Price limits: Are they worth the price?

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Abstract

This paper analyzes the effect of price limits on price behavior, volatility, trading volume and profit-making ability in equity markets. I conducted seventeen experimental asset markets to compare behavior across three regulatory regimes: unconstrained markets, markets with 15% limits, and markets with 10% limits. I find that the presence of limits curbs volatility; the tighter the controls, the lower the volatility. Also, informed traders are able to profit less in the presence of limits than in unconstrained markets. Thus, price limits improve social welfare. However, I did not find any significant relationship between the presence of price limits and trading volume or the magnitude of the absolute deviation in price from fundamental value.

Key words: price limits, efficiency, ethics

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The raison d' être for a financial market is to facilitate the transfer of funds from savings-surplus units to savings-deficit ones in the economy. In this way funds are supposed to be invested in productive assets which ultimately add to the wealth of the economy. Efficiency and ethics are the two governing principles of stock markets and are highly valued by policy makers and market regulators. A fundamental debate in political economy is whether free markets can self-regulate and resolve issues of efficiency and social justice on their own. Proponents of free markets, or believers in the efficient market hypothesis (e.g., Fama, 1970) assume that market prices reflect the fundamental values of assets. If they do not, rational people stand to gain by trading. By buying underpriced and selling overpriced assets, rational traders can and will bring prices back to their fundamentals, thus contributing to price efficiency. Price efficiency is important to ensure that resources are allocated efficiently in the economy. If a market is subject to a fundamental shock, economic efficiency is served best if prices are allowed to absorb the shock and adjust toward the new fundamental value. That naïve and uninformed traders can get crushed by such sudden changes in prices, is not a concern of the market. In contrast to the believers in efficient market hypothesis, those who believe in the noise trader approach (e.g., Shleifer & Summers, 1990) lack faith in the ability of markets to self-regulate. According to this perspective, noise traders are affected by their beliefs, overconfidence, and other behavioral biases. Since rational traders have limited financial resources, they are not able to fully counter the patterns created by irrational or noise traders. Thus, the activity of noise traders can cause assets to be mispriced. To safeguard the market against such mispricing, and protect unsophisticated investors, regulatory mechanisms such as price limits are needed.

A price limit is a boundary set by market regulators to confine the daily movements of stock prices within a predetermined range based on the previous day's closing price. For instance, assume that a stock exchange imposes a price limit equivalent to 10% of the pervious day's closing price. Suppose a stock 'SDD' closed at a price of $100 yesterday. 'SDD' would be allowed to trade on the consecutive day anywhere in the range of $90 to $110. The intended function of price limits is to enable stabilization of markets. It is posited that such limits would have prevented the price freefall during the 1987 crash of the U.S. stock market and averted the dotcom mania. Price limits are thought to serve three purposes: (i) they increase allocational efficiency by forcing market participants to trade securities at prices close to their 'true' value by offering naive traders a time-out to process the information being unleashed in the market; (ii) they curb volatility; and (iii) they prevent the market from overreacting to news events, and thereby protect naïve traders.

Are price limits truly beneficial to financial markets? price limit critics argue that placing limits and thereby restricting the trading process can lead to a host of problems. Price limits prevent large one-day price changes and prevent immediate corrections in order imbalance. This causes volatility to be spread out over a longer period of time instead of staying concentrated over one day. Roll (1989) states, 'Most investors would see little difference between a market that went down 20% in one day and a market that hit a 5% down limit 4 days in a row. Indeed, the former might very well be preferable'. The higher volatility level that may occur on days after a limit has been hit is referred to as *'volatility spillover'*. By putting constraints on price movements, stocks may be prevented from reaching their equilibrium prices for that day. Under such circumstances, the stocks will have to wait till the next day (or subsequent days) to journey toward their true price. The possibility that prices may be prevented from effectively reaching their equilibrium values is referred to as '*delayed price discovery'*. Price limits could also pose serious threats to liquidity. A trader may be unwilling to trade a stock if trading is confined to a certain price range. This would lower the stock's liquidity and this is undesirable. Without a liquid stock market, many profitable long-term investments would not be undertaken because people would be reluctant to tie up their investments for long periods of time. The possibility of liquidity being lowered as a consequence of price limits is referred to as '*trading interference'*.

Most of the empirical papers on price limits address the questions: (i) Do price limits curb volatility? (ii) Do they mitigate investor overreaction? Kim and Yang (2003) find mixed results. They find that price limits induce overreaction when the price approaches the limit, but they also reduce overreaction when the limit price is traded consecutively. They also find support for the magnet hypothesis in their measures of trading volume and relative spread, but not on return autocorrelation data. Ma, Rao and Sears (1989a) find evidence of price reversals after limits are reached, indicating overreaction and subsequent correction. In a subsequent study they (Ma, Rao and Sears, 1989b) find that price limits do indeed offer a cooling-off period for the market. Choi and Lee (2001) analyze interday and intraday data from the Korea Stock Exchange and conclude that price limits act as magnets, cause biases in the supply of liquidity, and reinforce a positive serial correlation among order types (upward or downward trends in price movement are augmented). More importantly, they identify the asymmetric feature of price limits by showing that price limits act differently on the upper and lower limit activities. They find that criticisms against price limits are partially supported by upper limit moves while price limits are found effective in the case of lower limit moves. Because of this asymmetric effect, they suggest a price-limit system with a wider upper limit than the lower limit to enhance market efficiency and lower market volatility. Nath (2004) analyses data from the NSE and BSE (Indian equity markets), which have different limits for stocks trading at different levels. Like Choi and Lee (2001), he finds that the criticisms do not hold symmetrically for both upward and downward moves. Specifically, he finds that while there is no delay in price discovery for stocks that hit their upper limits, stocks that hit the lower limits do witness a delay in price discovery. In addition, he finds that the criticisms that appear to hold for narrow price limits do not hold for the broader limit rules. These findings while extremely interesting, are inconclusive to either advocate price limits or warrant their removal.

Kim and Rhee (1997) find evidence on the Tokyo Stock Exchange for all three counts of delayed price discovery, volatility spillover and trading interference, suggesting that price limits are detrimental to markets. Phylaktis, Kavussanos, and Manalis (1999) examine the effect of price limits on the volatility of returns. Using daily data for 10 stocks from the Athens Stock Exchange, they find support for the delayed price discovery hypothesis but not for the over-reaction hypothesis. In yet another study, Kim and Limpaphayom (2000) reaffirm Kim and Rhee's (1997) findings on employing data from the Taiwanese and Thai stock exchanges. Osler and Tooma (2003) use data from the Egyptian Stock Exchange to show that price limits do indeed exert a 'magnetic' force. Henke and Voronkova (2005) claim that price limits delay the adjustment of prices to equilibrium levels but do not impact volatility. It is clear that the empirical findings so far are at best mixed.

Empirical studies examining the efficacy of price limits are riddled with challenges. Field data fails to provide the equilibrium value of stocks and does not distinguish between noise traders (uninformed traders) and informed traders. This is one reason we turn to experimental techniques. The main advantage experiments offer is the possibility of measuring the risk-neutral expected value of a stock. Also, they enable the experimenter to distinguish between informed and uninformed traders and determine the path of information dissemination and equilibrium. The use of experimental methods allows us to examine behavior under alternative market structures (e.g., in the presence and absence of price limits). Such an examination cannot be conducted in naturally occurring markets[1]. Hence, using experimental techniques, we are better equipped to understand the role of price limits in stock markets.

Experimental studies

A number of experimental studies have demonstrated that when individuals are provided with enough time and trading experience in a laboratory market, their trading behavior and the resulting asset prices will be substantially similar to those found in naturally occurring markets[2]. For instance, Plott and Sunder (1982) examine a market in which certain 'insiders' have special information about the payoffs to securities and make observations about the rate of dissemination of private information. Experimental markets have found that even nonbinding price controls affect market dynamics and reduce market efficiency (Isaac and Plott, 1981 and Smith and Williams, 1981). Coursey and Dyl (1990) conducted an experimental study to compare the market's adjustment to significant new public information in the presence of price limits or trading halts. In contrast to the predictions put forth by Subrahmanyam's (1995) model, their findings seem to indicate that the adjustment of prices to new information is more effective in markets with price limits than in those with trading halts. It is worthwhile to note that in the Coursey-Dyl experimental set-up, the payoffs of the same asset are different for different traders based on the 'investor class' that they belong to. Harris (1998) was critical of the Coursey-Dyl results and suggested that they may be misleading because extreme volatility in the real world is

[1] See McDaniel and Hand (1996) for further discussion of the benefits of an experimental approach.
[2] See Hagel and Roth (1995).

more due to uncertainty about common values than uncertainty about distribution of quantity among traders who are artificially induced to value assets differently. Taking my cue from Harris (1998), in this paper, I test whether price limits contribute to the efficiency and practice of fairness in stock markets; as recommended by Harris, the uncertainty in my markets is related to information about the underlying value of assets. Below, I describe the methodology of my study.

Method

Participants and study design. One hundred and fifty-three graduate students participated in the experiment and based on their performance, received monetary compensation for their participation. The experiment lasted for one hour. The study had a 2 (information: public or private) X 3 (market regulation: unconstrained, 15% limits, or 10% limits) factorial design. The subjects were randomly assigned to the six treatments. Instructions pertaining to the experiment were sent via email to all the subjects and the link to the experimental market website was also sent with the instructions to help acquaint them with the software. On arriving at the laboratory they were asked to sit at computer terminals with the trading interface windows open in front of them. The instructions were projected on a big screen and were simultaneously read aloud by the experimenter. Subjects were encouraged to ask questions to clarify any doubts they had. They then had to answer correctly two questions pertaining to the task before being allowed to trade.

Trading features. In the study there were three different securities, called Asset A, Asset B and Asset C. Trading was allowed for 10 periods of 3 minutes each. One of the three possible outcomes or 'states of the world' was randomly selected at the end of period 10. Each state had an equal probability ($p = 1/3$) of being selected. At the end of the 10^{th} period, the assets were liquidated at different prices based on the state of the world drawn by the software. The payoff matrix of the assets at the end of the 10th period is given in Table 1. Subjects were initially endowed with different quantities of these assets and some risk-free cash (see Table 2). The endowment matrix was designed such that at the start of the experiment, each subject held the same amount in expectation.

After the instructions were read, the subjects were asked to trade the stocks amongst themselves. Neither borrowing nor short sales was permissible.[3] The subjects were told that it was possible that some of them might be randomly selected to receive private information of the nature, "The future state of the world is NOT State X." They were advised to frequently check the 'News' window on their trading interface. The design matrix is shown in Table 3. There were six possible treatments in our experiment. We conducted 17 sessions - one of each kind. There were nine subjects in each of the seventeen sessions. Based on their initial endowments, they belonged to Type I, Type II or Type III investors (please refer Table 2). In each treatment, there were three participants belonging to each investor class. In the treatments with information asymmetry, two traders out of nine were randomly chosen to receive private information at the beginning of period 5.[4] In the treatment with no information asymmetry, all participants received public information. The nature of the information was constant across all treatments and was, "The future state of the world is NOT Blue." In treatments with price limits, the limits were imposed starting from period 2. The price limits were a percentage of the previous period's closing price. The closing price for each period was public information. The tick size was 0.25

[3] Allowing short sales and borrowing means setting up margin accounts and introducing banking – both of which unduly complicate the design. See Hagel and Roth (1995) for further explanation.

[4] We make the assumption that it does not matter whether the informed traders belong to Type I, II or III since the opportunity to trade for five periods (prior to receiving information) gives all traders enough time to hold a portfolio of their choosing irrespective of their initial endowment. This is debatable and we suggest that more experiments be conducted by varying the combination of the types of the two traders who receive private information.

and there were no transaction costs. The software 'Stock Simulation' was used in all sessions. A view of the trading screen is provided in Appendix I.

Results

Deviation of price from fundamentals. I was interested in observing how close prices would converge to their fundamental value after the information shock at the beginning of period 5. So I computed deviation of price from fundamentals as the mean deviation of the price from the risk-neutral expected price from periods 5 through 10. The expected prices across all periods are summarized in Table 4.

To test whether market regulation was effective in the presence/absence of information asymmetry, I conducted an Analysis of Variance (ANOVA) with the absolute value of the deviation in price from the predicted price, normalized by the predicted price as the dependent variable and the following predictors variables: (i) riskiness of asset; (ii) information asymmetry (as a dummy variable); and (iii) market regulation. I obtained a marginally significant main effect for the riskiness of the asset ($F=2.81$, $p<.10$, partial $\eta^2=.15$) but no main or interaction effects involving information asymmetry and market regulation. One possible reason for not obtaining a significant effect for market regulation may have been low statistical power (observed power = .11).

Period volatility. Period volatility (equivalent to daily volatility in real life) was measured by, $V_{t,j} = r_{t,j}{}^2$, where $r_{t,j}$ is the close-to-close return for asset j between periods t-1 and t. To test whether market regulation had any influence on period volatility in the presence/absence of information asymmetry, I conducted an ANOVA with mean period volatility as the dependent variable and the following predictors variables: (i) riskiness of asset; (ii) information asymmetry (as a dummy variable); and (iii) market regulation. I obtained a significant main effect for market regulation ($F=7.04$, $p<.01$, partial $\eta^2=.30$). The estimated marginal means for period volatility across different market regulations are presented in Table 5. These results indicate that the tighter the limits, the lower the volatility.

Trading volume. Trading volume was measured as the number of units of asset traded. To test whether market regulation had any influence on trading volume in the presence/absence of information asymmetry, I conducted an ANOVA with mean period volatility as the dependent variable and the following predictors variables: (i) riskiness of asset; (ii) information asymmetry (as a dummy variable); and (iii) market regulation. I obtained no main or interaction effects. Once again, one possible reason for not obtaining a significant effect for market regulation may have been low statistical power (observed power = .30).

Trading profits. Trading profits were equal to a participant's final cash holding at the end of the experiment (after all assets had been liquidated). To examine if uninformed traders fared better in regulated markets as opposed to unregulated markets, I first isolated data corresponding to treatments with information asymmetry. This resulted in a reduction of sample size and lowering of statistical power. To compensate for the loss in power, I created a dummy variable which was set to "1" if the market was regulated and "0" if no price limits were in place. Also, I created a dummy variable called *informed* which was set to 1 if the trader had information about which future state would not occur. I then conducted a hierarchical, moderated regression analysis (Cohen & Cohen, 1983; Stone & Hollenbeck, 1989) on trading profits, entering the predictor variables in the following order: (i) independent variables – informed (as a dummy variable), and market regulation (also as a dummy variable); and (ii) two-way interaction between information asymmetry and market regulation.

Table 6 presents the results of the hierarchical regression analysis. Of most importance, I obtained a 2-way interaction effect between informed and market regulation (β = -.88, t = -2.28, $p < .05$). To illustrate the nature of the 2-way interaction effect, I exhibit in Figure 1 the values of the dependent variable at one standard deviation above and one standard deviation below the means for the independent variables (Aiken & West, 1991). As is evident in the figure, in unregulated markets, informed traders are able to profit more; whereas regulated markets negatively affect the earnings of informed traders.

Discussion

To summarize, I find that price curb volatility and reduce the gains from informed trades. By increasing the gains of uninformed people, price limits serve to protect the naïve or uninformed traders, thereby contributing to social justice. Though I did not find any significant difference in trading volume or deviation of price from fundamentals in regulated versus unregulated markets, it is possible that the lack of significance was due to low power. This paper makes a significant contribution to the existing literature. For the first time the role of price limits in computerized asset markets has been examined. Price limits were found to be welfare-improving: prices become less volatile and trading profits of informed traders are lower in the presence of price limits. Of course, these results are preliminary. Factors such as short sale, borrowing, and transaction costs may reinforce or diminish the effectiveness of price limits. More work is needed. Hopefully, these results will challenge the view that circuit breakers are either misguided social work or cosmetic devices designed by the exchanges to appease their customers and congressional critics.

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Table 1

Payoff matrix: Liquidation values of assets

	Green	Blue	Yellow
Asset A	60	35	55
Asset B	45	75	30
Asset C	10	80	60
Cash	1	1	1

Table 2

Endowment matrix

Investor class	Asset A	Asset B	Asset C	Cash
Type I	10	0	10	1000
Type II	0	12	8	1000
Type III	5	15	0	1000

Table 3

Various kinds of treatments used for the 17 sessions

	Unconstrained	15% limit	10% limit
Private information	3 sessions	2 sessions	4 sessions
Public information	3 sessions	3 sessions	2 sessions

Table 4

Risk-neutral expected prices

Periods	Asset A	Asset B	Asset C	Cash
1 though 4	50	50	50	1
5 through 10	57.5	37.5	35	1

Table 5

Estimated marginal means of period volatility across different market regulations

Investor class	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Unconstrained Market	39.72	8.13	23.19	56.26
15% Price Limit	1.53	9.09	-16.57	18.51
10% Price Limit	0.97	8.62	-16.96	20.02

Table 6

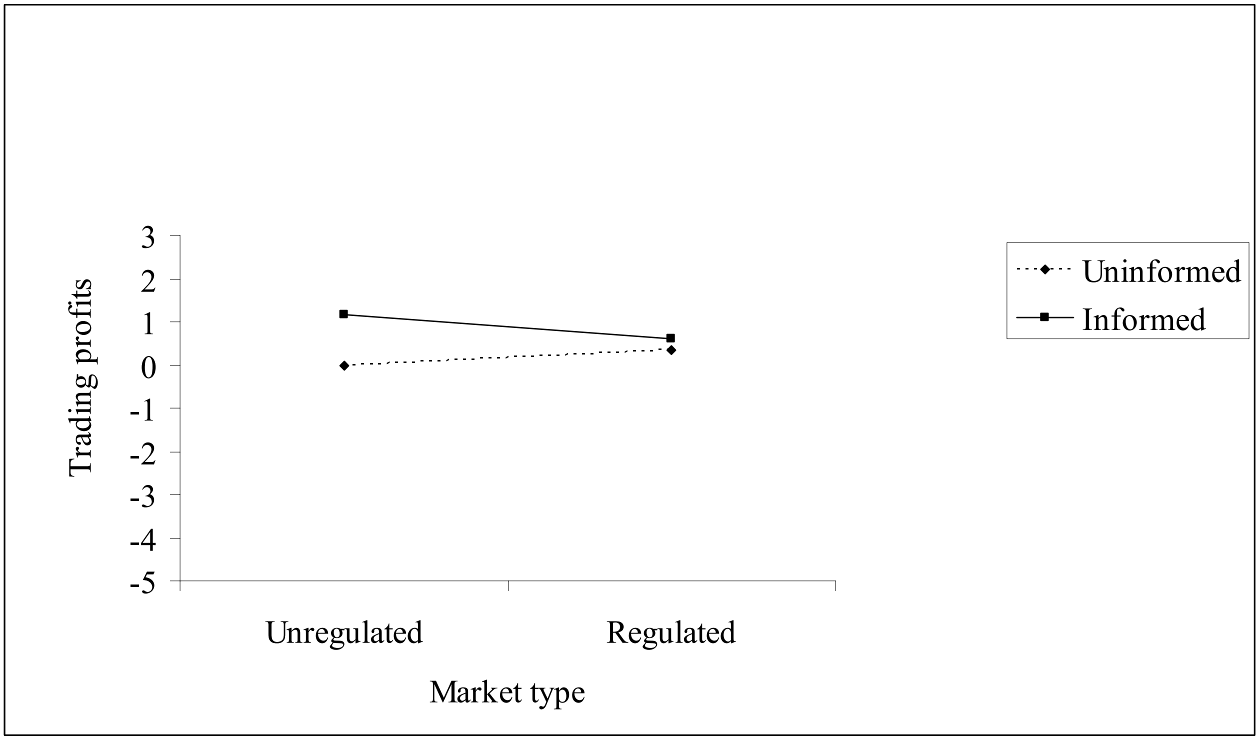
Summary of hierarchical regression analysis of variables predicting trading profits[a]

	Step 1	Step 2
Main effects		
Informed	0.52*	1.15**
Regulation	-0.09	0.35
Two-way interaction		
Informed X Regulation		-0.88*
Model F	2.96	4.26
ΔF		5.22*
R^2	0.28†	0.48*
ΔR^2		0.20
Adjusted R^2	0.19†	0.37*

Note. All tests of variables are two-tailed (N = 81).
[a]Beta coefficients are standardized.
†$p \leq .10$; *$p \leq .05$; **$p \leq .01$; ***$p \leq .001$.

Figure 1

Informed X Market regulation



Appendix I

Stock Market Simulation

User pages
View Sessions

Logout

Trading Session Information	News!
[redacted]	
[redacted]	
Current Time: **10:16:10am Wednesday, April 23, 2008** Trading as: **Jaya Lakshmi** Session Time Remaining: **41:27** Period Number: **2** Period Time Remaining: **2:27** Upper Trading Limit: **10%** Lower Trading Limit: **10%**	*Time* *Subject* *Message Body* [redacted]

My Personal Information

[redacted]

The purchase price you have chosen is above the current trading limits. Try lowering the purchase price to or below $55

Sale Bids			Purchase Bids			Balances
Asset	**Units**	**Price**	**Asset**	**Units**	**Price**	Asset A: **0** Asset B: **12** Asset C: **8** Cash: **$1,000.00**
[redacted]			[redacted]			
Asset B	4	$ 70.00	Asset A	2	$ 45.00	
			Asset A	5	$ 50.00	
Assetclass Id: Asset A Number Units Sale Price Submit Sale Bid			Assetclass Id: Asset A Number Units Purchase Price Submit Purchase Bid			

World Information

[redacted]

Asset A Last traded at **$No Trade**	**Asset B** Last traded at **$50**	**Asset C** Last traded at **$No Trade**

Sell Order Book	Buy Order Book

Asset A	Asset B	Asset C	Asset A	Asset B	Asset C
[redacted]			[redacted]		
	4 @ $70.00		5 @ $50.00 2 @ $45.00		

View History

Stock Market Simulation