minimize the effect of liquidity changes on spread, and thus also do not control for volume in the regressions. Selecting only heavily traded stocks addresses a second liquidity problem, as well. If the share of trading shifted significantly away from the NYSE to the Nasdaq, the decrease in liquidity causes an identification problem. However, because “liquidity can obtain in fragmented trading, at least for the most active securities” (O’Hara, 2004, 43), we use only heavily traded stocks to avoid falling below a liquidity threshold.

##### 4.2. Spread decomposition

For each stock in our sample, we calculate the spread twice for each day: once using Nasdaq transactions and once using NYSE transactions. Recall that although we have described the NYSE as having a near-monopoly, 20% of trades of NYSE-listed stocks had traded on the Nasdaq long before Reg. NMS. So, for each stock on each day, we can separate Nasdaq transactions from NYSE transactions and calculate a separate spread for each exchange’s transactions. In this way, we can compare the spread generated by trading activity on the Nasdaq with the spread generated by trading activity on the NYSE for the same stock on the same day. We follow Bessembinder and Kaufman (1997) in decomposing spreads in this manner.

##### 4.3. Event window

Our time window for analysis is the 30 trading days before and after the implementation of Reg. NMS, which began on July 9, 2007. While 30 days is a relatively short time in which to see large changes in market outcomes, the time window is intentionally small in order to isolate the effects of regulatory change from other changes in the market. Again, to select the size of our event window, we follow existing studies including Easley et al. (1996),



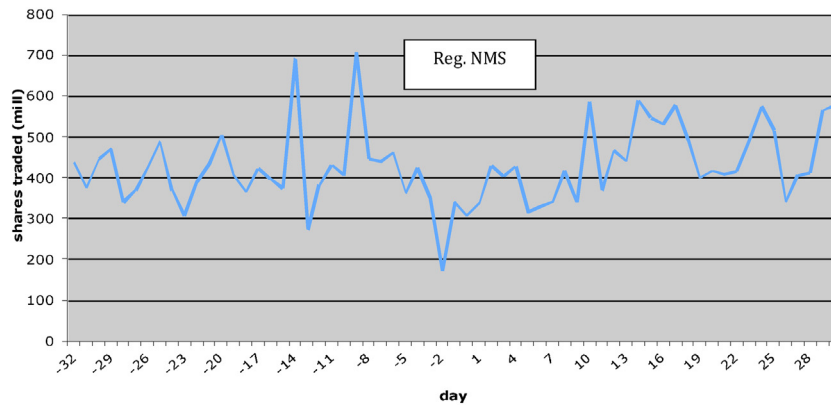


Fig. 2. Average difference in trading volume for sample (mill shares): NYSE transactions – Nasdaq transactions.

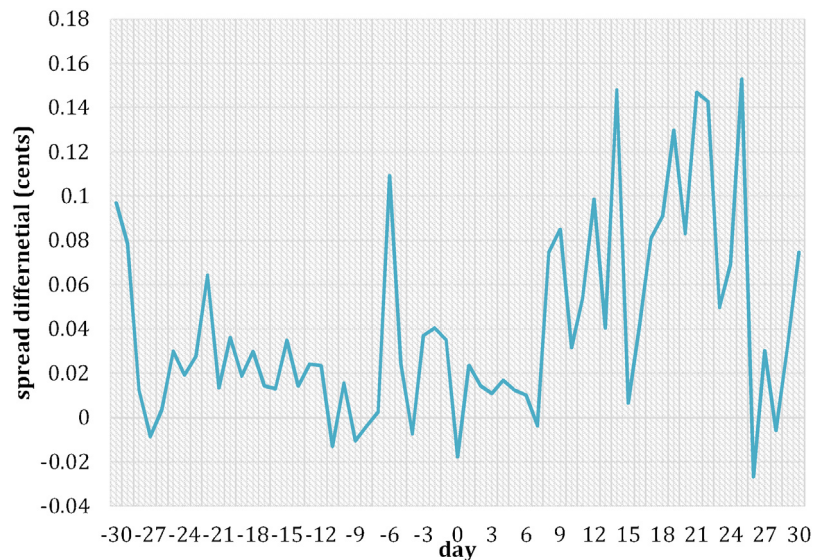


Fig. 3. Spread differential over event date.

Battalio et al. (1998), Foucault and Menkveld (2008), and Chung and Chuwonganant (2012) who also study Reg. NMS and find a decline in other indicators of market quality after its implementation. The SEC also applied a similar 60-day event window to its pilot study for Reg. NMS.<sup>9</sup>

Figs. 2 and 3 plot descriptive statistics for our sample over the event window. Fig. 2 shows no appreciable shift in average trading volume for our sample stocks over the event window—certainly nothing as great as the eventual shift in trading volume seen in Fig. 1. Fig. 3 shows our metric of interest, the average spread differentials for NYSE and Nasdaq transactions for our sample (i.e., Nasdaq spread – NYSE spread). A slightly higher level after Reg. NMS may be discernable, as is a positive differential even before Reg. NMS.

## 5. Results

Table 1 presents results from variations of the model in Eq. (1), where spread is measured in cents (i.e., calculated spread is multi-

plied by 100). Model 1 is the basic specification in Eq. (1). We find that the interaction term is positive and significant, indicating that Nasdaq spreads for NYSE-listed shares increase relative to NYSE spreads after Reg. NMS.

We also find that Nasdaq spreads are higher overall than NYSE spreads. One explanation for this is that Nasdaq trades met the posted NYSE quote, while NYSE transactions occurred inside the quote, i.e., at a better price. This would be consistent with Petersen

Table 1

Change in bid-ask spread of trades before and after the implementation of Reg. NMS (July 9, 2007).

	(1)	(2)	(3)
Nasdaq (y = 1)	0.024*** (0.004)	0.024*** (0.004)	0.024*** (0.004)
After	0.163*** (0.015)	-0.054** (0.022)	-0.550*** (0.059)
Nasdaq*after	0.033*** (0.007)	0.033*** (0.007)	0.033*** (0.007)
Trend		0.007*** (0.001)	0.001 (0.001)
Trend*after			0.014*** (0.001)
R2 (within)	0.013	0.020	0.026
R2 (between)	0.053	0.044	0.053
R2 (overall)	0.013	0.019	0.026
N	27,166	27,166	27,166

Notes. Values are estimated coefficients, with standard errors in parentheses. The dependent variable is the bid-ask spread.

\* Significantly different from zero at the 10% level.

\*\* Significantly different from zero at the 5% level.

\*\*\* Significantly different from zero at the 1% level.

<sup>9</sup> The SEC ordered a pilot test of Reg. NMS and asked the NYSE to select 100 listings for a 30-day test, which began July 9, 2007. We constructed our distinct sample by selecting all large-cap, heavily traded stocks in the same industries as the pilots. Because there were no technological barriers to implementing the new Order Protection Rule on July 9 for all listings, we tested whether trades for pilot stocks were routed differently than other NYSE stocks and found that they were not. We therefore take July 9 to be the start date for Reg. NMS generally for all NYSE listings.

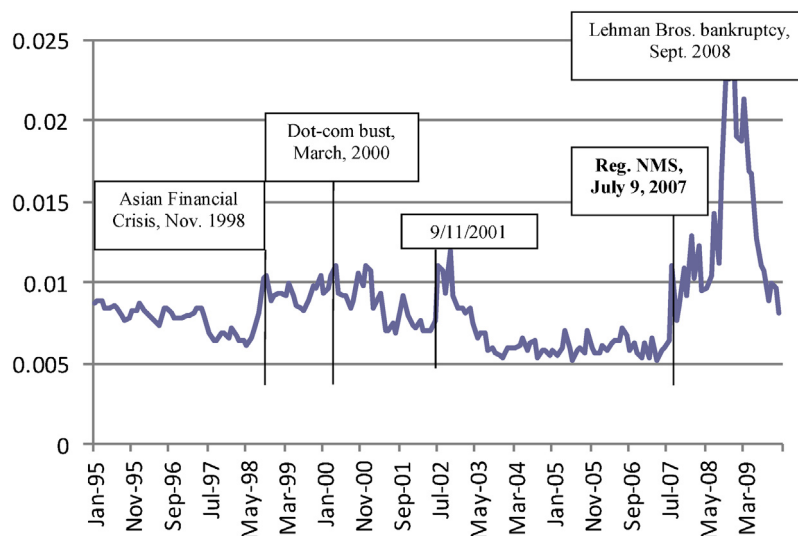


Fig. 4. Average Bid-Ask Spread (\$) for NYSE-listed stocks, Jan 1995–Dec 2009.

and Fialkowski's (1994) findings that actual spreads are half the size of posted spreads for trades on the NYSE.

Model 1 also shows a secular increase in spreads after Reg. NMS. Models 2 and 3 present our robustness check, by adding a control for a time trend. The results show a positive and significant effect of time. However, Model 3, which interacts the time trend with *after NMS*, shows that the time trend begins after Reg. NMS, with no trend before Reg. NMS. This suggests that the effects of regulation might occur gradually.

The average spread in our sample is 0.53 cents for NYSE trades and 0.57 cents for Nasdaq trades. The coefficients, also reported in cents, suggest that spreads increase by 0.033 cents, or 6%, for Nasdaq trades relative to NYSE trades in the first month of the new regulation. This is in addition to higher spreads for Nasdaq trades generally of about 0.024 cents, or 4.5%. Thus, the first month of Reg. NMS saw a difference in spreads between NYSE and Nasdaq trades of 10%. The longer-term descriptive data in Fig. 4 suggest that spreads increase substantially more over time.

Note that our results allow us to reject alternate hypotheses. The competitive outcome of lower spreads does not obtain, nor does the no-change outcome. Rather, market outcomes are driven by heterogeneous incentives.

## 6. Discussion & conclusion

Nonprofits are not always strange animals. In fact, sometimes they do exactly what a for-profit would do, as was the case with the nonprofit and for-profit versions of the Nasdaq. But nonprofits can behave differently than for-profits for predictable reasons and in predictable ways.

In this study, we provide an example of a nonprofit member organization vertically integrating into stock trading to enhance underwriting profits. While underwriting activity gets less attention than trading, it is a lucrative business in which a single initial public offering (IPO) can easily generate tens of millions – and even hundreds of millions – of dollars in fees for the lead underwriters (Ho and Demos, 2014). To maximize that business, underwriters, which we posit have long dominated the NYSE, ensured that trading was orderly, i.e., continuous and relatively smooth, by tightly regulating specialists. This helped prevent the development of a “lemons” problem at the NYSE (Akerlof, 1970), which in turn enabled underwriters to generate higher and more accurate IPO valuations and, therefore, higher underwriting profits. Our institu-

tional analysis highlights the incentives behind mechanisms and outcomes that are often taken for granted, with recent problems serving as counterfactuals. Events such as the “flash crash” of 2010 and the allegations of market “rigging” in favor of so-called “high frequency traders” (Lewis, 2014), can undermine investor confidence in the market. In addition, botched IPOs, such as that of Facebook on the Nasdaq and BATS on its own internal trading system, demonstrate that the underwriting process is difficult and complex.

The stock market is an economically important institution, but it is just one of many regulated industries. Nonprofits are frequently involved in providing public goods, often as monopolies. This study demonstrates the importance of carefully analyzing nonprofit incentives, including their potential heterogeneity.

(\*foreign-owned; \*\*exchange traded fund; \*\*\*out of business)

ABI APPLERA CORP  
 ABT ABBOTT LABORATORIES  
 ABY ABITIBI CONSOLIDATED INC\*\*  
 ACI ARCH COAL INC  
 AEO AMERICAN EAGLE OUTFITTERS INC NE  
 AET AETNA INC NEW  
 AG AGCO CORP  
 AHM AMERICAN HOME MORTGAGE INVT CORP \*\*\*  
 AIG AMERICAN INTERNATIONAL GROUP INC  
 ANF ABERCROMBIE & FITCH CO  
 AT ALLTEL CORP  
 BR BROADRIDGE FINANCIAL SOLUTIONS INC  
 BTU PEABODY ENERGY CORP  
 C CITIGROUP INC  
 CAG CONAGRA INC  
 CAH CARDINAL HEALTH INC  
 CAL CONTINENTAL AIRLINES INC  
 CCJ CAMECO CORP \*\*  
 CCU CLEAR CHANNEL COMMUNICATIONS INC  
 CNP CENTERPOINT ENERGY INC  
 CNQ CANADIAN NATURAL RESOURCES LTD \*  
 CPB CAMPBELL SOUP CO  
 D DOMINION RESOURCES INC VA NEW  
 DNA GENENTECH INC  
 DOW DOW CHEMICAL CO  
 DOX AMDOCS LTD \*\*  
 DRL DORAL FINANCIAL CORP  
 ED CONSOLIDATED EDISON INC

EEM ISHARES TRUST \*\*  
 EIX EDISON INTERNATIONAL  
 EP EL PASO CORP  
 EWT ISHARES INC  
 FCS FAIRCHILD SEMICONDUCTOR INTL INC  
 FMT FREMONT GENERAL CORP  
 FRX FOREST LABS INC  
 GCI GANNETT INC  
 GD GENERAL DYNAMICS CORP  
 GE GENERAL ELECTRIC CO  
 GS GOLDMAN SACHS GROUP INC  
 GSF GLOBALSANTAFE CORP \*  
 HC HANOVER COMPRESSOR CO  
 HES HESS CORP  
 HIG HARTFORD FINANCIAL SVCS GRP INC  
 HK PETROHAWK ENERGY CORP  
 HON HONEYWELL INTERNATIONAL INC  
 HRB BLOCK H & R INC  
 IBN ICICI BANK LTD \*  
 IGT INTERNATIONAL GAME TECHNOLOGY  
 IMH IMPAC MORTGAGE HOLDINGS INC \*\*  
 IP INTERNATIONAL PAPER CO  
 JNJ JOHNSON & JOHNSON  
 JPM JPMORGAN CHASE & CO  
 KG KING PHARMACEUTICALS INC  
 KSS KOHLS CORP  
 LM LEGG MASON INC  
 LOW LOWES COMPANIES INC  
 LTR LOEWS CORP  
 MAS MASCO CORP  
 MDT MEDTRONIC INC  
 MO ALTRIA GROUP INC  
 MRK MERCK & CO INC  
 MRO MARATHON OIL CORP  
 MS MORGAN STANLEY DEAN WITTER & CO  
 MTG M G I C INVESTMENT CORP WIS  
 NEM NEWMONT MINING CORP  
 NFX NEWFIELD EXPLORATION CO  
 NLY ANNALY CAPITAL MANAGEMENT INC \*\*  
 NRG N R G ENERGY INC  
 NSM NATIONAL SEMICONDUCTOR CORP  
 NWS NEWS CORP  
 NYT NEW YORK TIMES CO  
 PDP POWERSHARES ETF TRUST\*\*  
 PG PROCTER & GAMBLE CO  
 PGR PROGRESSIVE CORP OH  
 PHM PULTE HOMES INC  
 PRU PRUDENTIAL FINANCIAL INC  
 Q QWEST COMMUNICATIONS INTL INC  
 RDC ROWAN COMPANIES INC  
 RDN RADIAN GROUP INC  
 RRI RELIANT ENERGY INC  
 RYL RYLAND GROUP INC  
 SAP SAP AG\*  
 SKM S K TELECOM CO LTD \*  
 SKS SAKS INC  
 SLR SOLECTRON CORP  
 STZ CONSTELLATION BRANDS INC  
 SVM SERVICEMASTER CO  
 T AT & T INC  
 TIE TITANIUM METALS CORP  
 TIN TEMPLE INLAND INC  
 TOL TOLL BROTHERS INC  
 TRI TRIAD HOSPITALS INC  
 TV GRUPO TELEVIS SA\*  
 VG VONAGE HOLDINGS CORP

VIA VIACOM INC NEW  
 WCI W C I COMMUNITIES INC

## References

- Affleck-Graves, John, Hegde, Shantaram, Miller, Robert, 1994. Trading mechanisms and the components of the bid-ask spread. *J. Finance* 49 (4), 1471–1488.
- Aggarwal, Reena, 2002. Demutualization and corporate governance of stock exchanges. *J. Appl. Corporate Finance* 15 (Spring), 105–113.
- Akerlof, George, 1970. The market for 'lemons' quality uncertainty and the market mechanism. *Q. J. Econ.* 9, 629–650.
- Barclay, Michael, Kandel, Eugene, Marx, Leslie, 1998. The effects of transaction costs on stock prices and trading volume. *J. Financ. Intermediation* 7, 130–150.
- Battalio, Robert, Greene, Jason, Jennings, Robert, 1997. Do competing specialists and preferencing dealers affect market quality. *Rev. Financ. Stud.* 10 (4), 969–993.
- Battalio, Robert, Greene, Jason, Jennings, Robert, 1998. Order flow distribution, bid-ask spreads, and liquidity costs: Merrill Lynch's decision to cease routinely routing orders to regional stock exchanges. *J. Financ. Intermediation* 7, 338–358.
- Battalio, Robert, Ellul, Andrew, Jennings, Robert, 2007. Reputation effects in trading on the New York stock exchange. *J. Finance* 62 (3), 1243–1271.
- Bessembinder, Hendrik, Kaufman, Herbert, 1997. A comparison of trade execution costs for NYSE and Nasdaq-listed stocks. *J. Financ. Quant. Anal.* 32 (3), 287–310.
- Budish, Eric, Peter, Cramton, Shim, John, 2015. The high-frequency trading arms race: frequent batch auctions as a market design response. *Q. J. Econ.* 130 (November (4)), 1547–1621.
- Carosso, Vincent P., 1970. *Investment Banking in America: A History.*
- Christie, William, Huang, Roger, 1994. Market structures and liquidity: a transactions data study of exchange listings. *J. Financ. Intermediation* 3, 300–326.
- Chung, Kee H., Chuwonganant, Chairat, 2012. Regulation NMS and market quality. *Financ. Manage. (Summer)*, 285–317.
- Corwin, Shane, Schultz, Paul, 2012. A simple way to estimate bid-ask spreads from daily high and low prices. *J. Finance* 67 (2), 719–760.
- DeMarzo, Peter, Fishman, Michael, Hagerty, Kathleen, 2005. Self-regulation and government oversight. *Rev. Econ. Stud.* 72, 687–706.
- Diamond, Stephen F., Kuan, Jennifer W., 2006. Ringing the bell on the NYSE: might a nonprofit stock exchange have been efficient? *Duquesne Bus. Law J.* 9 (Spring), 1–18.
- Dutta, Prajit, Madhavan, Ananth, 1995. Price continuity rules and insider trading. *J. Financ. Quant. Anal.* 30 (2), 199–221.
- Easley, David, Kiefer, Nicholas M., O'Hara, Maureen, 1996. Cream-skimming or profit-sharing? The curious role of purchased order flow. *J. Finance* (July), 811–833.
- Foucault, Thierry, Menkveld, Albert, 2008. Competition for order flow and smart order routing systems. *J. Finance* (February), 119–158.
- Gasparino, Charles, 2007. *King of the Club: Richard Grass and the Survival of the New York Stock Exchange.*
- Geisst, Charles R., 1997. *Wall Street: A History.*
- Gertler, Paul, Kuan, Jennifer, 2009. Does it matter who your buyer is? The role of nonprofit mission in the market for corporate control of hospitals. *J. Law Econ.* 52 (May), 295–306.
- Golub, Anton, John, Keane, Ser-Huang, Poon, 2012. High Frequency Trading and Mini Flash Crashes (November 28, 2012), Available at SSRN: <https://ssrn.com/abstract=2182097> or <https://doi.org/10.2139/ssrn.2182097>.
- Hansmann, Henry, 1980. *The role of nonprofit enterprise.* Yale Law J. 89, 835–901.
- Harris, Lawrence (Ed.), 2010. *Regulated Exchanges: Dynamic Agents of Economic Growth.* Oxford University Press.
- Hart, Oliver, Moore, John, 1996. The governance of exchanges: members' cooperatives versus outside ownership. *Oxford Rev. Econ. Policy* 12 (4), 53–69.
- Ho, Prudence, Demos, Telis, 2014. Alibaba to pay underwriters 1% of U.S. IPO as base fee. *Wall Street J.* (March).
- Huang, Roger, Stoll, Hans, 1996. Dealer versus auction markets: a paired comparison of execution costs on NASDAQ and the NYSE. *J. Financ. Econ.* 41, 313–357.
- Klein, April, Mohanram Partha, S., April 2005. Why Did so Many Poor-Performing Firms Come to Market in the Late 1990s?: Nasdaq Listing Standards and the Bubble. NYU Working Paper No. APRIL KLEIN -8, Available at SSRN: <https://ssrn.com/abstract=1280678>.
- Kuan, Jennifer W., 2001. The phantom profits of the opera: nonprofit ownership in the arts as a make-buy decision. *J. Law Econ. Organ.* 17, 507–521.
- Lewis, Michael, 2014. *Is the U.S. Stock Market Rigged?* 60 Minutes, March 30.
- Loss, Louis, Seligman, Joel, 2006. *Fundamentals of Securities Regulation.*
- Madhavan, Ananth, Panchapagesan, Venkatesh, 2000. Price discovery in auction markets: a look inside the black box. *Rev. Financ. Stud.* 123 (3), 627–658.
- Mann, Steven, Seijas, Robert, 1991. Bid-ask spreads, NYSE specialists, and NASD dealers. *J. Portf. Manage.*, 54–58, Fall.
- Michie, R.C., 1914. *The London and New York Stock Exchanges, 1850–1914.*
- NYSE Group, Inc., 2006. *Registration Statement on Form S-1, Amendment No. 4, May 4.*
- O'Hara, Maureen, 2004. Searching for a new center: U.S. securities markets in transition. *Econ. Rev.*, 37–52, Federal Reserve Bank of Atlanta, Fourth quarter.
- Parker, Geoffrey, Van Alstyne, Michael, 2005. Two-sided network effects: a theory of information product design. *Manage. Sci.* 51 (10), 1494–1504.



- Petersen, Mitchell A., Fialkowski, David, 1994. [Posted versus effective spreads: good prices or bad quotes?](#) *J. Financ. Econ.* 35, 269–292.
- Pirrong, Craig, 2000. [A theory of financial exchange organization.](#) *J. Law Econ.* 43 (2), 437–472.
- Rochet, Jean-Charles, Tirole, Jean, 2003. [Platform competition in two-sided markets.](#) *J. Eur. Econ. Assoc.* 1 (June (4)), 990–1029.
- Securities and Exchange Commission, 1996. [Report Pursuant to Section 21\(a\) of the Securities Exchange Act of 1934 Regarding the NASD and the NASDAQ Market.](#)
- Securities and Exchange Commission, 2004. [Analysis of Volatility for Stocks Switching from Nasdaq to NYSE, December 15.](#)
- Securities and Exchange Commission, 2005a. [In the matter of the New York Stock Exchange, Rel. No. 34-51524 \(April 12\).](#)
- Securities and Exchange Commission, 2005b. [Regulation NMS \(Release No. 34-51808, June 9\).](#)
- Steil, Benn, 2002. [Changes in the ownership and governance of securities exchanges: causes and consequences.](#) In: *Brookings-Wharton Papers on Financial Services.*, pp. 61–82.
- Stoll, Hans, 2002. [Changes in the ownership and governance of securities exchanges: comment and discussion.](#) In: *Brookings-Wharton Papers on Financial Services.*, pp. 83–90.