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Do Short Selling and Margin Trading Affect Price Randomness?

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A B S T R A C T

Purpose: Both short sellers and margin traders believe in active investment. However, they have the opposite opinions about the prediction of future share price direction: while short sellers are those who predict future price declines, investors buying on margin are those who predict future share price increases. Short selling and margin trading are generally perceived to intensify stock price volatility and undermine market stability. However, this general perception in investment practice lacks in scientific empirical evidence. This paper investigates the effect of short selling and margin trading on stock price randomness in Korean stock market.
Design/methodology/approach: The random walk hypothesis has been tested for many equity markets since Lo and MacKinley (1988) work, which proposes the variance ratio test for the random walk hypothesis. The Dickey-Fuller unit root test or the Box-Pierce Q test are widely used to test the stock price efficiency. However, Lo and MacKinley (1989) indicate that the variance ratio test is more reliable and more powerful than the two tests. Ayadi and Pyun (1994) also acknowledge that the variance ratio test is more appealing than other traditional tests for the random walk.
Findings: Our main findings are as follows. Short selling increases variance ratios, suggesting that short selling decreases the degree of price randomness. However, margin trading is negatively related to variance ratios. Short selling makes stock prices more predictable; on the contrary, margin trading makes stock prices more random. Dividing by market, short selling and margin trading is more active in the KOSPI market than the KOSDAQ market. The variance ratio test shows that short selling in KOSPI market exacerbates price randomness compared to KOSDAQ market. We also find that a significant and positive relation between short selling and absolute deviation of the variance ratio when short selling is constrained.
Research limitations/implications: Our study tried to provide new implications to both practitioners and academicians by analyzing the effects of short selling and margin trading on price randomness, a major aspect of market efficiency. However, this study still has some limitations in that the effect of short selling and margin trading on market efficiency has not been completely fully analyzed. Therefore, we expect that further studies on the effects of short selling and margin trading on market efficiency will be conducted to provide additional implications.
Originality/value: Our study uses the same data in analyzing the impact of short selling and margin trading. Thus, compared to two separate strands of studies on short selling and margin trading, our study would facilitate the comparison of the empirical results on the impact of these two investment methods. Analyzing and comparing the effects of two investment methods on the same data would enhance the reliability of the comparative empirical results.

Keywords: short selling, margin trading, random walk, price efficiency, variance ratio test

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I. Introduction

Stock price behavior has been a topic of great interest for a long time. Stock price moves on new information. In general, if stock price quickly and accurately reflects new information, which comes randomly, then stock price would follow a random walk. This makes the stock price more efficient. The informational efficiency of stock prices is a key attribute of capital markets that can significantly impact the real economy (Boehmer and Wu, 2013).

This paper aims to systematically quantify the effect of daily trading activities of short selling and margin trading on the price discovery process. Short selling and margin trading are essential factors that can affect volatility, liquidity and regulations in the stock markets because two transactions reflect conflicting predictions of future stock prices. The main concerns of previous studies on short selling are whether short-sellers are informed traders, whether short-selling constraints affect the efficiency of price discovery and the relationship between short selling and market efficiency. Most agree that short sellers are traders with access to value-relevant information, and they play an essential role on price discovery (Boehmer et al., 2008; Diether et al., 2008; Christophe et al., 2004). In other words, they are informed traders who have incentives to trade to minimize information leakage and affect stock price discovery and efficiency. As a result, short selling is associated with more informational efficiency of stock prices, and stock prices incorporate public information faster when short sellers are more active (Chang et al., 2007; Boehmer and Wu, 2013; and Hou and Moskowitz, 2005).

While the role of short selling on asset pricing receives considerable attention from both academicians and practitioners, margin trading, which is another type of leverage activities, receives less attention. This is mainly due to data limitations in the United States, where margin trading data is published monthly. Recently, some studies related to the effects of margin trading on the stock market or individual stocks have been steadily proceeding in stock markets such as India, Japan, China, and Taiwan. However, those have mixed results about the impact of margin trading on stock returns and price efficiency according to the measurement method. Seguin and Jarrell (1993), Alexander et al. (2004) and Chang et al. (2007) demonstrated that margin trading might increase stock price efficiency. On the other hand, Lee and Ko (2016) argued that margin trading is not related to future returns and implied that margin traders are not well-informed investors. Segun (1990) and Chang et al. (2007) found that margin trading is negatively related to future stock prices, does not have price predictability, and reflects high volatility. In other words, the results of the empirical analysis are still contradictory. Short sellers are institutional investors considered informed, while margin traders are retail investors who are less informed (Hirose et al., 2009; Kahraman and Tookes, 2017). Retail investors are more active in margin trading than institutional investors because they need funds to trade. They are more likely to noise traders highly influenced by psychological factors, and thus there is a concern that volatility increases as margin traders increase (Barber and Odean, 2001).

Both short sellers and margin traders believe in active investment. However, these two investment methods have different opinions about the prediction of future share price direction: short seller are those who predict future price declines, and investors buying on margin are those who predict future share price increases. Generally speaking, mass media have a negative perception that short selling and margin trading will intensify stock price volatility and undermine market stability. Individual investors also accuse short selling of causing stock price declines. However, these general perception lacks in scientific empirical evidence. Therefore, we believe that it is academically worthwhile to obtain additional implications for active investment by empirically analyzing short selling and margin trading together and comparing the effects of these trading activities. Our study uses the same data in analyzing the impact of short selling and margin trading. Thus, compared to two separate strands of studies on short selling and margin trading, our

study would facilitate the comparison of the empirical results on the impact of these two investment methods. Analyzing and comparing the effects of two investment methods on the same data would enhance the reliability of the comparative empirical results.

This paper aims to apply the variance ratio test developed by Lo & MacKinlay (1988) to investigate the stock price behavior traded on the Korean stock market. Short selling and margin trading affect the stock price and the price randomness. We would provide practical implications on whether short selling and margin trading enhance or hurt the market efficiency. Very few studies examined these trading activities together. The motivations and strategies of short sellers and margin traders could be different in their prediction about the future stock price movement: short sellers bet in down-market, and margin traders in up-market. Accordingly, the effect of the two trading activities on the stock prices could be different. According to Chang et al. (2014) and Chen et al. (2016), short selling improves price efficiency, but the effect of margin trading on price efficiency is not consistent. These studies generally support the view that short-sellers hold superior information, while margin traders do not have predictive power for future return.

Our study uses daily and weekly data of individual stocks over the period from January 3, 2011 to June 30, 2019 in order to analyze the effect of short selling and margin trading on price randomness in the Korean stock market. Previous studies on short selling used high-frequency intra-day data of short-selling or monthly data of short interest, lending supply, and loan transactions. Due to the limitation on data availability, previous studies could not perform the analysis using daily or weekly data. Our analysis using daily and weekly data on short selling and margin trading is expected to provide additional useful implications, which add on empirical results from using high-frequency intra-day data or long-horizon monthly data.

Our main findings are as follows. Short selling increases variance ratios, suggesting that short selling decreases the degree of price randomness. However, margin trading is negatively related to variance ratios. Short selling makes stock prices more predictable; on the contrary, margin trading makes stock prices more random. Dividing by market, short selling and margin trading is more active in the KOSPI market than the KOSDAQ market. However, the short selling of firms listed on the KOSDAQ market is negatively related to the variance ratio, and thus stock prices of these firms follow the random walk. Stock prices of firms listed on the KOSPI market have a positive effect on the variance ratio. We also find that a significant and positive relation between short selling and absolute deviation of the variance ratio when short selling is banned and allowed. The variance ratios deviate more when short selling is banned.

The remainder of this study is as follows. Section 2 describes the hypothesis and the measure of stock price randomness, Section 3 contains a description of the data and variables, and Section 4 reports the empirical results. Section 5 concludes.

II. Methodology and Hypothesis

A. Price randomness

Various theories and models are developed to test the stock price behavior. The random walk hypothesis is one of them. It states that traders cannot predict the future stock prices using the past information of stock prices. The random walk hypothesis has been tested for many equity markets since Lo and MacKinley (1988) work, which proposes the variance ratio test for the random walk hypothesis. The Dickey-Fuller unit root test or the Box-Pierce Q test are widely used to test the stock price efficiency. However, Lo and MacKinley (1989) indicate that the variance ratio test is more reliable and more powerful than the two tests. Ayadi and Pyun (1994) also acknowledge that the variance ratio test is more appealing than other traditional tests for the random walk.

The essence of the random walk hypothesis is as follows. If the stock price follows the random walk, the stock return is unpredictable. Denote the

stock price at time t by P_t and define the log-price process by X_t.

$$R_t = logP_t - logP_{t-1} = X_t - X_{t-1} \quad (1)$$

When the stock price follows the random walk, our hypothesis is given by Eq (2).

$$X_t = X_{t-1} + \mu + \varepsilon_t \quad (2)$$

where μ is a drift parameter, and ε_t is the random disturbance term.

The random walk hypothesis can be tested by statistically examining if the variance ratio at lag q

$$VR_q = \frac{\sigma^2(q)}{\sigma^2(1)} \quad (3)$$

where $\sigma^2(q)$ is an unbiased estimator of 1/q times of the variance of q-period returns, $X_t - X_{t-q}$; and $\sigma^2(1)$ is an unbiased estimator of the variance of the single period returns, $X_t - X_{t-1}$.

Lo and MacKinlay (1988) set the null hypothesis that $H_o : VR_q = 1$ or not statistically different from 1. They recognized that the random walk hypothesis could not be rejected under the null hypothesis H_o. (see Appendix for more detail)

B. Effect of short selling and margin trading

After testing for the random walk in the Korean stock market, we examine the effect of short selling and margin trading. Our analysis starts with examining whether short selling (or margin trading) relates to the stock returns or not. Miller (1977) theoretically shows that short-sales constraints lead to overvaluation of stock and drive a wedge between stock price and fundamental value. Moreover, pessimistic investors are forced to remain out of the market when sufficient short sales are not available, thereby enabling enthusiastic buyers to bid at prices above the level that average investors perceive as fair. Chang et al. (2007) found that stock returns show higher volatility when short selling is allowed. Wang and Lee (2015) and Wang et al. (2017) argued that foreign investors are regularly engaged in short selling, and their activity predicts future returns in the Korean stock market. Short selling is more concentrated for high-priced stocks, large-cap stocks, and stocks with low institutional ownership. Woo and Kim (2017) argued that short sellers are informed traders, and short selling is negatively related to future returns.

We would examine whether Korean short-sellers and margin traders predict future stock returns and are profitable. So, we set the following hypothesis.

Hypothesis H1: Short selling (or margin trading) is positively related to the stock returns.

To measure the relationship between two activities and the stock returns, we propose the following regression equation.

$$r_{it} = \beta_0 + \beta_1 Short_{it}(or\ Margin_{it}) + \beta_k \Sigma_{k=2}^{n} Controls_{kit} + \varepsilon_i \quad (4)$$

where r_{it} is weekly returns for firm *i* in week *t*. $Short_i$ is the average number of shorted shares divided by the number of shares traded in the week of firm *i*. $Margin_i$ is the average number of shares traded on the margin devided by the number of shares traded in the week of firm *i*. All variables are measured on the firm level. Control variables are as follows. *Size* is the natural logarithm of the market capitalization of firms. *Major* is a ratio of common shares including the largest shareholders divided by a total number of shares. *Foreign* is a ratio of shares held by foreigners divided by the total number of shares. *Floating* is the natural logarithm of the ratio of market capitalization standardized by the total number of shares. *Turnover* is a ratio of transaction amount standardized by market capitalization.

The second hypothesis relates to the effect of short selling and margin trading on the stock price randomness. According to Fama (1970), if the stock price reflects quickly and accurately new information that comes randomly, the stock price should follow a random walk. And thus, the stock prices would be efficient.

Boehmer and Wu (2013) argue short selling positively influences the stock price efficiency. Chang et al. (2007) show that short selling is associated with more informational efficiency of the stock prices.

If short-sellers are informed traders, the more the short-selling flow will reduce the deviation of the stock price from a random walk. On the other hand, if short selling (or margin trading) makes the variance ratio higher, then the stock prices deviate from the property of randomness. According to this consensus, we hypothesize as follows:

Hypothesis H2: Short selling (or margin trading) increases the variance ratio of the stock prices.

We use Equation (5) to estimate the effect of short selling and margin trading on the stock price randomness. We use the variance ratio of the stock prices as a dependent variable.

$$VR_{it} = \beta_0 + \beta_1 Short_{it}(or\ Margin_{it}) + \beta_k \Sigma_{k=2}^{n} Controls_{kit} + \varepsilon_i \quad (5)$$

where VR_{it} is the variance ratio of the stock price of firm i in period q.

The third hypothesis is related to short selling on the stock price randomness under the short-sales constraint. The Financial Supervisory Service of Korea banned the short selling of financial stocks from Oct 2008 to Nov13, 2013. The previous studies largely support the impact of the regulation and short-sales constraints. Most studies accepted the view that short-sales restrictions affect stock price discovery and efficiency. For example, Miller (1977) argued that the short-sales limitation excludes pessimistic investors from the market. As a result, it can lead to overpricing because the stock prices under constraint reflect only the more optimistic investors.

Furthermore, short-sales constraints decrease the market quality (Boehmer et al., 2013; Saffi and Sigurdsson, 2011; Beber and Pagano, 2013) and make prices less efficient (Bris et al., 2007). Short-sales constraints lead to higher stock prices (Chang et al., 2007: Chan et al., 2010) while allowing margin trading to increase the stock price (Sharif et al., 2014). When short selling is banned, the stock price reduces price efficiency because it may not incorporate all available information. In other words, the stock price is less efficient as the deviation of variance ratio increases. According to this consensus, we hypothesize as follows:

Hypothesis H3: Short selling increases the variance ratio of the stock price when short selling is banned.

III. Data

A. Data

We collected daily short selling and margin trading flow data between 3 January 2011 and 30 June 2019 for 2,066 stocks listed on the Korean stock market. We exclude data of Financial companies from our sample. We obtained all price data, trading volume, short selling and margin trading volume, and firms' characteristics from the FnGuide database. Short-selling data starts from 3 January 2010, and margin trading data starts from 4 Sept 2014. We handled some value from our obtained data. For example, if there are no values of traded shares (total trading volume is 0), we changed the returns of these shares by missing value. We define our main variables, short selling and margin trading, as a ratio of the number of shorted (traded on margin) shares to total shares traded in day t.

$$short\ selling(or\ margin\ trading)_{i,t} = \frac{Number\ of\ shorted\ shares\ (margin)_{i,t}}{Number\ of\ total\ traded\ shares_{i,t}} \quad (6)$$

Using weekly stock return data of each firm, we investigate the effect of short selling and margin trading on stock returns. We computed the weekly return using Wednesday close price. We constructed 435 weekly returns of data from the daily prices from January 3, 2011 to June 30, 2019.

Control variables are as follows. *Size* is the natural logarithm of the market capitalization of firms. *Major* is a ratio of common shares including the largest shareholders divided by a total number of shares.

Foreign is a ratio of shares held by foreigners divided by the total number of shares. *Floating* is the natural logarithm of the ratio of market capitalization standardized by the total number of shares. *Turnover* is a ratio of transaction amount standardized by market capitalization. At first, we collected 3,595,032 daily observations. However, we discontinued some observations if stocks were suspended from trading.

B. Descriptive statistics

In Table 1, we report descriptive statistics and the pairwise correlation among our variables. Panel A shows the descriptive statistics. The mean of short selling is 0.016 with a standard deviation of 0.021, ranging from 0 to 0.203. On the other hand, the mean of margin trading is 0.163, and the standard deviation is 0.084. Thus, the ratio of short selling is lower than margin trading. This indicates that more shares are traded on margin than short selling on the Korean stock market.

In Panel B, we show the pairwise correlations among our explanatory variables to explain how variables relate to firm characteristics. There is a negative correlation between short selling and margin, p = - 0.278. In addition, short selling has strong positive relation with size (p = 0.837) and floating (p = 0.832), and negative relation with major shareholdings (p = -0.009) and turnover (p = -0.292). However, margin trading has negative relation with size (p = -0.243), foreign (p = -0.246) shares and floating (p = -0.271), and positive relation with major (p = 0.162) and turnover (p = 0.056).

Table 1. Descriptive statistics

Panel A. Descriptive Statistics

	N	Mean	St.Dev	min	p25	Median	p75	max
Short	2,066	0.016	0.021	0.000	0.003	0.008	0.020	0.203
Margin	2,061	0.163	0.084	0.006	0.103	0.163	0.220	1.000
Size	2,066	11.840	1.328	9.288	10.920	11.559	12.422	19.163
Major	2,066	0.411	0.159	0.042	0.288	0.403	0.521	0.883
Foreign	2,066	0.069	0.112	0.000	0.009	0.022	0.074	0.826
Floating	2,064	11.218	1.328	8.454	10.331	10.953	11.740	18.826
Turnover	2,066	0.087	0.094	0.001	0.029	0.061	0.113	1.396

Panel B. Pairwise correlation of explanatory variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Short	1.000						
(2) Margin	-0.278	1.000					
(3) Size	0.837	-0.243	1.000				
(4) Major	-0.009	0.162	0.090	1.000			
(5) Foreign	0.484	-0.246	0.569	-0.031	1.000		
(6) Floating	0.832	-0.271	0.962	-0.151	0.569	1.000	
(7) Turnover	-0.292	0.056	-0.364	-0.316	-0.257	-0.268	1.000

This sample includes a daily average of 2,066 stocks listed on the Korean stock market from The first week of January 2011 to the last week of June 2019 using data from FnGuide. Panel A reports the summary statistics. Short is a ratio of shares of short selling standardized by total traded shares. Margin is a ratio of shares of margin trading standardized by total traded shares. Size is the natural logarithm of the market capitalization of firms. Major is the percentage of common shares including the largest shareholders standardized by total shares. Foreign is shares held by foreigners standardized by total shares. Floating is the natural logarithm of market capitalization multiplied by the current share ratio. Finally, turnover is the transaction amount standardized by market capitalization. Panel B presents the correlations between short selling, margin trading and firms' characteristic variables.

IV. Empirical results

A. Variance ratio test

We start with the variance ratio test of the random walk hypothesis in stock prices. We calculated the variance ratio, *VR(q),* test statistic under the assumption of homoscedasticity, *Z(q),* and test statistic under the assumption of heteroscedasticity, *Z*(q)*, respectively. Under the random walk hypothesis of Lo and MacKinley (1988), the ratio of (1/q) times the variance of the q-differences over the first-differences equals 1.

The results for the sample period, from The first week of January 2011 to the last week of June 2019, are shown in Table 2. Under the assumption of homoscedasticity, the variance ratio test rejects the null hypothesis for every interval of *q*. Our empirical results show that the *Z*-statistics associated with the weekly intervals of *q*=2, 4, 8, and 16 is 3.33, 2.71, 1.77 and 1.32, respectively. When the values are compared with the critical value of 1.96 for the five per cent level, the variance ratios, *VR(q),* are statistically different from unity. This result suggests that the stock prices are random.

Therefore, the result shows that the variance ratio is larger than 1 for all intervals of *q*. The variance ratio is 1.28 in the interval of *q=2*. This means that the first autocorrelation is approximately 28 per cent. Values of the variance ratios and *Z*-statistics decrease with intervals of *q*. Lo & MacKinlay (1988) describes that the decline of *Z*-statistics means that the significance of hypothesis rejection becomes weaker.

In Panel B, we show the number of firms whose stock price follows the random walk. Our full sample includes 2,066 firms. Seven hundred seventy-one of them are listed on the KOSPI market, and 1,295 are listed on the KOSDAQ market, respectively. The stock prices of 2,033 firms follow the random walk in intervals of *q=2.* On the other hand, the stock prices of 1,713 firms follow the random walk in *q=6.* This means the stock prices follow the random walk in the short term.

B. Effect of short selling and margin trading on stock returns

We used panel data of 2,066 firms during ten years. The panel model can consider the effect of individual characteristics and the effect of time characteristics. Panel models may have problems of autocorrelation and heteroscedasticity of error terms due to data characteristics. Thus, we performed the Wooldridge test and Wald test to confirm the autocorrelation and the heteroscedasticity, respectively. The Wooldridge test result for autocorrelation shows Prob> F=0.0000, suggesting that the panel model has the first-order autocorrelation. We also implemented

Table 2. Variance ratio test

	Number of lags (q)			
	q=2	q=4	q=8	q=16
Panel A. Result of Variance ratio test				
VR(q)	1.28	1.258	1.237	1.202
Z(q)	3.33**	2.71**	1.77**	1.32**
Z*(q)	2.46	2.06	1.41	1.10
Panel B. Number of firms follow the random walk				
Total	2033	1966	1828	1713
KOSPI	759	740	695	654
KOSDAQ	1274	1226	1133	1059

This sample includes 2,066 stocks listed in the Korean stock market from The first week of January 2011 to the last week of June 2019 obtained from FnGuide. This table presents the results of Lo-MacKinlay variance ratio test estimates using weekly returns. *VR(q)* is the variance ratio. *Z(q)* and *Z*(q)* are the statistics under the assumption of homoscedasticity and heteroscedasticity.

the Wald test for heteroscedasticity. The result shows that Prob > chi2=0.0000. According to the results, our data have autocorrelation and heteroscedasticity. Since autocorrelation and heteroscedasticity exist in the error terms in our panel data, we applied GLS (Generalized Least Squares) to obtain an efficient estimator.

Table 3 presents the GLS regression results to analyze short selling and margin trading effects on the stock returns. Columns (1) and (2) show short selling, margin trading effects on the stock returns, respectively. Short selling has a significant and negative impact on the stock return. This result suggests that short selling increases as the stock price decreases. On the other hand, margin trading has a negative effect on the stock return, and then margin trading increases as the stock price decreases. Our result shows that short selling is strongly related to the stock returns than margin trading. Column (3) shows the effects of control variables. The efficient coefficients of short selling and margin trading are -0.145 and -0.00211, respectively. The coefficients

Table 3. Effect of short selling and margin trading on stock returns

	Dependent variable = Weekly Returns (%)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
short	-13.18***		-14.5***				
	(-41.28)		(-38.13)				
margin		-0.03**	-0.21***				
		(-3.15)	(-8.82)				
size			00.83***				
			(5.90)				
major			2.19***				
			(8.42)				
foreign			00.28				
			(-0.97)				
floating			-1.21***				
			(-8.92)				
turnover			45.7***				
			(173.65)				
$Short_{t-1}$				-4.26***	-4.68***		
				(-13.21)	(-14.36)		
$Return_{t-1}$ * $short_{t-1}$					-44.61***		
					(-7.42)		
$Margin_{t-1}$						-0.03	-0.07***
						(-0.26)	(-5.72)
$Return_{t-1}$ * $Margin_{t-1}$							-10.3***
							(-10.84)
Firms-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	745126	413425	412533	743308	741304	411461	411104
R^2	0.002	0.005	0.074	0.000	0.000	0.000	0.000
F	1703.94***	9.93***	4678.47***	174.54***	116.08***	0.07	58.81***

This sample includes 2,066 stocks listed in the Korean stock market from The first week of January 2011 to the last week of June 2019 using data from FnGuide. The dependent variable is the weekly return. Short is a ratio of shares shorted standardized by total traded shares. Margin is a ratio of shares of margin trading standardized by total traded shares. Size is the natural logarithm of the market capitalization of firms. Major is the percentage of common shares including the largest shareholders standardized by total shares. Foreign is shares held by foreigners standardized by total shares. Floating is the natural logarithm of market capitalization multiplied by the current share ratio. Turnover is the transaction amount standardized by market capitalization. t-statistics are reported in parentheses, and the significance levels are as follows: *** p<0.01, ** p<0.05, * p<0.1.

are more substantial than those in Column (1) and Column (2). Size, major and turnover have significant positive effects on the stock returns, but Foreign and Floating have negative impacts on the stock return. Column (4) and Column (6) show the impact of past values (1 week ago) of short selling and margin trading. Column (5) and Column (7) show an interaction term of past values of short selling (or margin trading) and stock return. Short selling in the past week ($short_{t-1}$) is significantly and negatively related to the returns. Margin trading in the past week ($margin_{t-1}$) is also negatively related to stock returns. Interaction terms, $return_{t-1}$ * $short_{t-1}$ and $return_{t-1}$ * $margin_{t-1}$, also have significant and negative effects on the stock returns. This result suggests that short selling and margin trading predict future returns.

C. Effect of short selling and margin trading on stock price randomness

Table 4 reports the regression result, which estimates the impact of short selling (or margin trading) on the variance ratio. Short selling is positively related to the variance ratio in all intervals. This suggests that greater short selling is associated with a greater

Table 4. Effect of short selling and margin trading on price randomness

	Q=2			Q=4			Q=8			Q=16		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Short	16.54***		11.44***	15.27***		10.36***	11.78***		7.76***	8.10***		7.29***
	(14.75)		(5.52)	(13.00)		(4.72)	(11.06)		(3.87)	(8.17)		(3.88)
Margin		-0.74***	-0.32*		-0.48**	-0.12		-0.38**	-0.12		-0.28*	-0.11
		(-4.70)	(-2.09)		(-2.95)	(-0.77)		(-2.60)	(-0.74)		(-2.10)	(-0.80)
Size			0.07			0.04			0.12			0.19
			(0.51)			(0.28)			(0.83)			(1.57)
Major			-1.08***			-0.71*			-0.54			-0.49
			(-3.55)			(-2.23)			(-1.86)			(-1.79)
Foreign			-0.468			-0.68*			-0.51*			-0.46*
			(-1.84)			(-2.55)			(-2.04)			(-1.98)
Floating			-0.04			0.01			-0.05			-0.17
			(-0.34)			(0.09)			(-0.39)			(-1.42)
Turnover			-9.75***			-9.22***			-6.90***			-5.48***
			(-6.53)			(-5.84)			(-4.64)			(-3.91)
Dummy_Kosdaq			-0.18**			-0.12			-0.05			0.01
			(-3.11)			(-1.92)			(-0.93)			(0.23)
Kospi100*short			6.83			4.62			-0.47			-5.24
			(1.90)			(1.22)			(-0.13)			(-1.62)
Kospi100*margin			0.02			0.19			-0.19			-0.28
			(0.03)			(0.21)			(-0.23)			(-0.35)
_cons	2.19***	2.58***	2.77***	1.81***	2.14***	1.88***	1.21***	1.47***	1.10*	0.97***	1.15***	0.98**
	(73.12)	(72.26)	(6.90)	(57.80)	(57.66)	(4.42)	(42.75)	(44.11)	(2.56)	(36.50)	(37.36)	(2.68)
N	2064	2061	2059	2063	2061	2059	2060	2058	2059	2059	2056	2050
Adj(R^2)	0.09	0.01	0.14	0.08	0.004	0.10	0.06	0.003	0.14	0.10	0.07	0.04
F	217.61***	22.09***	31.98***	168.89***	8.72***	23.07***	122.21***	6.78***	15.66***	66.68***	4.42*	9.31***

This sample includes 2,066 stocks listed in the Korean stock market from The first week of January 2011 to the last week of June 2019 obtained from FnGuide. The dependent variable is the variance ratio. Short is a ratio of shares shorted standardized by total traded shares. Margin is a ratio of shares of margin trading standardized by total traded shares. Size is the natural logarithm of the market capitalization of firms. Major is the percentage of common shares, including the largest shareholders, standardized by total shares. Foreign is shares held by foreigners standardized by total shares. Floating is the natural logarithm of market capitalization multiplied by the current share ratio. Turnover is the transaction amount standardized by market capitalization. Dummy_Kosdaq is a dummy variable of shares listed in the KOSDAQ market. Kospi100 is Kospi 100 index that includes the top 100 shares listed in the KOSPI market. t-statistics are reported in parentheses, and the significance levels are as follows: *** p<0.01, ** p<0.05, * p<0.1.

variance ratio. If the variance ratio deviates more from 1, then the stock price does not follow the random walk. The null hypothesis is accepted at the 10 percent level of significance. Short selling increases the variance ratio, and thus short selling does not affect stock price randomness. The coefficients are 16.54 in the two-week interval and 8.10 in the 16-week interval, respectively. The coefficients decrease as the week interval increases. In other words, short selling makes more deviations of the variance ratio, and thus the stock price is less efficient. On the contrary, margin trading has a negative effect on the variance ratios. Greater margin trading is associated with a smaller variance ratio, and the stock price randomness.

The coefficient of margin trading increases as the week interval increases. It is statistically significant at the 1, 5 and 10 percent levels of significance. The null hypothesis that margin trading increases the variance ratio is accepted. Margin trading makes the stock price more efficient. We use control variables to describe the role of firm characters. Control variables show fixed results. The size of firms is positively associated with the variance ratio. Stock prices of firms with higher market capitalization are not random. Greater common shares and foreign shareholders are associated with a lower variance ratio. If firms have higher foreign shareholders, the stock prices are more likely to follow the random walk, and thus those are efficient. Short selling and margin trading are more active in the KOSPI market than in the KOSDAQ market. However, the short selling of firms listed on the KOSDAQ market is negatively related to the variance ratio, and thus stock prices of these firms follow the random walk. Stock prices of firms listed on the KOSPI market positively affect the variance ratio when q = 2 and 4.

Finally, we examined the effect of short selling on the stock price randomness under short-sales constraints. Table 5 shows the difference of variance ratios between the periods when short selling banned

Table 5. Impact on price efficiency under the period of short-sales constraint

	Short selling is banned								Short selling is allowed							
	Q=2		Q=4		Q=8		Q=16		Q=2		Q=4		Q=8		Q=16	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Short	28.25***	11.46***	25.15***	11.16**	15.60***	14.27***	14.36***	12.22***	15.60***	14.27***	14.36***	12.22***	11.20***	7.70***	7.72***	5.14**
	(13.49)	(3.68)	(10.92)	(3.24)	(16.89)	(8.32)	(14.79)	(6.73)	(16.89)	(8.32)	(14.79)	(6.73)	(12.69)	(4.63)	(9.36)	(3.29)
Size		-0.38*		-0.36*		0.08		0.04		0.08		0.04		0.14		0.19
		(-2.48)		(-2.11)		(0.62)		(0.28)		(0.62)		(0.28)		(1.12)		(1.65)
Major		0.92**		0.94*		-1.12***		-0.73*		-1.12***		-0.73*		-0.53		-0.43
		(2.73)		(2.54)		(-3.85)		(-2.39)		(-3.85)		(-2.39)		(-1.90)		(-1.63)
Foreign		-0.76**		-1.03***		-0.45		-0.68**		-0.45		-0.68**		-0.54*		-0.53*
		(-3.05)		(-3.76)		(-1.83)		(-2.60)		(-1.83)		(-2.60)		(-2.23)		(-2.34)
Floating		0.59***		0.55**		-0.08		-0.01		-0.08		-0.01		-0.06		-0.13
		(3.88)		(3.25)		(-0.65)		(-0.05)		(-0.65)		(-0.05)		(-0.50)		(-1.10)
Turnover		-0.59		-2.59		-11.17***		-10.42***		-11.17***		-10.42***		-5.78***		-3.97**
		(-0.45)		(-1.80)		(-7.06)		(-6.16)		(-7.06)		(-6.16)		(-3.74)		(-2.72)
_cons	2.51***	0.224	2.09***	0.05	2.14***	2.84***	1.77***	1.95***	2.14***	2.83***	1.77***	1.95***	1.18***	0.63	0.94***	0.41
	(86.04)	(0.71)	(65.18)	(0.15)	(71.88)	(7.12)	(56.51)	(4.63)	(71.88)	(7.12)	(56.51)	(4.63)	(41.47)	(1.64)	(35.39)	(1.14)
N	1608	1607	1608	1607	2064	2062	2063	2061	2064	2058	2063	2052	2060	2058	2054	2052
Adj(R^2)	0.102	0.140	0.069	0.099	0.122	0.150	0.096	0.116	0.12	0.15	0.09	0.11	0.073	0.08	0.04	0.05
F	181.85***	43.44***	119.23***	29.37***	60.39***	16.01***	14.61***	6.58***	285.36***	60.40***	218.76***	45.13***	160.96***	31.19***	87.62***	17.66***

This sample includes 2,066 stocks listed in the Korean stock market from the first week of January 2011 to the last week of June 2019 obtained from FnGuide. The dependent variable is the variance ratio. Short is a ratio of shares shorted standardized by total traded shares. Margin is a ratio of shares of margin trading standardized by total traded shares. Size is the natural logarithm of the market capitalization of firms. Major is the percentage of common shares, including the largest shareholders, standardized by total shares. Foreign is shares held by foreigners standardized by total shares. Floating is the natural logarithm of market capitalization multiplied by the current share ratio. Turnover is the transaction amount standardized by market capitalization. t-statistics are reported in parentheses, and the significance levels are as follows: *** p<0.01, ** p<0.05, * p<0.1.

and allowed. Short selling is significantly and positively related to the variance ratio in all periods. But, the coefficients under the short-sales constraints are higher than the periods when short-sales are allowed. This result suggests that greater short selling is associated with a greater variance ratio, and thus stock price is not random, and thus stock prices are less efficient. This result is similar to Bai et al. (2006), Saffi and Sigurdsson (2011) and Bris et al. (2007). They argue that short-sales constraint is associated with lower price efficiency.

V. Conclusion

This paper analyzed whether short selling and margin trading affect the stock returns and stock price randomness. We used daily data of stocks listed on the Korean stock market. Our result shows that short selling and margin trading are negatively related to the stock return. On the other hand, short selling and margin trading increase as the stock price falls. This result is similar to the previous studies. Second, most stocks on the Korean stock market follow the random walk, and thus stock price is efficient. Third, short selling increases the variance ratio. Thus, it makes stock prices less efficient. On the other hand, margin trading decreases the variance ratio. Thus, margin trading makes stock prices more efficient, especially in the short term. Therefore, if a firm has higher market capitalization, its share price is more likely to have price randomness. If firms have a higher portion of major shareholders and foreign shareholders, stock prices are more likely to follow the random walk. Short selling is more active in the KOSPI market than the KOSDAQ market. Investors tend to buy stocks that are included in the KOSPI100 index. This is similar to the results of Wang and Lee (2015) and Wang et al. (2017). However, the stock prices of firms listed in the KOSDAQ market are more efficient. Under the short-sales constraint, greater short selling is associated with a greater variance ratio. Therefore, Short-sales constraint makes stock prices less efficient. This result is similar to Bai et al. (2006), Saffi and Sigurdsson (2011) and Bris et al. (2007). They argue that the short-sales constraint is associated with lower price efficiency. After the constraint is lifted, stock prices are more efficient under the constraint period.

We have examined the effect of short selling and margin trading on the stock returns and the stock price randomness. Prior studies focused on analyzing the effect on price discovery that was enhanced by short selling. However, finance literature on short selling and margin trading tends to neglect research on various other aspects related to market efficiency. Our study tried to provide new implications by analyzing the effects of short selling and margin trading on price randomness, a major aspect of market efficiency. However, this study still has some limitations in that the effect of short selling and margin trading on market efficiency has been fully completely analyzed in our study. Therefore, we expect that further studies on the effects of short selling and margin trading on market efficiency will be conducted to provide additional implications.

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Appendix

Lo and MacKinlay (1988) variance ratio test examine whether securities follow the random walk. The Variance ratio test is based on the attribute that when two random variables are independent of each other, the variance of the sum of two random variables is equal to the sum of the variances of two random variables.

Suppose that the stock price at time t by P_t and define X_t is the log-price process.

$$R_t = logP_t - logP_{t-1} = X_t - X_{t-1} \tag{1}$$

When the stock price follows the random walk, our hypothesis is given by Eq (2).

$$X_t = X_{t-1} + \mu + \varepsilon_t \tag{2}$$

where μ: a drift parameter and ε_t is the random disturbance term.

If the stock price is generated by the random walk, a variance of q-period returns will be equal to q times of the variance of one-period returns.

$$VR_q = \frac{\sigma^2(q)}{\sigma^2(1)} \tag{3}$$

where $\sigma^2(q)$ is 1/q times the variance of $X_t - X_{t-q}$ and $\sigma^2(1)$ is the variance of $X_t - X_{t-1}$. $\sigma^2(q)$ and $\sigma^2(1)$ are calculated as follows.

$$\sigma^2(1) = \frac{1}{nq-1}\sum_{t=1}^{nq}(X_t - X_{t-1} - \hat{\mu})^2 \tag{4}$$

$$\hat{\mu} = \frac{1}{nq}\sum_{t=1}^{nq}(X_t - X_{t-1}) \tag{4a}$$

$$\sigma^2(q) = \frac{1}{m}\sum_{t=q}^{nq}(X_t - X_t - q - q\hat{\mu})^2 \tag{5}$$

$$m = q(nq-q+1)(1-\frac{q}{nq}) \tag{5a}$$

According to the Lo and MacKinlay variance ratio test, under the random walk hypothesis, the normal test statistic is

$$z(q) = \frac{(VR(q)-1)\sqrt{nq}}{\sqrt{\frac{2(2q-1)(q-1)}{3q}}} \sim N(0,1) \tag{6}$$

$$z^*(q) = \frac{(VR(q)-1)}{\sqrt{\theta^*(q)}} \sim N(0,1) \tag{7}$$

$$\theta^*(q) = \sum_{j=1}^{q-1}(\frac{2(q-j)}{q})^2\delta(j) \tag{8}$$

$$\delta(j) = \frac{\sum_{t=j+1}^{nq}(x_t - x_{t-1} - \hat{\mu})^2(x_{t-j} - x_{t-j-1} - \hat{\mu})^2}{(\sum_{t=1}^{nq}(x_t - x_{t-1} - \hat{\mu})^2)^2} \tag{9}$$