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# The SHO Goes On: A Theoretical and Empirical Evaluation of Uptick-Related Short-Sale Constraints

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*This paper explores the effects of uptick-related short-sale constraints first on the Glosten-Milgrom Model of Sequential Trade and then empirically on the stocks in the Russell 3000 index used by the SEC in the pilot program created by Reuglation SHO. Finally, the effect of uptick constraints on the relationship between the short and put call ratios is studied through the use of impulse response functions. Both the general and alternative uptick rules are found to decrease informational efficiency in hypothetical financial markets, have no statistically significant positive effects on key financial market metrics, and the change in sign from negative to positive in the response of the put call ratio to a positive shock in the short ratio may be seen as evidence of the use of the options market to avoid short-sale constraints.*

## 1 Introduction

In light of recent events in global financial markets, many financial regulating bodies around the world have placed limits on and even banned short selling hoping to keep investors from driving down the value of volatile securities and causing even more instability and uncertainty in many already precarious markets. One presidential candidate even went as far as to say that short-selling would "turn our markets into a casino," (Meckler, 1). Outright bans have been enacted in Greece and Belgium, and rules governing both the practice of short-selling and which securities are and are not eligible for the practice have been put into place in Spain, France and the United States. These restrictions are intended to discourage speculation and disincentivize panic mongering and the spreading of negative rumors.

However, critics of these policies argue that restrictions on short-selling cause prices to not reflect all available information by failing to include the expectations of those who believe the security will soon decline in value. This stops investors from being able to profit from superior information and can lead to distortions in asset pricing. Also short-sell bans can undermine the very confidence and stability they seek to create. According to said Robert Sloan, a managing partner of S3 Partners, a firm that helps hedge funds manage relationships with their brokers. "It is a crisis of confidence, and when you do something like [impose short sell restrictions], it shows a lack of confidence, which is exactly the opposite of what you want to say to the markets," (Story & Castle, 1). Furthermore, without regulation of so-called "synthetic short-sells," created in the options market using call and put options investors are still free to simulate a short position regardless of what is and is not explicitly allowed for the underlying asset.

In 1938 the SEC adopted the uptick rule (rule 10a-1), under which securities can be short-sold only at a price above the last traded price of the security, or at the last traded price if that price was higher than the price in the previous trade. After testing the rule in 2004 and 2005, a year in which short sales comprised

as much as 24% of share volume for NYSE-listed stocks (Diether et al., 38) the SEC chose to eliminate the rule in 2007.

As early as 2008 a bill was introduced in congress (H.R. 6517) to reinstate the uptick rule. Its proponents argue that the reinstatement of the rule would curtail speculative behavior without the rigidity and price distorting implications of an outright ban. As recently as 2009 even Federal Reserve Chairman Ben Bernanke said, "in the kind of regulatory environment that we have seen recently, [the uptick rule] might have had some benefit." (Westbrook). In February of 2010 the SEC amended Regulation SHO, the regulation that led to the abolition of the uptick rule, to include Rule 201, which is commonly known as the "alternative uptick rule." Rule 201(b)(1) provides that "[a] trading center shall establish, maintain, and enforce written policies and procedures reasonably designed to: (i) Prevent the execution or display of a short sale order of a covered security at a price that is less 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 (SEC)." The rule is described as a "circuit breaker approach" to the regulation of short-selling, and is intended to prevent short-sellers from "piling on" a security already facing a precipitous drop in value. On the other hand, critics of the "alternative uptick rule" argue that because investors wishing to short-sell stocks which are rapidly losing their value face higher and higher borrowing costs as the stock continues losing value, a fact that will lead to an eventual halt in short-sell activity and naturally prevent the type of speculation-driven free fall that short-sell seeks to curtail. It can be argued that there is no need for a "circuit breaker rule," which would lead to upward price bias by asymmetrically constraining pessimists (short-sellers) without constraining optimists (buyers) (Diamond, 279).

In this paper I replicate Glosten and Milgrom's model in an unconstrained market, in a market subject to an uptick rule, and a market subject to an "alternative uptick rule." I then evaluate the difference in price paths over time in the different scenarios and draw conclusions about uptick restrictions effects on pricing and rate of price adjustment. I find that, as Xu (2007) predicted, in the presence of short-sale constraints markets overreact to good information and prices, for better or for worse, adjust upward more quickly than they would if short-sellers were unconstrained. Then, I will empirically evaluate the efficacy of both aforementioned types of uptick constraints and their possible effects on returns, volatility, short volume, and several option-related metrics, as well as whether the rule has a stronger effect on stocks without options. Finally I create impulse response functions for each stock in the study and the statistical significance of changes in impulse responses in the short and put call ratios before and after the uptick rule was suspended and find a change from negative to positive in the response of the put call ratio to a positive shock in the short ratio after the suspension of the general uptick rule.

## 2 Short-Sale Constraints in the Glosten-Milgrom Model

The Glosten-Milgrom model predicts how a market maker will adjust the bid-ask spread while interacting with both informed and uninformed traders. There are no transaction or inventory costs in the model and the market maker and all traders are assumed to be risk neutral. Traders do not hold inventory and all sales are assumed to be short-sales. Only unit trading takes place in the model. While this is not a very realistic assumption, it is necessary in order to make the model simple enough to be feasibly simulated. Individual cycles of the model are presumed to take place over the space of one day, but are otherwise independent of time and the model abstracts away discounting. Informed traders are defined by their access to non-public

information, which in this case is the final value of the asset. Uninformed traders do not have access to this information and can be thought of as participating in the market for liquidity reasons. In the unconstrained version of the model the informed trader buys the asset when it is undervalued compared to the asset's final value and sells the asset when it is overvalued. Because they are ignorant of the asset's final value, uninformed traders are assumed to buy or short-sale with a probability of 0.5 regardless of where the price of the asset is in relation to its final value.

The model assumes that there is a competitive market for market making services and the market maker expects to earn zero profit. Because informed traders will only trade when it is advantageous to them, the market maker knows she will lose money trading with them and adjusts the spread in order to make money trading with uninformed traders. In the unconstrained version of the model traders buy and sell freely. When the general uptick rule is introduced a trader can only sell if the price quoted to her is higher than the price quoted on the preceding trade. In the version of the model governed by the alternative uptick rule the aforementioned short-sale constraint is applied for the duration of the simulation if and when the asset falls 10% below its initial value. Traders are assumed to arrive anonymously (i.e. the market maker does not know if a given trader is informed or uninformed) and one at time. After receiving the bid and ask quotes from the specialist each trader either buys or sells the stock. Because in the model we have assumed that investors do not hold inventory, from this point on in the analysis we will assume that the terms "selling" and "short-selling" are synonymous. After each trade the market maker adjusts the bid and ask prices based on whether the trade was a buy or sell and then the exercise is repeated.

# 3 Parameters, Equations, and Model Mechanics

The value of an asset (V) is either a low value (Vdown) or high value (Vup) with probabilities d and (1-d) respectively. Although the model assumes that Vup is true value of the stock (i.e. the final value at which informed traders know that the price will eventually arrive), the name Vup is somewhat misleading as Vup can be set above or below Vdown in order to study the effects of both positive and negative price information in the model . The probability that a given trader is informed is m. For the purposes of the model, we will define "being informed" somewhat abstractly as knowing the value of Vup. Alternatively, the probability that a trader is uninformed is given by (1-m). As previously mentioned, informed traders buy with a probability of 1 when the stock is V=Vup and sell with a probability of 1 when V=Vdown, and uninformed traders buy or sell with a probability of .5 regardless of the situation.

Bayes theorem gives us the following equations:

$$\text{P(V=Vup|buy)} = \frac{(1-d)(1+m)}{1+m(1-2d)} \tag{1}$$

$$\text{P(V=Vdown|buy)} = \frac{d(1-m)}{1+m(1-2d)} \tag{2}$$

$$\text{P(V=Vup|sell)} = \frac{(1-d)(1-m)}{1-m(1-2d)} \tag{3}$$

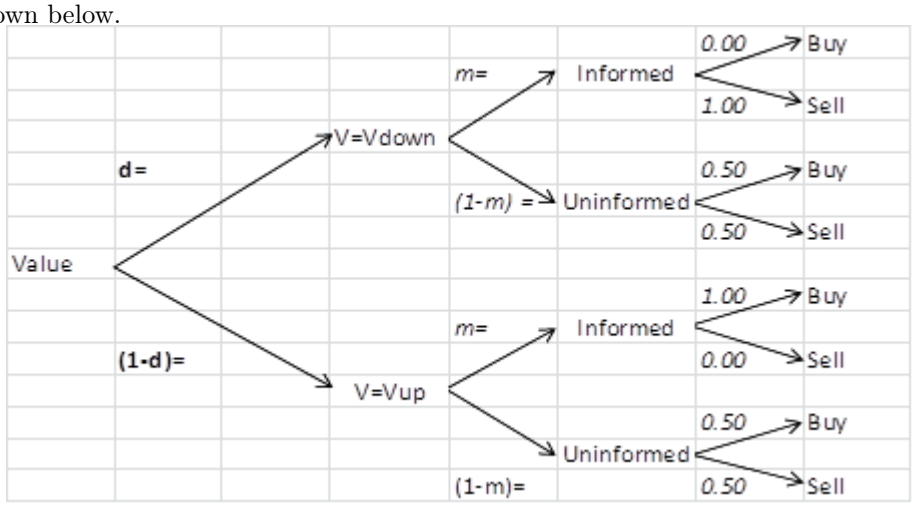
$$\text{P(V=Vdown|sell)} = \frac{d(1+m)}{1-m(1-2d)} \tag{4}$$

The ask price is the expected value of the asset given that a buy has taken place, and the bid price is the expected value of the asset given that a sale has taken place.

$$\text{Ask}=\text{Vdown}*\text{P(V=Vdown|buy)} + \text{Vup}*\text{P(V=Vup|buy)} = \text{Vdown}\ \frac{d(1-m)}{1-m(1-2d)} + \text{Vup}\frac{(1-d)(1+m)}{1+m(1-2d)} \quad (5)$$

$$\text{Bid}=\text{Vdown}*\text{P(V=Vdown|sell)} + \text{Vup}*\text{P(V=Vup|sell)} = \text{Vdown}\ \frac{d(1+m)}{1-m(1-2d)} + \text{Vup}\frac{(1-d)(1-m)}{1+m(1-2d)} \quad (6)$$

Before each trade a uniform random variable is generated. In the unconstrained versions of the model if that variable is higher than d the trade is a buy, otherwise the trade is a sale. If the trade is a buy, P(V=Vdown|buy) becomes d for the next trade and the sequence is repeated. If the trade is a sale P(V=Vup|sell) becomes d for the next trade instead. In the versions of the model where short-selling is restricted traders are prevented from selling and the trade is restarted with a new random variable if the ask price on the current trade is lower than the ask price on the previous trade. A single trade in this model is shown below.




# 4 Results

We will assume that the difference between the Vup and Vdown prices is caused by some event about which informed traders have additional, non-public information. For the purposes of drawing conclusions based on model results, we can assume that these divergent expectations are caused by different interpretations of earnings announcements or some other event. Blau and Pinegar (2009) and Xu (2007) both show that restriction of short-selling will lead to convex responses to information.

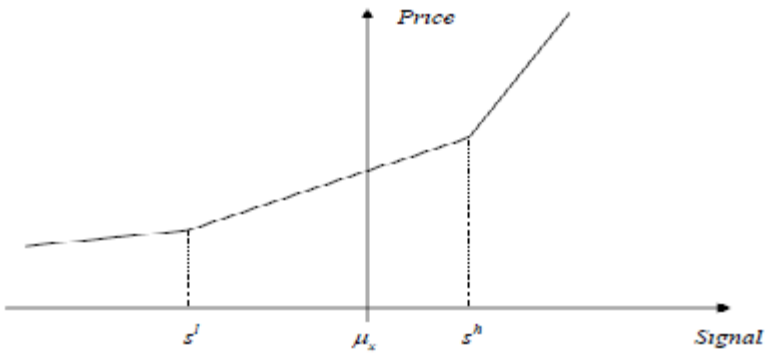
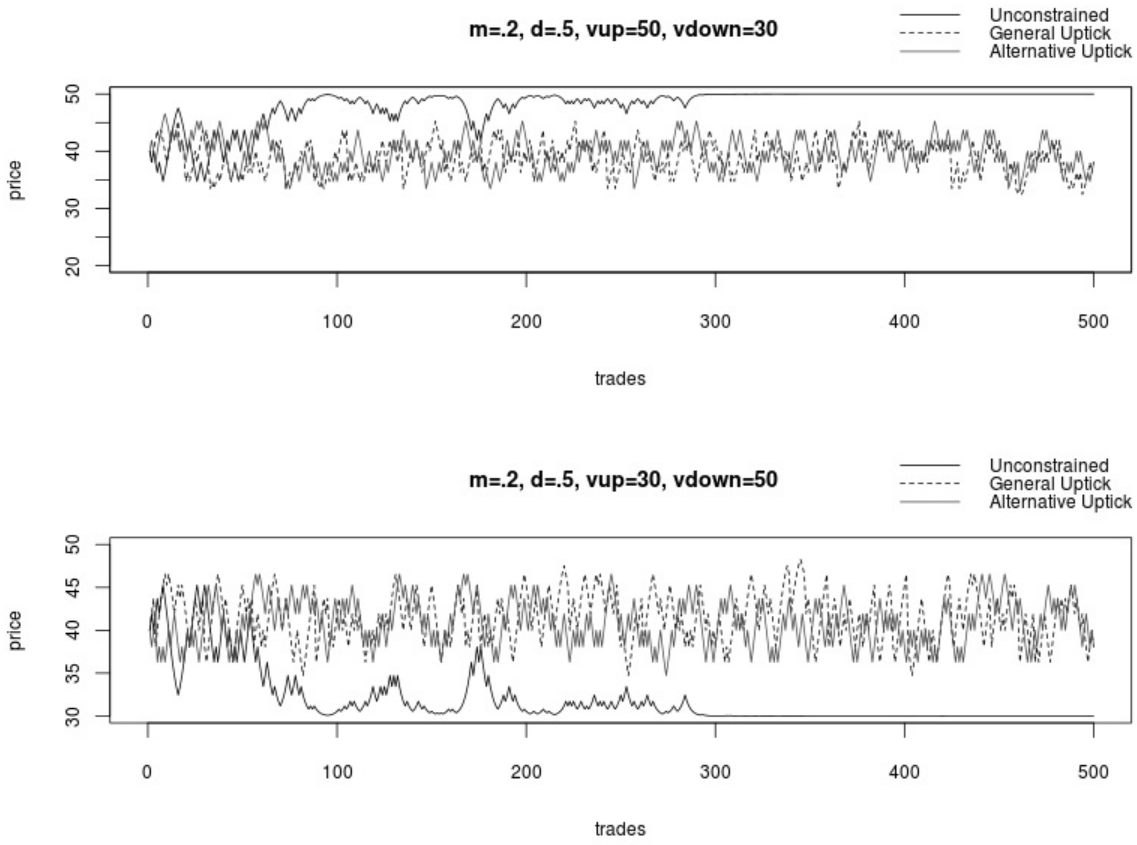



**Figure 1. Price convex in signal.** The market reacts to signals through the reaction of market participants. When the signal is sufficiently positive (negative), only high (low) precision investors participate in the market. Since high precision investors react more to the signal than low precision investors, price reactions are stronger to positive than to negative signals.

Figure 1, taken from the aforementioned paper by Jianguo Xu shows that, when short-selling is constrained prices will over-adjust to positive information and under adjust to negative information. If we assume that there is an earnings announcement immediately prior to the first trade, this phenomenon will be adjustment of prices to their stable values. Additionally, if this theory is robust to different degrees of uptick restrictions, the price path of a stock constrained by the alternative uptick rule should lie somewhere between those of the unconstrained stock and the stock that is subject to the general uptick rule. The following figures were generating by simulating five hundred repetitions of the model without constraints, with a general uptick constraint, and with an alternative uptick constraint. The parameters used in each simulation are given above each graph.

# 5 The Relative Effects of Positive and Negative Information

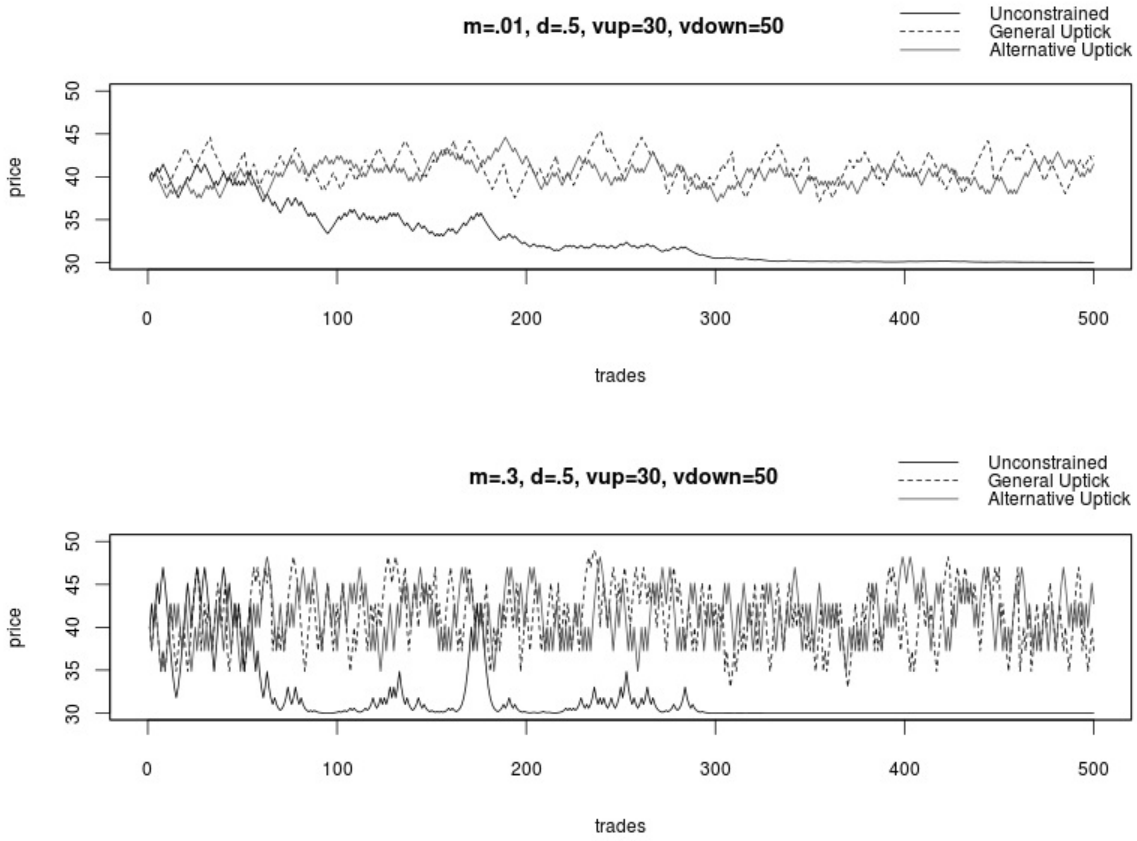



The preceding figure shows two hypothetical market scenarios with identical parameters, but with the notable exception of vup and vdown being switched in the two scenarios. If we assume vup to be the informationally correct price of the stock, restricting short-selling prevents the stock price from reaching its correct value. Presumably, limiting what traders are allowed to do discourages informed traders from trading. This leaves only uninformed "noise" traders in the market and greatly decreases the informational content of each individual trade. This is supported by the observation that the stocks traded without uptick-related constraints in both scenarios reach and remain at the correct price after approximately 275 trades while no stock traded in the presence of constraints in either scenario ever reaches a stable price. It is worth noting that prices appear to be more volatile when the true price (vup) is lower than vdown. This is likely caused by the interaction between the downward pressure from informed traders shorting overvalued stocks and the constraints placed upon that activity. This friction is not nearly as prominent when the stock is undervalued because in that scenario only uninformed traders are affected by short sale constraints which are, by nature, asymmetric.

Also, while the model shows the underreaction to negative information predicted by both Xu and Diamond and Verrecchia, the overarreaction to positive information theoretically suggested is conspicuously absent. This occurs because once the model returns vup the value which is compared to a uniform random variable to determine whether the next trade begins return exclusively the values 1 and 0. As a result, the model is mathematically incapable of returning a value higher than vup when vup is greater than vdown, or from a value less than vup when vup is less than vdown. This fact highlights a serious shortcoming of the model

that limits the model's ability to mirror the real world, which by logical extension limits the robustness and trustworthiness of the results produced by the model.

# 6 The Effects of the Ubiquity of Private Information



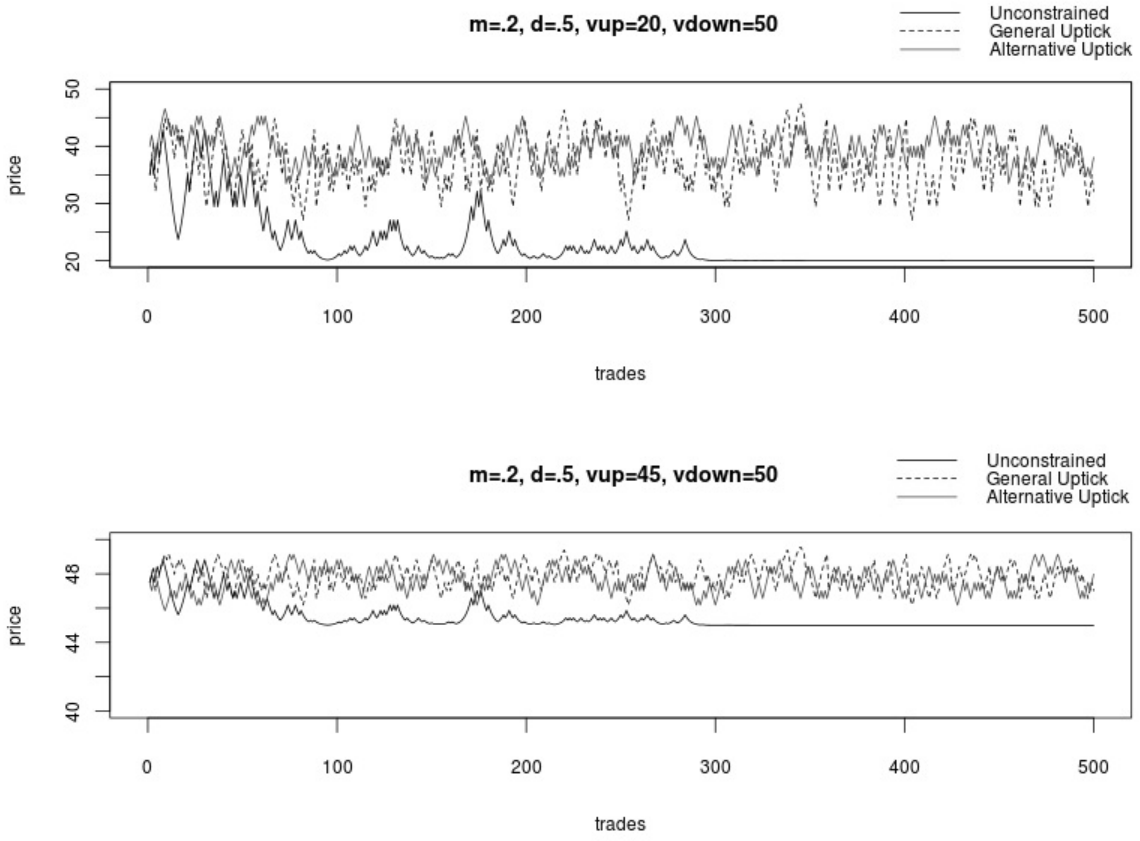

Perhaps more than any other parameter, changes in the value of m, which reflect the probability that a given trader entering to the market is informed (and therefore also the ubiquity of private information), drastically affect the path of stock prices in every one of the scenarios explored in this paper. Because the model's definition of being informed, i.e. knowing vup, is so abstract, it is difficult to pin down a consistent, measurable way to separate the informed from the uninformed or empirically estimate the value of m for a given stock. In some situations the cohort of informed traders may exclusively include institutional traders. In other situations perhaps only insiders know vup. Instead, thinking of m more broadly as a representation of the ubiquity of explicit material information, and assuming a discrete difference between informed and uninformed traders such that it is impossible to be "partially informed" affords the model a degree of simplicity that allows it to be calculable.

In the model, as m decreases price volatility decreases. This happens in part because the number of trades made on private information decreases the informational quality of each trade decreases. As m approaches 0 the trading scenario comes closer and closer to being pure random noise trading. Once m reaches 0 both the bid and ask prices converge to 0. At this price the bid-ask spread is 0 and the market maker, having lost the need to earn a profit uninformed traders to make up for losses incurred from trading with informed traders,

earn a normal profit. The final outcome of this scenario is a stock price (which in the model is determined to be the arithmetic average of the bid and ask prices) that oscillates closely around the midpoint between vup and vdown. Conversely, if m is equal to 1 the process breaks down it can be shown that the ask price, which is equal to $\text{Vdown}\frac{d(1-m)}{1-m(1-2d)} + \text{Vup}\frac{(1-d)(1+m)}{1+m(1-2d)}$, becomes 0. This implies that market makers are no longer willing to participate in the market and the process breaks down. As m increases the informational quality of each trade increases, and consequently the speed at which the unconstrained stock price reaches its equilibrium value.

Finally, even when m is extremely close to 1 uptick-related short-sale constraints still prevent the stock price from reaching its equilibrium value. Even when the vast majority of investors are informed short-sale constraints still eliminate informed investors' incentives to participate in the market such that their influence is not sufficient to push the stock's price to its true value.

# 7 Effects of Changes in Homgeneity of Investors' Expectations




Because heterogeneous investor expectations are a crucial assumption of the model, the paper would be incomplete without a study of how changes in the degree to which investors disagree about prices affect prices paths in the model. The absolute difference between vup and vdown can be used to measure the degree of heterogeneity of investors' expecations such that the greater the difference between vup and vdown the greater the degree of heterogeneity of investors' expectations.

Unsuprisingly, as the absolute diffrence between vup and vdown increases in the model so does price

volatility. Because the values of both vup and vdown figure prominently in the calulation of both the bid and ask spreads in the model it is easy to see how their values can affect way the stocks' prices change over time. Bearing in mind that the value of the stock is bounded by the value of vup and that noise trading will largely lead to flucuations around the midpoint between vup and vdown as the absolute spread between vup and vdown decreases the range of feasible stock prices decreases. The result is that unconstrained stocks with low levels of heterogeneity of investors' expectations converge relatively quickly to their equilibrium prices and the muddled, largely noise-based trading that takes place in models constrained by both general and alternative uptick rules move around within a smaller range. The result in each case is a reduction in price volatility.

# 8 Part I Conclusions

Unfortunately, only a few of the conclusions given by imposing short-sale restrictions on the Glosten-Milgrom model are emprically testable. Because it is impossible to pin down any of the key parameter values used in the model for real securities in real situations, many of the precise quantative results generated by the model cannot be reliably tested against appropriate real world data. Even in past data it is impossible to even reliably estimate m, vup, vdown, or d for a given security. However, if the model is a reasonable approximation of the real world it should be the case that, seeing as constraining short-selling prevents stocks from reaching equilibrium values, uptick-related short-sale constraints lead to an increase in stock price volatility. The presence of options and possibility of irrational behavior may also lead to differences between the results of the Glosten-Milgrom Model and the price paths generated from daily stock return data.

# 9 Null Hypotheses

i. In the presence of the alternative uptick rule returns, volume, short volume, and volatility do not differ significantly from their levels in an unconstrained market.

ii. Even though in the presence of short-sale constraints it is possible to achieve an artificial short position in the options market, put call ratios will not be significantly affected by the presence of the alternative uptick rule, negating the case for constraint-induced put-option activity (Blau and Brough, 2011).

iii. Stock-fixed and Day-fixed effects will not be significantly different in an unregulated market and a market constrained by the alternative uptick rule.

# 10 Data

> " On May 2, 2005, roughly 1,000 U.S. stocks—so called Pilot stocks—began to trade without short-sale price tests (Uptick test for the NYSE and bid price test for Nasdaq). These stocks were selected by the SEC to represent a broad cross-section of the U.S. equity market. The Pilot stocks were drawn from the Russell 3000 index, comprising every third stock ranked by volume... The experiment was designed by the SEC to investigate whether Rule 10a-1, NYSE's Uptick Rule, and Nasdaq's bid price test affect market quality, and to develop uniform price tests if such rules were deemed necessary going forward"

Using data taken at the daily level from the stocks used in the pilot study of the uptick rule implemented by Reuglation SHO I examine data from 2005 before and after May 2, the day the program was enacted. In order to study the potential effects of the alternative uptick rule I eliminate all observations which would not be effected by the rule, that is all stocks with daily returns greater than -10% I further separate the data into portfolios based on whether a particular stock has an option listed. I then use data obtained from WRDS to generate a battery of daily, market-quality and short-selling-related activities.

# 11 Univariate Results

| | **General Uptick Rule** | | | | | **Alternative Uptick rule** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | return | Non-Short Volume | Return Volatility | Price Volatility | Price | Return | Non-Short Volume | Return Volatility | Price Volatility | Price |
| | **Before** | | | | | **Before** | | | | |
| Mean | -.00108 | 1523303 | .0193 | .0284 | 30.54 | -.1529 | 1008513 | .0552 | .1179 | 21.64 |
| Std Dev | .0234 | 4628383 | .0121 | .0182 | 19.70 | .0696 | 18303312 | .0255 | .05 | 16.82 |
| Min | -.475 | 0 | .00060 | 0 | 1.4 | -.475 | 179543 | .0309 | .0339 | 1.76 |
| Max | .6789 | 1.562E8 | .2170 | .3395 | 126.4 | -.1 | 1.184E8 | .1519 | .6216 | 83.33 |
| | **After** | | | | | **After** | | | | |
| Mean | .00784 | 1600823 | .0189 | .0267 | 32.12 | -.1679 | 9197657 | .0591 | .12 | 18.88 |
| Std Dev | .0225 | 4720435 | .0126 | .0172 | 21.04 | .0898 | 21358146 | .0293 | .0675 | 17.05 |
| Min | -.7175 | 0 | .00026 | 0 | .35 | -.7175 | 3500 | .03 | .0216 | .35 |
| Max | .7854 | 2.893E8 | .2386 | .6216 | 205.1 | -.1 | 2.893E8 | .2238 | .6216 | 106.6 |
| | **Differences in means (after - before)** | | | | | **Differences in means (after - before)** | | | | |
| Diff. | .00186** | 77820** | -.00046** | -.00174** | 1.58** | -.15 | -887496 | .00387 | .00222 | -2.76 |
| p-value | .0001 | .0008 | .0001 | .0001 | .0001 | .0887 | .675 | .1834 | .7349 | .111 |
| t-stat | 16.69 | 3.36 | -7.49 | 20.35 | 15.37 | -1.99 | -.42 | 1.33 | .34 | -1.6 |

Table 1: Summary Statistics: Stocks With Options

As we can see (and confirmed by Deither, Lee, and Werner (2009)), the repeal of the general uptick rule led to a significant increase in returns, non-short volume, and price, as well as a decrease in price and return volatility at the daily level. The increase in returns, volume and price support Diamond and Verrecchia's (1987) findings that allowing short-sellers to trade unrestricted leads to an increase in the speed of incorporation of positive news as well as negative news. The decrease in volatility is supported by the idea that allowing prices to more accurately reflect public information makes them more efficient, and therefore less volatile. Table two drops all observations in which daily returns are greater than -0.1% in an attempt to view the effects of an "alternative uptick rule. The tables show that the results obtained for the general uptick rule are not robust to a test of the alternative uptick rule.

| | General Uptick Rule | | | | | Alternative Uptick rule | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | return | Non-Short Volume | Return Volatility | Price Volatility | Price | Return | Non-Short Volume | Return Volatility | Price Volatility | Price |
| **Before** | | | | | | **Before** | | | | |
| Mean | -.00111 | 399537 | .0194 | .0295 | 31.31 | -.1348 | 1945028 | .0498 | .138 | 11.56 |
| Std Dev | .0288 | 3096171 | .0109 | .0194 | 57.38 | .0422 | 2124542 | .0138 | .0438 | 11.99 |
| Min | -.3847 | 0 | .00036 | 0 | .52 | -.3847 | 6888 | .0326 | .043 | .56 |
| Max | .3922 | 1.5367E8 | .1279 | .3194 | 963.5 | -.1 | 3527400 | .1146 | .3 | 48.93 |
| **After** | | | | | | **After** | | | | |
| Mean | .000822 | 421118 | .0197 | .02084 | 32.54 | -.162 | 2317233 | .0712 | .1571 | 11.21 |
| Std Dev | .0321 | 3593151 | .0126 | .0204 | 57.92 | .0838 | 3895976 | .044 | .0807 | 12.84 |
| Min | -.7459 | 0 | .000251 | 0 | .4 | -.7459 | 0 | .0315 | .0236 | .40 |
| Max | .5066 | 2.4058E8 | .2736 | .5682 | 899.9 | -.1 | 31385649 | .2697 | .5682 | 74.33 |
| **Differences in means (after - before)** | | | | | | **Differences in means (after - before)** | | | | |
| Diff. | .00194** | 21581 | .00026* | -.00109** | 1.2331* | -.0263* | 372205 | .0214** | .0191 | -.3446 |
| p-value | .0001 | .369 | .023 | .0001 | .0019 | .002 | .6253 | .0001 | .0213 | .8605 |
| t-stat | 12.26 | .9 | 3.05 | -7.85 | 3.11 | -3.15 | .49 | 6.01 | 2.33 | .18 |

Table 2: Summary Statistics: Stocks Without Options

Similar results can be seen for stocks without options but with several important differences. The presence of the alternative uptick rule leads to a statistically significant increase in average daily returns, and a decrease in price and return volatility among stocks whose value has fallen at least 10% in a single day. It is also worth noting that in all 4 cases currently discussed the minimum value of all observations is much lower in the presence of an uptick-related short-sale constraint, suggesting that uptick rules benefits companies whose securities are rapidly declining.

| | General Uptick Rule | | | | | | Alternative Uptick Rule | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Short Volume | Num Shorts | Short Ratio | Put Volume | Call Volume | Put/Call Ratio | Short Volume | Num Shorts | Short Ratio | Put Volume | Call Volume | Put/Call Ratio |
| **Before** | | | | | | | **Before** | | | | | |
| Mean | 39563 | 915.8 | .2908 | 753.8 | 1215.1 | .3455 | 2642861 | 74723.9 | .2985 | 8662.2 | 12701.2 | .4001 |
| Std Dev | 1384527 | 2622.5 | .1454 | 3530.2 | 6573.3 | .3119 | 4727463 | 16639.6 | .1542 | 22579.9 | 33942.3 | .2407 |
| Min | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Max | 62868043 | 135145 | 1 | 153841 | 471041 | 1 | 37917884 | 135145 | 1 | 153847 | 227161 | 1 |
| **After** | | | | | | | **After** | | | | | |
| Mean | 423650 | 1142.8 | .2991 | 867.6 | 114.76 | .3469 | 2802954 | 6808.1 | .3256 | 5992.6 | 6488 | .412 |
| Std Dev | 1481526 | 2378.1 | .1507 | 4039.7 | 10986.8 | .3042 | 6101116 | 10130 | .1429 | 24955.5 | 22903.1 | .0109 |
| Min | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Max | 1.2267E8 | 146712 | 1 | 364152 | 2739057 | 1 | 99333118 | 109889 | 1 | 364152 | 366503 | 1 |
| **Differences in means (after - before)** | | | | | | | **Differences in means (after - before)** | | | | | |
| Diff. | 2796734** | 227** | .00831** | 113.7** | 232.5** | .00143 | 1600094 | -664.8 | .0271 | -2669.7 | -6213.2 | .0119 |
| p-value | .0001 | .0001 | .0001 | .0001 | .0001 | .3777 | .7883 | .5758 | .0669 | .2847 | .0165 | .6287 |
| t-stat | 3.87 | 19.05 | 11.27 | 5.83 | 4.55 | .88 | .27 | -.56 | 1.75 | -1.07 | -2.4 | .48 |

Table 3: Summary Statistics: Option Metrics

Table 3 shows that the elimination of the general uptick rule leads to an increase in short volume, the short ratio, put and call volume, and the put call ratio. These results are consistent with the idea that the elimination of short-sell constraints allows prices to more accurately reflect negative information (Diamond & Verrecchia (1987)), and option investors should, in theory, be more willing to purchase put options when

pessimistic short-sellers are not constrained. The increase in call volume may be at least partially explained by the aforementioned increase in the rate of incorporation of good news into stock prices as a result of short-sale freedom. Once again, these results are not robust to an "alternative uptick world." Also, even though Table I showed a statistically significant increase in non-short volume following the suspension of the alternative uptick rule, the fact that both put volume and the put call ratio actually increase after the general uptick rule is suspended suggests that short-sellers were not migrating en masse to the options market to avoid the restrictions caused by uptick constraints.

# 12 Multivariate Results

In order to address the concern that an increase in the short ratio and/or option activity around the date in question may be driven by factors other than a suspension of the uptick rule, I regress short ratio and put call ratio onto a number of lagged and contemporaneous factors. The regression equations are given as follows:

$$shortratio_{i,t} = \beta_1(return\_5\_1) + \beta_2(return) + \beta_3(shortratio\_5\_1) + \beta_4(sigma) + \beta_5(sigma\_5\_1) + \beta_6(turn\_5\_1) + \beta_7(afShortratioter) + \beta_8(dummy) + \beta_9(afterdummy) + \varepsilon_t \quad (7)$$

$$PCratio_{i,t} = \beta_1(return\_5\_1) + \beta_2(return) + \beta_3(pcratio\_5\_1) + \beta_4(sigma) + \beta_5(sigma\_5\_1) + \beta_6(turn\_5\_1) + \beta_7(after) + \beta_8(dummy) + \beta_9(afterdummy) + \varepsilon_t \quad (8)$$

Where ret_5_1 is 5 day lagged returns, shortratio_5_1 is 5 day lagged short ratio, sigma is volatility, sigma_5_1 is 5 day lagged volatility, pcratio_5_1 is 5 day lagged put call ratio, and turn_5_1 is 5 day lagged turnover. Both standard and fixed effects regressions are run for short and put call ratios. The variable "dummy" is 1 if an observation's returns are less than -10%, and 0 otherwise. The variable after is 1 if the observation is dated after May 2, 2005, and zero otherwise, and the variable "afterdummy" is equal to the product of the variables after and dummy for a given observation.

| | **Table IV: Short ratio** | | | | | |
|---|---|---|---|---|---|---|
| | **Stocks with options** | | | **Stocks Without options** | | |
| | [1] | [2] | [3] | [1] | [2] | [3] |
| *intercept* | *.04157*** | *.2216*** | *.2288*** | *.08221*** | *.08429*** | *.08293*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| *ret_5_1* | *.07108*** | *.07119*** | *.04199*** | *.06371*** | *.06476*** | *.06387*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| *return* | *.4781*** | *.5145*** | *.07122*** | *.6063*** | *.6463*** | *.6459*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| *shortratio_5_1* | *.8159*** | *.8163*** | *.8163*** | *.7303*** | *.7309*** | *.7306*** |
| | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) | (<.0001) |
| *Sigma* | *.2674*** | *.2216*** | *.2288*** | *.02335* | *-.02495* | *-.02495* |
| | (<.0001) | (<.0001) | (<.0001) | *(.3332)* | *(.3208)* | *(.3209)* |
| *sigma_5_1* | *.2029*** | *.2293*** | *.2288*** | *-.09341** | *-.0731* | *-.07257* |
| | (<.0001) | (<.0001) | (<.0001) | *(.0048)* | *(.0279)* | *(.0290)* |
| *Turn_5_1* | *.000249* | *.000196* | *.000204* | *.000312* | *.000139* | *.000116* |
| | *(.1892)* | *(.3002)* | *(.2813)* | *(.4142)* | *(.7154)* | *(.7622)* |
| *after* | *-.0001* | | *-.0002* | *.001857* | | *.001745* |
| | *(.8586)* | | | *(.0803)* | | *(.1006)* |
| *dummy* | | *.05508*** | *.03953*** | | *.06914* | *.05147* |
| | | (<.0001) | *(.0002)* | | (<.0001) | *(.0160)* |
| *afterdummy* | | | *.01911* | | | *.02180* |
| | | | *(.098)* | | | *(.3521)* |

The regression coefficients for the first six variables in equation 1 confirm the findings of Diether, Lee, and Werner (2009). Of the last three variables, only "dummy" is statistically significant in any of the regressions. This suggests that short-sellers tend to target stocks that have fallen at least 10% in a single day despite their generally contrarian behavior as seen in short-selling's positive correlation with both contemporaneous and lagged returns. Even though the results in table VII suggest that short sellers target stocks that have fallen at least 10% in a day more than other stocks, the lack of a statistically significant coefficient in any of the regressions for "after" or "afterdummy" would suggest that uptick restraints do not significantly change this practice.

| Table V: put call Ratio | | | |
|---|---|---|---|
| | [1] | [2] | [3] |
| *intercept* | *.2039* | *.2050* | *.2027* |
| | *(<.0001)* | *(<.0001)* | *(<.0001)* |
| *ret_5_1* | *-.1928* | *-.19323* | *-.1932* |
| | *(<.0001)* | *(<.0001)* | *(<.0001)* |
| *return* | *-1.0187* | *-1.1042* | *-1.1048* |
| | *(<.0001)* | *(<.0001)* | *(<.0001)* |
| *pcratio_5_1* | *.5037* | *.5041* | *.5040* |
| | *(<.0001)* | *(<.0001)* | *(<.0001)* |
| *sigma* | *-.03885* | *.06759* | *.06829* |
| | *(.3367)* | *(.1084)* | *(.1048)* |
| *sigma_5_1* | *-1.0716* | *-1.3334* | *-1.3320* |
| | *(<.0001)* | *(<.0001)* | *(<.0001)* |
| *turn_5_1* | *.007043* | *.007129* | *.007139* |
| | *(<.0001)* | *(<.0001)* | *(<.0001)* |
| *after* | *.002679* | | *.007139* |
| | *(.0969)* | | *(.0933)* |
| *dummy* | | *-.1220* | *-.1454* |
| | | *(<.0001)* | *(<.0001)* |
| *afterdummy* | | | *.02843* |
| | | | *(.3631)* |

Also, while it is true that table IV showed that average returns declined after the suspension of the uptick rule, the fact that the variable "after" does not have a statistically significant coefficient in any of the regressions run suggests that those lower returns are not the result of increased short-selling. This conclusion is also robust to a hypothetical "alternative uptick world" in that the variable "afterdummy" also has no statistically significant coefficient.

The negative correlation between the put call ratio and both contemporaneous and lagged returns suggests that pessimistic, put-option traders follow a momentum strategy, targeting stocks with declining returns. These results are consistent with Blau and Brough's (2011) findings. Again, of the last three variables only "dummy" is statistically significant in any of the regressions. However, "dummy" is inversely related to the put call ratio, whereas it was positively related to short ratio. This would suggest that bearish option traders naturally tend to shy away from stocks that are rapidly losing value independent of uptick-related short-sale constraints, despite their general preference for stocks with declining returns. The lack of statistical significance of the coefficients of "after" and "afterdummy" shows that uptick constraints have no statistically significant effect on option trading.

# 13 Part II Conclusions

The fact that short-sellers tend to follow a contrarian strategy while option traders tend to follow a momentum strategy, except when stocks lose 10% of their value in a day which causes both types of traders to change strategies, supports previous findings that short-sellers and option traders are fundamentally different traders with different philosophies divided more by their chosen method of trading than their beliefs about the direction that a given stock's price will move. Whether or not the activities of short-sellers affect those of short-sellers (or vice versa) will be further explored in the next section.

# 14 Analysis of Uptick-Related Short-Sale Constraints' Effects on the Relationship Between the Short and Put Call Ratios

The empirical results generated in the last section raised several questions about potential, less obvious effects that uptick rules could have on financial markets, and on the option market in particular. Because pessimistic investors can still establish artificial short positions in the option markets, one can easily see how these investors could side step uptick rules or any other short-sale restrictions for that matter. However, the data examined in the previous section failed to show evidence of this behavior happening on a significant scale. The fact that there was no significant change in the put call ratio before and after the implementation of the general uptick rule (stocks that would have been affected by a hypothetical alternative uptick rule also showed no significant change before and after the date of implementation). This does not mean that restricting short-selling has no effect on the relationship between the short and put call ratios and the actions of pessimistic traders.

In this final section I use the same data used in the previous section to create a vector autoregression and ultimately an impulse response function in order to study the quantitative nature of the relationship between the short and put call ratios, how each ratio responses to exogenous shocks and exogenous shocks to the other variable, and whether or not one drives the other.

# 15 Process

First, subjecting the data to a Johansen Test (Johansen, 1558) showed the data to be cointegrated. The very fact that the two variables are significantly cointegrated suggests that there is a long-term relationship between the two variables suggests that they are related, but also suggests some econometric challenges. This cointegration necessitated the use of a vector error correction model (VECM) to in order to produce reliable impulse response functions. Once the VECM has adjusted for the cointegration impulse response functions can be generated and the effect of exogenous shocks on the data can be studied.

Because the panel data is used in the study, data for each individual stock must be analyzed separately and VECMs, VARs and IRFs must be generated for each stock individually. The resulting data can then be analyzed and the statistical significance of changes in the responses of the short ratio and put call ratio before and after the repealing of the general uptick rule on May 2, 2005 can be studied. Also, the same process can be used with only data from stocks whose value have fallen at least 10% in a single day in the period in question (i.e. stocks that would be affected by the alternative uptick rule) to allow us to study the hypothetical effect of an alternative uptick rule as was also studied in part 2.

# 16 Results

After the cumulative impulse response for each stock is calculated, yielding four separate impulse responses (short ratio response to a shock in the short ratio, put call ratio response to a shock in the short ratio, short ratio response to a shock in the put call ratio, and put call ratio response to a shock in the put call ratio). In the preceding univariate analysis of the impulse responses before and after the May 2, 2005 repealing of the general uptick rule is performed. The presence of non-zero impulse response values on average and in the overwhelming majority of individual cases indicates that there is not a clean, cause-effect relationship does not exist between the short and put call ratios, but that they together constitute a feedback system. In

both the general and alternative uptick studies positive shocks to the short ratio tend to negatively affect the put call ratio and vice versa. However, this negative effect becomes positive once uptick-related short-sale constraints are repealed. This finding is consistent with the previously discussed observation that short-sellers and pessimistic option traders follow fundamentally different strategies, the former typically being contrarian and the latter momentum traders.

| | **General Uptick Rule** | | | | **Alternative Uptick Rule** | | | |
|---|---|---|---|---|---|---|---|---|
| Response of | S.Ratio | P.C. Ratio | S.Ratio | P.C. Ratio | S.Ratio | P.C. Ratio | S.Ratio | P.C. Ratio |
| to Shock in | S.Ratio | S.Ratio | P.C. Ratio | P.C. Ratio | S.Ratio | S.Ratio | P.C. Ratio | P.C. Ratio |
| | **Before** | | | | | | | |
| Mean | 1.6675 | -.3322 | -.1900 | 1.2975 | 1.5202 | -.8735 | -.3551 | 1.4203 |
| Min | -.1814 | -3.6017 | -1.6275 | .0114 | .1499 | -3.6017 | -1.3087 | .0199 |
| Max | 7.7572 | 3.8487 | 2.0583 | 2.8643 | 1.2884 | 2.6238 | .8468 | 2.7895 |
| Std Dev | 1.6396 | 1.6555 | .7656 | .6780 | 1.3825 | 1.6718 | .6796 | .6809 |
| | **After** | | | | | | | |
| Mean | 1.1283 | .0142 | -.421 | 1.7322 | .9934 | .0648 | -.0275 | 2.0078 |
| Min | .1499 | -2.6128 | -1.4492 | .1568 | .1543 | -2.9468 | -1.6901 | .0199 |
| Max | 6.1823 | 2.1951 | .0768 | 2.8539 | 5.4478 | 3.3897 | 1.1918 | 3.2933 |
| Std Dev | 1.1286 | 1.2480 | .5699 | .7476 | 1.0315 | 1.2566 | .6369 | .6449 |
| | **Differences in Means (Before-After)** | | | | | | | |
| Difference | .5391 | -.3464 | -.1479 | -.4346 | .5268 | -.9383 | -.3276 | -.5875 |
| t-stat | 1.68 | -1.08 | -1.00 | -3.10 | 2.18 | -3.2 | -2.3 | -4.08 |
| P Value | .0955 | .2799 | .3175 | .0023** | .0306 | .0017** | .0228 | .0001** |

After the cumulative impulse response for each stock is calculated, yielding four separate impulse responses (short ratio response to a shock in the short ratio, put call ratio response to a shock in the short ratio, short ratio response to a shock in the put call ratio, and put call ratio response to a shock in the put call ratio). The preceding univariate analysis of the impulse responses before and after the May 2, 2005 repealing of the general uptick rule is performed. The presence of non-zero impulse response values in on average and in the overwhelming majority of individual cases indicates that there is a clean, cause-effect relationship does not exist between the short and put call ratios, but that they together constitute a feedback system. In both the general and alternative uptick studies positive shocks to the short ratio tend to negatively affect the put call ratio and vice versa. However, this negative effect becomes positive once uptick-related short-sale constraints are repealed. This finding is consistent with the previously discussed observation that short-sellers and pessimistic option traders follow fundamentally different strategies, the former typically being contrarian and the latter momentum traders.

Initially under the general uptick rule the response of the short ratio to a positive shock in the short ratio is positive and the response of the put call ratio to a positive shock in the put call ratio is positive as well. Each ratio exhibits a negative response to a positive shock in the other ratio. The only statistically significant change after the suspension of the general uptick rule is that the response of the put call ratio to positive shocks in its own value increases.

If only stocks affected by the alternative uptick rule are studied the results are slightly different. A positive shock to the short ratio negatively affects the put call ratio before the suspension of alternative

uptick rule and positively after. This implies that a negative shock to the short ratio would cause a response in the put call ratio. One explanation of this phenomenon could be that short-sellers, frustrated by their inability to establish short positions, instead migrate to the options market where they can establish bearish positions unrestricted. Unfortunately, this hypothesis is clearly untestable. However, the fact that after the suspension of the alternative uptick rule the response of the put call ratio to a positive shock in the short ratio becomes positive and the change is statistically significant lends support to the idea that the suspension of the uptick rule ended the need for pessimistic traders' migration to the options market. Also, because this phenomenon is seen only in stocks affected by the alternative uptick rule it may be valid to conclude that this migration only took place on a significant level where troubled stocks (that is, stocks that had lost at least 10% of their value in a day during the period in question) were concerned.

# 17 Final Conclusions

Both the general and alternative uptick rules theoretically decrease informational efficiency, are shown empirically to not significantly affect the short or put call ratios, and there is evidence that traders may have used the options market to circumvent the rules. It is very likely that uptick-related short-sale constraints are ineffective at best and harmful to markets at worst. Furthermore, the uptick rules fail to decrease the short ratio, and therefore any significant decreases in returns or increases in volatility before and after May 5, 2005 cannot be reasonably attributed to the removal of uptick constraints. Finally, if the goal of constraining short-selling is to decrease pessimistic "piling on" of stocks that are rapidly losing much of their value any such constraint on short-selling is useless without a comparable restriction in the options market.

While further study is surely warranted, the outlook for the efficacy of uptick-related short-sale constraints is dim. While regulators' goal of stabilizing financial markets is noble, it would seem that they ought to seek other ways to accomplish that goal. It is possible that the case can be made that constraining the short-selling of severely distressed stocks may be beneficial, but uptick rules as presently constituted are too broad in scope and hurt the performance of non-distressed stocks and reduce the informational efficiency of the stock entire market. It is possible that the value of some stocks may fall precipitously for purely behavioral, non-market related reasons, and perhaps much of this could be curtailed through careful, uptick regulation, but it is hardly responsible to do so at the expense of the market as a whole.

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