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Transaction Information Transparency and Market Quality: The Effect of Pre-market Information Disclosure

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Abstract

In order to improve pre-market information disclosure transparency, Taiwan Futures Exchange and Taiwan Stock Exchange have implemented "information disclosure prior to opening" policies that disclose simulated transaction price, trading volume, five best bid/ask prices, and bid/ask volumes in 2014 and 2015, respectively. This paper aims to examine whether the improvement of pre-market information disclosure transparency can enhance market quality measures, such as trading volume, liquidity and volatility. We collect intraday data within the opening five minutes or one minute by November 2013 to December 2014 and December 2014 to December 2015. The empirical results show that three market quality measures are significantly impacted after the improvement of pre-market information disclosure transparency.

Keywords: Futures Markets, Market Transparency, Pre-market Transparency, Volume, Liquidity, Volatility

1. Introduction

Futures market provides a medium for firms to hedge risks and for investors to trade. How to attract more capital to revitalize the market, increase market liquidity, and reduce market volatility is a crucial topic. A high-quality environment and well-developed market system can encourage more firms and investors to invest capital in the market, achieving a triple–win situation between firms, investors, and governments. With the development of technology, information dissemination worldwide has fostered linkages between stock markets in several countries. The ultimate goal of information transparency and investor relationship is to obtain

investors' trust and enhance investors' confidence to place their capital in the market, thus boosting the market. Since the establishment of Taiwan Futures Exchange in 1998, the trading volume has increased every year. In addition, the market's hedging needs and the emergence of new commodities and systems have caused the market to prosper and led to a longer time being required for futures trading than for spot trading. For example, the futures trading sessions last from 8:45 a.m. to 1:45 p.m., whereas the stock trading sessions are from 9:00 a.m. to 1:30 p.m.. An empirical study conducted by Hsieh (2002) verified that Taiwan's futures market, which focuses on stock index futures and commodity options, serves as price discovery in the spot market, exerting a stabilizing effect on stock market volatility. Taiwan Futures Exchange launched premarket information disclosure on May 12, 2014 to reflect the domestic and foreign market information accumulated after the trading hours of the previous day and before the market opens the next day. This can increase the pricing efficiency in a market opening and reduce the bid-ask spread, making Taiwan's futures market system more comprehensive. Moreover, the simulated premarket opening price and volume and the five best bid-ask prices and volumes are provided between 8:30 and 8:45 a.m. before the market opens. According to Bloomfield and O'Hara (1999), compared with a market without transparent information, transparent market information can rapidly reflect on the transaction price. Introducing information on price and volume during the premarket period can stimulate quality improvement. Therefore, the host market may provide a communication platform for traders before trading to communicate their liquidity needs and deliver information on asset prices. However, to prevent human manipulation of the simulated premarket information, orders cannot be cancelled or modified in the last 2 minutes before the trading session (i.e., between 8:43 and 8:45 a.m.); they can only be added. In addition, to increase the value of the information disclosed earlier, the matching priority of orders with the same price before the trading session is determined according to the time order, instead of being determined randomly as in the past. The improvement measures adopted by Taiwan Futures Exchange aim to increase market information transparency, which indirectly affects the trading behavior of participants in the futures market. The increase in information transparency typically results in an increase of transaction fairness and efficiency. Therefore, it is a goal to be achieved by the competent government authority. If the simulated trading information before the trade is immediately and rapidly disclosed, market participants can observe possible trading opportunities and identify the true value of their targets; they thus have more time to respond to the market. This can both accelerate the process of successful transactions and improve the prices.

Information transparency affects market behavior to a certain extent, but scholars have not reached a consensus on whether its effect is positive or negative. Scholars with a positive attitude believe that increasing market transparency can enhance market liquidity and efficiency and reduce market volatility. By contrast, those with a negative perspective contend that market transparency actually lowers market liquidity and efficiency. Some scholars also argue that the effect of information transparency on the market being positive or negative depends on the type of market and traders. The appropriateness and influence of the market trading system is a topic of concern for market participants and policy makers. Whether or not the existing system should be maintained in the market should be investigated by comparing it with a new trading system. Therefore, to determine how the new trading system influences the market, empirical data should be applied to relevant theories and models.

Most of the existing studies have not discussed the new system implemented by Taiwan Futures Exchange on May 12, 2014. The purpose of the new system is to reduce the possibility of human manipulation and increase information transparency. Therefore, this study investigated the changes in market liquidity, trading volume, market volatility, and market quality between before and after the implementation of the new system to understand whether a system change exerts influence on the market. Specifically, this study examined whether the change of the futures

exchange system increased the efficiency of price discovery and analyzed the influence of system changes on trading volume, volatility, and liquidity.

The balance of the paper is organized as follows. The relevant literature is discussed in Section 2; Section 3 outlines methodology and data processing. In Section 4, the empirical findings are illustrated; the conclusion and implications are expressed in Section 5.

2. Relevant Literature

To attract more capital to boost the market, Taiwan Futures Exchange proposed numerous reform measures to increase the trading volume, that is, market liquidity and price discovery ability. O`Hara (2001) stresses that market liquidity and price discovery ability should be strengthened because they are substantially influenced by information transparency. O`Hara (2001) also argues that whether market information is fully disclosed affects investors' ability to select their investment target and their measurement of the target's true value. Bessembinder and Seguin (1993) contend that sudden news may cause great market volatility. Therefore, providing transparent information to reduce market volatility and lessen the effect caused by unexpected information can enhance an institution's ability to hedge risks and investors' willingness to participate in the market. Accordingly, the increase of market transparency is conducive to market fairness, competitiveness, and attractiveness. According to O`Hara (1995), market transparency is defined as market participants' ability to obtain information during transactions. Such information includes strike price, trading volume, and order price, which can all help market participants determine the market direction and the real price of the target asset. Bloomfield and O`Hara (1999) argue that compared with opaque market, transparent market disclosure of trade information is more rapidly reflected on the trading price. Easley and O'Hara (2004) assert that the quality and quantity of market information exert a substantial influence on asset price, and how the market discloses trading information affects the price discovery ability. After Taiwan Futures Exchange disclosed information regarding institutional investors' futures trading (i.e., trading volume, open interest, and contract sum), Chen (2009) summarized the information and concluded that the increase of market transparency enables market participants to access more information, which may be closely related to price variations in the spot and futures markets. This conclusion is consistent with Taiwan Futures Exchange's expectation that increasing market transparency will enhance information efficiency. Sankaraguruswamy, Shen, and Yamada (2013) report that uninformed traders make trading decisions according to the information released by the market. Therefore, to prevent market participants from making decisions in situations of information asymmetry, market regulators seek to increase the frequency of information disclosure, creating an equal and fair market environment for all market participants. Because the futures market in Taiwan has a lower trading volume than that in other countries, the government proposed market system improvement measures to increase market information transparency. Although market transparency has received considerable attention, whether market transparency changes market participants' behaviors, which in turn influences the market on several levels still requires investigation. Hsu and Lee (2014) theoretically infer the trading strategy adopted by informed futures traders; the futures possessed by these informed traders prompt them to actively trade in the futures market. However, adverse selection may lower the liquidity of the futures market. To prevent informed traders from manipulating the prices, the government implemented the premarket information disclosure system to increase premarket information transparency, thus enabling investors to obtain more price and volume information, reducing information asymmetry, and increasing market efficiency. The stock markets in several countries (e.g., New York Stock Exchange, NASDAQ, Toronto Stock Exchange, Australian Securities Exchange, Paris Bourse, Milan Borsa, and Madrid Borsa) enable traders to openly disseminate the prices temporarily set for the orders that are not legally bound before the market opens. However, because no real transactions are made before the market opens, their economic significance is questionable.

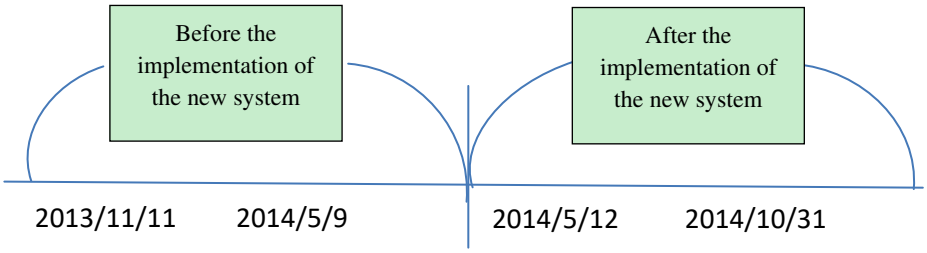
According to Dia and Pouget (2005), informed traders who have a liquidity need may rationally disclose their information during the premarket period, using the premarket information to reduce their participation cost. Therefore, liquidity providers will reduce the entailed risk of adverse selection. Such trading strategy is called sunshine trading. Information disclosure at this time point can prevent poor market operation, and introducing information on price and volume during the premarket period can stimulate quality improvement. Therefore, the competent authority provides a communication platform for traders to disseminate information regarding liquidity needs and asset prices before transactions are performed. However, Medrano and Vives (1998) mention that traders can rationally deduct information on price and volume from the amount of orders just before the trading session. However, this involves a risk given that the manipulated orders cannot be modified or cancelled. Taiwan Futures Exchange's policy according to which orders cannot be cancelled or modified, only added, in the last 2 minutes (i.e., between 8:43 and 8:45 a.m.) before the trading session is to prevent deliberate manipulation. Wang and Yau (2000) report that trading volume is positively correlated with price volatility. Liquidity refers to the level of difficulty in the conversion of an asset (tangible asset or securities) into cash. Liquidity can also correspond to the immediacy of a transaction, that is, whether the transaction can be immediately performed at a set time point. The level of liquidity is determined by whether the transaction of the target can be immediately performed. A market that enables rapid transactions demonstrates high liquidity. Under high transaction immediacy, when investors have the need to buy or sell, they can usually find a seller or buyer immediately. In their theory of clientele effect, Amihud and Mendelson (1986) contend that a high illiquidity of the securities indicates how long the securities are held. Koski and Michaely (2000) use the trading time and trading volume to estimate the effect of information asymmetry and state that, under information asymmetry, market asset prices tend to be easily influenced by the large amount of transactions. When the level of information asymmetry is high, market liquidity is low, which indirectly reduces market quality.

3. Data and Methodology

This study targets the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) Futures (TX). To understand the influence of information disclosure during the premarket period (i.e., 8:30–8:45 a.m.) before and after the implementation of an information disclosure system and considering that premarket information only exerts a short-term effect, this study uses the intraday data between 1 and 5 minutes after the market opens, including the opening price, highest price, lowest price, trading volume, and closing price. The data source is the Taiwan Economic Journal intraday disc database, and the data period is from November 2013 to December 2014. The futures contracts in the most recent months at 8:45–8:46 a.m. and 8:45–8:50 a.m. over a total of 240 days (i.e., 120 days before and after May 12, 2014) were retrieved from the futures market to investigate the changes in trading volume, liquidity, and volatility after the introduction of the premarket information disclosure system. The market quality, which is influenced by the increase of premarket information transparency, includes trading volume, liquidity, and volatility, and the effect resulting from the introduction of this new system is measured using the system implementation date as baseline date. However, because trading volume, liquidity, and volatility are correlated, this study uses control variables to measure these associations. The detailed definitions of the control variables are displayed in Appendix A.

Apart from the t test, a simple regression analysis is conducted to examine the influence of the new system and to measure the relationship between trading volume, liquidity, and volatility. Trading volume, liquidity, and volatility are also used to measure the changes in market quality.

Figure 1: Timeline for the implementation of a premarket information disclosure system by Taiwan Futures Exchange



- Volume
  The intraday data between 1 and 5 minutes after the market opens are used to estimate the difference of trading volume before and after the implementation of the premarket information disclosure system (hereafter referred to as "the event"). The estimation is performed using Eq. (1) as follows:
  $Volume_{i,t} = \beta_0 + \beta_3 D_{i,t} + \beta_4 S\&P_{i,t-1} + \varepsilon_{i,t}$
- Illiquidity
  This study estimates whether the market features illiquidity before and after the event. The estimation method for illiquidity proposed by Amihud (2002) is adopted, as presented in the following Eq. (2).
  $ILLIQ_{i,t} = |R_{i,t}|/Volume_{i,t}$
  Where
  $|R_{i,t}|$ is the absolute rate of return value, calculated using the continuously compounded rate of return ($\ln \frac{\text{closing price}}{\text{opening price}}$).
  $Volume_{i,t}$ is the trading volume of the corresponding day.
  The intraday data between 1 and 5 minutes after the market opens are used to estimate the difference of liquidity before and after the event. The estimation method used is indicated as follows:
  $ILLIQ_{i,t} = \beta_0 + \beta_3 D_{i,t} + \beta_4 S\&P_{i,t-1} + \varepsilon_{i,t}$
- Volatility
  To ensure estimation rigorousness, three common volatility estimation methods are used, namely the classic estimator, Parkinson estimator, and Garman–Klass estimator, as follows:
  $\hat{\sigma}_V^2 = (\ln\ C_t - lnO_t)^2$
  Parkinson (1980)
  $\hat{\sigma}_{Park}^2 = \frac{1}{4ln2}(lnH_t - lnL_t)^2$
  Where H_t denotes the highest price, and L_t denotes the lowest price.
  Garman and Klass (1980)
  $\hat{\sigma}_{GK}^2 = 0.5[\ln\ (H_t - L_t)]^2 - [2ln2 - 1][\ln\ (C_t - O_t)]^2$
  Where H_t is the highest price, L_t is the lowest price, C_t is the closing price, and O_t is the opening price.
  The intraday data between 1 and 5 minutes after the market opens are used to observe the difference of the three volatility estimation equations before and after the event. In the simple regression analysis, the variables of volume and illiquidity are first controlled, followed by the S&P 500. Therefore, whether the control variables influence volatility can be determined according to the statistical significance of the independent variables. The coefficients β_1, β_2, and β_3 can be used to determine the level of association between the variables. The three volatility estimation methods are presented as follows:

$$\hat{\sigma}_V^2 = \beta_0 + \beta_1 Volume_{i,t} + \beta_2 Illiqui_{i,t} + \beta_3 D_{i,t} + \beta_4 S\&P_{i,t-1} + \varepsilon_{i,t}$$
$$\hat{\sigma}^2_{\text{Park}} = \beta_0 + \beta_1 \text{Volume}_{\text{i,t}} + \beta_2 \text{Illiqui}_{\text{i,t}} + \beta_3 \text{D}_{\text{i,t}} + \beta_4 \text{S\&P}_{\text{i,t}-1} + \varepsilon_{\text{i,t}}$$
$$\hat{\sigma}_{GK} = \beta_0 + \beta_1 Volume_{i,t} + \beta_2 Illiqui_{i,t} + \beta_3 D_{i,t} + \beta_4 S\&P_{i,t-1} + \varepsilon_{i,t}$$

4. Empirical Findings

4.1. First Five Minutes after the Market Opens

This study examines the effect of premarket information disclosure on market quality. The information disclosed includes the opening price, volume, and the five best bid-ask prices and volumes. This study focuses on the 120 days before and after the implementation of the premarket information disclosure system and investigates the changes in trading volume, liquidity, and volatility within the first 5 minutes after the market opens, given that premarket information exerts only a short-term effect. The trading volume is examined using the t test. When the t value is negative and significant, it indicates that the trading volume before the event is smaller than that after the event. This implicates that the trading volume increases considerably after information disclosure. Subsequently, the Wilcoxon rank-sum test, a nonparametric test, is conducted. The result indicates that the expected goal of Taiwan Futures Exchange, for information disclosure to enhance the efficiency and referenceability of futures information, is achieved. From 8:45 a.m. to 8:50 a.m. in the futures market, the average trading volume before the event was 7083.092, which is smaller than that after the event (8865.817) by 1782.725. This result can be explained by the increase of premarket information transparency, which substantially increases market participants' willingness to invest and reduces the level of information asymmetry. Firms can disclose their information before the trading session starts to meet their needs for hedging. This result is consistent with what Dia and Pouget (2005) argue, that is, informed traders with a liquidity need may rationally disclose their need before the market opens and use the premarket information to reduce their participation cost. The increase in trading volume after information disclosure also indicates an increase of market quality. Regarding the measurement of market illiquidity before and after premarket information disclosure, this study adopts a dummy variable representing the situation before and after the event and examines the liquidity of the market in the 120 days before and after May 12, 2014 (baseline date). The illiquidity index proposed by Amihud (2002) is tested using the t test. The result demonstrates that the average illiquidity significantly decreased after the implementation of the premarket information disclosure system, implicating the increase of market liquidity after the event.

Table 1: Statistics for the Futures Market Between 08:45 a.m. and 08:50 a.m

	Mean		***t* value**	**Wilcoxon rank-sum test**
Volume	Before	7083.092	-3.6497	-4.379
	After	8865.817	(0.0003***)	(0.0000***)
illiquidity	Before	1.55e-07	3.3615	2.676
	After	1.05e-07	(0.0009***)	(0.0075***)
Volatility	Before	1.30e-06	-1.0155	0.669
	After	1.77e-06	(0.3109)	(0.5032)
Volatility (Parkinson)	Before	1.58e-06	-0.4768	1.426
	After	1.79e-06	(0.6340)	(0.1538)
Volatility (Garman and Klass)	Before	1.69e-06	-0.2377	1.605
	After	1.80e-06	(0.8123)	(0.1085)

t statistics in parentheses * p < 0.1, **p < 0.05, *** p < 0.01

To ensure meticulous evaluation, three volatility estimation methods are used. The result of the t test indicates no significant variation in volatility before and after the event. However,

after the variable of volume is controlled, the increase of trading volume leads to an increase in volatility, and the two variables are significantly correlated (Table 2). In addition, the volatility after the event increased slightly, although the difference is nonsignificant. The Wilcoxon rank-sum test results also demonstrate a nonsignificant difference of volatility before and after the event, consistent with the result of the t test.

Table 2: Regression Analysis for the Futures Market from 08:45 a.m. to 8:50 a.m.

	(1) Volume	**(2) Illiquidity**	**(3)** $\widehat{\sigma}_V^2$	**(4)** $\widehat{\sigma}_{park}^2$	**(5)** $\widehat{\sigma}_{GK}^2$
volume(β_1)			5.17e-10*** (10.71)	4.99e-10*** (10.62)	4.92e-10*** (10.13)
Illiqui(β_2)			14.25*** (8.93)	9.210*** (5.93)	7.266*** (4.53)
dummy(β_3)	1782.7*** (3.65)	-4.97e-08*** (-3.36)	0.000000255 (0.69)	-0.000000227 (-0.63)	-0.000000413 (-1.11)
Constant (β_0)	7083.1*** (20.51)	0.000000155*** (14.84)	-0.00000457*** (-8.71)	-0.00000338*** (-6.61)	-0.00000292*** (-5.53)
R^2	0.0530	0.0453	0.4106	0.3518	0.3164
N	240	240	240	240	240

t statistics in parentheses * p < 0.1, **p < 0.05, *** p < 0.01

According to Table 2, the coefficient of the dummy variable in Model (1) is positive, indicating a significant increase of the trading volume after the event. The coefficient of the dummy variable in Model (2) is negative, indicating a significant decrease of illiquidity after the event, which implicates the increase of liquidity. In Models (3), (4), and (5), volume and illiquidity are controlled, and the obtained coefficients are positive, indicating that the larger the trading volume is, the higher the volatility. This is consistent with the result of Wang and Yau (2000), which reported a positive correlation between trading volume and price volatility. Moreover, the high illiquidity of the market leads to high volatility, which is consistent with the result of Madhavan (1996) stating that low market liquidity causes high price sensitivity and in turn high price volatility. Table 4 presents no significant difference in volatility before and after the event.

4.2. First Minute after the Market Opens

This study shortens the targeted period to 1 minute to measure the influence of premarket information transparency on market quality within a short time. From 8:45 a.m. to 8:46 a.m. in the futures market, the average trading volume before the event is 3344.017, which is smaller than that after the event by 846.783. Despite the shortened targeted period, the trading volume after information disclosure still appears higher than that before information disclosure in a 1-minute period. The liquidity also significantly increases within 1 minute, indicating that the premarket information disclosure system effectively improves market liquidity. By comparison, volatility does not change significantly change within 1 minute before and after the event. However, the Wilcoxon rank-sum test results indicate a significant difference of volatility before and after the event. This may be because the t test assumes the normal distribution of the data, but volatility is particularly high in the first minute of trading, and such high volatility is inconsistent with a normal distribution. Therefore, in the Wilcoxon rank-sum test, the level of significance of the volatility obtained using the Parkinson and Garman–Klass estimators decreases. The increase of trading volume and liquidity and the decrease of volatility all manifest the improved quality of the futures market.

Table 3: Statistical Analysis for the Futures Market from 08:45 a.m. to 8:46 a.m

		Mean	*t* value	Wilcoxon rank-sum test
Volume	Before	3344.017	-3.5862	-4.180
	After	4190.8	(0.0004***)	(0.0000***)
illiquidity	Before	2.29e-07	3.5534	2.816
	After	1.46e-07	(0.0005***)	(0.0049***)
Volatility	Before	7.06e-07	-0.0915	1.442
	After	7.30e-07	(0.9272)	(0.1492)
Volatility (Parkinson)	Before	9.84e-07	0.4107	3.151
	After	8.96e-07	(0.6816)	(0.0016***)
Volatility (Garman and Klass)	Before	1.09e-06	0.5394	3.780
	After	9.60e-07	(0.5901)	(0.0002***)

t statistics in parentheses * p < 0.1, **p < 0.05, *** p < 0.01

According to Table 4, within the first minute after the market opens, the coefficient of the dummy variable in Model (1) is positive, indicating a significant increase of the trading volume after the event. The coefficient of the dummy variable in Model (2) is negative, indicating that illiquidity decreases significantly after the event, which implies the increase of liquidity. In Models (3), (4), and (5), the trading volume and illiquidity are controlled, and the coefficients are positive, indicating that the larger the trading volume is, the higher the volatility. The high market illiquidity also causes volatility to increase. Table 12 presents no significant difference in volatility before and after the event.

Table 4: Regression Analysis for the Futures Market from 08:45 a.m. to 8:46 a.m.

	(1) Volume	(2) Illiquidity	(3) $\hat{\sigma}_V^2$	(4) $\hat{\sigma}_{park}^2$	(5) $\hat{\sigma}_{GK}^2$
volume(β_1)			4.90e-10***	4.62e-10***	4.52e-10***
			(8.03)	(8.95)	(7.20)
Illiqui(β_2)			5.914***	3.159***	2.095***
			(9.55)	(6.02)	(3.29)
dummy(β_3)	846.8***	-8.27e-08***	9.86e-08	-0.000000219	-0.000000342
	(3.59)	(-3.55)	(0.44)	(-1.15)	(-1.48)
Constant (β_0)	3344.0***	0.000000229***	-0.00000228***	-0.00000128***	-0.000000898***
	(20.03)	(13.91)	(-7.26)	(-4.82)	(-2.77)
R^2	0.0513	0.0504	0.3477	0.2891	0.1881
N	240	240	240	240	240

t statistics in parentheses * p < 0.1, **p < 0.05, *** p < 0.01

4.3. First Five Minutes of Trading with Other Factors Considered

According to Table 5, the dummy variable coefficient of Model 1 is positive, implicating that the trading volume in the first 5 minutes of trading increases significantly after the event. The coefficient for S&P 500 is negative and significant, indicating that when the US stock market rises, the TAIEX falls. The reason for that phenomenon is that S&P 500 and TAIEX are highly and positively correlated. The spot market in 2014 was a bull market, causing investors to put their capital. However, when the market participants reduce the hedge ratio, the trading volume in the futures market may also decline because of the crowding-out effect. In Model (2), the dummy variable coefficient is significantly negative, indicating a significant decrease of illiquidity after the event, that is, the increase of liquidity. S&P 500 has no significant influence on market illiquidity. The volume and illiquidity are controlled in Models (3), (4), and (5), and the results reveal that the coefficients are all positive, indicating that the larger the trading volume is, the higher the volatility. The high illiquidity of the market also results in high volatility. However,

volatility is not affected by the introduction of the premarket information disclosure system and the S&P 500.

Table 5: Regression Analysis for the Futures Market from 08:45 a.m. to 8:50 a.m.

	(1) Volume	(2) Illiquidity	(3) $\widehat{\sigma}_V^2$	(4) $\widehat{\sigma}_{park}^2$	(5) $\widehat{\sigma}_{GK}^2$
volume(β_1)			5.22e-10*** (10.59)	4.92e-10*** (10.26)	4.81e-10*** (9.71)
Illiqui(β_2)			14.29*** (8.94)	9.145*** (5.87)	7.157*** (4.46)
dummy(β_3)	1771.2*** (3.68)	-4.97e-08*** (-3.36)	0.000000250 (0.67)	-0.000000220 (-0.61)	-0.000000402 (-1.08)
S&P(β_4)	-101272.3*** (-2.95)	-0.000000279 (-0.26)	0.0000138 (0.53)	-0.0000185 (-0.73)	-0.0000310 (-1.19)
Constant (β_0)	7144.1*** (20.98)	0.000000155*** (14.80)	-0.00000462*** (-8.65)	-0.00000331*** (-6.36)	-0.00000280*** (-5.22)
R^2	0.0865	0.0456	0.4113	0.3533	0.3205
N	240	240	240	240	240

t statistics in parentheses * p < 0.1, **p < 0.05, *** p < 0.01

4.4. First Minute of Trading with Other Factors Considered

According to Table 6, the dummy variable coefficient in Model (1) is positive, indicating that the trading volume in the first minute after the market opens increases significantly after the event. By contrast, S&P 500 has no significant influence on the trading volume. The dummy variable coefficient in Model (2) is negative, attesting of a significant decrease of market illiquidity and therefore of an increase of liquidity after the event. S&P 500 has no significant influence on the illiquidity. In Models (3), (4), and (5), trading volume and illiquidity are controlled. The coefficients are all positive, implicating that the larger the trading volume is, the higher the volatility. The high illiquidity of the market also results in high volatility. However, volatility is not affected by the introduction of the premarket information disclosure system and the S&P 500.

Table 6: Regression Analysis of the Futures Market from 08:45 a.m. to 8:46 a.m.

	(1) Volume	(2) Illiquidity	(3) $\widehat{\sigma}_V^2$	(4) $\widehat{\sigma}_{park}^2$	(5) $\widehat{\sigma}_{GK}^2$
volume(β_1)			4.88e-10*** (7.94)	4.55e-10*** (8.77)	4.42e-10*** (7.01)
Illiqui(β_2)			5.911*** (9.53)	3.143*** (6.00)	2.073*** (3.26)
dummy(β_3)	843.7*** (3.59)	-8.26e-08*** (-3.55)	9.91e-08 (0.44)	-0.000000216 (-1.14)	-0.000000338 (-1.46)
S&P(β_4)	-27393.9 (-1.63)	8.48e-08 (0.05)	-0.00000276 (-0.18)	-0.0000176 (-1.34)	-0.0000233 (-1.47)
Constant (β_0)	3360.5*** (20.16)	0.000000229*** (13.85)	-0.00000228*** (-7.18)	-0.00000124*** (-4.65)	-0.000000846*** (-2.60)
R^2	0.0618	0.0504	0.3478	0.2945	0.1954
N	240	240	240	240	240

t statistics in parentheses * p < 0.1, **p < 0.05, *** p < 0.01

Table 7 presents the empirical results regarding the changes in the futures market after the implementation of a premarket information disclosure system on May 12, 2014. The trading volume and liquidity investigated in this study both increase significantly within the first 5 or 1 minute after the market opens. Only the volatility estimated using a classic estimator increases slightly, whereas that calculated using Parkinson and Garman–Klass estimators decreases slightly.

Table 7: Empirical Results of the Futures Market

First 5 minutes of trading	Market quality	Coefficient before the factors are controlled	Coefficient after the factors are controlled
	Volume	+	+
	Liquidity	+	+
	Volatility	+ - -	+ - -
First 1 minute of trading			
	Volume	+	+
	Liquidity	+	+
	Volatility	+ - -	+ - -

5. Conclusions

In terms of market supervisory authority, a market system that keeps pace with the times can facilitate the formation of a more comprehensive market, directly or indirectly increasing market fairness and efficiency. This can enhance market participants' intention to enter the market as well as progressively provide new financial products, an outcome welcomed by both the supervisory authority and market participants. Proposing premarket information disclosure in the futures market aims to cope with the lack of premarket information transparency and enables market participants to determine the most appropriate opening price. Therefore, the supervisory authority discloses the simulated five best bid-ask prices and volumes during the premarket period, which serves as reference for market participants.

According to the result of the t test on the futures market from 08:45 a.m. to 08:50 a.m., the trading volume and market liquidity significantly increase after information is disclosed before the market opens. However, volatility increases with the trading volume. When the period is shortened to between 08:45 a.m. and 8:46 a.m., the result is consistent with that obtained using a 5-minute trading period. Therefore, the results meet the expectations about increasing market transparency to enhance information efficiency. The regression analysis of the first 5 or 1 minute of trading also yields the same results. In addition, the variable of S&P 500 has significant influence only on volume but no significant influence on liquidity or volatility.

The level of market transparency has extensive influence on the market. This study focused on the premarket information disclosure and how such information disclosure influences other market factors. Future studies should investigate the effect of premarket information disclosure on market quality from different perspectives to fully understand such effect and make up for the deficiencies in this study. In this study, the increase of information transparency results in an increase of trading volume. However, whether market transparency and premarket information disclosure may lead to the reduction of noise trading still requires further investigation. This study focused on the 120 days before and after the implementation of the premarket information disclosure system. However, whether this system can continue to contribute to the increase of trading volume in the future remains unknown. This study only examines trading volume, liquidity, and volatility; therefore, it is suggested that future studies take additional variables into account or use other estimation methods, which may produce different results. The results may also vary depending on the countries, markets, or research hypotheses. Therefore, a comparison between Taiwan and other countries could be conducted to observe whether the effect of premarket information disclosure is also significant in other countries.

References

[1] Amihud, Y., & Mendelson, H., 1986. "Asset pricing and the bid-ask spread", *Journal of Financial Economics* 17(2), pp.223-249.

[2] Amihud, Y., 2002. "Illiquidity and stock returns: cross-section and time-series effects", *Journal of Financial markets* 5(1), pp.31-56.

[3] Alexakis, P., 2007. "On the effect of index futures trading on stock market volatility", *International Research Journal of Finance and Economics* 11(7), pp.7-29.

[4] Bessembinder, H., & Seguin, P. J., 1993. "Price volatility, trading volume, and market depth: Evidence from futures markets", *Journal of Financial and Quantitative Analysis* 28(1), pp.21-39.

[5] Bloomfield, R., & O'Hara, M., 1999. "Market transparency: Who wins and who loses?", *Review of Financial Studies*12(1), pp.5-35.

[6] Chou, R. Y., Chou, H., & Liu, N., 2010. "Range volatility models and their applications in finance. In Handbook of Quantitative Finance and Risk Management", Springer US.

[7] Dia, M., & Pouget, S., 2005. "Liquidity Formation and Preopening Periods in Financial Markets", *Working Paper*, University of Toulouse I Capitole.

[8] Easley, D., & O'hara, M., 1992. "Time and the process of security price adjustment", *The Journal of Finance* 47(2), pp.577-605.

[9] Easley, D., & O'hara, M., 2004. "Information and the cost of capital", *The Journal of Finance* 59(4), pp.1553-1583.

[10] Hsieh, W. L. G., 2002. "Market integration, price discovery, and information transmission in Taiwan index futures market", *Journal of Financial Studies* 10(3), pp.1.

[11] Hsu, C.H. and Lee, H.C., 2014. "Insider trading and information revelation with the introduction of futures markets", *Economic Modelling*43, pp.173-182.

[12] Jiang, L., & Kryzanowski, L., 1997. "Trading activity, quoted liquidity, and stock volatility", *Multinational Finance Journal* 1(3), pp.199-227.

[13] Kawaller, I. G., Koch, P. D., & Koch, T. W., 1987. "The temporal price relationship between S&P 500 futures and the S&P 500 index", *The Journal of Finance* 42(5), pp.1309-1329.

[14] Koski, J. L., & Michaely, R., 2000. "Prices, liquidity, and the information content of trades", *Review of Financial Studies* 13(3), pp.659-696.

[15] Lyons, R. K., 1993. "Optimal transparency in a dealership market with an application to foreign exchange (No.w4467)", *National Bureau of Economic Research*.

[16] Madhavan, A., 1996. "Security prices and market transparency", *Journal of Financial Intermediation* 5(3), pp.255-283.

[17] Medrano, L. A., & Vives, X., 2001. "Strategic behavior and price discovery", *RAND Journal of Economics*, pp.221-248.

[18] O'hara, M., 1995. "Market microstructure theory (Vol. 108)", Cambridge, MA: Blackwell.

[19] O'Hara, M., 2001. "Designing markets for developing countries", *International Review of Finance* 2(4), pp.205-215.

[20] Sankaraguruswamy, S., Shen, J., & Yamada T., 2013. "The relationship between the frequency of news release and the information asymmetry: The role of uninformed trading", *Journal of Banking & Finance* 37, pp.4134–4143.

[21] Wang, G. H., & Yau, J., 2000. "Trading volume, bid-ask spread, and price volatility in futures markets", *Journal of Futures markets* 20(10), pp.943-970.

Appendix A. Variable Definitions

Variable name	Variable code	Definition
Volume	Volume	The total trading volume within the first 5 or 1 minute after the market opens.
Illiquidity	ILLIQ	The absolute value of daily rate of return divided by the daily trading volume, in which the rate of return is calculated using the continuously compounded rate of return.
Volatility	$\hat{\sigma}_V^2$	The natural logarithms of the opening price subtracted from the closing price in the first 5 or 1 minute of trading; the obtained value is squared.
Volatility (Parkinson)	$\hat{\sigma}_{Park}^2$	The volatility estimation formula proposed by Parkinson (1980), where H_t and L_t respectively represent the highest and lowest price on the t^{th} day in the first 5 or 1 minute after the market opens.
Volatility (Garman–Klass)	$\hat{\sigma}_{GK}^2$	The volatility estimation formula proposed by Garman and Klass (1980), where H_t, L_t, C_t, and O_t represent the highest price, lowest price, closing price, and opening price, respectively, in the first 5 or 1 minute after the market opens on the t^{th} day.
Dummy	D	The dummy variable is determined based on the date when the new system is implemented; 1 denotes the period after the system implementation, and 0 denotes the period before the system implementation.
S&P 500	S&P	The influence of the rate of return of S&P 500 of the previous day on the futures and spot markets.