The Aggregate Price Impact of the Disposition Effect

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Abstract

We find that the disposition effect has an impact on market volatility and short-term return. Using a comprehensive data covering over 60,000 investors in the Korean futures market, we find that a higher disposition effect bias causes higher current and future market volatility from a daily analysis. These results hold after controlling trading volume, volatility persistence, potential endogeneity bias, and are robust to various volatility measures. We also find that the increased disposition effect in the long (short) position has a tendency to decrease (increase) asset prices over a short-term period. Our finding justifies the opinion that the disposition effect has an impact on market volatility and prices, and is in line with Kogan, Ross, Wang, and Westerfield (2006).

Keywords: Disposition effect; Price impact; Volatility; Irrational trader; Behavioral bias

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1. Introduction

The disposition effect, the tendency to hold losers too long and sell winners too soon, has been found in a variety of data sets and time periods with the availability of account-level transaction data. The disposition effect is one implication of “prospect theory” (Kahneman and Tversky (1979)) and “mental accounting” (Thaler (1985)) and named by Shefrin and Statman (1985). Subsequent to the well-known paper by Odean (1998), a number of studies find empirical regularity in the stock market.[1] Odean (1998) demonstrates the existence of the disposition effect with empirical evidence from a large sample of individual investors in the US stock market. By analyzing trading records for 10,000 accounts at a major discount brokerage firm, he shows that individual investors have a strong preference for realizing winners rather than losers. He also shows that on average, the trades that these traders place appear irrational. However, there is little evidence about the disposition effect in the futures market.[2]

In this paper, we focus on the disposition effect on market volatility and short-term return in the Korean index futures market. The reason for investigating the futures market is as follows. First, even though a lot of studies find evidence about the disposition effect, there is little evidence in the futures market. Locke and Mann (2005) find the disposition effect of professional futures traders, but find no evidence of costs associated with this behavior. However, their analysis is limited to professional traders and has limitations to interpret these results. Second, when the stock market is in an upward-moving stage, investors tend to sell winners than losers even though they have no disposition bias because their portfolios are appreciated. In contrast, in the futures market, a long position holder’s gain equals to a short

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[1] See, for example, Grinblatt and Keloharju (2001), Ranguelova (2001), Shapira and Venezia (2001), Wermer (2003), Feng and Seasholes (2005), Jin and Scherbina (2005), Shumway and Wu (2005), Dhar and Zhu (2006), Frazzini (2006), and Kumar (2006).

[2] Coval and Shumway (2005) investigate market makers in the Treasury Bond futures contracts at the Chicago Board of Trade (CBOT) and Locke and Mann (2005) analyze the trading behavior of professional futures traders on the Chicago Mercantile Exchange (CME). Choe and Eom (2006) investigate the effect the disposition bias has on investment performance.

position holder's loss. Consequently, there is no need to control market conditions such as an upward-moving market or downward-moving market to identify the disposition effect. Finally, since expiration date exists in the futures contracts, we can measure profits correctly. We don't need to assume that there is no beginning inventory. This enables us to calculate the exact profits which are critical for figuring out the disposition effect.

We examine the disposition effect on market prices based on a transactions dataset of the Korean index futures market. Because we begin with every transaction made by all market participants over a 2-year period, the results have significant power to detect behavioral biases in trading behavior. Since previous papers use a particular investor database on a brokerage house, they have limitations on finding behavioral biases and interpreting these results. Using high frequency transaction data, we examine the disposition effect at the market-level on market volatility and short-term return to test the hypothesis that irrational traders can influence asset prices.

Most asset pricing models assume that market participants are rational (e.g., Lucas (1978)). However, Kahneman and Tversky (1979) say that market participants are not rational on average and there is a lot of evidence to support the irrational behavior of traders (e.g., Odean (1998), Grinblatt and Keloharju (2001)). Whether irrational traders affect financial markets or not still remains as an open question. Recently, Kogan, Ross, Wang, and Westerfield (2006) show that irrational investors can have a significant impact on asset prices even when their wealth becomes negligible. In their model, irrational traders can survive and even dominate rational traders, but even when they do not survive, they can still have a persistent impact on asset prices. Following the implications of Kogan el. al. (2006), we present empirical evidence that the behavior of irrational traders affects asset prices.

We find that the disposition effect has an impact on market volatility and short-term return.

Using a comprehensive data covering over 60,000 investors in the Korean futures market, we find that a higher disposition effect bias causes higher current and future market volatility from a daily analysis. These results hold after controlling trading volume, volatility persistence, potential endogeneity bias, and are robust to various volatility measures. We also find that the increased disposition effect in the long (short) position has a tendency to decrease (increase) asset prices over a short term period. Our finding justifies the opinion that the disposition effect has an impact on market volatility and prices, and is in line with Kogan el. al. (2006).

This paper proceeds as follows. Section 2 describes the futures trading data, general methodology, and hypothesis. Section 3 analyzes the time series properties of the disposition effect. Section 4 shows empirical evidence of the disposition effect on market volatility and Section 5 presents empirical evidence of the disposition effect on short-term return. Finally, Section 6 concludes.

2. Data and Methodology

2.1 Korean Futures Market

The Korea Exchange (KRX) launched stock index futures on the Korea Stock Price Index (KOSPI) 200 on May 3, 1996. Despite its short history, the derivatives market in Korea has grown dramatically since its introduction and is the largest market by trading volume in the world. According to the Futures Industry Association (FIA), the futures and options trading volume of KRX was 2.9 billion contracts in 2003 and 2.6 billion contracts in 2004, and it was ranked 1st in the world. The stock index futures volume of KRX was 62 million contracts in 2003 and 56 million contracts in 2004, and it was ranked 4th in the world, following the E-Mini S&P 500 of CME, DJ Euro STOXX 50 of EUREX, and E-Mini NASDAQ 100 of CME.

The underlying asset of stock index futures in the KRX is KOSPI 200. It is a market capitalization weighted index composed of 200 major stocks listed in the KRX. Contract months of index futures are March, June, September, and December. The last trading day for each contract month is the second Thursday of the contract month. The normal trading hours are from Monday through Friday, 09:00 to 15:15. There are no trades during the last ten minutes, when orders are collected for the closing call auction at 15:15. Trading prices during the rest of the trading hours are determined by continuous auction. On the last trading day of futures, the trading of matured futures contracts ends at 14:50. The settlement price is set to the closing price of the cash market, which is determined by call auction at 15:00. The KRX does not have designated market makers. Buyers and sellers meet via the Automated Trading System. The stock index futures price is the same as KOSPI 200 times KRW 500,000. The trading unit is one contract and the minimum tick size is 0.05 index point, representing a value of KRW 25,000. The daily price limit is 10 percent of the previous closing price.

2.2 Data

In this paper, we use a unique data set to shed new light on the issue of whether investors exhibit the disposition effect. For better understanding the disposition effect, it is useful to analyze a data set on how all market participants behave. By looking at all the market participants in the Korean index futures market, we are able to generate a more complete picture of the stylized facts of trading.

Our primary data consist of the entire history of transactions of the Korean index futures from January 2003 to March 2005. The data include a trader’s account information, identifiers for the buying trader and the selling trader, the price, and the time for each transaction. They provide information on the country of residence of investors as well as on whether they are individuals or institutions. The number of individuals, institutions, and foreign investors are 59,081, 9,742, and 568, respectively. The percentage of individual investors is approximately 85 % and strikingly higher than that of institutions (14%) and foreign investors (1%). However, the percentage of individual investors by trading volume is not so high. In 2004, 48.6% of the gross volume of trade was by individual investors. In contrast, 29.1% of the gross volume of trade was by institutional investors and 22.3% was by foreign investors.[3]

2.3 Measuring the Disposition Effect

We slightly modify the Odean (1998) methodology and measure the disposition effect (DE) as the difference between investors' propensity to realize gains and their propensity to realize losses. The current futures price is compared to the contract-weighted average open-buy (or open-sell) price to determine whether the futures contract is trading at a gain or a loss. If the current price is above (below) the reference price in the long position, then the futures contract is counted as trading at a gain (loss). There are two types of gains and losses. If the investor trades at a gain (loss), it is counted as a "realized gain (loss)". If the investor does not close-buy (or close-sell) futures contracts and holds the positions, it is counted as a "paper gain (loss)" which the current price is above (below) the reference price in the long position.

We calculate the disposition effect at the aggregate level by assuming that investors' trade or accounts are independent. Proportion of gain realized (PGR) and proportion of loss realized (PLR) at date t (or time t) are defined as:

$$PGR^t = \frac{N_{RG}^t}{N_{RG}^t + N_{PG}^t}, \quad PLR^t = \frac{N_{RL}^t}{N_{RL}^t + N_{PL}^t}$$

[3] In 2005, individuals, institutions, and foreign investors were 44%, 31.7%, and 23.7% in the gross volume of trade, respectively.

N_{RG}^{t} = number of accounts at date *t* (or time t) where a gain is realized

N_{RL}^{t} = number of accounts at date *t* (or time t) where a loss is realized

N_{PG}^{t} = number of accounts at date *t* (or time t) where there is a paper gain

N_{PL}^{t} = number of accounts at date *t* (or time t) where there is a paper loss

The disposition effect at date t (or time t) is defined as the difference of PGR and PLR.

$$DE^{t} = PGR^{t} - PLR^{t}$$

The difference between the disposition effect in the long position and short position is defined as ΔDE.

$$\Delta DE^{t} = Long\ DE^{t} - Short\ DE^{t}$$

2.4 Hypothesis

Kogan el. al. (2006) and Hirshleifer, Subrahmanyam, and Titman (2006) show that the behavior of irrational investors has an impact on asset prices. Specifically, we want to present empirical evidence that the disposition effect affects asset prices. To test the price implications of the disposition effect, we set the following two hypotheses.

Hypothesis 1: *The increased disposition effect has an impact on current and future market volatility.*

Goetzmann and Massa (2003) derive several additional implications of the Grinblatt and Han (2005) model about the expected relationship between the preponderance of dispositionprone investors in a market and volume, volatility, and stock returns. They show that in a period of rising prices, there is a significant negative correlation between the prevalence of disposition investor trades and turnover rate or volatility. Coval and Shumway (2005) find any price impact resulting from traders' behavioral biases dissipates extremely quickly. Consistent with this, they find that mornings with widespread losses lead to increases in short-run afternoon volatility but no increase in volatility measured over longer periods. In contrast, the noisy rational models of Hellwig (1980) and that of Wang (1993, 1994) show that volatility increases with non-informational trading while informed trading leads to decline in volatility. The disposition effect suggests that uninformed traders are more likely to sell when their portfolios are appreciated. As a result, if the increased disposition effect leads to an increase in market volatility, there will be a positive relationship between the disposition effect and market volatility. To test the above hypothesis, we investigate the dynamic relationship between the disposition effect and market volatility.

Hypothesis 2: *The increased disposition effect in the long position has a tendency to decrease current market prices over a short term period. The increased disposition effect in the short position has a tendency to increase current market prices over a short term period.*

Grinblatt and Han (2005) suggest that the disposition effect creates a spread between a stock's fundamental value and its equilibrium price, as well as price underreaction to information. Frazzini (2006) assesses that the disposition effect can induce underreaction to news, leading to return predictability and post-announcement drift. He finds additional support for the Grinblatt and Han (2005) model by showing that the post-announcement drift following earnings surprise and changes in analyst recommendations are most severe when capital gains and the news have the same sign. Moreover, the magnitude of the post-announcement drift is directly related to the amount of unrealized capital gains/losses experienced by the stockholders at the announcement date. He also finds that a holding-based proxy for capital gains is a better predictor of returns than both past returns and turnover-based proxy for capital gains. If the disposition effect has an impact on market prices, the following returns after the increased disposition effect in the long position will decrease and the following returns after the increased disposition effect in the short position will increase. To test the above hypothesis, we investigate the intraday returns around the extreme disposition effect event.

3. Time Series Properties of the Disposition Effect

3.1. Daily Disposition Effect

Table Ⅰ reports the minimum, 25th percentile, median, mean, 75th percentile, maximum, and standard deviation of the following variables over 556 trading days. Proxy for volatility variables are |ret|, ret^2, |high-low|, std(1min), std(5min), and std(10min). Return is calculated using the nearest KOSPI 200 futures price. |ret| is the absolute return, ret^2 is the squared return, |high-low| is the absolute difference between the high and low price during a day, std(1min) is a standard deviation of a one minute return, and so on. ln(amt) is the log of trading value of futures, ln(OI) is the log of open interest, |basis| is the absolute difference between futures and spot price, and 1/remain is one over the remaining days before maturity. DE is the difference of one representative agent's PGR and PLR. Individual DE, institutional DE, and foreigner DE are calculated treating each category investor as one representative agent.

A time series average of the disposition effect measure is 0.0882, which is almost as same as the market-level disposition effect, 0.0889, calculated by aggregating the number of realized gains, realized losses, paper gains, and paper losses on a daily basis during the sample period

(Jan 2003-Mar 2005) and across all accounts in the data set (Choe and Eom(2006)). This result supports the evidence that investors have the disposition bias. We also find that individual investors (DE = 0.0968) have a greater disposition effect value than institutional (DE = 0.0214) and foreign investors (DE = 0.0394).

Figure 1 depicts the time series pattern of the daily disposition effect measure. The disposition effect measure lies between 0.3 and -0.2. Though it varies between days, positive values are dominant which is evidence of the disposition bias. This picture implies that the disposition bias does not always exist, but depends on market condition or it has an impact on market prices.

Table Ⅱ reports the correlation estimates of the volatility and disposition effect measures. All volatility variables show significantly positive values, especially between volatility measures using the intraday data. As we expected, the log trading value has a positive correlation with volatility measure, which is documented by numerous papers. (e.g., Bessembinder and Seguin (1992, 1993), Chan and Fong (2002)) However, there is no consistent correlation pattern between open interest or basis and volatility. The disposition effect measure shows a positive correlation with volatility, but some volatility variables are not significant. Based on investor type, the disposition effect of individual and institutional investors has a positive relationship with volatility, but the disposition effect of foreign investors has a negative relationship with volatility. This result implies that individual and institutional investors' behavioral biases have a positive impact on market volatility.

3.2. Intraday Disposition Effect

Figure 2 depicts the time-series mean of DE, PGR, and PLR at each time. The one minute interval result during the continuous auction (09:00 – 15:05) is reported in Panel A, and the five minute interval result is in Panel B. There is an interesting aspect in the intraday pattern of the disposition effect in that DE is stable during the day, but it is decreases during the last 30 minutes.

One possible explanation for this phenomenon is the trading experience hypothesis that investors can reduce behavioral biases as they trade frequently. However, this hypothesis seems not to be appliable to a short-term investment horizon because DE does not decrease, but is almost stable during the day. Another more reasonable interpretation for this result is the position risk aversion hypothesis that investors do not want their positions exposed to the overnight risk. If investors don’t close out their positions during the day, they have to bear the overnight position risk. Therefore, they are more likely to clear their positions as it gets closer to market close. This figure indicates that investors are more averse to holding loss position than to gain position because PGR is stable during the day, but PLR increases for the last 30 minutes. The disposition bias becomes smaller when investors are more sensitive to loss. As a result, the disposition effect decreases for the last 30 minutes.

Figure 3 depicts the time-series mean of DE in Panel A, PGR in Panel B, and PLR in Panel C for every five minute interval across investor types. We can find a similar pattern of DE, PGR, and PLR for all investor types. In particular, the decreasing DE for the last 30 minutes in individual investors is more evident than institutional and foreign investors, which means that individual investors are more averse to holding loss positions than other investor groups. This interpretation is supported by the fact that most individuals trade futures contracts for a speculative purpose, but institutions and foreigners usually trade futures contracts for an arbitrage or hedge.

4. Impact of the Disposition Effect on Market Volatility

4.1. Contemporaneous Relationship between the Disposition Effect and Daily Price Volatility

Having identified the relationship between market volatility and the disposition effect measure, we then ask whether the disposition effect has an impact on market volatility. We use time series regressions to study the impact of the disposition effect on market volatility. Regressions take the following form;

$$Vol_t = \alpha + \beta_1 Vol_{t-1} + \beta_2 \ln(Amt)_t + \beta_3 \ln(OI)_t + \beta_4 |basis|_t + \beta_5 (1/remain)_t + \beta_6 DE_t + e_t \quad (1)$$

$$Vol_t = \alpha + \beta_1 Vol_{t-1} + \beta_2 \ln(Amt)_t + \beta_3 \ln(OI)_t + \beta_4 |basis|_t + \beta_5 (1/remain)_t + \beta_6 Ind\ DE_t + \beta_7 Ins\ DE_t + \beta_8 For\ DE_t + e_t \quad (2)$$

where Vol_t is the volatility variables on day t such as |ret|, ret^2, |high-low|, std(1min), std(5min), and std(10min). $\ln(Amt)_t$ is the log of trading value of futures, $\ln(OI)_t$ is the log of open interest, $|basis|_t$ is the absolute difference between futures and spot price, $(1/remain)_t$ is one over the remaining days before maturity, DE_t is the aggregate level of the disposition effect, and $Ind\ DE_t$, $Ins\ DE_t$, $For\ DE_t$ are the individual, institutional, foreigner's disposition effect measure on day t. Vol_{t-1} is added to control the volatility persistence (e.g., Lamoureux and Lastrapes (1990)), $\ln(Amt)_t$ is for the volatility-volume relationship (e.g., Karpoff (1987)), and $(1/remain)_t$ is for the Samuelson effect (e.g., Samuelson (1965)). In addition to those variables, we add $\ln(OI)_t$, a proxy for the dispersion of opinion, and $|basis|_t$, a proxy for the temporary price inequilibrium. Standard errors are adjusted for heteroscedasticity and autocorrelation according to the Newy-West method.

Table Ⅲ reports the results of time-series regression of the disposition effect on volatility using equation (1) in Panel A and equation (2) in Panel B. In Panel A, the disposition effect shows a positive coefficient after controlling other variables. In particular, there exist the volatility persistence and volatility-volume relationship in the Korean futures market. Whatever the dependent variable is, the sign of the independent variable is unchanged. The adjusted R^2 is over 0.4 except for |ret| and ret^2. For example, when we use |high-low|, the disposition effect coefficient shows a positive value and is statistically significant at the one percent level. In the case of std(1min), which shows the highest adjusted R^2, 0.730, the disposition effect coefficient is also positive and statistically significant at the ten percent level. The above evidence demonstrates that the increased disposition effect enlarges contemporaneous market volatility after controlling other factors, which is the first key finding of this paper.

Panel B of Table Ⅲ reports the results of estimating equation (2). As we expected, the sign of coefficients is the same as that of Panel A, but the disposition effect across the investor group shows a different pattern. The individual and institutional investor's disposition effect shows a positive coefficient, but the foreigner's disposition effect has a negative value. For instance, in the case of |high-low|, the institutional investor's disposition effect has a greater impact on current volatility than the individual investor's disposition effect, but the foreign investor's disposition effect has a negative impact on current volatility.

However, this approach has a potential caveat because there may be an endogeneity problem. To better understand the dynamic relationship between the disposition effect and market volatility, we turn to the other specifications and the VAR model in the following section.

4.2. Relationship between the Disposition Effect and Future Daily Price Volatility

Having investigated the contemporaneous relationship between the disposition effect and volatility, we ask whether the current disposition effect influences future volatility. We estimate the daily price volatility following Schwert (1990), Bessembinder and Seguin (1992, 1993), Jones, Kaul, and Lipson (1994), Chan and Fong (2000), and Avramov, Chordia, and Goyal (2006). The daily return on futures or spot price is first regressed on its own 12 lags and the day-of-the-week dummy variable using the following equation:

$$R_t = \sum_{k=1}^{5} \hat{\alpha}_k D_{kt} + \sum_{j=1}^{12} \hat{\beta}_j R_{t-j} + \hat{\varepsilon}_t \tag{3}$$

where R_t is the return of the nearest futures price or stock index on day t, D_{kt} are the day-of-the-week dummy variables. The absolute residual of the above model is the volatility measure and used in the following regressions:

$$|\hat{\varepsilon}_t| = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j |\hat{\varepsilon}_{t-j}| + \gamma_{Amt} Amt_t + \delta_{DE} DE_{t-1} + \eta_t \tag{4}$$

$$|\hat{\varepsilon}_t| = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j |\hat{\varepsilon}_{t-j}| + \gamma_{Amt} Amt_t + \delta_{Ind} Ind\,DE_{t-1} + \delta_{Ins} Ins\,DE_{t-1} + \delta_{For} For\,DE_{t-1} + \eta_t \tag{5}$$

where M_t is the Monday dummy, Amt_t is the trading volume (trading value), and DE_{t-1} is the disposition effect measure. The disposition measure is also calculated by individuals ($Ind\,DE_{t-1}$), institutions ($Ins\,DE_{t-1}$), and foreigners ($For\,DE_{t-1}$). The lagged values of $|\hat{\varepsilon}_t|$ are added to control the volatility persistence. Bessembinder and Seguin (1992, 1993) use a similar two-stage procedure to estimate volatility and examine the volatility-volume relation in the futures market. This specification enables us to examine the volatility-disposition relation after controlling the volatility-volume relation. Specifically, a positive δ_{DE} stands for the disposition effect on future market volatility since it suggests that an increase in the lagged disposition effect enlarges current market volatility. Standard errors are adjusted for heteroscedasticity and autocorrelation according to the Newy-West method. For the benefit of brevity, the coefficients for the Monday dummy and the 12 lags of absolute residual are not reported.

Panel A of Table Ⅳ reports the estimates of regressions of daily futures price volatility on the disposition effect measure. Daily price volatility for futures is estimated from the absolute residuals of equation (3) using the nearest KOSPI 200 futures price. We find that the coefficient δ_{DE} is 0.0174 (t-statistic=2.95) and statistically significant at the one percent level for equation (4) when the trading value is used as a control variable. Furthermore, the sign of δ_{DE} does not change when using the trading volume. This result supports the statement that the increased disposition effect has a positive impact on price volatility on the next day. Analyzing the disposition effect based on investor type, the individual coefficient, δ_{Ind}, is 0.0148 (t-statistic=2.06) and statistically significant at the five percent level for equation (5). Even though the sign of institutional and foreign investors is positive, the value is not statistically significant. From the above result, we can say that individual investors have a greater effect on the next day volatility than institutional and foreign investors.

Panel B of Table Ⅳ reports the estimates of regressions of daily spot price volatility on the disposition effect measure. Daily price volatility for spot is estimated from the absolute residuals of equation (3) using the KOSPI 200 Index. The spot market result is similar to the futures market. This result indicates that the disposition effect of the futures market, specifically the disposition effect of individual investors, also causes an impact on price volatility of the spot market.

4.3. VAR Analysis

We use the vector autoregression (VAR) and associated impulse response functions to study the interaction of volatility and the disposition effect. The form of the VAR model is as follows.

$$\begin{bmatrix} Vol_t \\ DE_t \end{bmatrix} = \begin{bmatrix} \alpha_{Vol} \\ \alpha_{DE} \end{bmatrix} + \sum_{k=1}^{5} A_k \begin{bmatrix} Vol_{t-k} \\ DE_{t-k} \end{bmatrix} + \sum_{l=0}^{2} B_l Amt_{t-l} + \begin{bmatrix} e_{Vol,t} \\ e_{DE,t} \end{bmatrix} \tag{6}$$

where Vol_t is a standard deviation of a one minute return of the nearest futures price or stock index and DE_t is the disposition effect measure on day t. Vol_t and DE_t both are endogenous variables. Amt_t is a demeaned log trading value on day t and plays a control (exogenous) variable. The regression coefficients, A_k and B_l , estimate the time series relationship between the endogenous and exogenous variables. We determine K = 5 and L = 2 based on the Schwartz Information Criterion (SIC).

To identify the relationship between the endogenous variables over time, we use impulse response functions. Impulse response functions trace the effect of one standard deviation shock in one residual to current and future values of the endogenous variables through the dynamic structure of the VAR. We also employ the Granger-causality test to evaluate the forecasting ability of one time series variable by another. Specifically, a process X Granger-causes another process Y if future values of Y can be better predicted using the past values of X and Y rather than only past values of Y. It is common that tests of Granger-causality are used both to investigate whether X fails to Granger-cause Y and vice versa. We test the null hypotheses such as the disposition effect doesn't Granger-cause volatility and volatility doesn't Granger-cause the disposition effect.

Table Ⅴ reports the results of the VAR of the disposition effect and volatility for the futures market. Rows are organized for each dependent variable and columns are for lagged dependent variable and exogenous variable coefficients. For each coefficient, we report the estimated value and t-statistic. Panel A shows that volatility is persistent, with a highly significant level in the first lagged coefficient, 0.5070 (t-statistic = 11.89), and declining on the higher lags. Yet there is no persistent property of the disposition effect. The first lagged coefficient of the disposition effect on volatility is 0.003 (t-statistic = 4.86) and statistically significant at the one percent level. Thus, the first lagged disposition effect contains information about future volatility, which implies that the increased disposition effect has a tendency to enlarge future volatility. However, we can’t find any evidence that current volatility has an impact on the future disposition effect. The positive and highly significant association between contemporaneous volatility and the lagged disposition effect is the second key empirical finding of this paper.

Panel B supports the previous study about the volatility-volume relationship. The contemporaneous relationship between volatility and trading value is positive, 0.0005 (t-statistic = 16.78), and statistically significant at the one percent level. Panel C reports Granger causality test results. The hypothesis that the disposition effect doesn’t cause volatility is rejected with a p-value of 0.0018, but the hypothesis that volatility doesn’t cause the disposition effect is not rejected. From this result, we infer that the disposition effect has information about future volatility in the futures market.

Table Ⅵ reports the results of the VAR of the disposition effect and volatility for the spot market. Volatility is a standard deviation of return using the one minute KOSPI 200 Index. Panel A shows that volatility is persistent, but the disposition effect is not. The first lagged coefficient of the disposition effect on volatility is 0.002 (t-statistic = 1.96), which is lower than the futures market in Table Ⅴ. This implies that there is also the disposition effect of the futures market on the future volatility for the spot market, but not vice versa. We also confirm the volatility-volume relationship in Panel B. In Panel C, all hypotheses are not rejected in the Granger causality test. In contrast to the futures market, the disposition effect of the futures market does not improve the forecasting performance of spot market volatility.

Panel A of Figure 4 shows the impulse-response function graphs of futures using the VAR estimation shown in Table Ⅴ. Impulse response functions use all the VAR coefficient estimates to trace the impact of one standard deviation shock. Using the estimated parameters and the dynamic structure of the VAR, we track how volatility responds over time to the disposition effect shock, and vice versa. The upper two figures represent the disposition effect response to the disposition effect and volatility shock and the lower two figures represent volatility response to the disposition effect and volatility shock, along with two standard-error confidence bands.

The upper left-hand side figure shows that the positive impact of the disposition effect shock to the disposition effect sharply decreases and is forced to zero. The upper right-hand side figure indicates that the volatility shock to the disposition effect is negligible and is not persistent, which supports the previous result. However, the volatility response to the disposition effect shows a different pattern. The lower left-hand side figure indicates a positive response in volatility to the disposition effect shock is persistent for longer days. We interpret this result as evidence that the disposition effect influences market volatility. The lower right-hand side figure verifies the serial dependence of volatility. The positive impact of a volatility shock sharply decreases for about 4 days and slowly decreases thereafter.

Panel B of Figure 4 shows the impulse-response function graphs of spot using the VAR estimation shown in Table Ⅵ. The upper two figures represent the disposition effect response to the disposition effect and volatility shock, which has a similar pattern as the futures market. In contrast to the futures market, the volatility response to the disposition effect is much lower than that of the futures market, in that the disposition effect in the futures market has a little or no impact on spot market volatility.

4.4. Robustness Check

To reinforce our empirical evidence about the volatility response to the disposition effect, we test diverse volatility measures to make sure that our results are not driven by the volatility measurement method used. We use the following regression with other volatility measures.

$$\sigma_t = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j \sigma_{t-j} + \gamma_{Amt} Amt_t + \delta_{DE} DE_{t-1} + \eta_t \quad (7)$$

$$\sigma_t = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j \sigma_{t-j} + \gamma_{Amt} Amt_t + \delta_{Ind} IndDE_{t-1} + \delta_{Ins} InsDE_{t-1} + \delta_{For} ForDE_{t-1} + \eta_t \quad (8)$$

where proxies for volatility variables (σ_t) are |ret|, ret^2, |high-low|, std(1min), std(5min), and std(10min). Futures return is calculated using the nearest KOSPI 200 futures price and spot return is calculated using the KOSPI 200 index.

Panel A of Table Ⅶ reports the estimates of regressions of other daily volatility measures in the futures market on the disposition effect measure. We find that the sign of the disposition effect is positive and statistically significant for all specifications. The result of an investor type is consistent with the previous result that the disposition effect of an individual investor has a positive effect on price volatility on the next day, but statistical significance is lower than that of the previous specification. In particular, the adjusted R^2 in the standard deviation of a one minute return is 0.779, which is higher than other volatility measures.

Panel B of Table Ⅶ reports the estimates of regressions of other daily volatility measures in the spot market on the disposition effect measure. We find that the disposition effect in the futures market has also an impact on spot market volatility except for some specification using intraday volatility measures. The result of an investor type analysis depends on the volatility measure. In particular, the disposition effect of individual and institutional investors is significant in some specifications. From the result of the spot market, we can say that the disposition effect in the futures market has a minor impact on spot market volatility, but the specific investor group effect is quite small.

Our VAR results are also robust to alternative volatility measures such as the volatility from equation (3) and a standard deviation of a five minute return. For the sake of brevity, we only report the results of the specification using equation (3).

Table Ⅷ reports the results of the VAR of the disposition effect and other volatility measures for the futures market in Panel A and the spot market in Panel B. Panel A shows that the first lagged disposition effect has a positive impact on future volatility, in that the first lagged coefficient of the disposition effect on volatility is 0.0146 (t-statistic = 2.39) and statistically significant at the five percent level. Volatility persistence is not clear because we calculate volatility using equation (3), which controls volatility persistence. We also confirm the volatility-volume relationship and that the disposition effect causes volatility. These findings support the disposition effect on volatility in the futures market. Panel B also shows the similar result as the previous result.

5. Impact of the Disposition Effect on Market Prices

To investigate the impact of the disposition effect on market prices, we examine the intraday returns around the extreme disposition effect using the conventional measure of the permanent effect (e.g., Choe, Kho, and Stulz(2005)). In the futures market, it is impossible to find information about future returns from the disposition effect because there are two types of the disposition effect such as the long and short disposition effect. Therefore, we analyze the difference (ΔDE) between the long disposition effect and the short disposition effect. The positive ΔDE means that the long disposition effect is greater than the short disposition effect. If the disposition effect has a permanent effect on market prices, the following returns after the positive ΔDE will decrease and the following returns after the negative ΔDE will increase.

Table Ⅸ reports the cumulative average return (CR) and t-statistics around the highest and lowest decile of ΔDE for 365 one minute intervals (09:00-15:05) a day. Panel A is the result of the futures market using the nearest KOSPI 200 futures price and Panel B is that of the spot market using the KOSPI 200 Index. ΔDE is the difference between the disposition effect measure in the long position and the disposition effect measure in the short position. After ΔDE is sorted by an ascending order on a given day, a low is the first decile of ΔDE, a benchmark is the fifth and sixth decile of ΔDE, and a high is the tenth decile of ΔDE. The cumulative return is calculated from -10 to 10 minutes around the event for one minute intervals and time series averaged.

When futures price increases, long position holder experiences profits. If the aggregate agent has the disposition bias, he has a tendency to realize a paper gain. Thus, the long disposition effect goes up after prices increase and the short disposition effect goes up after prices decrease. Panel A shows that a low ΔDE follows a sequence of negative returns and a high ΔDE follows a sequence of positive returns. The cumulative return of a low ΔDE from the -10 to -1 minute interval is -0.061% (t-statistic = -34.99) and that of a high ΔDE is 0.061% (t-statistic = 36.39), but that of a benchmark is -0.001% (t-statistic = -1.30). This result is evidence of the disposition effect. However, contemporaneous ΔDE and return have a negative relationship. A low ΔDE has a positive return of 0.039% (t-statistic = 86.03) at time 0 and a high ΔDE has a negative return of -0.038% (t-statistic = -82.24) at time 0. As we expected, a high ΔDE has a tendency to decrease the current futures return and a low ΔDE has a tendency to increase the current futures return. Whether this impact on futures price is temporary or permanent is important. If the effect results from temporary trade imbalance, we expect the excess price increase (or decrease) to disappear within a few minutes. To measure the permanent effect, we calculate the cumulative return from the 0 to +5 minute interval, CR(0, +5), and from the 0 to +10 minute interval, CR(0, +10). If the trade imbalance resolves as new information flows, the cumulative return from the +1 to +5 minute interval, CR(+1, +5), and from the +1 to +10 minute interval, CR(+1, +10), is the temporary effect. Hereafter, we describe the results based on the return to the +10 minute interval. The permanent effect of a low ΔDE is 0.024% (t-statistic = 13.76), but the temporary effect is -0.015% (t-statistic = -9.26). The effect of a high ΔDE is the same magnitude with an opposite sign. This result supports the hypothesis that the disposition effect has a permanent effect on the futures price over a short-term period in that the greater disposition effect in a long position decreases the futures price and the greater disposition effect in a short position increases the futures price. This result is the third key empirical finding of this paper.

Panel B reports the permanent and temporary effect of the disposition effect on the spot market. In contrast to the futures market, the permanent effect on the spot market of a low ΔDE is -0.002% (t-statistic = -1.11) and that of a high ΔDE is -0.000% (t-statistic = -0.09), which show insignificant values. But, there exists the temporary effect of the disposition bias on the spot market. Even though the futures market and spot market are closely linked, the disposition effect in the futures market has no permanent impact on the spot market prices.

Table Ⅹ reports the cumulative average return and t-statistics for each investor type around the highest and lowest decile of ΔDE for 365 one minute intervals (09:00-15:05) a day. Panel A presents that the cumulative return of a low ΔDE from the -10 to -1 minute interval for individual, institutional, and foreign investors are -0.073% (t-statistic = -40.89), -0.024% (t-statistic = -8.08), and 0.014% (t-statistic = 3.59), respectively. This result implies that individual and institutional investors, especially individual investors, have a tendency to sell when the position shows a paper gain, but foreign investors don't. The cumulative return of a high ΔDE shows a similar pattern with an opposite sign. Yet contemporaneous ΔDE and return have a negative relationship for all investors, which means that the ΔDE of an investor type also has an impact on prices. The permanent effect of a low ΔDE for individual, institutional, and foreign investors are 0.025% (t-statistic = 14.18), 0.027% (t-statistic = 9.55), and 0.024% (t-statistic = 6.50), respectively. The effect of a high ΔDE shows a similar magnitude with an opposite sign. Even though the disposition bias is quite diverse across investor types, the permanent effect of the disposition is quite similar across investor types. Panel B reports the result of the disposition effect on the spot market prices. In particular, institutional and foreign investors have a permanent effect on the spot price. For example, the permanent effect of a low ΔDE for individual, institutional, and foreign investors are -0.003% (t-statistic = -1.82), 0.013% (t-statistic = 4.72), and 0.020% (t-statistic = 5.55), respectively.

Figure 5 depicts the cumulative average return of futures and spot around the highest and lowest decile of ΔDE for 365 one minute intervals (09:00-15:05) a day. Panel A shows the result of a high ΔDE and Panel B shows that of a low ΔDE. The futures return increases -5 minutes before the high ΔDE event, but the futures return sharply decreases at time 0. This result implies that a greater disposition effect in the long position has the tendency to decrease futures prices. However, futures prices overshoot at time 0 and recover to the stable level after the +1 minute interval. The spot price behavior is quite interesting. Even though the disposition effect of the futures market does not affect the spot market directly, there exists an indirect relationship between the disposition effect of futures and spot price through the futures market. The spot return also increases -5 minutes before the high ΔDE event until time +1 minute. The futures market drop from the disposition effect leads to a decrease in spot prices in the following minute. Panel B also shows a similar pattern with an opposition sign.

6. Conclusion

This paper examines the price impact of the disposition effect. Using a comprehensive data covering over 60,000 investors in the Korean futures market, we present empirical evidence that the behavior of irrational traders affect asset prices. From the perspective of volatility, we find that a higher disposition effect bias causes higher current and future market volatility. These results hold after controlling trading volume, volatility persistence, potential endogeneity bias, and are robust to various volatility measures. These results are consistent with Hellwig (1980) and Wang (1993, 1994) in that uninformed traders generally increase volatility. We also find that the increased disposition effect in the long (short) position has a tendency to decrease (increase) asset prices over a short term period. Although it is still an open issue how irrational traders affect financial markets, our finding justifies the opinion that the disposition effect has an impact on financial markets and is consistent with Kogan el. al. (2006). We expect our study to suggest further theoretical development and empirical research on behavioral biases.

Appendix. Calculating Trading Profit and Holding Time

We follow the Locke and Mann (2005) methodology to calculate trading profit and holding time using high frequency transaction data. *Trade* is categorized into buy or sell. More specifically, open buy, open sell, close buy, close sell, netting open buy, netting open sell, netting close buy, netting close sell, position out buy, and position out sell are the types of trade. *Position* is categorized into long and short positions. *Trade price* is the transaction price and *end price* is the price of each minute. *Average cost* is the volume weighted buy (or sell) price. *Holding time* is the volume weighted holding time of the position. *Realized profit* is calculated when the trade reduces positions or buy and sell (or sell and buy) happen in a minute. It is categorized into realized gain, realized zero, and realized loss. *Unrealized profit* is calculated based on the average cost and end price. It is also categorized into paper gain, paper zero, and paper loss. We calculate holding time and profit every minute for all traders (69,391 traders) in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. Table A.1 presents an example of the methodology calculating profit and holding time.

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Table Ⅰ
Time Series Distribution

This table reports the minimum, 25th percentile, median, mean, 75th percentile, maximum, and standard deviation of the following variables over 556 trading days. Proxy for volatility variables are |*ret*|, ret^2, |*high-low*|, *std(1min)*, *std(5min)*, and *std(10min)*. Return is calculated using the nearest KOSPI 200 futures price. |*ret*| is the absolute return, ret^2 is the squared return, |*high-low*| is the absolute difference between the high and low price during a day, *std(1min)* is a standard deviation of a one minute return, and so on. *ln(amt)* is the log of trading value of futures, *ln(OI)* is the log of open interest, |*basis*| is the absolute difference between futures and spot price, and *1/remain* is one over the remaining days before maturity. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. *Individual DE, Institutional DE, and Foreigner DE* are calculated treating each category investor as one representative agent. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005.

	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
|*ret*|	0.0128	0.0113	0.0000	0.0042	0.0094	0.0177	0.0670
ret^2	0.0003	0.0005	0.0000	0.0000	0.0001	0.0003	0.0045
|*high-low*|	1.9811	0.9049	0.6000	1.4000	1.8000	2.3000	8.6500
std(1min)	0.0007	0.0002	0.0003	0.0005	0.0006	0.0008	0.0017
std(5min)	0.0014	0.0005	0.0006	0.0010	0.0013	0.0016	0.0043
std(10min)	0.0019	0.0008	0.0006	0.0014	0.0017	0.0022	0.0075
ln(amt)	23.1106	0.2139	22.4076	22.9625	23.1028	23.2575	23.7508
ln(OI)	11.3899	0.1372	10.5105	11.3442	11.4183	11.4754	11.5880
|*basis*|	0.4302	0.4028	0.0000	0.1600	0.3300	0.5800	2.6700
1/remain	0.0640	0.1439	0.0110	0.0149	0.0222	0.0455	1.0000
DE	0.0882	0.0793	-0.1844	0.0362	0.0858	0.1401	0.3005
Indvidual DE	0.0968	0.0986	-0.2582	0.0373	0.0922	0.1606	0.3619
Institutional DE	0.0214	0.0831	-0.1872	-0.0375	0.0211	0.0807	0.2372
Foreigner DE	0.0394	0.0735	-0.1670	-0.0125	0.0395	0.0907	0.2382

Table Ⅱ

Correlation of Daily Disposition Effect Measure

This table reports the Pearson correlation estimates of the following variables over 556 trading days. Proxy for volatility variables are *|ret|*, *ret*^{2}, *|high-low|*, *std(1min)*, *std(5min)*, and *std(10min)*. Return is calculated using the nearest KOSPI 200 futures price. *|ret|* is the absolute return, *ret*^{2} is the squared return, *|high-low|* is the absolute difference between the high and low price during a day, *std(1min)* is a standard deviation of a one minute return, and so on. *ln(amt)* is the log of trading value of futures, *ln(OI)* is the log of open interest, *|basis|* is the absolute difference between futures and spot price, and *1/remain* is one over the remaining days before maturity. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. *Individual DE, Institutional DE, and Foreigner DE* are calculated treating each category investor as one representative agent. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold.

	|ret|	*ret*^{2}	*|high-low|*	*std(1min)*	*std(5min)*	*std(10min)*	*ln(amt)*	*ln(OI)*	*|basis|*	*1/remain*	*DE*	*Ind DE*	*Ins DE*	*For DE*
|ret|														
ret^2	**0.924**													
|high-low|	**0.530**	**0.543**												
std(1min)	**0.305**	**0.333**	**0.617**											
std(5min)	**0.289**	**0.336**	**0.659**	**0.959**										
std(10min)	**0.271**	**0.331**	**0.665**	**0.920**	**0.962**									
ln(amt)	**0.151**	**0.167**	**0.626**	**0.536**	**0.571**	**0.581**								
ln(OI)	0.048	0.047	**0.091**	-0.031	-0.055	-0.045	**0.180**							
|basis|	0.038	0.060	**0.088**	0.033	0.056	0.055	-0.043	**-0.106**						
1/remain	-0.066	-0.063	-0.029	-0.048	-0.036	-0.031	-0.026	**-0.645**	-0.026					
DE	**0.163**	**0.156**	**0.136**	0.009	0.032	0.035	-0.038	-0.007	0.040	0.039				
Individual DE	**0.151**	**0.149**	**0.141**	0.004	0.030	0.035	-0.010	0.002	0.026	0.045	**0.975**			
Institutional DE	**0.184**	**0.142**	**0.195**	**0.114**	**0.103**	**0.091**	-0.030	-0.064	0.040	-0.002	**0.255**	0.075		
Foreigner DE	**-0.154**	**-0.134**	**-0.200**	-0.034	-0.025	-0.036	**-0.118**	-0.038	0.042	-0.072	-0.056	-0.070	**-0.121**	

Table Ⅲ
Impact of the Disposition Effect on Current Volatility

This table reports the results of time-series regressions of the disposition effect on volatility. Regressions take the following form;

Model 1: $$Vol_t = \alpha + \beta_1 Vol_{t-1} + \beta_2 \ln(Amt)_t + \beta_3 \ln(OI)_t + \beta_4 |basis|_t + \beta_5 (1/remain)_t + \beta_6 DE_t + e_t$$

Model 2: $$Vol_t = \alpha + \beta_1 Vol_{t-1} + \beta_2 \ln(Amt)_t + \beta_3 \ln(OI)_t + \beta_4 |basis|_t + \beta_5 (1/remain)_t + \beta_6 Ind\ DE_t + \beta_7 Ins\ DE_t + \beta_8 For\ DE_t + e_t$$

where Vol_t is the volatility variables on day t such as |*ret*|, *ret*^{2}, |*high-low*|, *std(1min)*, *std(5min)*, and *std(10min)*. $\ln(Amt)_t$ is the log of trading value of futures, $\ln(OI)_t$ is the log of open interest, $|basis|_t$ is the absolute difference between futures and spot price, $(1/remain)_t$ is one over the remaining days before maturity, DE_t is the aggregate level of the disposition effect, and $Ind\ DE_t$, $Ins\ DE_t$, $For\ DE_t$ are the individual, institutional, foreigner's disposition effect measure on day t. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold. Standard errors are adjusted for heteroscedasticity and autocorrelation according to the Newy-West method.

Panel A. Model 1

Dependent variable	|*ret*|	*ret*^{2}	|*high-low*|	*std(1min)*	*std(5min)*	*std(10min)*
Intercept	**-0.1796**	**-0.0097**	**-55.4154**	**-0.0055**	**-0.0159**	**-0.0255**
	(-2.08)	(-2.19)	(-9.22)	(-7.42)	(-7.59)	(-7.10)
Vol_{t-1}	-0.0120	0.0152	0.0971	**0.6799**	**0.5511**	**0.4532**
	(-0.19)	(0.22)	(1.25)	(21.12)	(14.43)	(11.22)
$\ln(Amt)_t$	**0.0091**	**0.0005**	**2.5636**	**0.0004**	**0.0011**	**0.0017**
	(3.26)	(3.00)	(11.04)	(9.06)	(9.47)	(8.75)
$\ln(OI)_t$	-0.0018	-0.0001	-0.2013	**-0.0002**	**-0.0007**	**-0.0011**
	(-0.43)	(-0.43)	(-0.79)	(-3.90)	(-3.48)	(-3.33)
$\|basis\|_t$	0.0010	0.0001	**0.2268**	0.0000	0.0001	0.0001
	(0.75)	(1.17)	(3.13)	(1.12)	(1.61)	(1.56)
$(1/remain)_t$	-0.0063	-0.0003	-0.2080	-0.0001	-0.0003	-0.0005
	(-1.66)	(-1.86)	(-0.71)	(-1.30)	(-1.45)	(-1.58)
DE_t	**0.0234**	**0.0011**	**1.8531**	0.0002	**0.0006**	0.0008
	(3.36)	(2.99)	(3.55)	(1.90)	(2.51)	(1.91)
adj R^2	0.049	0.056	0.434	0.730	0.643	0.564
Observations	556	556	556	556	556	556

Panel B. Model 2						
Dependent variable	*|ret|*	ret^2	*|high-low|*	*std(1min)*	*std(5min)*	*std(10min)*
Intercept	-0.1631	-0.0088	**-53.9253**	**-0.0053**	**-0.0159**	**-0.0256**
	(-1.88)	(-1.95)	(-9.82)	(-7.25)	(-7.86)	(-7.26)
Vol_{t-1}	0.0027	0.0262	0.1187	**0.6836**	**0.5504**	**0.4515**
	(0.04)	(0.38)	(1.55)	(20.11)	(13.78)	(10.88)
$\ln(Amt)_t$	**0.0082**	**0.0004**	**2.4690**	**0.0004**	**0.0010**	**0.0017**
	(2.94)	(2.72)	(11.59)	(8.98)	(9.47)	(8.80)
$\ln(OI)_t$	-0.0013	-0.0001	-0.1388	**-0.0002**	**-0.0007**	**-0.0011**
	(-0.31)	(-0.36)	(-0.63)	(-4.09)	(-3.52)	(-3.34)
$\|basis\|_t$	0.0011	0.0001	**0.2253**	0.0000	0.0001	0.0001
	(0.86)	(1.29)	(3.19)	(1.17)	(1.62)	(1.56)
$(1/remain)_t$	-0.0065	-0.0003	-0.2142	-0.0001	-0.0003	-0.0005
	(-1.70)	(-1.92)	(-0.78)	(-1.44)	(-1.47)	(-1.59)
$Individual\ DE_t$	**0.0149**	**0.0007**	**1.2101**	0.0001	**0.0005**	0.0006
	(2.63)	(2.54)	(2.90)	(1.86)	(2.32)	(1.77)
$Institutional\ DE_t$	**0.0206**	**0.0007**	**2.0947**	0.0001	0.0003	0.0004
	(3.30)	(2.61)	(6.24)	(0.86)	(1.43)	(1.52)
$Foreigner\ DE_t$	**-0.0190**	**-0.0008**	**-1.3988**	**-0.0001**	0.0000	-0.0001
	(-2.93)	(-2.58)	(-3.77)	(-2.06)	(-0.31)	(-0.31)
$adj\ R^2$	0.084	0.076	0.483	0.732	0.644	0.564
Observations	556	556	556	556	556	556

Table Ⅳ
Impact of the Disposition Effect on Future Volatility

This table reports the estimates of regressions of daily futures and spot price volatility on the disposition effect measure. Daily price volatility for futures or spot is estimated from the absolute residuals of the following equation:

$$R_t = \sum_{k=1}^{5} \hat{\alpha}_k D_{kt} + \sum_{j=1}^{12} \hat{\beta}_j R_{t-j} + \hat{\varepsilon}_t$$

where R_t is the return of futures or spot on day t, D_{kt} are the day-of-the-week dummy variables. The 12 lagged returns are used to control any serial dependence in daily returns. The absolute residual from this regression is used in the following regressions:

$$\left|\hat{\varepsilon}_t\right| = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j \left|\hat{\varepsilon}_{t-j}\right| + \gamma_{Amt} Amt_t + \delta_{DE} DE_{t-1} + \eta_t$$

$$\left|\hat{\varepsilon}_t\right| = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j \left|\hat{\varepsilon}_{t-j}\right| + \gamma_{Amt} Amt_t + \delta_{Ind} Ind\, DE_{t-1} + \delta_{Ins} Ins\, DE_{t-1} + \delta_{For} For\, DE_{t-1} + \eta_t$$

where M_t is the Monday dummy, Amt_t is the trading volume (trading value), and DE_{t-1} is the disposition effect measure, the difference of one representative agent's PGR and PLR on day t-1. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. Futures return is calculated using the nearest KOSPI 200 futures price and spot return is calculated using the KOSPI 200 Index. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. The t-statistics are in parenthesis and 5% statistical significance is indicated in bold. Standard errors are adjusted for heteroscedasticity and autocorrelation according to the Newy-West method. The coefficient for the Monday dummy and the 12 lags of absolute residual are not reported.

Panel A. Futures

	Value	*Volume*	*DE*	*Ind DE*	*Ins DE*	*For DE*	*adj* R^2
Model 1	**0.0063**		**0.0174**				0.138
	(2.44)		(2.95)				
Model 2	**0.0064**			0.0132			0.130
	(2.38)			(1.85)			
Model 3	**0.0063**				0.0039		0.125
	(2.40)				(0.98)		
Model 4	**0.0064**					0.0173	0.128
	(2.42)					(1.64)	
Model 5	**0.0068**			0.0134	0.0037	0.0167	0.132
	(2.49)			(1.87)	(0.91)	(1.57)	
Model 6		**0.0103**	**0.0168**				0.157
		(4.77)	(2.95)				
Model 7		**0.0108**		**0.0147**			0.151
		(4.60)		(2.05)			
Model 8		**0.0104**			0.0031		0.145
		(4.57)			(0.80)		
Model 9		**0.0104**				0.0155	0.148
		(4.54)				(1.51)	
Model 10		**0.0108**		**0.0148**	0.0029	0.0150	0.152
		(4.55)		(2.06)	(0.73)	(1.44)	

Panel B. Spot							
	Value	*Volume*	*DE*	*Ind DE*	*Ins DE*	*For DE*	*adj* R^2
Model 1	**0.0075**		**0.0174**				0.147
	(4.05)		(2.93)				
Model 2	**0.0078**			**0.0175**			0.142
	(4.07)			(2.40)			
Model 3	**0.0076**				0.0059		0.133
	(4.13)				(1.50)		
Model 4	**0.0074**					0.0088	0.131
	(3.96)					(0.93)	
Model 5	**0.0081**			**0.0179**	0.0062	0.0075	0.144
	(4.30)			(2.44)	(1.59)	(0.80)	
Model 6		**0.0040**	**0.0170**				0.123
		(3.22)	(2.76)				
Model 7		**0.0041**		**0.0160**			0.117
		(3.34)		(2.19)			
Model 8		**0.0039**			0.0031		0.107
		(3.06)			(0.81)		
Model 9		**0.0038**				0.0049	0.106
		(3.07)				(0.41)	
Model 10		**0.0041**		**0.0161**	0.0033	0.0038	0.115
		(3.32)		(2.20)	(0.87)	(0.40)	

Table Ⅴ
VAR Estimation for Futures

This table reports coefficient and t-statistic from the VAR of futures market volatility (*Vol*) and the disposition effect measure (*DE*) and Granger causality test results. The form of the VAR model is as follows.

$$\begin{bmatrix} Vol_t \\ DE_t \end{bmatrix} = \begin{bmatrix} \alpha_{Vol} \\ \alpha_{DE} \end{bmatrix} + \sum_{k=1}^{5} A_k \begin{bmatrix} Vol_{t-k} \\ DE_{t-k} \end{bmatrix} + \sum_{l=0}^{2} B_l Amt_{t-l} + \begin{bmatrix} e_{Vol,t} \\ e_{DE,t} \end{bmatrix}$$

Volatility is a standard deviation of a one minute return of the nearest KOSPI 200 futures price during a day. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. The exogenous variable, a demeaned log trading amount (*Amt*), also included. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold.

Panel A. Endogenous variables						
		Vol(t-1)	*Vol(t-2)*	*Vol(t-3)*	*Vol(t-4)*	*Vol(t-5)*
Vol(t)	Coefficient	**0.5070**	**0.1682**	-0.0150	**0.0993**	**0.1172**
	t-statistic	(11.89)	(3.57)	(-0.38)	(2.59)	(3.38)
DE(t)	Coefficient	1.87	12.01	-22.82	40.74	-32.07
	t-statistic	(0.06)	(0.32)	(-0.73)	(1.34)	(-1.17)
		DE(t-1)	*DE(t-2)*	*DE(t-3)*	*DE(t-4)*	*DE(t-5)*
Vol(t)	Coefficient	**0.0003**	0.0000	0.0000	0.0001	0.0001
	t-statistic	(4.86)	(-0.79)	(0.18)	(1.42)	(1.03)
DE(t)	Coefficient	0.0202	-0.0253	-0.0463	-0.0125	0.0625
	t-statistic	(0.46)	(-0.57)	(-1.04)	(-0.28)	(1.43)
Panel B. Exogenous variables						
		Constant	*Amt(t)*	*Amt(t-1)*	*Amt(t-2)*	
Vol(t)	Coefficient	**0.0001**	**0.0005**	**-0.0001**	**-0.0001**	
	t-statistic	(2.45)	(16.78)	(-3.92)	(-4.23)	
DE(t)	Coefficient	**0.0883**	0.0190	-0.0241	-0.0289	
	t-statistic	(5.62)	(0.88)	(-0.87)	(-1.11)	
Panel C. Granger causality test						
					Chi-Square	Pr > ChiSq
H0:	DE doesn't cause Volatility				**19.15**	0.0018
H0:	Volatility doesn't cause DE				3.33	0.6491

Table Ⅵ
VAR Estimation for Spot

This table reports coefficient and t-statistic from the VAR of spot market volatility (*Vol*) and the disposition effect measure *(DE)* and Granger causality test results. The form of the VAR model is as follows.

$$\begin{bmatrix} Vol_t \\ DE_t \end{bmatrix} = \begin{bmatrix} \alpha_{Vol} \\ \alpha_{DE} \end{bmatrix} + \sum_{k=1}^{5} A_k \begin{bmatrix} Vol_{t-k} \\ DE_{t-k} \end{bmatrix} + \sum_{l=0}^{2} B_l\, Amt_{t-l} + \begin{bmatrix} e_{Vol,t} \\ e_{DE,t} \end{bmatrix}$$

Volatility means a standard deviation of a one minute return of the KOSPI 200 index during a day. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. The exogenous variable, a demeaned log trading amount (*Amt*), also included. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold.

Panel A. Endogeneous variables						
		Vol(t-1)	*Vol(t-2)*	*Vol(t-3)*	*Vol(t-4)*	*Vol(t-5)*
Vol(t)	Coefficient	**0.1706**	**0.1860**	**0.1565**	**0.1526**	**0.1531**
	t-statistic	(3.93)	(4.35)	(3.78)	(3.73)	(3.72)
DE(t)	Coefficient	-3.1974	-11.9388	-12.0519	7.4908	3.0809
	t-statistic	(-0.20)	(-0.74)	(-0.78)	(0.49)	(0.20)
		DE(t-1)	*DE(t-2)*	*DE(t-3)*	*DE(t-4)*	*DE(t-5)*
Vol(t)	Coefficient	**0.0002**	0.0000	0.0002	0.0000	0.0000
	t-statistic	(1.96)	(-0.11)	(1.30)	(0.36)	(0.15)
DE(t)	Coefficient	0.0216	-0.0113	-0.0360	-0.0041	0.0603
	t-statistic	(0.50)	(-0.26)	(-0.84)	(-0.09)	(1.40)
Panel B. Exogeneous variables						
		Constant	*Amt(t)*	*Amt(t-1)*	*Amt(t-2)*	
Vol(t)	Coefficient	**0.0001**	**0.0003**	**-0.0002**	0.0000	
	t-statistic	(2.06)	(6.51)	(-4.13)	(-0.18)	
DE(t)	Coefficient	**0.0970**	**0.0469**	-0.0226	-0.0329	
	t-statistic	(6.00)	(2.72)	(-1.09)	(-1.84)	
Panel C. Granger causality test						
					Chi-Square	Pr > ChiSq
H0:	DE doesn't cause Volatility				3.24	0.6630
H0:	Volatility doesn't cause DE				3.02	0.6932

Table Ⅶ
Impact of the Disposition Effect on Other Volatilities

This table reports the estimates of regressions of daily futures and spot price volatility on the disposition effect measure. Proxies for volatility variables are |*ret*|, *ret*^{2}, |*high-low*|, *std(1min)*, *std(5min)*, and *std(10min)*. Return is calculated using the nearest KOSPI 200 futures price or KOSPI 200 Index. |*ret*| is the absolute return, *ret*^{2} is the squared return, |*high-low*| is the absolute difference between high and low price during a day, *std(1min)* is a standard deviation of a one minute return, and so on. The proxies for volatility, σ_t, are used in the following regressions:

$$\sigma_t = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j \sigma_{t-j} + \gamma_{Amt} Amt_t + \delta_{DE} DE_{t-1} + \eta_t$$

$$\sigma_t = \phi_0 + \phi_M M_t + \sum_{j=1}^{12} \phi_j \sigma_{t-j} + \gamma_{Amt} Amt_t + \delta_{Ind} Ind\, DE_{t-1} + \delta_{Ins} Ins\, DE_{t-1} + \delta_{For} For\, DE_{t-1} + \eta_t$$

where M_t is the Monday dummy, V_t is the trading volume (trading value), and DE_{t-1} is the disposition effect measure, the difference of one representative agent's PGR and PLR on day t-1. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. The t-statistics are in parenthesis and 5% statistical significance is indicated in bold. Standard errors are adjusted for heteroscedasticity and autocorrelation according to the Newy-West method. The coefficient for the Monday dummy and the 12 lags of absolute residual are not reported.

Panel A. Futures

	Amt	*DE*	*Ind DE*	*Ins DE*	*For DE*	*adj R*^{2}
std(1min)	**0.0003**	**0.0003**				0.779
	(9.50)	(3.61)				
	0.0003		0.0000	0.0001	0.000	0.768
	(9.37)		(-0.60)	(1.55)	(1.53)	
std(5min)	**0.0009**	**0.0007**				0.703
	(9.82)	(3.10)				
	0.0009		-0.0001	0.0002	0.000	0.693
	(9.68)		(-0.44)	(1.81)	(1.00)	
std(10min)	**0.0014**	**0.0008**				0.636
	(8.49)	(3.06)				
	0.0014		-0.0002	0.0003	0.001	0.630
	(8.43)		(-0.68)	(1.81)	(1.87)	
|*ret*|	0.0049	**0.0142**				0.151
	(1.89)	(2.55)				
	0.0054		0.0127	0.0057	0.012	0.148
	(2.01)		(1.90)	(1.42)	(1.12)	
ret^2	**0.0003**	**0.0006**				0.142
	(2.02)	(2.14)				
	0.0003		**0.0007**	0.0003	0.001	0.146
	(2.10)		(2.42)	(1.80)	(1.58)	
|*high-low*|	**2.2071**	**1.7886**				0.476
	(8.85)	(4.43)				
	2.2534		**0.9573**	**0.7076**	0.619	0.463
	(8.59)		(2.05)	(2.37)	(1.00)	

Panel B. Spot						
	Amt	*DE*	*Ind DE*	*Ins DE*	*For DE*	*adj* R^2
std(1min)	**0.0002**	0.0002				0.350
	(4.98)	(1.20)				
	0.000		0.000	**0.000**	0.000	0.356
	(5.39)		(0.15)	(2.98)	(-0.28)	
std(5min)	**0.0004**	0.0007				0.372
	(4.67)	(1.55)				
	0.000		0.000	**0.001**	0.000	0.371
	(5.07)		(0.11)	(2.10)	(-0.40)	
std(10min)	**0.0006**	0.0007				0.324
	(4.32)	(0.93)				
	0.001		0.000	**0.001**	0.000	0.330
	(4.73)		(0.33)	(2.38)	(-0.54)	
|*ret*|	**0.0071**	**0.0127**				0.142
	(3.96)	(2.33)				
	0.008		**0.016**	**0.008**	0.007	0.147
	(4.38)		(2.36)	(1.99)	(0.68)	
ret^2	**0.0003**	**0.0006**				0.174
	(3.99)	(2.26)				
	0.000		**0.001**	**0.000**	0.001	0.181
	(4.32)		(2.91)	(2.13)	(1.37)	
|*high-low*|	**0.6009**	**1.6943**				0.282
	(4.87)	(3.66)				
	0.626		0.492	0.476	0.097	0.258
	(5.04)		(0.95)	(1.62)	(0.16)	

Table Ⅷ
VAR Estimation for Other Volatilities

This table reports coefficient and t-statistic from the VAR of volatility (*Vol*) and disposition effect measure (*DE*) and Granger causality test results. The form of the VAR model is as follows.

$$\begin{bmatrix} Vol_t \\ DE_t \end{bmatrix} = \begin{bmatrix} \alpha_{Vol} \\ \alpha_{DE} \end{bmatrix} + \sum_{k=1}^{5} A_k \begin{bmatrix} Vol_{t-k} \\ DE_{t-k} \end{bmatrix} + \sum_{l=0}^{2} B_l Amt_{t-l} + \begin{bmatrix} e_{Vol,t} \\ e_{DE,t} \end{bmatrix}$$

The absolute residual of the following model is used proxy for volatility.

$$R_t = \sum_{k=1}^{5} \hat{\alpha}_k D_{kt} + \sum_{j=1}^{12} \hat{\beta}_j R_{t-j} + \hat{\varepsilon}_t$$

DE is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. The exogenous variable, demeaned log trading amount (*Amt*), also included. Futures return is calculated using the nearest KOSPI 200 futures price and spot return is calculated using the KOSPI 200 Index. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold.

Panel A. Futures						
Endogeneous variables						
		Vol(t-1)	*Vol(t-2)*	*Vol(t-3)*	*Vol(t-4)*	*Vol(t-5)*
Vol(t)	Coefficient	-0.0714	**0.1231**	0.0675	**0.1320**	**0.1300**
	t-statistic	(-1.61)	(2.80)	(1.51)	(2.97)	(2.92)
DE(t)	Coefficient	-0.4053	**-0.6400**	-0.0478	0.0770	0.3722
	t-statistic	(-1.25)	(-1.99)	(-0.15)	(0.24)	(1.14)
		DE(t-1)	*DE(t-2)*	*DE(t-3)*	*DE(t-4)*	*DE(t-5)*
Vol(t)	Coefficient	**0.0146**	0.0001	-0.0042	-0.0086	0.0072
	t-statistic	(2.39)	(0.01)	(-0.68)	(-1.41)	(1.17)
DE(t)	Coefficient	0.0277	-0.0014	-0.0303	-0.0079	0.0541
	t-statistic	(0.62)	(-0.03)	(-0.67)	(-0.18)	(1.21)
Exogeneous variables						
		Constant	*Amt(t)*	*Amt(t-1)*	*Amt(t-2)*	
Vol(t)	Coefficient	**0.0068**	**0.0084**	-0.0031	-0.0005	
	t-statistic	(4.28)	(2.79)	(-0.99)	(-0.18)	
DE(t)	Coefficient	**0.0928**	0.0225	-0.0249	-0.0230	
	t-statistic	(8.04)	(1.03)	(-1.09)	(-1.06)	
Granger causality test						
					Chi-Square	Pr > ChiSq
H0:	DE doesn't cause Volatility				**9.36**	0.0956
H0:	Volatility doesn't cause DE				7.12	0.2118

Panel B. Spot						
Endogeneous variables						
		Vol(t-1)	*Vol(t-2)*	*Vol(t-3)*	*Vol(t-4)*	*Vol(t-5)*
Vol(t)	Coefficient	-0.0428	**0.1472**	**0.0883**	**0.1617**	**0.1344**
	t-statistic	(-0.98)	(3.46)	(2.09)	(3.84)	(3.16)
DE(t)	Coefficient	**-0.7465**	-0.6060	-0.1754	0.0303	0.4052
	t-statistic	(-2.04)	(-1.71)	(-0.50)	(0.09)	(1.14)
		DE(t-1)	*DE(t-2)*	*DE(t-3)*	*DE(t-4)*	*DE(t-5)*
Vol(t)	Coefficient	**0.0173**	0.0023	-0.0002	-0.0091	0.0087
	t-statistic	(3.28)	(0.43)	(-0.04)	(-1.73)	(1.65)
DE(t)	Coefficient	0.0310	0.0043	-0.0216	0.0059	0.0447
	t-statistic	(0.70)	(0.10)	(-0.49)	(0.13)	(1.02)
Exogeneous variables						
		Constant	*Amt(t)*	*Amt(t-1)*	*Amt(t-2)*	
Vol(t)	Coefficient	**0.0042**	**0.0130**	**-0.0085**	-0.0021	
	t-statistic	(2.94)	(6.28)	(-3.45)	(-0.97)	
DE(t)	Coefficient	**0.0957**	**0.0433**	-0.0144	**-0.0386**	
	t-statistic	(7.98)	(2.49)	(-0.70)	(-2.16)	
Granger causality test						
					Chi-Square	Pr > ChiSq
H0:	DE doesn't cause Volatility				**16.27**	0.0061
H0:	Volatility doesn't cause DE				10.15	0.0710

Table Ⅸ

Cumulative Return around the Highest (Lowest) Decile of the Difference between the Long Disposition Effect and Short Disposition Effect

This table reports the cumulative average return (%) and t-statistics around the highest and lowest decile of ΔDE for 365 one minute intervals (09:00-15:05) a day. Panel A is the result of the futures market using the nearest KOSPI 200 futures price and Panel B is the result of the spot market using the KOSPI 200 Index. ΔDE is the difference between the long disposition effect measure and short disposition effect measure. After ΔDE is sorted by an ascending order on a given day, a low is the first decile of ΔDE, a benchmark is the fifth and sixth decile of ΔDE, and a high is the tenth decile of ΔDE. The cumulative return is calculated from -10 to 10 minutes around the event and time series averaged. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold.

Panel A. Futures

Cumulative return (%)	Low (N=16,372)		Benchmark (N=33,349)		High (N=16,379)	
CR(-10,-1)	**-0.061**	(-34.99)	-0.001	(-1.30)	**0.061**	(36.39)
CR(-5,-1)	**-0.060**	(-48.22)	0.000	(-0.50)	**0.060**	(51.16)
R(0)	**0.039**	(86.03)	0.000	(-0.53)	**-0.038**	(-82.24)
CR(0,+1)	**0.025**	(35.63)	0.000	(0.18)	**-0.025**	(-35.18)
CR(0,+5)	**0.025**	(19.70)	0.000	(0.47)	**-0.025**	(-19.12)
CR(0,+10)	**0.024**	(13.76)	0.000	(0.33)	**-0.024**	(-13.98)
CR(+1,+5)	**-0.014**	(-11.20)	0.001	(0.79)	**0.014**	(11.40)
CR(+1,+10)	**-0.015**	(-9.26)	0.001	(0.54)	**0.015**	(8.80)
CR(-10,+10)	**-0.037**	(-15.23)	-0.001	(-0.64)	**0.037**	(15.42)

Panel B. Spot

Cumulative return (%)	Low (N=16,372)		Benchmark (N=33,349)		High (N=16,379)	
CR(-10,-1)	**-0.037**	(-21.70)	-0.001	(-1.18)	**0.035**	(20.51)
CR(-5,-1)	**-0.036**	(-30.26)	-0.001	(-0.84)	**0.036**	(30.71)
R(0)	**-0.012**	(-25.48)	0.000	(1.49)	**0.012**	(26.74)
CR(0,+1)	**-0.005**	(-7.72)	0.001	(1.07)	**0.005**	(7.07)
CR(0,+5)	-0.001	(-0.86)	0.001	(0.80)	0.001	(1.01)
CR(0,+10)	-0.002	(-1.11)	0.001	(0.89)	0.000	(-0.09)
CR(+1,+5)	**0.011**	(9.74)	0.000	(0.27)	**-0.011**	(-9.60)
CR(+1,+10)	**0.011**	(6.64)	0.001	(0.49)	**-0.012**	(-7.84)
CR(-10,+10)	**-0.039**	(-16.53)	0.000	(-0.19)	**0.034**	(14.92)

Table X

Cumulative Return around the Highest (Lowest) Decile of the Difference between the Long Disposition Effect and Short Disposition Effect across Investor Types

This table reports the cumulative average return (%) and t-statistics for each investor type around the highest and lowest decile of ΔDE for 365 one minute intervals (09:00-15:05) a day. Panel A is the result of the futures market using the nearest KOSPI 200 futures price and Panel B is the result of the spot market using the KOSPI 200 Index. ΔDE is the difference between the long disposition effect measure and short disposition effect measure. After ΔDE is sorted by an ascending order on a given day, a low is the first decile of ΔDE, a benchmark is the fifth and sixth decile of ΔDE, and a high is the tenth decile of ΔDE. The cumulative return is calculated from -10 to 10 minutes around the event and time series averaged. *DE* is the difference of one representative agent's PGR and PLR. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses. *DE* at the aggregate level is equivalent to treating all investors as one representative agent. The sample consists of the trading experiences of 69,391 traders in the Korean index futures market over 556 trading days from Jan 2003 to Mar 2005. 5% statistical significance is indicated in bold.

Panel A. Futures

Cumulative return(%)	Low: Individual (N=15,316)		Low: Institution (N=6,960)		Low: Foreigner (N=4,242)		High: Individual (N=15,316)		High: Institution (N=6,960)		High: Foreigner (N=4,242)	
CR(-10,-1)	**-0.073**	(-40.89)	**-0.024**	(-8.08)	**0.014**	(3.59)	**0.065**	(37.95)	**0.013**	(4.53)	**-0.051**	(-13.36)
CR(-5,-1)	**-0.068**	(-53.79)	**-0.027**	(-12.72)	**0.005**	(2.00)	**0.063**	(52.23)	**0.022**	(10.79)	**-0.025**	(-8.75)
R(0)	**0.038**	(84.66)	**0.039**	(45.09)	**0.033**	(25.01)	**-0.039**	(-82.62)	**-0.040**	(-45.91)	**-0.031**	(-23.08)
CR(0,+1)	**0.025**	(34.40)	**0.031**	(24.72)	**0.029**	(16.41)	**-0.026**	(-35.50)	**-0.032**	(-24.57)	**-0.027**	(-15.59)
CR(0,+5)	**0.026**	(19.61)	**0.031**	(14.75)	**0.028**	(9.74)	**-0.026**	(-19.59)	**-0.030**	(-14.11)	**-0.025**	(-8.45)
CR(0,+10)	**0.025**	(14.18)	**0.027**	(9.55)	**0.024**	(6.50)	**-0.026**	(-14.82)	**-0.029**	(-10.25)	**-0.024**	(-6.27)
CR(+1,+5)	**-0.012**	(-9.66)	**-0.008**	(-3.95)	**-0.005**	(-2.20)	**0.013**	(10.06)	**0.010**	(5.01)	**0.006**	(2.40)
CR(+1,+10)	**-0.013**	(-7.51)	**-0.012**	(-4.21)	**-0.009**	(-2.67)	**0.013**	(7.37)	**0.011**	(3.97)	0.007	(1.87)
CR(-10,+10)	**-0.047**	(-18.81)	0.003	(0.72)	**0.038**	(7.23)	**0.038**	(15.60)	**-0.017**	(-4.11)	**-0.075**	(-14.14)

Panel B. Spot												
	Low						High					
Cumulative return(%)	Individual (N=15,316)		Institution (N=6,960)		Foreigner (N=4,242)		Individual (N=15,316)		Institution (N=6,960)		Foreigner (N=4,242)	
CR(-10,-1)	**-0.044**	(-25.63)	**-0.012**	(-4.19)	**0.016**	(4.43)	**0.038**	(22.12)	-0.002	(-0.83)	**-0.051**	(-13.47)
CR(-5,-1)	**-0.041**	(-34.05)	**-0.015**	(-7.29)	**0.007**	(2.78)	**0.037**	(31.48)	**0.010**	(4.95)	**-0.025**	(-8.82)
R(0)	**-0.014**	(-29.20)	-0.001	(-1.18)	**0.009**	(7.87)	**0.013**	(27.08)	0.001	(1.00)	**-0.010**	(-9.34)
CR(0,+1)	**-0.008**	(-11.44)	**0.011**	(9.54)	**0.021**	(12.82)	**0.005**	(7.95)	**-0.011**	(-10.06)	**-0.022**	(-12.81)
CR(0,+5)	**-0.003**	(-2.60)	**0.017**	(8.17)	**0.025**	(8.98)	0.002	(1.27)	**-0.015**	(-7.35)	**-0.025**	(-8.49)
CR(0,+10)	-0.003	(-1.82)	**0.013**	(4.72)	**0.020**	(5.55)	-0.001	(-0.43)	**-0.015**	(-5.47)	**-0.020**	(-5.41)
CR(+1,+5)	**0.011**	(9.15)	**0.018**	(9.47)	**0.016**	(6.63)	**-0.011**	(-9.31)	**-0.016**	(-8.45)	**-0.014**	(-5.60)
CR(+1,+10)	**0.011**	(6.81)	**0.014**	(5.32)	**0.011**	(3.30)	**-0.014**	(-8.17)	**-0.016**	(-6.02)	**-0.010**	(-2.81)
CR(-10,+10)	**-0.047**	(-19.74)	0.001	(0.17)	**0.036**	(7.37)	**0.037**	(15.70)	**-0.017**	(-4.51)	**-0.071**	(-14.14)

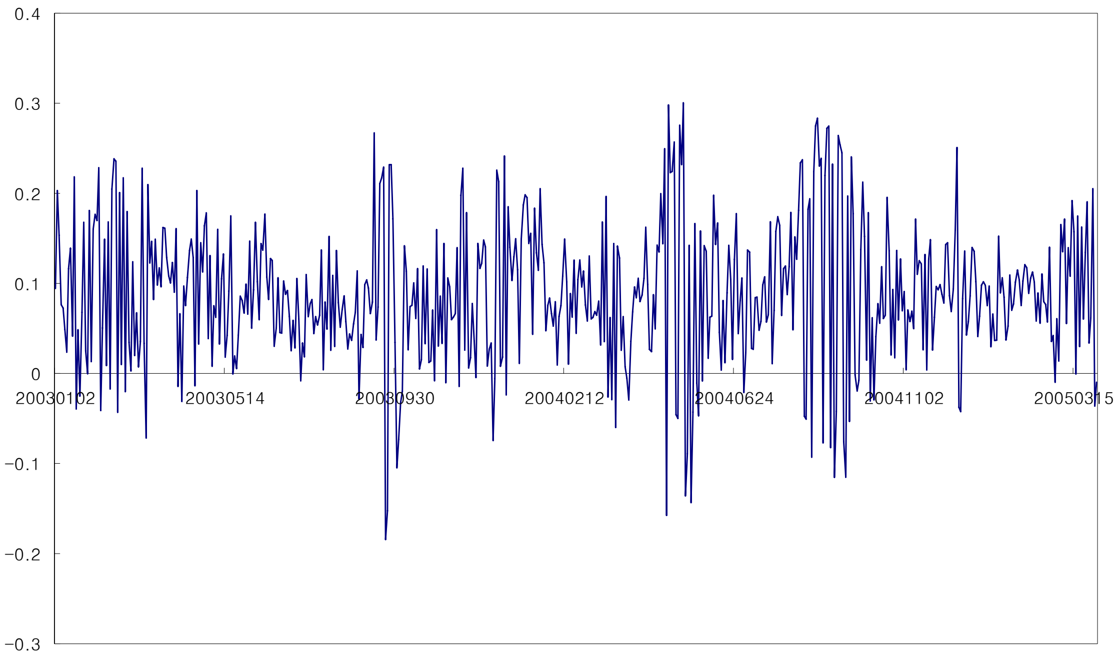
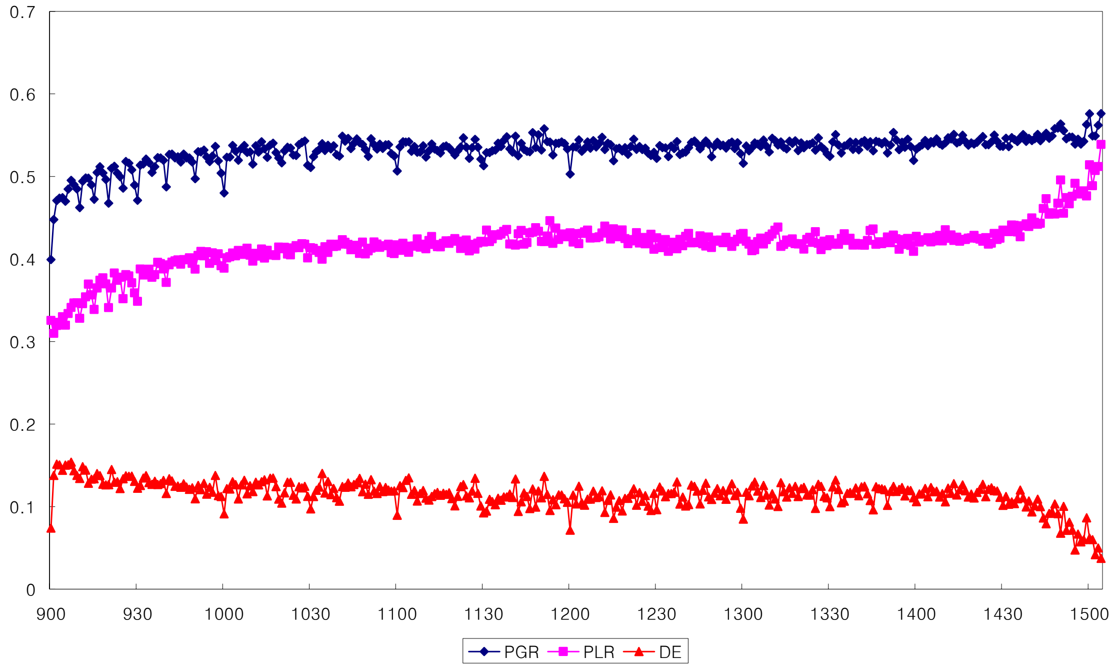


Figure 1. Daily Pattern of the Disposition Effect Measure.

This figure depicts the time-series of the disposition effect during the sample period from Jan 2003 to Mar 2005. The disposition effect measure is the difference of one representative agent's PGR and PLR at each time. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses.

Panel A. One minute frequency (09:00 – 15:05)



Panel B. Five minute frequency (09:00 – 15:05)

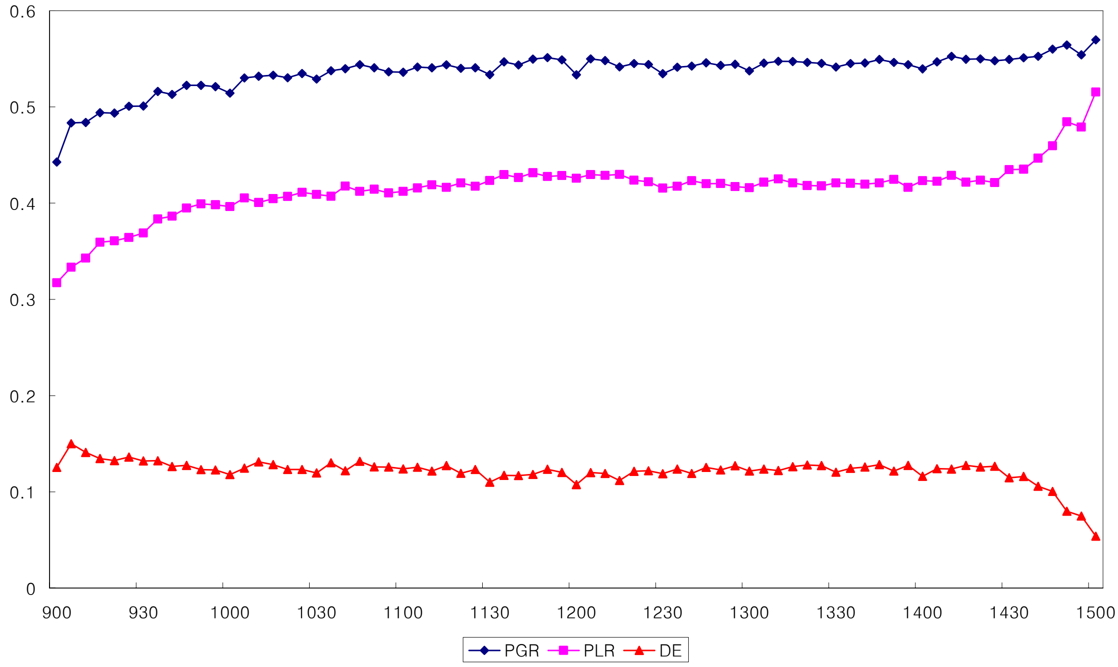
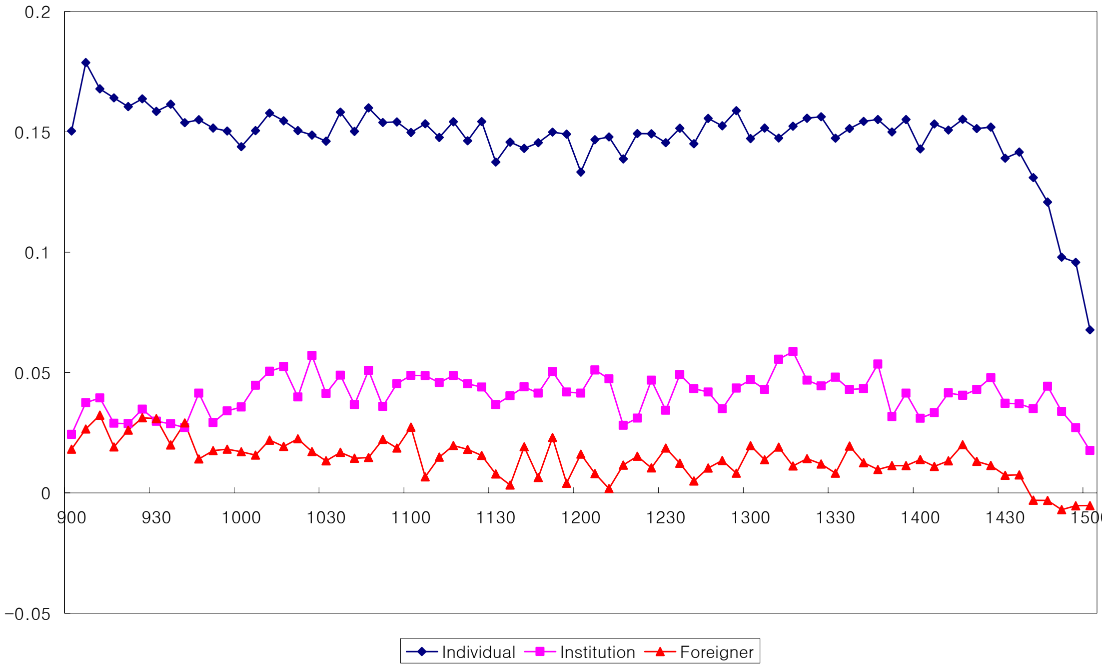


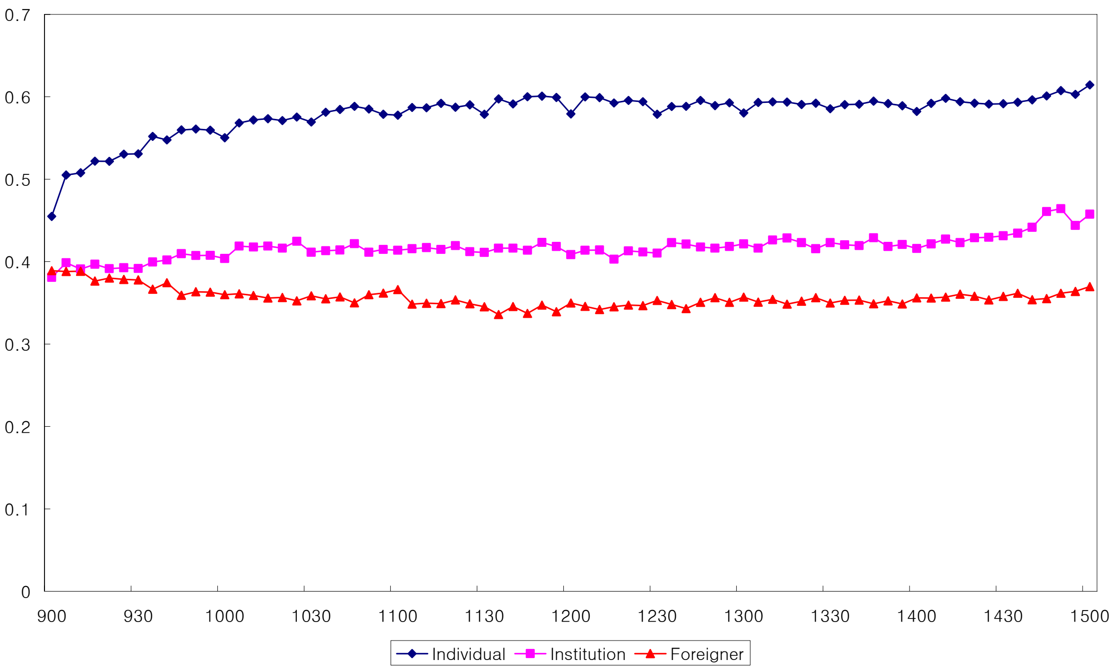
Figure 2. Intraday Pattern of the Disposition Effect Measure.

This figure depicts the time-series mean of DE, PGR, and PLR at each time during the sample period from Jan 2003 to Mar 2005. The one minute interval result during the continuous auction (09:00 – 15:05) is in Panel A and the five minute interval result is in Panel B. The disposition effect measure (DE) is the difference of one representative agent's PGR and PLR at each time. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses.

Panel A. DE



Panel B. PGR



Panel C. PLR

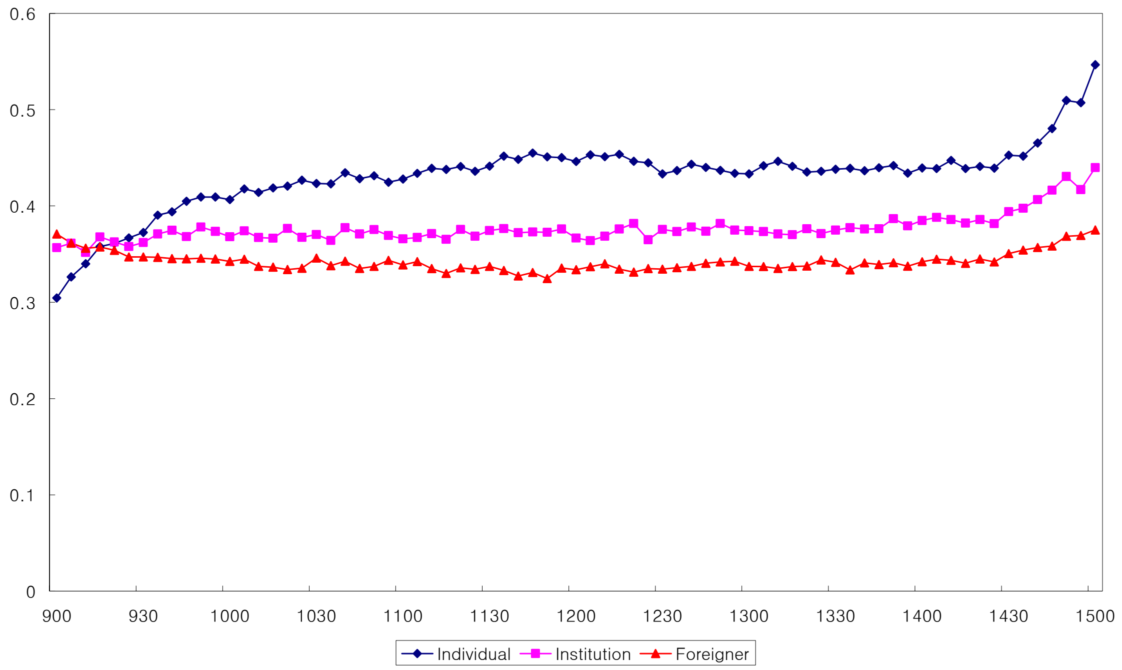
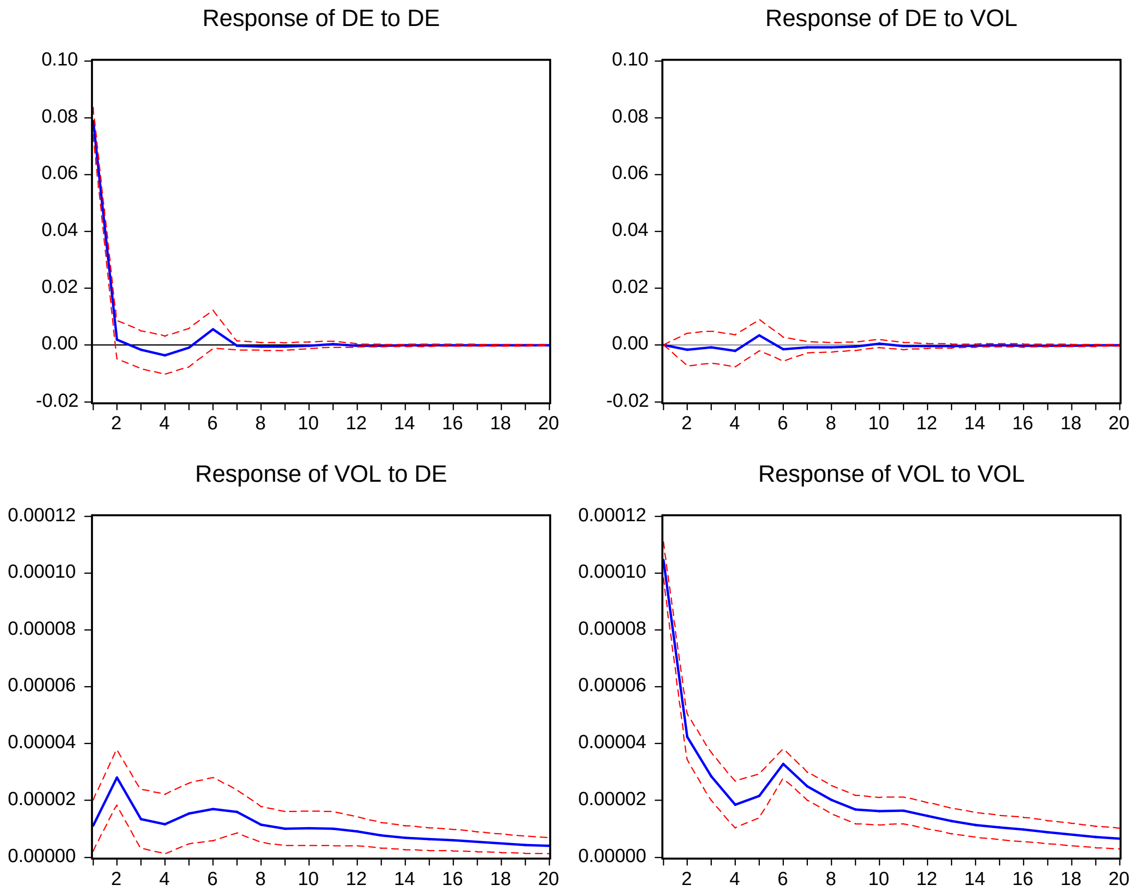


Figure 3. Intraday Pattern of the Disposition Effect Measure across Investor Types. This figure depicts the time-series mean of DE, PGR, and PLR at each time (during 5 minutes) across investor types during the sample period from Jan 2003 to Mar 2005. The five minute interval result during the continuous auction (09:00 – 15:05) of DE is in Panel A, that of PGR is in Panel B, and that of PLR is in Panel C. The disposition effect measure (DE) is the difference of one representative agent's PGR and PLR at each time. PGR is the number of trading on realized gains divided by the number of trading on realized gains plus the number of trading on paper gains, and PLR is the number of trading on realized losses divided by the number of trading on realized losses plus the number of trading on paper losses.

Panel A. Futures



Panel B. Spot

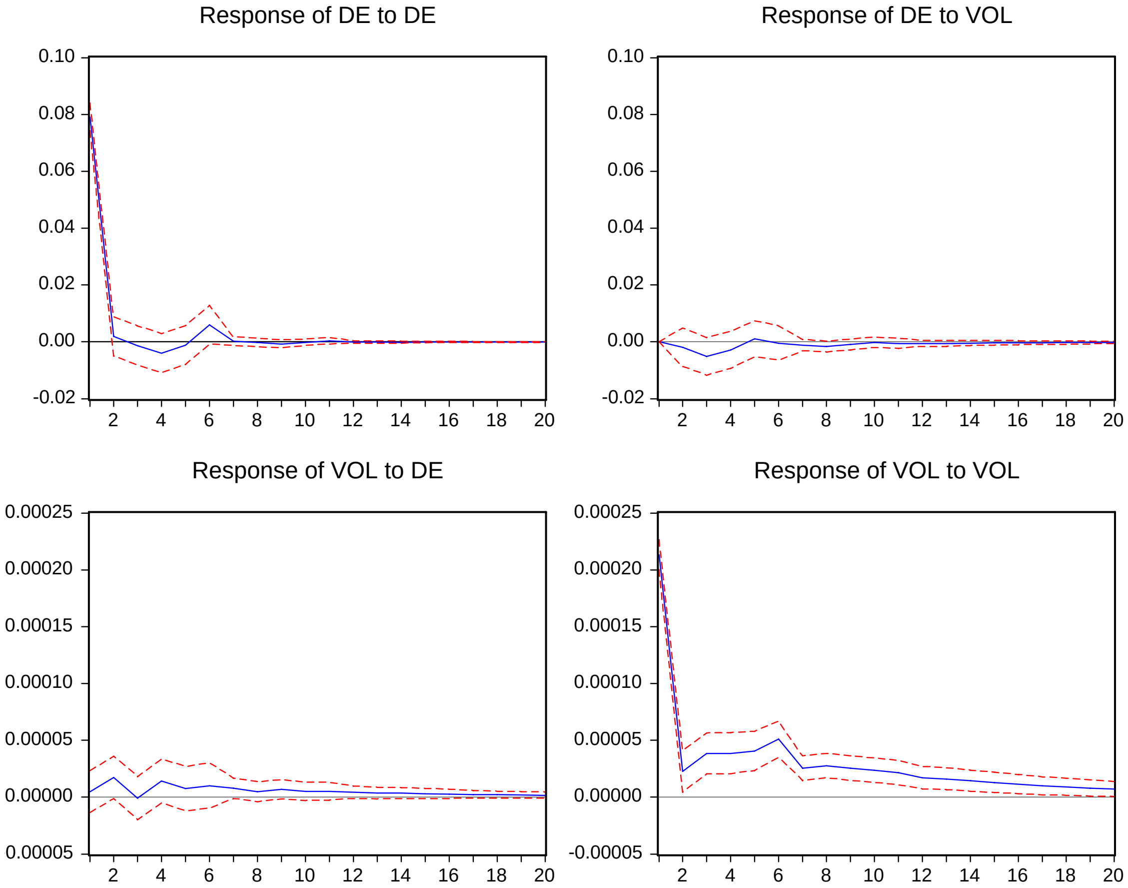
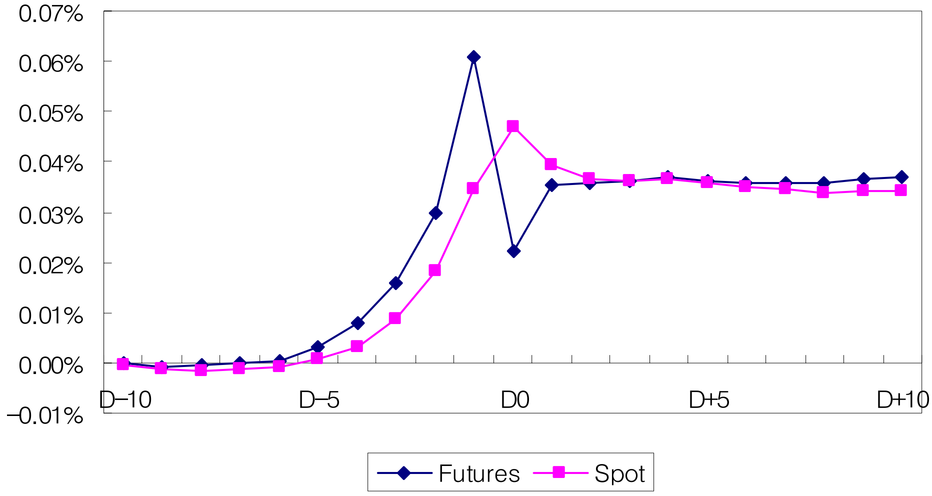


Figure 4. Impulse Response Functions with Two-standard Error Bands.
This figure depicts the impulse-response function graphs of futures using the VAR estimation in Panel A and that of spot in Panel B. The upper two figures represent DE response to a DE and volatility shock, respectively. The lower two figures represent volatility response to a DE and volatility shock, respectively.

Panel A. Highest decile of the difference between long DE and short DE



Panel B. Lowest decile of the difference between long DE and short DE

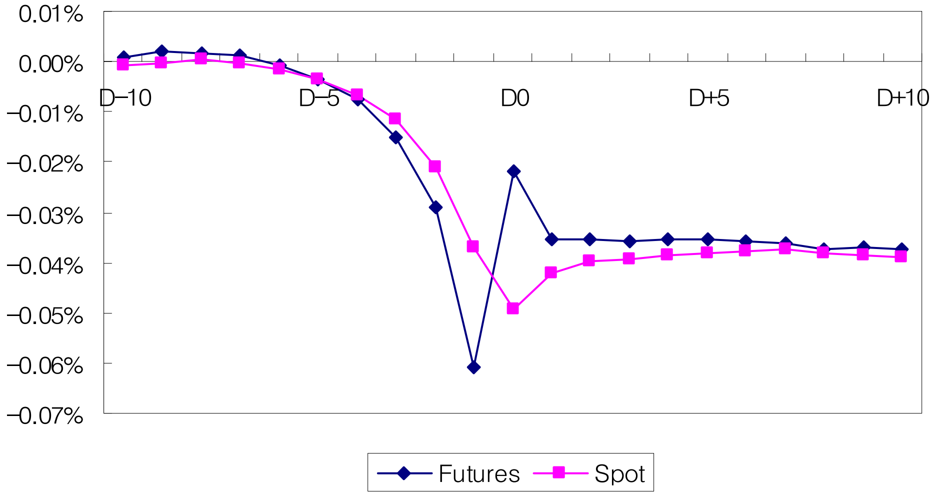


Figure 5. Cumulative Return around the Highest (Lowest) Decile of the Difference between the Long Disposition Effect and Short Disposition Effect

This figure depicts the cumulative average return (%) of futures and spot around the highest and lowest decile of ΔDE for 365 one minute intervals (09:00-15:05) a day. Panel A shows the result of a high ΔDE and Panel B shows that of a low ΔDE. After ΔDE is sorted by an ascending order on a given day, a low is the first decile of ΔDE, a benchmark is the fifth and sixth decile of ΔDE, and a high is the tenth decile of ΔDE. The cumulative return is calculated from -10 to 10 minutes around the event for one minute interval and time series averaged.

Table A. I

Example of Calculating Holding Time and Profit

This table reports the example of calculating holding time and profit for a specific investor. Trade is categorized into buy or sell, the number of trade, and trade type. Open buy, open sell, close buy, close sell, netting open buy, netting open sell, netting close buy, netting close sell, position out buy, and position out sell are the types of trade. Position is categorized into long and short position. Trade price is the transaction price and end price is the price of each minute. Average cost is the volume weighted buy (or sell) price. Holding time is the volume weighted holding time of the position. Realized profit is calculated when the trade reduces positions or buy and sell (or sell and buy) happen in a minute. RG, R0, RL are realized gain, realized zero, and realized loss, respectively. Unrealized profit is calculated using the average cost and end price. PG, P0, PL are paper gain, paper zero, and paper loss respectively.

Time	Trade			Position		Price		Average Cost		Holding		Realized Profit				Unrealized Profit			
	B/S	#	Type	L/S	#	Trade	End	Start	End	Start	End	Total	#	Per	Type	Total	#	Per	Type
10:00	Buy	1	Open Buy	Long	1	$100	$100		$100.00		0					0	1	0	P0
10:01	Buy	1	Open Buy	Long	2	99	99	$100.00	99.50	1.0	0.5					-$1	2	-$0.50	PL
10:02	Buy	1	Open Buy	Long	3	98	98	99.50	99.00	1.5	1.0					-3.00	3	-1.00	PL
10:03	Sell	1	Close Sell	Long	2	96	96	99.00	99.00	2.0	2.0	-$3.00	1	-$3.00	RL	-6.00	2	-3.00	PL
10:04	Buy	1	Netting	Long	2	95	96	99.00	99.00	3.0	3.0	1.00	1	1.00	RG	-6.00	2	-3.00	PL
	Sell	1				96													
10:05				Long	2		95	99.00	99.00	4.0	4.0					-8.00	2	-4.00	PL
10:06				Long	2		92	99.00	99.00	5.0	5.0					-14.00	2	-7.00	PL
10:07				Long	2		94	99.00	99.00	6.0	6.0					-10.00	2	-5.00	PL
10:08	Sell	1	Close Sell	Long	1	93	95	99.00	99.00	7.0	7.0	-6.00	1	-6.00	RL	-4.00	1	-4.00	PL
10:09	Sell	2	Position out Sell	Short	1	96	95	99.00	96.00	8.0	0.0	-3.00	1	-3.00	RL	1.00	1	1.00	PG
10:10				Short	1		94	96.00	96.00	1.0	1.0					2.00	1	2.00	PG
10:11	Buy	1	Close Buy	Short	0	95	95	96.00	96.00	2.0		1.00	1	1.00	RG				
10:12							93												
10:13							94												
10:14	Sell	2	Open Sell	Short	2	93	93		93.00		0.0					0.00	2	0.00	P0

10:15	Buy	1	Netting Open Sell	Short	4	91	92	93.00	92.50	1.0	0.5	1.00	1	1.00	RG	2.00	4	0.50	PG
	Sell	3				92													
10:16				Short	4		91	92.50	92.50	1.5	1.5					6.00	4	1.50	PG
10:17				Short	4		90	92.50	92.50	2.5	2.5					10.00	4	2.50	PG
10:18	Buy	4	Close Buy	Short	0	91	91	92.50	92.50	3.5		6.00	4	1.50	RG				