

## Bears and Bulls: Greater Volatility without Ticks?

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A 2007 rule change regarding short sales in equity markets changed the markets and perhaps the volatility thereof. During the majority of modern history of the United States equity market investors have only been allowed to conduct short sales after an upward price movement on the security. Rule 10a-1 of the Securities and Exchange Act of 1934 required that a short sell of an exchange-listed security take place after a plus tick or on a zero-plus tick in the market. The National Association of Securities Dealers (NASD) instituted a rule in 1994 that closely followed Rule 10a-1. On May 2, 2005 the SEC began an experiment with the “tick” rule allowing short sell trades to take place on some securities without the “plus-tick” thus providing an opportunity for a “pilot study” of whether the removal of the “plus-tick” requirement significantly impacts the volatility of the firms involved and, ultimately, the market as a whole. According to the SEC the results of the experiment indicated there was “no significant change in volatility, so in mid-2007 the short sell uptick restriction was removed from all U.S. securities. However, a 2008 technical study by Harmon and Bar-Yam on the results of the pilot study suggests the SEC misinterpreted the findings. The purpose of this research is to explore the impact of this rule change. Our findings, which are a major contribution to the literature, show greater volatility in U.S. financial markets when the “plus tick” requirement was removed from all equity securities.

*JEL classification:* G12

*Keywords:* Asset Pricing, Short Selling, Rule 10a1

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### 1. Introduction

Short selling equity securities is a logical reaction when an investor believes that a security's price will soon decline. The investor simply borrows the security to be sold and sells it. They must eventually repurchase the security to replace that which they borrowed. Throughout most of modern history of the United States equity market investors have been required, if they chose to conduct short sales, to do so after an upward price movement. Rule 10a-1 of the Securities and Exchange Act of 1934 required that a short sale of an exchange-listed security take place after a plus tick or a zero-plus tick in the market. NASDAQ securities were not technically exchange listed prior to 2006; however, the National Association of Securities Dealers (NASD) instituted a rule in 1994 that short sales could only be initiated at a price that was one penny higher than the most recent bid when the national best bid price is less than the price of the most recent transaction. This ensured that security short sales were instituted after positive price changes.

Regulation SHO allowed the SEC to examine short sales and for an experiment to suspend Rule 10a-1 to determine the impact of having no short sale restrictions. On May 2, 2005 the SEC began an experiment with the “tick” rule that allowed short sell trades on approximately one-third of U.S. exchange traded securities without the “plus tick” requirement, i.e., without regard to the direction of the most recent price movement. This provided an opportunity for a “pilot study” of the removal of the “plus tick” requirement on the equity prices of firms involved and, ultimately, the market as a whole. The pilot was continued until mid-2007 when, after the results of the experiment indicated there was no significant change in volatility, the short sell restriction was removed from all U.S. securities.

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<sup>1</sup> The authors would like to thank the *Wall Street Courier, Inc.* for providing the short-sell data used in this study. We would also like to thank the reviewer(s) for comments that improved the paper.

In the pilot study the SEC staff compared the volatility of the securities and portfolios comprised of securities exempt from the plus tick to others required to follow the plus-tick rule.<sup>2</sup> The intent of the study was to analyze whether freedom from Rule 10a-1 was beneficial. Additional freedom in the market provides more trading options and greater ease in timing trades. The SEC analysis indicated that removing the plus-tick requirement of Rule 10a-1 and the positive pricing requirements of the NASD did not negatively impact the financial markets. They found an insignificant increase in the volatility of the securities released from the uptick requirements in 2005 and that the market rapidly dissipated any increase in volatility.

If the SEC analysis of the results was correct it is a positive result that should hold when all securities are released from the uptick rule. The pilot study found a -2.38% cumulative 6-month return differential between New York Stock Exchange (NYSE) securities not subject to the uptick rule (unregulated) and NYSE securities subject to the uptick rule (regulated), and a -2.09% differential between unregulated and regulated NASDAQ securities. Harmon and Bar-Yam (2008) reevaluated the statistical and economic significance of the SEC findings using a standard error estimated from the return distribution of individual stocks and conducted additional tests based upon daily returns. Their analysis of the SEC pilot study actually shows an impact on securities where the uptick regulation was not in place that is statistically significant at the 5% level. Harmon and Bar-Yam also examine the number of equity securities experiencing large percentage price declines in a single day pre- and post-uptick repeal and find that percentage price declines greater than 40% are significantly higher post-uptick repeal.

Based on the SEC analysis of the pilot study of the SHO regulation that allowed for the experiment, the SEC removed Rule 10a-1 and the NASD restrictions from all SEC regulated securities on July 6, 2007. Because of Harmon and Bar-Yam questioning the interpretation of the experiment results the following question must be asked: "Does the same result hold for all securities that held for the one-third that the SEC staff studied?" Unfortunately, that question is not easily answered because the detailed short sell data used in the pilot study has not been collected since the removal of the uptick rules. Hence we are at ground zero regarding the impact of elimination the short sale restrictions. However, we can still ask and attempt to answer whether short sell activity has increased since July 6, 2007 and whether volatility of the equity market has increased since the uptick restriction was eliminated for all investors and all securities. These two areas are the focus of this study, and the findings will be a contribution to the literature. Section two examines the literature and history relating to short sales. Section three outlines our questions, hypotheses, and data. Section four discusses the statistical tests performed and presents the results while Section five presents some conclusions and directions for future research.

## 2. Short Sales: Their Impact on the Financial Markets

van Dillen (1935) traces evidence of short selling to 1609 when Dutch trader Isaac Le Maire executed a plan to benefit from the declining value of the Dutch East India Company (VOC). This is perhaps the first known use of short selling that impacted the markets. As a result of Le Marie actions and to prevent further abuses the Dutch government enacted the first ban on short selling.

In the United States regulation of short selling dates to 1917 when the NYSE required that traders disclose the names of their short selling clients, the names and amounts of all borrowed stocks, and from whom stocks were borrowed. This disclosure requirement was intended to identify the source(s) of malicious rumors that were spread in an attempt to drive down market prices.<sup>3</sup> This rule applied only to the NYSE and contained no provision to punish traders failing to comply so it was not truly a regulation of short sale activities.

The first significant short sale restriction in the U.S. was SEC Rule 10a-1 that was introduced in 1934 and adopted in 1938. Rule 10a-1 restricted short selling of exchange listed securities to

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<sup>2</sup> See "Economic Analysis of the Short Sale Price Restrictions Under the Regulation SHO Pilot," Office of Economic Analysis, U.S. Securities and Exchange Commission, February 6, 2007.

<sup>3</sup> "Stock Exchange Moves To Curb Short Selling", *New York Times*, p. A-1, (Nov. 2, 1917).

instances where the short sale price is above the price at which the immediate preceding sale was effected (uptick rule), or the short sale price is above the last different price at which a sale was effected (zero-plus tick).<sup>4</sup> The conditions that allowed short sales became known as the tick test, and the rule remained largely unchanged and in effect for approximately 70 years. Rule 10a-1 did not cover securities not listed on a national exchange, i.e., securities traded in over-the-counter markets, on bulletin boards, or via Pink Sheets. Under Rule 10a-1 short selling was a viable trading device as long as markets were advancing, however, in a down market, the tick test prevented short sellers from forcing market prices further downward and slowed the acceleration of declining markets by requiring that successively lower prices be set by long sellers rather than speculative short sellers.<sup>5,6</sup>

The SEC granted exemptions from Rule 10a-1 in cases where the proposed trading activity did not appear to involve the types of trading abuses the rule was designed to prevent. Exemptions include:

1. transactions in exchange traded funds (ETFs)
2. permitting registered market makers and exchange specialists publishing two-sided quotes in a security to sell short to facilitate customer market and marketable limit orders at the consolidated best offer, regardless of the last trade price
3. certain transactions executed on a volume-weighted average price basis
4. electronic trading systems that match and execute trades at independently derived prices during random times within specific time intervals
5. transactions that allow broker/dealers to fill customer orders if:
  - a. the broker/dealer receives a sell order from a customer with a net long position, and the broker/dealer seeks to execute that order by executing a sale, even if the broker/dealer currently holds a short position; or
  - b. the broker/dealer receives a buy order from a customer, and they seek to execute that order by purchasing the security and selling it to the customer, even if the broker/dealer has a net short position in the security<sup>7</sup>

From the NASDAQ's inception in 1971, its securities were exempt from the restrictions of Rule 10a-1. However, beginning in 1994 the SEC granted permission to the NASD to administer short selling regulations under NASD Rule 3350. Originally, the rule applied only to NASDAQ Global Market securities, was adopted on an 18-month trial basis, and did not cover NASDAQ Capital Market securities (Small Caps). Rule 3350 (bid test) required that short sales occur at a price above the current national best bid when the current national best bid is below the preceding national best bid.<sup>8</sup>

Rule 3350 was renewed until January 2006, when the SEC approved NASDAQ's application to become a national securities exchange. When applying for national exchange status, the NASDAQ requested and was granted exemption from Rule 10a-1. Instead, the NASDAQ was permitted to continue to regulate short sales under NASD Rule 3350.<sup>9</sup> NASDAQ Global Market securities were subject to the bid test under the existing NASD Rule 3350, while NASDAQ Capital Market securities remained free from any price test.<sup>10</sup> Among the reasons for granting NASDAQ exemption from Rule 10a-1 was that the continuing status of the rule was under review by the SEC. The SEC adopted Rule 202T of Regulation SHO in July 2004. It allowed the SEC to establish a pilot program

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<sup>4</sup> 03 Federal Register 1548 (Jan. 24, 1938)

<sup>5</sup> 41 Federal Register 56530 (Dec. 28, 1976)

<sup>6</sup> Many people believe speculative short sellers drove Lehman Brothers into bankruptcy. For example, see Matsumoto, Gary, "Naked Short Sales Hint Fraud in Bringing Down Lehman," Bloomberg Press, March 19, 2009.

<sup>7</sup> 71 Federal Register 75071-72 (Dec. 13, 2006)

<sup>8</sup> 59 Federal Register 34885 (July 7, 1994)

<sup>9</sup> 71 Federal Register 3550-62 (Jan 23, 2006)

<sup>10</sup> *ibid*

exempting certain stocks from the tick test, i.e., the pilot program exempted one-third of the stocks in the Russell 3000 Index from all short sale price restrictions.<sup>11,12</sup> This program began on May 2, 2005, was originally scheduled to end on April 28, 2006, but the termination date was subsequently extended to August 6, 2007.<sup>13</sup> Instead of waiting for the second scheduled termination date, the SEC adopted Rule 201 of Regulation SHO on July 2, 2007. Rule 201 eliminated all short sale price restrictions effective July 6, 2007 and prohibited all self-regulating organizations from imposing a price test.<sup>14</sup>

The SEC's primary objective from adopting Rule 201 of Regulation SHO was to achieve regulatory uniformity and simplicity with regard to short sale transactions.<sup>15,16</sup> The SEC also cited regulatory uniformity and simplicity as reasons for opposition to a "phased-in" approach to the new rule and to allowing issuers the option to have price tests imposed on their security offerings.<sup>17</sup> The SEC reasoned that today's markets are much more transparent than they were 70 years ago and price manipulation would be equally unlikely with or without price tests rendering Rule 10a-1 unnecessary. No instances of intentional manipulation were observed during the pilot program.<sup>18</sup> Section 12(k)(2) of the Securities Exchange Act does give the SEC the right to issue an exemption to Rule 201:

The Commission, in an emergency, may by order summarily take such action to alter, supplement, suspend, or impose requirements or restrictions with respect to any matter or action subject to regulation by the Commission or a self-regulatory organization under this title, as the Commission determines is necessary in the public interest and for the protection of investors —

1. to maintain or restore fair and orderly securities markets (other than markets in exempted securities); or
2. to ensure prompt, accurate, and safe clearance and settlement of transactions in securities (other than exempted securities).<sup>19</sup>

On July 15, 2008 and September 17, 2008 the SEC invoked this right by imposing new restrictions on naked short selling in response to the ongoing financial crisis.<sup>20</sup>

Recent studies of short selling activity have examined the impact of short sells on various aspects in the financial markets. For example, Chen and Sengal (2003) find evidence of short selling influence in the weekend effect as shorts are closed on Friday and reinstated on Monday to avoid the risk of the weekend in equity markets while Blau, Van Ness and Van Ness (2009) find evidence to contradict their results and find that short selling on Monday is significantly less than on Friday. Boehmer, Jones, and Zhang (2008) use a proprietary data base and find that short selling was rather easily accomplished in the period 2000-2004 and short sellers are, in general, well informed investors who benefit from the short sells. To date no one has examined the effect of eliminating the uptick rule for all U.S. securities in mid-2007 on the financial markets.

### 3. Data and Methodology

As discussed in the previous sections, as of July 6, 2007, SEC Rule 10a-1, and its NASD counterpart were suspended for all SEC regulated securities.<sup>21</sup> This suspension allows anyone to

<sup>11</sup> Exchange Act Release No. 34-50103 (July 28, 2004)

<sup>12</sup> Exchange Act Release No. 34-50104 (July 28, 2004)

<sup>13</sup> Exchange Act Release No. 34-53684 (April 20, 2006)

<sup>14</sup> 72 Federal Register 36348 (July 3, 2007)

<sup>15</sup> 72 Federal Registry 36352 (July 3, 2007)

<sup>16</sup> *ibid*

<sup>17</sup> *ibid*

<sup>18</sup> 72 Federal Registry 3651 (July 3, 2007)

<sup>19</sup> Securities Exchange Act, Section 12(k)(2), (1934)

<sup>20</sup> Exchange Act Release No. 34-58572 (September 17, 2008)

short sell equity securities in the U.S. market at any time without regard to the direction of the most recent price change for the security. If a security is experiencing a price decline, investors, portfolio managers, hedge fund managers, and others can place additional downward price pressure on the security by selling it short. Has this unfettered ability to pressure prices resulted in greater volatility in the equity markets? Has the ability to sell short without regard to recent pricing increased the total number of shares traded in short sales? It is our belief that the answer to both of the above questions is “yes” and we examine the impact of unrestricted short selling on the overall volatility of the market.<sup>22</sup>

To examine the impact of the rule change one must have information on short sale activity. Because the SEC has chosen to no longer collect and maintain data relating to the short selling of U.S. equity securities, it was necessary to identify and acquire a different source for the information. Fortunately, Wall Street is interested in such activity and the Wall Street Courier graciously provided weekly data on short sales from January 1, 2007 through September 21, 2007, allowing sufficient information to consider the impact of the July 6, 2007 elimination of Rule 10a-1. Weekly short sale information is summarized in Table 1 and is graphically depicted in Figure 1. The Wall Street Courier also provided monthly short interest data for the period January 2005 through June 2008 for AMEX, NYSE, and NASDAQ securities.

**Table 1**  
**Short Sale Summary Information**

<b>Panel A</b>						
Weekly		Before 7/6/08		After 7/6/08		Change
		Average	Standard Dev.	Average	Standard Dev.	Average
Tot. Short Sales		1,317,908	142,380	1,888,891	536,638	570,983
NYSE Memb.	Short Sales	552,694	69,571	638,778	161,894	86,085
Specialists	Short Sales	105,702	16,805	112,324	24,640	6,622
Floor Traders	Short Sales	582	234	0	0	-582
Other Memb.	Short Sales	446,410	59,431	526,455	153,567	80,044
Public	Short Sales	765,214	77,170	1,250,112	378,568	484,898
Odd-Lot	Short Sales	18,740	3,333	28,267	9,632	9,527
Odd-Lot	Short Sales in \$	920,726	165,619	1,418,005	503,199	497,279
NYSE Volume		8,135,143	1,054,460	8,909,851	2,502,967	774,708
<b>Panel B</b>						
Daily Odd-Lot	Short Sales	3,840,916	804,011	5,628,151	2,079,780	1,787,235

As can be seen from Table 1 and Figure I, short sale activity did increase in July 2007 at the time that Rule 10a-1 was eliminated. The activity apparently returned to more normal levels in September 2007. The increase is apparent in both the level of short sales and the standard deviation. The Wall Street Courier also provided daily data for odd-lot short sales, the only daily short sale data available. Panel B in Table 1 shows that the increase in volatility is evident in daily trading.

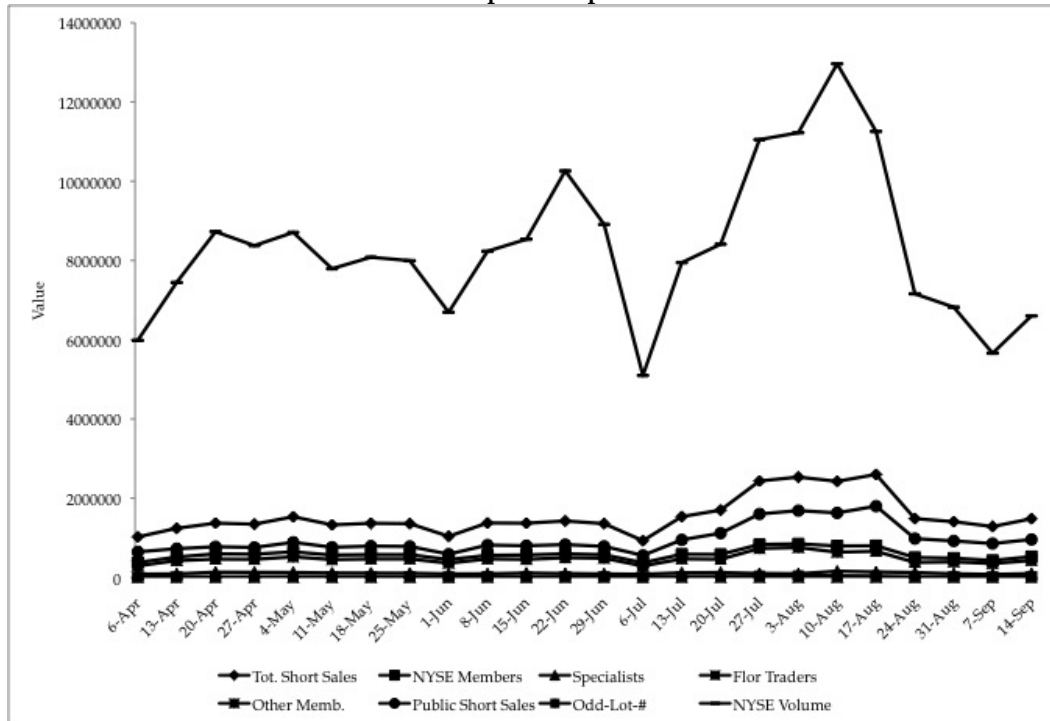
To examine the impact of the elimination of Rule 10a-1, and its NASD counterpart, data relating to equity returns are also necessary. Rather than examine all equity securities, we chose to examine the impact of the rule change on 100 randomly selected securities that are included in the Standard and Poor's 500 (S&P 500). This “portfolio” of securities includes diverse equities that are broadly traded with significant market capitalization. The listing of the sample of securities is provided in

<sup>21</sup> Throughout the remainder of this research “adoption of Rule 201 of Regulation SHO” and “removal of Rule 10a-1” are considered synonymous.

<sup>22</sup> Market participants seem to believe that the removal of Rule 10a-1 has dramatically increased market pressures. See, for example, Harmon, Dion and Yaneer Bar-Yam, “Technical Report on SEC Uptick Repeal Pilot,” NECSI Technical Report 2008-11, New England Complex Systems Institute, Cambridge, MA.

Table 2.<sup>23</sup> To examine the impact of the Rule 10a-1 elimination on a broader selection of securities, we also analyzed several market indices: S&P 500, the DJIA, the Russell 1000, the Russell 2000, the Russell 3000 and the Wilshire 5000.

Figure I  
Short Sales: April to September 2007



Daily price data for the sample of 100 firms was obtained from Commodity Systems, Inc. (CSI) and used to calculate the daily holding period returns [ $HPR_t$ ] for the sample.<sup>24,25</sup> The daily  $HPR_t$  were calculated based upon Equation 1:

$$HPR_t = \frac{P_t}{P_{(t-1)}} - 1 \quad (1)$$

Where

$HPR_t$  = the holding period return for day  $t$ ,  $P_t$  = the price of the security on day  $t$ .  $HPR_t$  were calculated on a daily basis for each of the 100 firms and for the following indices:

- The S&P 500
- The Dow Jones Industrial Average
- The NYSE

<sup>23</sup> Firms from the S&P 500 were selected using a random number generated by the RAND function in Excel.

<sup>24</sup> Daily data for the firms and the market indices were used to calculate the HPR to examine daily changes and daily volatility. Short-sale information is weekly (or monthly in the case of the "short-interest ratios") because that is the only data available to us.

<sup>25</sup> CSI is a vendor of summary world financial market data. CSI's historical coverage includes all commodity markets gathered from over 80 futures exchanges traded worldwide. CSI also supplies daily summary data on all New York Stock Exchange stocks, nearly all American, and NASDAQ stocks, and virtually all 25,000 US mutual funds. This data has been shown to provide results equivalent to that obtained using CRSP data by Clayton, Ronnie J., John S. Jahera and Bill Schmidt, "Estimating Capital Market Parameters: CRSP Versus Yahoo Data," *Advances in Investment Analysis and Portfolio Management*, Volume 3, C. F. Lee, Editor. 2008.

- d. The Russell 1000
- e. The Russell 2000 The Russell 3000 and
- f. The Wilshire 5000.

The average  $HPR_i$  and the standard deviation of the  $HPR_i$  for each firm and index was computed for the period April 1, 2007 through July 3, 2007 and for the period July 9, 2007 through September 21, 2007. These time periods represent approximately two months prior to the elimination of Rule 10a-1 and approximately two months following the elimination of the rule. The number of daily observations in each period is sufficient to compute averages and standard deviations. We also examine volatility from a number of other perspectives, including the days when the  $HPR_i$  were positive, both before and after the elimination of the rule, and, similarly, the days when the  $HPR_i$  were negative. Also examined were the opening prices relative to the closing prices, and the daily high prices versus the daily low prices. The average value of each metric was determined for both the pre and post period.

**Table 2**  
**Firms and Tickers Symbols**

<b>Firm</b>	<b>Ticker</b>	<b>Firm</b>	<b>Ticker</b>	<b>Firm</b>	<b>Ticker</b>
Abbott Labs	ABT	Cummins, Inc.	CMI	Proctor & Gamble	PG
Adobe Systems	ADBE	Danaher Corp	DHR	Public Storage, Inc.	PSA
Air Prod. & Chem	APD	Deere & Co.	DE	Rockwell Automation	ROK
Amer. Int'l Grp	AIG	Dominion Res. Inc.	D	Ryder Systems, Inc.	R
Amer. Power Conv	APCC	RR Donnelly & Sons	RRD	Safeco Corp	SAFC
Andrew Corp	ANDW	Duke Energy Corp	DUK	Schlumberger, Ltd.	SLB
Apache Corp	APA	Engelhard Corp	EC	Sealed Air Corp	SEE
Applied Materials	AMAT	Entergy Corp	ETR	Sherwin-Williams	SHW
AT&T, Inc.	T	Equifax, Inc.	EFX	Southern Co.	SO
Avery Denison Corp	AVY	Exelon Corp	EXC	St. Jude Med. Inc.	STJ
Ball Corp	BLL	Ford Motor Co.	F	St. Paul Travelers	STA
CR Bard Inc.	BCR	Gannett Co., Inc.	GCI	Stanley Works	SWK
Baxter Int'l Inc.	BAX	Golden West Fin.	GDW	State Street Corp	STT
Bear Stearns Cos.	BSC	Goodyear Tire	GT	Stryker Corp	SYK
Bemis Co. Inc.	BMS	Hasbro, Inc.	HAS	Sun Microsystems	SUNW
Best Buy Co. Inc.	BBY	Honeywell Int'l	HON	Sunoco, Inc.	SUN
Boeing Co.	BA	Humana, Inc.	HUM	T. Rowe Price	TROW
Brunswick Corp	BC	Illinois Tool Works	ITW	Temple-Inland, Inc.	TIN
Campbell Soup Co.	CPB	Int'l Bus Mach	IBM	Textron, Inc.	TXT
Cardinal Health Inc.	CAH	Interpublic Grp.	IPG	Thermo Electron	TMO
Carnival Corp	CCL	Kellogg Co.	K	TJX Companies	TJX
Centex Corp	CTX	Lennar Corp	LEN	Torchmark Corp	TMK
Centurytel, Inc.	CTL	Ely Lilly & Co.	LLY	Tyco Int'l, Inc.	TYC
Charles Schwab, Inc.	SCHW	Lockheed Martin	LMT	US Bancorp	USB
Cigna Corp	CI	McGraw-Hill Co. Inc.	MHP	Union Pacific Corp	UNP
CMS Energy CP	CMS	Mellon Financial	MEL	Unisys Corp	UIS
Coca-Cola Ent., Inc.	CCE	Microsoft Corp	MSFT	Valero Energy Corp	VLO
Colgate-Palmolive	CL	Mylan Labs. Inc.	MYL	Vornado Realty Trust	VNO
Comcast Corp	CMCSA	Nat'l Semiconductor	NSM	Wachovia Corp	WB
Consolidated Edison	ED	Navistar Int'l Corp	NAV	Walt Disney Co.	DIS
Cooper Ind., LTD	CBE	Northrop Grumman	NOC	Whirlpool Corp	WHR
Corning, Inc.	GLW	Occidental Petro.	OXY	Xerox Corp	XRX
Costco Whole. Corp	COST	Oracle Corp	ORCL		
CSX Corp	CSX	PPL Corp	PPL		

The primary emphasis and contribution of this research is to determine the significance of the removal of Rule 10a-1. Two statistical methods are used to examine this issue in conjunction with the randomly selected portfolio identified above. First, to gain insight into the impact of the removal of Rule 10a-1, the difference of means test is conducted. This test examines whether the mean value of two groups of similar items is different. For instance, is the mean value of the portfolio  $HPR_t$  different in the period prior to the removal of Rule 10a-1 from the period after the removal. The test is performed for all variables previously identified. The hypothesis tested is:

$$H_0 : \mu_1 - \mu_2 = 0, \text{ with the alternative } H_1 : \mu_1 - \mu_2 \neq 0$$

To test for significance the standard deviation of the difference in means must be computed using the standard formula:

$$\sigma_{diff} = \sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}} \quad (2)$$

Where

$\sigma_1^2$  = the variance computed for the period prior to removal of Rule 10a-1

$\sigma_2^2$  = the variance computed for the period after removal of Rule 10a-1

$N_1$  = Number of days used to compute  $\mu_1$  prior to removal of Rule 10a-1

$N_2$  = Number of days used to compute  $\mu_2$  after removal of Rule 10a-1<sup>26</sup>

The above computations are then used to compute a standard t-statistic and determine statistical significance.

Second, to gain additional insight into the removal of Rule 10a-1, a regression analysis is structured using a dummy variable approach. The general character of the regressions is shown in Equation 3:

$$y = \alpha + \beta D + \varepsilon \quad (3)$$

Where,

$y$  = the dependent variable represented by the average value or the standard deviation, as appropriate, of the variables discussed above, i.e.,  $HPR_t$ , positive  $HPR_t$ , negative  $HPR_t$ , opening price-closing price, and high price-low price for each day for the equally weighted portfolio, where:

$\alpha$  = the intercept

$\beta$  = the coefficient associated with the dummy variable

$D$  = a dummy variable that is equal to 0 for days prior to the adoption of Rule 201 and 1 for days that Rule 201 is in place

$\varepsilon$  = error term

The coefficient of primary interest in the above regression is  $\beta$  and the sign associated with this coefficient is dependent upon the variable being analyzed. Significant estimated  $\beta$  coefficients indicate that the particular dependent variable being examined is significantly different in the period after the removal of Rule 10a-1 than in the period before removal. Results of these tests are presented below in Tables 3, 4 and 5 and discussed in Section four.

In addition to the initial work based upon data described above, analysis of monthly data relating to short sales obtained from the Wall Street Courier, Inc. allows for a more extensive examination of the issues surrounding short sales. The monthly data includes short interest, average daily volume, and the short-interest ratio for stocks traded on the NYSE, the AMEX, and the NASDAQ from the period January 2005 through June 2008. In this analysis, the monthly mean and

<sup>26</sup> For full explanation of the "difference of means" test see any advanced statistics textbook, for example, Hayes, William L., *Statistics for the Social Sciences*, 1973.



standard deviation for each of the market classifications (NYSE, AMEX, NASDAQ) is examined for the short-interest ratio computed as the ratio of the reported short-interest divided by the average daily volume for each stock. A difference of means test, as outlined above, is used to determine whether the average short-interest or the average volatility of the short-interest ratio computed for the period following the removal of Rule 10a-1, August 2007-June 2008, is different from the same parameters computed for the period commencing January 2005 through June 2007. In addition, the short-interest ratios are examined for differences between the two periods using dummy variable regression as discussed above. Results of these tests are presented below in Tables 6 and 7 and discussed in the Results section of the paper.

#### 4. Results

In this section we discuss the results of the statistical tests described in the prior section. Table 3 provides summary analytical information of the impact of the elimination of Rule 10a-1 on daily equity returns and prices. As the table shows, whether one is measuring the volatility of  $HPR_t$ , or of the daily high-low prices, or the opening prices-closing prices the volatility increased after July 6, 2007. The volatility increase is present for the random sample of 100 firms and for each of the market indices used in the analysis. The volatility of all measures of equity prices, returns and volume increased dramatically from the April-July 2007 period to the July-September 2007 period.

**Table 3**  
**Summary Averages and Standard Deviations Before and After Elimination of Rule 10a-1**

	Portfolio	S&P	DOW	NYSE	RU1000	RU2000	RU3000	WIL5000
HPR								
Bef.Avg.	0.0010	0.0011	0.0015	0.0012	0.0010	0.0009	0.0010	0.0011
Aft Avg	-0.0004	0.0000	0.0004	-0.0000	-0.0000	-0.0007	-0.0001	-0.0001
Bef Std. Dev.	0.0134	0.0067	0.0061	0.0070	0.0067	0.0089	0.0068	0.0067
Aft Std. Dev.	0.0194	0.0132	0.0119	0.0136	0.0130	0.0156	0.0131	0.0135
Closing Price-Opening Price								
Bef.Avg.	0.0080	0.0011	0.0015	0.0012	0.0011	0.0008	0.0011	0.0010
Aft Avg	-0.0058	0.0001	0.0003	-0.0001	-0.0000	-0.0012	-0.0000	-0.0004
Bef Std. Dev.	0.0197	0.0067	0.0060	0.0070	0.0065	0.0083	0.0068	0.0067
Aft Std. Dev.	0.0202	0.0132	0.0118	0.0136	0.0123	0.0141	0.0131	0.0126
High Price-Low Price								
Bef.Avg.	0.0181	0.0086	0.0142	0.0086	0.0086	0.0113	0.0089	0.0086
Aft Avg	0.0285	0.0161	0.0220	0.0163	0.0161	0.0194	0.0163	0.0157
Bef Std. Dev.	0.0085	0.0038	0.0029	0.0037	0.0038	0.0044	0.0038	0.0037
Aft Std. Dev.	0.0154	0.0078	0.0070	0.0080	0.0075	0.0100	0.0078	0.0075
Negative HPR								
Bef.Avg.	-0.0092	-0.0049	-0.0048	-0.0063	-0.0053	-0.0072	-0.0055	-0.0053
Aft Avg	-0.0150	-0.0113	-0.0100	-0.0112	-0.0122	-0.0148	-0.0114	-0.0111
Bef Std. Dev.	0.0088	0.0052	0.0048	0.0052	0.0053	0.0057	0.0053	0.0051
Aft Std. Dev.	0.0118	0.0091	0.0083	0.0095	0.0087	0.0087	0.0089	0.0082
Positive HPR								
Bef.Avg.	0.0098	0.0052	0.0047	0.0051	0.0051	0.0076	0.0052	0.0052
Aft Avg	0.0150	0.0090	0.0087	0.0095	0.0083	0.0105	0.0090	0.0094
Bef Std. Dev.	0.0090	0.0038	0.0036	0.0039	0.0036	0.0045	0.0037	0.0037
Aft Std. Dev.	0.0127	0.0079	0.0066	0.0083	0.0078	0.0096	0.0077	0.0091
Volume								
Bef.Avg.	5.773E+6	2.948E+09	2.95E+9	2.95E+9	0	0	0	2.157E+9
Aft Avg	6.961E+6	8.574E+09	3.61E+9	3.55E+9	0	0	0	2.366E+9
Bef Std. Dev.	2.621E+6	3.781E+08	3.78E+8	3.78E+8	0	0	0	4.292E+8
Aft Std. Dev.	2.979E+6	3.644E+10	9.6E+8	1.08E+9	0	0	0	6.961E+8

**Table 4**  
**Difference of Means**

	Panel A: HPR			Panel B: Close Price - Open Price		
	Difference	$\sigma_{diff}$	T Statistic	Difference	$\sigma_{diff}$	T Statistic
Portfolio	-0.0014	0.0020	-0.7286	-0.0135*	0.0018	-7.4879
Portfolio Volatility	0.0027**	0.0010	2.8232	-0.2042*	0.0059	-34.7974
S&P	-0.0011	0.0019	-0.5622	-0.0010	0.0019	-0.5541
DOW	-0.0011	0.0017	-0.6505	-0.0012	0.0017	-0.6959
NYSE	-0.0013	0.0019	-0.6578	-0.0013	0.0019	-0.6588
RU1000	-0.0011	0.0019	-0.5714	-0.0011	0.0018	-0.6176
RU2000	-0.0016	0.0023	-0.7145	-0.0020	0.0021	-0.9682
RU3000	-0.0011	0.0019	-0.5926	-0.0011	0.0019	-0.5762
WIL5000	-0.0012	0.0019	-0.6263	-0.0014	0.0018	-0.7891
	Panel C: High Price - Low Price			Panel D: Negative HPR		
	Difference	$\sigma_{diff}$	T Statistic	Difference	$\sigma_{diff}$	T Statistic
Portfolio	0.0102*	0.0014	7.1961	-0.0035*	0.0012	-2.9733
Portfolio Volatility	0.0048*	0.0010	4.8957	-0.0002	0.0023	-0.1045
S&P	0.0075*	0.0011	6.8243	-0.0063*	0.0021	-2.9708
DOW	0.0078*	0.0010	8.1188	-0.0052**	0.0020	-2.6572
NYSE	0.0077*	0.0011	6.8559	-0.0049**	0.0022	-2.2140
RU1000	0.0075*	0.0011	7.0493	-0.0069*	0.0021	-3.2308
RU2000	0.0082*	0.0014	5.9061	-0.0076*	0.0021	-3.7109
RU3000	0.0075*	0.0011	6.7744	-0.0059*	0.0021	-2.8225
WIL5000	0.0071*	0.0011	6.6604	-0.0058*	0.0019	-3.0458
	Panel E: Positive HPR			Panel F: Volume		
	Difference	$\sigma_{diff}$	T Statistic	Difference	$\sigma_{diff}$	T Statistic
Portfolio	0.0035*	0.0009	4.0161	1.169E+6*	2.71E+05	4.3096
Portfolio Volatility	0.0020**	0.0009	2.3069	1.591E+6**	6.91E+05	2.3030
S&P	0.0038**	0.0015	2.5031	5.626E+9*	4.56E+09	1.2352
DOW	0.0039*	0.0013	3.0014	6.617E+8*	1.31E+08	5.0685
NYSE	0.0044**	0.0016	2.6921	6.026E+8*	1.44E+08	4.1807
RU1000	0.0033**	0.0015	2.2133	NA	NA	NA
RU2000	0.0029	0.0019	1.5447	NA	NA	NA
RU3000	0.0038**	0.0015	2.4996	NA	NA	NA
WIL5000	0.0042**	0.0018	2.3967	2.089E+8**	1.05E+08	1.9934

Notes: Significance Levels: \*=0.01, \*\*=0.05

The difference of means tests is presented in Table 4. As shown, whether the  $HPR_t$  are examined for the sample portfolio or for the market indices, the mean difference is not statistically significant. The volatility of the sample portfolio is significantly greater after the removal of Rule 10a-1, directly supporting our hypothesis that the removal of the uptick rule increased market volatility. In addition, closer examination shows that the mean difference between the high and low prices for each day is significantly greater in the period after the removal of Rule 10a-1. These findings are consistent with the SEC staff Pilot Study of the SHO regulation that indicated that short sale effects tended to dissipate during the day of the short sale. It is also consistent with anecdotal evidence from traders that they do not leave themselves exposed when the markets are closed. Typically traders close out positions that would leave them exposed to the price risk from holding an open short position over night or over a weekend. This activity puts upward pressure on closing

prices and will be greater in periods of greater short sale activity. Additional evidence of differential mean values is found for much of the remainder of the information presented in this table. The mean difference for days when the HPR are negative (down days) is significant for the period after the removal of Rule 10a-1 with the declines significantly greater during this period. For the days that the  $HPR_t$  increase, the gains are significantly greater during the period after the removal of Rule 10a-1 and the overall volume of trading is significantly greater after the removal except for the S&P 500 index.

Table 5 provides the results of the dummy variable regression analysis. These results reinforce the finding that significant differences exist between the period prior to removal of Rule 10a-1 and the period after the removal of the rule. As shown, while the estimated coefficient for the  $HPR_t$  and for the closing price-opening price differential is not significant, it is negative as is expected for the period without the restriction on short sales.

The exception is the coefficient of "Portfolio Volatility" which is significantly positive for  $HPR_t$ , indicating increased volatility in the period after removal. The "Portfolio Volatility" coefficient for the closing price-opening price analysis is significantly negative, indicating that this particular variable exhibits a significantly lower value in the period after the removal of Rule 10a-1. The average level of each of the remaining variables is significantly different between the two periods and the signs of the coefficients are as expected.

**Table 5**  
**Dummy Variable Analysis**

	<b>Panel A:</b> HPR		<b>Panel B:</b> Closing Price-Opening Price		<b>Panel C:</b> High Price-Low Price	
	Coefficient+	T-Statistic	Coefficient+	T-Statistic	Coefficient+	T-Statistic
Portfolio	-0.0014	-0.7641	-0.0136*	-7.7300	0.0102*	7.7099
Portfolio Volatility	0.0027*	2.7132	-0.2039*	-32.5151	0.0048*	5.1906
S&P	-0.0010	-0.5335	-0.0010	-0.5227	0.0074*	6.7839
DOW	-0.0010	-0.6075	-0.0011	-0.6476	0.0076*	7.9839
NYSE	-0.0012	-0.6067	-0.0012	-0.6079	0.0076*	6.7946
RU1000	-0.0010	-0.5410	-0.0010	-0.5833	0.0074*	7.0080
RU2000	-0.0016	-0.7096	-0.0020	-0.9567	0.0080*	5.8580
RU3000	-0.0010	-0.5644	-0.0010	-0.5458	0.0074*	6.7378
WIL5000	-0.0010	-0.5474	-0.0013	-0.7362	0.0070*	6.6264
	<b>Panel D:</b> Negative HPR		<b>Panel E:</b> Positive HPR		<b>Panel F:</b> Volume	
	Coefficient+	T-Statistic	Coefficient+	T-Statistic	Coefficient+	T-Statistic
Portfolio	-0.0035*	-2.9729	0.0035*	4.2064	1.1645E+6*	4.4736
Portfolio Volatility	-0.0002	-0.0961	0.0020**	2.3507	1.5931E+6**	2.2832
S&P	-0.0063*	-3.0329	0.0038**	2.6620	5.52E+09	1.2334
DOW	-0.0054*	-2.7199	0.0038*	3.1287	6.4548E+8*	4.9705
NYSE	-0.0052**	-2.3051	0.0042*	2.9247	5.8746E+8*	4.1101
RU1000	-0.0069*	-3.3306	0.0032**	2.3511	NA	NA
RU2000	-0.0076*	-3.8570	0.0028	1.5675	NA	NA
RU3000	-0.0059*	-2.8511	0.0037**	2.6820	NA	NA
WIL5000	-0.0060*	-3.1554	0.0041**	2.6117	2.1214E+8**	2.0281

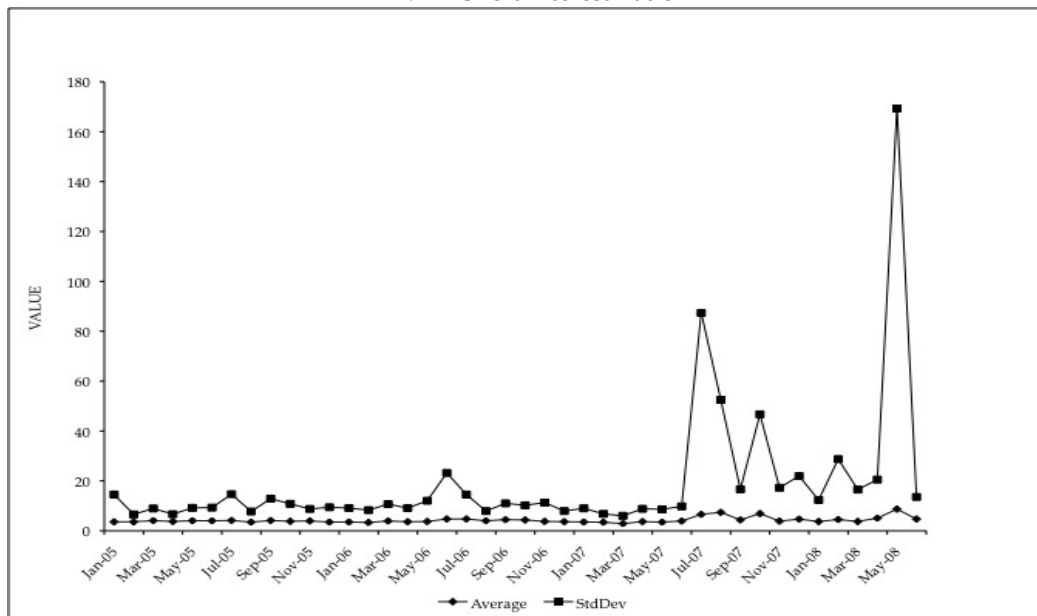
The average percentage difference between the high and low prices for the day, i.e., High-Low, has a positive and significant coefficient consistent with downward pressure on prices from short

sale activity during the day. Examining separately the days with negative  $HPR_t$  and those with positive  $HPR_t$  shows that both are more significant when short sales are not restricted. These findings are consistent with greater volatility during the period when short sales are not restricted. In addition, the average volume of trading activity is significantly greater in the period when short sales are not restricted. The volatility, as measured by standard deviation, of all of the variables is significantly different between the two periods except for when negative  $HPR_t$  days are examined separately. As shown in Table 5, the level of significance is 0.01 for three measures and 0.05 for two. The positive volatility coefficient associated with the  $HPR_t$  directly indicates that return volatility is greater when Rule 10a-1 is not in effect. The positive volatility coefficients for High-Low and positive  $HPR_t$  indicates greater volatility when short sales are unrestricted, as does the positive coefficient for the volatility of volume.

To gain additional insights into the rule change using monthly data, short-interest ratios are examined for each of the three market classifications: AMEX, NYSE, and NASDAQ. The average short-interest ratio and standard deviation are calculated for each month for the period January 2005 through June 2008. All stocks that had a short-interest ratio for any given month were included in the average and standard deviation computations.<sup>27</sup>

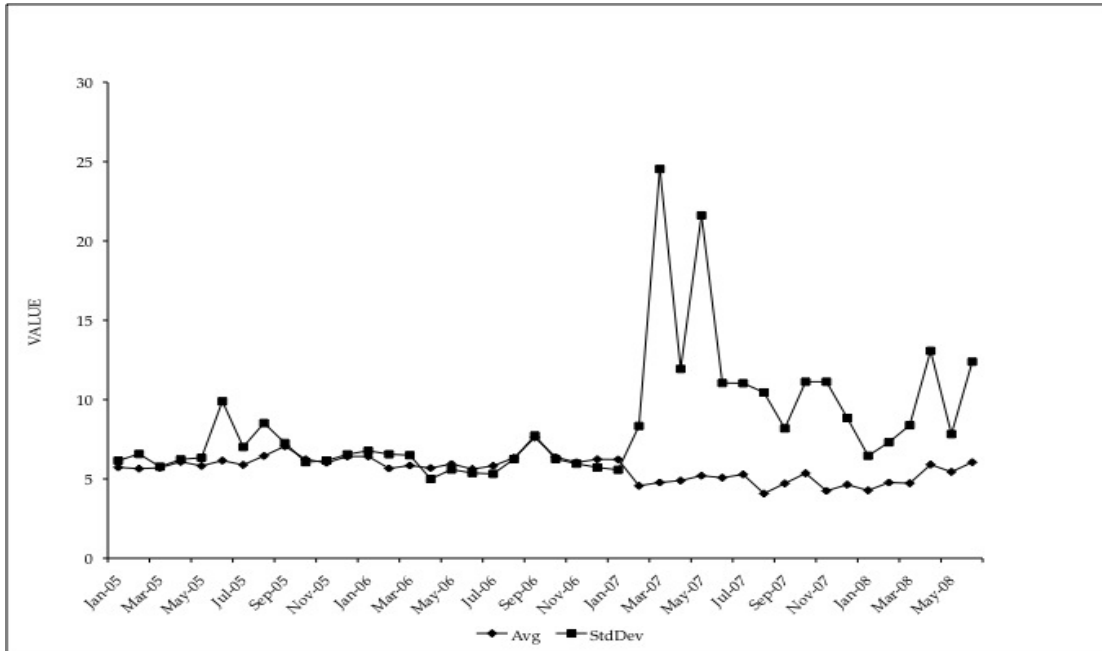
Results are shown graphically in Figures II-IV for the AMEX, NYSE and NASDAQ respectively. Each of the graphs shows the average monthly short-interest ratio and the monthly standard deviation of the short-interest ratio for the stocks for the particular market classification. Figure II depicts these measures for the AMEX, Figure III does the same for the NYSE while Figure IV portrays the NASDAQ. Visually, especially for the AMEX in Figure II, it is evident that July 2007 is an event month. Prior to that point, both the average and standard deviation show little consistent movement for each of the market classifications. However, moving forward from July 2007 there is a consistent visual difference, particularly for the monthly standard deviation.

**Figure II**  
**AMEX Short Interest Ratio**

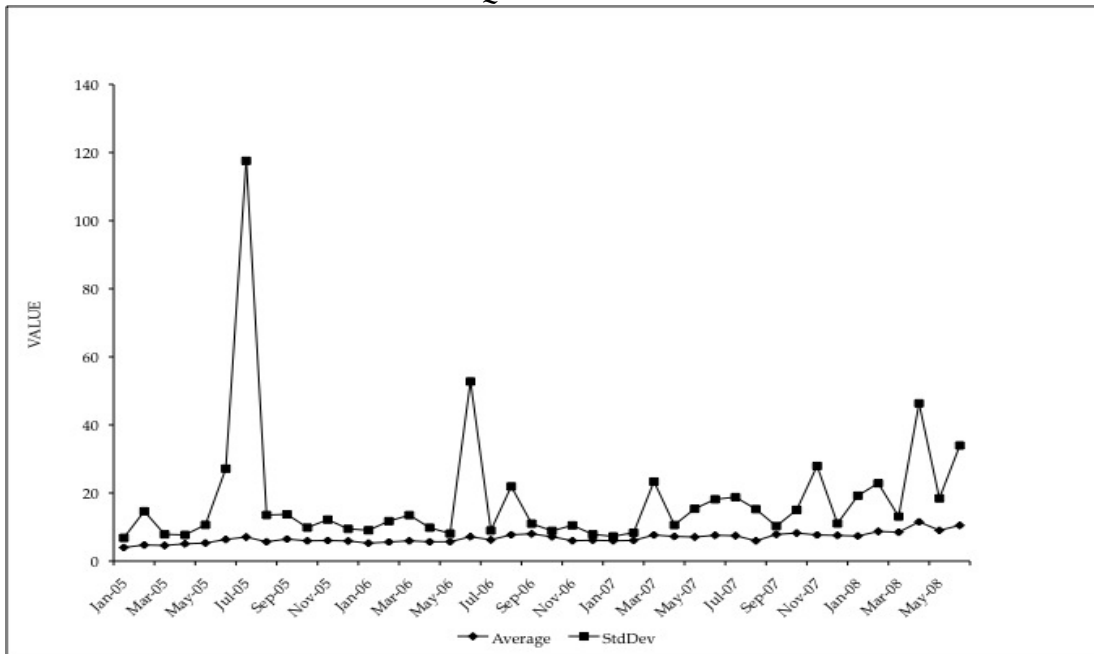


<sup>27</sup> Some stocks did not have sufficient information to compute the short-interest ratio for every month in the period of analysis. However, since we are examining averages, those stocks with sufficient information to compute a short-interest ratio in any given month are included in the calculation.

**Figure III**  
**NYSE Short Interest Ratio**



**Figure IV**  
**NASDAQ Short Interest Ratio**



Still using monthly data, panels A, B, and C of Table 6 show the standard difference of means result for each of the three market classifications. Excluding the month of July 2007, the test examines the difference in means for the average short-interest ratio for January 2005 through June 2007 versus the average short-interest ratio for August 2007 through June 2008. The statistics confirm the graphical analysis. Panel A shows that the average short-interest and the volatility of

the short-interest ratio is significantly higher for the period after July 2007 than that found before that date for the AMEX market classification.

**Table 6**  
**Difference of Means Tests**

<b>Panel A: AMEX</b>		
	01/2005-06/2008	08/2007-06/2009
Average of "Short-Interest"	3.8221	5.2402
Standard Deviation	0.4043	1.6644
Average Volatility	10.1291	37.8222
Standard Deviation	3.3753	45.5764
<i>Difference of Means: Short Interest</i>		
Average of Short-Interest		1.4191
$\sigma_{diff}$		0.5313
T Statistic		2.6712**
<i>Difference of Means: Volatility</i>		
Average Volatility		27.6934
$\sigma_{diff}$		14.4252
T Statistic		1.9223***
<b>Panel B: NYSE</b>		
	01/2005-06/2008	08/2007-06/2009
Average of "Short-Interest"	5.9184	4.9292
Standard Deviation	0.6303	0.6681
Average Volatility	7.9532	9.5611
Standard Deviation	4.4363	2.1802
<i>Difference of Means: Short Interest</i>		
Average of Short-Interest		-0.9901
$\sigma_{diff}$		0.2404
T Statistic		-4.1201*
<i>Difference of Means: Volatility</i>		
Average Volatility		1.6078
$\sigma_{diff}$		1.0639
T Statistic		1.5103
<b>Panel C: NASDAQ</b>		
	01/2005-06/2008	08/2007-06/2009
Average of "Short-Interest"	6.1809	8.4454
Standard Deviation	0.9876	1.5243
$\sigma_{diff}$	16.9489	21.2250
Standard Deviation	20.9856	11.0241
<i>Difference of Means: Short Interest</i>		
Average of Short-Interest		2.2638
$\sigma_{diff}$		0.5145
T Statistic		4.4003*
<i>Difference of Means: Volatility</i>		
Average Volatility		4.2786
$\sigma_{diff}$		5.1804
T Statistic		0.8302

Significance Levels: \*=0.01, \*\*=0.05

Panel B indicates that, for the NYSE, the average short-interest ratio declined significantly during the second period while the volatility remained the same. This may result from the difficulty one would encounter should there be an attempt to intentionally pressure prices. For the larger, more established firms of the NYSE, traders would likely find difficulty should they attempt to put extreme downward pressure on prices by shorting the stock, whereas for some of the smaller

firms of the AMEX and the NASDAQ, price pressure might be more readily brought to bear through short selling activity. Panel C shows significantly higher average short interest ratios in the NASDAQ market for the second period; however, the volatility is not significantly different between the two periods.<sup>28</sup>

Table 7 summarizes the dummy variable regression analysis of the AMEX, NYSE, and NASDAQ. As with the difference of means test, the estimated coefficients associated with the short interest variable are all significantly different from zero.

For the AMEX and NASDAQ both are significantly positive indicating that short interest is significantly greater after the removal of Rule 10a-1 while, like the difference of means, the coefficient for the NYSE is significantly negative, which indicates less short interest in the latter period. As indicated above, the NYSE having larger firms and traders having less ability to influence prices may explain this difference.

**Table 7**  
**Regression Analysis**

<b>Panel A: AMEX</b>		
	Short Interest	Volatility
Coefficient	1.3301	25.2034
T Statistic	3.7998*	2.7708**
<b>Panel B: NYSE</b>		
Coefficient	-0.9689	1.5094
T Statistic	-4.3167*	1.0856
<b>Panel C: NASDAQ</b>		
Coefficient	2.2233	4.2167
T Statistic	5.4994*	0.6421

Significance Levels: \*=0.01, \*\*=0.05

## 5. Conclusions

The removal of SEC Rule 10a-1 provided investment managers and investors the freedom to enter into short sales without regard to the pricing relationships. This research, the first to examine a full set of equity markets in the U.S., shows that this freedom has led to an increase in the volatility of the equity markets. Even though some of the results are mixed, given the results concerning HPR, any reasonable interpretation of the results indicates that traders have sought to influence prices and, therefore, returns leading to greater volatility in the U.S. financial markets. This research also shows a significant increase in the short-interest ratio for both the AMEX and NASDAQ and a significant increase in the volatility of the short-interest ratio for the AMEX market. These markets may be more easily influenced by short selling activity than the NYSE where firms tend to be larger and less susceptible to short selling pressure. These findings compliment those of Harmon and Bar-Yam (2008) and indicate that the SEC should have been more cautious in changing or repealing Rule 10a-1. The uptick rule was in place for approximately 70 years and served to reduce volatility during that time. The repeal likely exasperated the market decline triggered by the over-extended mortgage and mortgage securities markets.

The findings of this research provide a foundation that will help the SEC examine the short sale rules that could lead to policy changes. In fact the SEC has recognized that volatility has increased in the market place and has subsequently modified short sale rules. On February 26, 2010 the SEC issued an amendment to Regulation SHO Rule 201 that instituted a "circuit-breaker" for short selling securities. Effective May 10, 2010 the amendment prevents the execution or display of a short sale order of a covered security (effectively, a vast majority of all equity securities) at a price that is less

<sup>28</sup> This lack of significance may be explained by the method used to compute the short-interest ratio which may result in outliers influencing the result. The ratio is computed as short-interest divided by the average daily volume. In some instances the average daily volume is extremely low relative to the number of shares sold short, resulting in an extremely high value for the short-interest ratio.

than or equal to the current national best bid if the price of that covered security decreases by 10% or more from the covered security's closing price as determined by the listing market for the covered security as of the end of regular trading hours on the prior day.<sup>29</sup>

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<sup>29</sup> For more information see SEC Release No. 34-61595.



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