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# DO LEVERAGED/INVERSE ETFS WAG THE UNDERLYING MARKET? EVIDENCE FROM THE KOREAN STOCK MARKET<sup>\*</sup>

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# Abstract

This paper addresses the question of whether leveraged and inverse exchange-traded funds (ETFs) affect the underlying market. The Korean markets provide a unique context to address the question in that (i) the ETFs contain only stocks and futures, and (ii) the futures markets close 15 minutes later than the stock markets. Although the Hasbrouck information shares do not indicate any dominant price discovery effect between the leveraged/inverse ETFs and the underlying stock market based on daily close-to-close returns, we find evidence that ETF managers' rebalancing activities have a significant impact on the daily close-to-open returns of the underlying stock market.

*Keywords:* ETF, price discovery, information share, market impact *JEL Classification Codes:* G12, G14, G15

# I. Introduction

Exchange-traded funds (ETFs) are one of the most rapidly growing financial products in global financial markets. In particular, ETFs that track the representative local stock market index are the most popular, and leveraged and inverse ETFs are among the top in terms of trading volume. However, due to the substantial trading volume of leveraged and inverse ETFs,

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policymakers and practitioners often assert that these ETFs are a source of market instability because the trades that are triggered by managers of these ETFs that attempt to match the promised multiples of the daily return of the underlying asset at the market close can affect the price of the underlying asset itself. This paper investigates this issue by using the data from the Korean stock and futures markets. Hereafter, we refer to both leveraged ETFs and inverse ETFs simply as leveraged ETFs, unless there is a need to differentiate them for the sake of clarity, because k-times leveraged ETFs with k being equal to -1 represent inverse ETFs.

ETFs have been popular in Korea since their inception in 2002. In Korea, the largest ETFs are those that track the KOSPI200 index, which is the most representative stock market index in the country. Although the ETFs tracking the KOSPI200 accounted for only 1.2% of the total market value of all component stocks of the KOSPI200 at the end of 2015, they accounted for approximately 20% of the total daily trading volume of all component stocks of the KOSPI200, with leveraged ETFs accounting for approximately 70% of the total trading volume of all ETFs tracking the KOSPI200.

The Korean stock and futures markets provide a unique context to address our research question of whether leveraged ETF markets influence the underlying market for the following three reasons. First, the leveraged ETFs listed in the Korean market should contain only stocks and futures. This operational feature is enforced by law, resulting that managers of leveraged ETFs need to actively rebalance their portfolios, i.e. their stocks and futures holdings, to match the promised daily return multiples. Second, the closing times of stock and futures markets are different. Specifically, the stock market closes 15 minutes earlier than the futures market. Third, the closing prices in both markets are determined by call markets. Specifically, the stock market closes with a 10-minute call market period of 2:50 pm to 3:00 pm, and the futures market closes with a 15-minute call market period of 3:00 pm to 3:15 pm. These operational and market features make it impossible for the managers of leveraged ETFs to rebalance their portfolios precisely at the market close.

Each day managers of the leveraged ETFs in the Korean stock markets must adjust their daily stock and futures positions at their respective market closes to match the promised multiples of the daily return of the underlying asset, i.e. the KOSPI200 index, during the next day. Even if the managers rebalance precisely at the end of the stock call market, i.e. 3:00 pm, they might end up with incorrect portfolios due to the change in the futures price during the futures call market period of 3:00 pm to 3:15 pm. When they finish with incorrect portfolios at the end of the futures call market, i.e. 3:15 pm, the managers should rebalance their portfolios during the opening stock and futures call markets on the next trading day. Traders of the KOPSI200 might also react to the price discrepancy between the leveraged ETFs and the KOPSI200. Thus, it will be interesting to examine the effect of the leveraged ETFs on the underlying market using the daily close-to-open prices as well as using the daily close-to-close prices.

The focus of this research is on whether the leveraged ETFs have a price impact on the underlying market. While many prior studies have investigated the influence of the leveraged ETF market on the volatility of the underlying market [see, e.g., Liu (2009), Trainor (2010) and Charupat and Miu (2011)], relatively little is known about the direct price impact between the leveraged ETF market and the underlying market, which this study aims at investigating. First, in order to examine price impacts between the two markets based on daily close-to-close price processes, we use the Hasbrouck (1995) information shares method, which are based on a

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vector error correction model. Using the method, we do not find any dominant price discovery effect between the leveraged ETF market and the underlying stock market. Second, in order to examine price impacts between the two markets based on daily close-to-open price processes, we use a regression method in which the close-to-open underlying market return is regressed on the return difference between k times the KOSPI200 daily return and the daily return of the k-times leveraged ETF at the previous day close. Using the regression method, we find that there is a significant price impact of the return difference at the previous-day close on the close-to-open underlying market return, i.e. on the opening price of the underlying market.

The remainder of the paper is organized as follows. The next section presents a literature review. Section 3 explains the rebalancing mechanism of the leveraged ETFs. Section 4 describes the data and empirical methodologies used, and Section 5 presents the empirical findings. Section 6 concludes the paper.

# II. Literature Review

In the literature, there have been several strands of research on leveraged ETFs. One strand has focused on whether investors can earn the promised multiple of the return of the underlying asset when they hold leveraged ETFs longer than a day. For example, Jarrow (2010) theoretically demonstrated that leveraged ETFs cannot make precisely the promised multiple of the underlying asset return in general investment horizons. Using simulation analysis for US equity markets, Loviscek et al. (2014) also argued that daily rebalanced leveraged ETFs are not appropriate investment vehicles for long-term strategies.

Another strand of research has focused on the volatility of leveraged ETFs or their impact on the market volatility. For example, Liu (2009) found that a significant jump risk exists in the high frequency data; thus, it is very difficult to predict the intraday volatility of leveraged ETFs. Using data from the Canadian market, Charupat and Miu (2011) provided evidence that leveraged ETFs contain large premiums or discounts, which leads to an increase in market volatility. In contrast, using data from the US market, Trainor (2010) found no evidence that leveraged ETFs generate additional market volatility. Kim et al. (2015) also found similar empirical evidence in the Korean market.

In relation to the literature, this paper falls within the latter strand of research. However, the issue is approached from the perspective of price discovery. That is, we are interested in the question of whether leveraged or inverse ETFs move or influence the underlying market? We address the question using both daily close-to-close price processes and daily close-to-open price processes. First, in order to address the question by using close-to-close price processes, we use the Hasbrouck (1995) information shares method, which measures the contributions to price discovery of several cointegrated price series. Second, in order to address the question by using close-to-open price processes, we use a regression method in which the close-to-open underlying market return is regressed on the difference between k times the KOSPI200 daily return and the daily return of the k-times leveraged ETF at the previous day close. In the methodology section, we explain these two methods of detecting price impacts of the leveraged ETF market on the underlying market in detail.

# III. Rebalancing Mechanism of the Leveraged and Inverse ETFs

The managers of the leveraged ETFs in the Korean markets should match the promised multiple of daily returns of the underlying asset. Therefore, they need to lower their leverage ratio, i.e. market exposure, when the price of the underlying asset increases and raise their leverage ratio when the price of the underlying asset decreases. This mechanism stems from the fact that managers of the leveraged ETFs in Korea should operate only with stocks and futures, which is enforced by law. For example, consider a manager of a  $2 \times$  leveraged ETF and suppose that the leverage ratio of the futures contract is 10.<sup>1</sup> For simplicity, we further assume that the daily change in the futures price is exactly the same as the daily change in the underlying market index and that there are no transaction costs. Then, each day the manager should always hold 88.9% (=8/9) of the 2× leveraged ETF value in the index basket and 11.1% (= 1/9) in the long futures contract at the market close in order to match the daily return multiple on the next day.<sup>2</sup> Let's suppose that the index increases by 5% on a day. Then, the daily return of the 2× leveraged ETF return on the same day would be 10%. However, if the manager does not rebalance her portfolio before the market closes, on the next day the proportional weights in the index basket and long futures contract would change to 84.8% and 15.2%, respectively, leading to a mismatch in the daily return of the leveraged ETF.<sup>3</sup> Thus, the manager should rebalance her portfolio by raising the leverage ratio of her portfolio before the market closes. Similarly, a manager of an inverse ETF should rebalance her portfolio by lowering the leverage ratio of her portfolio before the market closes. In essence, managers of leveraged and inverse ETFs should rebalance their portfolios near or at the market close. Clearly, this typical rebalancing trading is executed near the market close, which may amplify the market volatility [see, e.g., Shum et al. (2016) and Li and Zhao (2014)].

# IV. Data and Empirical Methodology

### 1. Data

The market data of the KOSPI200 index, KODEX leveraged ETF, and KODEX inverse ETF are used.<sup>4</sup> As of December 2015, the four leveraged and four inverse ETFs that track the KOSPI200 index are listed in the Korea Exchange (KRX).<sup>5</sup> We choose to use only the KODEX leveraged ETF because it comprises 94% of the total market value of all four leveraged ETFs. The situation is similar for the inverse ETFs because the KODEX inverse ETF comprises 96%

<sup>&</sup>lt;sup>1</sup> A leverage ratio of 10 means that the minimum margin requirement is one tenth of the futures price.

<sup>&</sup>lt;sup>2</sup> Let r be the close-to-close return of the underlying index on a day. If the manager hold 100x% of the  $2 \times$  leveraged ETF value in the index basket and 100(1-x)% in the long futures contract at the close of the previous day, then the close-to-close daily return is equal to x(r)+(1-x)(10r), which should be equal to 2r. Hence, we get x=8/9 and 1-x=1/9.

<sup>&</sup>lt;sup>3</sup> Without rebalancing trades, the weight in the index basket changes to (8/9)(1.05)/(1.10)=84.8%.

<sup>&</sup>lt;sup>4</sup> KODEX is the brand name of the ETF series managed by Samsung Asset Management Co. Ltd. in Korea. KODEX ETFs represent ETFs that track the Korea Index.

<sup>&</sup>lt;sup>5</sup> This is the sole securities exchange operator in South Korea.

### TABLE 1. DESCRIPTIVE STATISTICS

This table presents the descriptive statistics for the daily returns of the leveraged ETFs and the associated scaled benchmark index, expressed in percent terms. The leveraged KOSPI200 and inverse KOSPI200 are constructed by multiplying the daily return of KOSPI200 by two and minus one, respectively. For the mean difference, t-statistics testing for the zero mean difference are reported in square brackets.

	Mean	Median	1 <sup>st</sup> Quartile	3 <sup>rd</sup> Quartile	Std. Dev.
Leveraged KOSPI200	0.022	0.020	-1.100	1.200	2.161
Leveraged ETF	0.012	0.011	-1.060	1.075	2.104
Difference	0.010 [0.119]	0.020	-0.210	0.230	0.442
Inverse KOSPI200	-0.011	-0.010	-0.600	0.550	1.081
Inverse ETF	-0.002	-0.000	-0.560	0.570	1.103
Difference	-0.009 [-0.219]	-0.010	-0.130	0.110	0.239

of the total market value of all four inverse ETFs listed in the KRX. The data were obtained from the KRX webpage and the FnGuide's DataGuide database, which is the most comprehensive financial data vendor in Korea. The sample period covers the period from April 2004 to December 2015, and we use only daily close and open prices of the ETFs and underlying spot market.

The basic descriptive statistics for the data used are provided in Table 1. It is noted that the daily return limit in KRX is bound to 15%; thus, the leveraged ETF returns cannot exceed 30%. As seen in the table, the mean return difference between k times the benchmark index returns and the k-times leveraged ETF returns are not significantly different from zero.

### 2. Empirical Methodology

1) Method of measuring price impacts by using close-to-close price processes

In order to investigate price impacts between the leveraged ETFs and their underlying benchmark asset, i.e. the KOSPI200 index, by using close-to-close price processes, the contributions to price discovery are estimated through estimating the Hasbrouck's information shares (Hasbrouck, 1995), which is based on a bivariate vector error correction model (VECM). By their construction, leveraged ETFs are designed to make the promised multiples of the daily return of the underlying asset. Thus, the long-term relationship between the daily return of the leveraged ETF and the daily return of the underlying asset is known. For this reason, the Hasbrouck's information shares method based on the bivariate VECM is an appropriate empirical framework to examine the contributions to price discovery between the leveraged ETF and its underlying asset.<sup>6</sup> Specifically, we employ a bivariate VECM of the following form:

$$p_{i} = \alpha \beta' p_{i} + \sum_{j=1}^{l} A_{j} \Delta p_{i-j} + \varepsilon_{i}, \qquad (1)$$

where  $p_t$  is the two-dimensional vector of the adjusted price of the KOSPI200, i.e. the benchmark price of the leveraged ETF, and the price of the leveraged ETF,  $p_t = [(ap)_t^{K200}, p_t^{LETF}]'$ ;  $\alpha$  is the error correction vector;  $\beta$  is the cointegration vector;  $A_i$  is the autoregressive coefficient matrix at lag *j*; and  $\varepsilon_t$  is a zero-mean vector of serially uncorrelated innovations with covariance matrix  $\Omega$ . Note that for the  $k \times$  leveraged ETF, the adjusted price of the KOSPI200, denoted as *ap*, represents the hypothetical price process that is constructed to match *k* times the daily return of the original KOSPI200 index each day. For example, in case of the 2× leveraged ETF, the adjusted price  $(ap)_t^{K200}$  is constructed to match two times the daily KOSPI200 return. Since KODEX-leveraged and inverse ETFs are designed to match 2 times the daily KOSPI return and -1 times the daily KOSPI return, respectively, the cointegration vector is set to  $\beta = (1, -1)'$ .

Hasbrouck (2002) derived the information share of each component vector of  $p_i$  through transforming the VECM model, Equation (1), into a vector moving average (VMA) model.<sup>7</sup> Let the transformed VMA model be

$$\Delta p_{t} = \Psi(L)\varepsilon_{t}, \tag{2}$$

and its integrated form be

$$p_{t} = \Psi(1) \sum_{s=1}^{t} \varepsilon_{s} + \Psi^{*}(L) \varepsilon_{t}, \qquad (3)$$

where  $\Psi(L)$  and  $\Psi^*(L)$  are matrix polynomials in the lag operator L. Because  $\beta' p_i$  is stationary,  $\beta' \Psi(1)$  should be zero, which implies that the two row vectors of  $\Psi(1)$  are identical. Let  $\psi$  denote the common row vector of  $\Psi(1)$ . Hasbrouck considers the increment  $\psi \varepsilon_i$  to be the component of the price change that is permanently impounded into the price and presumably results from new information (Baillie et al. 2002). If the covariance matrix of  $\varepsilon_i$ ,  $\Omega$ , is diagonal, then the information share of security j is defined by

$$S_{j} = \frac{\psi_{j} \Omega_{jj}}{\psi \Omega \psi'},\tag{4}$$

where  $\psi_j$  is the *j*th element of  $\psi$ . If  $\Omega$  is not a diagonal matrix, let *F* be the lower triangular matrix from the Cholesky factorization of  $\Omega$  (i.e.  $\Omega = FF'$ ). The information share of the security *j* is defined by

$$S_{j} = \frac{(\phi F)_{j}^{2}}{\phi \Omega \phi'},$$
(5)

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<sup>&</sup>lt;sup>6</sup> For example, Kurov and Lasser (2004) investigated the price dynamics in the E-mini futures market, where the regular futures contracts on the same underlying assets are also traded. Through estimating Hasbrouck's information shares, it was found that E-mini dominates in the S&P 500 and Nasdaq-100 futures markets in terms of the contribution to price discovery.

<sup>&</sup>lt;sup>7</sup> Baillie et al. (2002) demonstrated that Hasbrouck's information shares can also be computed directly from the fitted VECM model.

where  $(\psi F)_j$  is the *j* th element of the row matrix  $\psi F$ . Because the Choleskey factorization depends on the order of securities stacked in  $p_i$ , changing the order of securities in the model results in different information share values. For each security, Hasbrouck defines the upper and lower bounds of the security's information share through changing the order of securities in the model.

2) Method of measuring price impacts by using close-to-open price processes

We next examine the effect of leveraged ETF managers' rebalancing trades on the opening price of the underlying benchmark index. Precisely speaking, we investigate whether there is any opening price impact on the underlying market index caused by the discrepancy between the underlying index return and the leveraged ETF return at the previous-day market close. Unlike delta-one ETFs, leveraged ETF managers in Korea need to rebalance their portfolios near the market close to match the promised multiples of the daily return of the KOSPI200 index. As explained earlier, the call market feature of the Korean stock and futures markets makes it difficult for the managers to rebalance their portfolios precisely at the market close and to fail to match the promised daily returns. Moreover, mismatching problems will continue on the next day unless they rebalance their portfolios as soon as possible during the next day because if managers start the next day with holding incorrect portfolios, then they will end up with another return mismatch.

Let's suppose that on a day KOSPI200 increases by 5%, whereas a  $2 \times$  leveraged ETF generates only an 8% return during the day. This generates a  $2\%(=2\times5\% - 8\%)$  discrepancy. This means that the ETF manager holds more stocks and less futures contract than the perfect matching portfolio. Therefore, the manager will begin the next day with a wrong portfolio. Thus, the manager will try to rebalance her wrong portfolio into the correct one as soon as possible, i.e. at the opening market on the next day. In our example, the leveraged ETF manager would sell stocks at the opening market, so the underlying stock market would have a downside price pressure. The similar reasoning can be applied in the opposite direction for inverse ETFs. Based on this mechanism, we have the following testable hypotheses:

 $H_0$ : The discrepancy between two (minus one) times the benchmark return and the return of the 2× (-1×) leveraged ETF at the previous-day market close has no impact on the opening price of the underlying benchmark index;

 $H_1$ : The discrepancy between two (minus one) times the benchmark return and the return of the 2× (-1×) leveraged ETF at the previous-day market close has a significant impact on the opening price of the underlying benchmark index.

We test these hypotheses with a regression model of the following form:

$$KOPSI_{t}^{co} = \alpha + \beta_{1}X_{t-1} + \beta_{2}KOPSI_{t-1}^{co} + \beta_{3}KOPSI_{t-1}^{cc} + \varepsilon_{t}, \tag{6}$$

where  $KOPSI_{t}^{co}$  is the close-to-open return from day t-1 to day t and  $KOPSI_{t-1}^{c-1}$  is the close-toclose return from day t-2 to day t-1. We employ three proxies for X, the variable of our interest: *Spread*, *Dum\_L*, and *Dum\_U*. *Spread* represents the difference between two (minus one) times the KOSPI200 daily return and the daily return of the  $2 \times (-1 \times)$  leveraged ETF. *Dum\_L* represents a dummy variable that takes one if *Spread* is below the (100*p*)th percentile

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of its distribution and zero otherwise. Similarly, *Dum\_U* represents a dummy variable that takes one if *Spread* is above the (100*p*)th percentile of its distribution and zero otherwise.

# V. Results

### 1. Results Based on Close-to-close Price Processes

Table 2 presents a summary of the results based on the Hasbrouck information shares. In the table, the information share of the KOPI200 is computed relative to each one of the KODEX leveraged and inverse ETFs by using the daily close-to-close price processes. It should be noted that only the information share of the KOSPI200 and its time-series properties are reported because the information share of either the leveraged ETF or the inverse ETF is simply one minus the information share of the KOSPI200.

For the results of Table 2, the information shares are computed over rolling 125-day windows. The hypothetical price processes of the benchmark index and leveraged ETFs are reset at the start of each rolling window and constructed newly over each rolling window. We employ such a rolling window procedure to make sure that the paired price processes converge over time on average. The leveraged ETF managers are mandated to match the promised daily return multiples within given tracking error levels, so practically there is no guarantee that the average of daily return discrepancies between the benchmark index and the leveraged ETFs is zero. Because of this, there is a concern that cumulative returns or price processes might diverge over a long time period. In order to deal with this issue, we set our rolling window size to a reasonably short time horizon. Several window sizes from 90 days to 250 days are tested, but the results remain qualitatively the same. The lag length l=7 is selected to fit the VECM of Equation (1), which is based on the Akaike's information criterion.<sup>8</sup>

The results of Table 2 indicate that for both pairs of (KOSPI200, Leveraged ETF) and

# TABLE 2. INFORMATION SHARES OF THE KOSPI200 BASED ON THE DAILY PRICE PROCESSES

This table presents the Hasbrouck's information shares of the KOSPI200 relative to the leveraged or inverse ETF based on the daily close-to-close price processes. Using the daily returns of the index and the leveraged or inverse ETF, we construct hypothetical price processes using the 125-day window moving one day at a time. The information shares are estimated for each moving window. The averages of the upper bound, lower bound, and midpoint across all moving windows are reported with their standard deviations in parentheses. Note that one minus the information share of the KOSPI200 represents the information share of the leveraged or inverse ETF. Bivariate vector error correction models that allow serial correlations up to lag 7 are used.

Model	Upper bound	Lower bound	Midpoint
KOSDI200 vg Lavaragad ETE	0.778	0.209	0.494
KOSPI200 vs. Leveraged ETF	(0.228)	(0.190)	(0.133)
KOSDI200 via Laviana ETE	0.827	0.169	0.498
KOSPI200 VS. Inverse ETF	(0.163)	(0.166)	(0.079)

<sup>&</sup>lt;sup>8</sup> We repeated our analysis with allowing for different numbers of lagged autocorrelations, ranging from five to ten, but the results remained qualitatively the same.

(KOSPI200, Inverse ETF), the midpoint information shares of the KOSPI200 are approximately 50%, and the upper and lower bounds are around 80% and 20%, respectively. For both pairs, the results do not provide evidence that one security exhibits a significantly larger impact on the other. That is, the results do not indicate any dominant price discovery effect between the leveraged/inverse ETFs and the underlying stock market in terms of the continuous price processes based on the daily close-to-close returns.

### 2. Results Based on Close-to-open Price Processes

### TABLE 3. EFFECT OF THE RETURN MISMATCH ON THE UNDERLYING INDEX

This table reports the results of the regression model (6) where the dependent variable is  $KOSPI_{co}^{c_{t}}$ , the close-to-open KOSPI200 return from day *t*-1 to *t*. In the table,  $KOPSI_{cc}^{c_{t}}$  represents the close-to-close return from day *t*-1 to *t*. Spread<sup>Lev</sup><sub>t-1</sub> represents the difference between two (minus one) times the daily KOSPI200 return and the daily return of the 2× leveraged (-1× inverse) ETF based on close-to-close returns on day *t*-1.  $Dum_{L}L^{Lev}$  is a dummy variable that takes one if *Spread<sup>Lev</sup>* is below 100*p* percentile of its distribution and zero otherwise. Similarly,  $Dum_{U}L^{ev}$  is a dummy variable that takes one if *Spread<sup>Lev</sup>* is above 100*p* percentile of its distribution and zero otherwise. Spread<sup>Inv</sup><sub>t-1</sub> and associated  $Dum_{L}L^{hv}$  and  $Dum_{U}U^{hv}$  are defined in the same manner. \* and \*\* indicate statistical significance at the 5% and 1% levels, respectively. Numbers in square brackets are t-statistics.

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	Entire sample	Spread <sup>Lev</sup> <sub>t-1</sub> belonging	Spread <sup>Lev</sup> <sub>t-1</sub> belonging
		to lower or upper 25%	to lower or upper 10%
Samoa dLev	-0.265**		
Spreud <sub>t-1</sub>	[-5.687]		
Dum I Lev		0.166**	0.278**
$Dum_L t-1$		[3.334]	[4.062]
D. IILev		-0.117*	-0.250**
$Dum_U$ t-1		[-2.369]	[-3.685]
VOCDI <sup>C0</sup>	0.022	0.015	0.024
KOSPI t-1	[0.609]	[0.416]	[0.662]
KODCICC	-0.004	-0.011	-0.009
KUPSI t-1	[-0.163]	[-0.418]	[-0.345]

### Panel A: Leveraged ETF

#### **Panel B: Inverse ETF**

	Entire sample	Spread $I_{t-1}$ belonging to lower or upper 25%	Spread $I_{t-1}$ belonging to lower or upper 10%
Spread <sup>Inv</sup> <sub>t-1</sub>	0.485** [5.769]		
Dum $L^{Inv}_{t-1}$		-0.156**	-0.214**
		[-3.141] 0.155**	[-3.147] 0.162*
$Dum_U$ $_{t-1}$		[3.144]	[2.386]
KOPSI <sup>co</sup> t-1	0.022 [0.609]	0.029 [0.806]	0.033 [0.922]
KOSPI <sup>cc</sup> <sub>t-1</sub>	-0.032 [-1.247]	-0.036 [-1.405]	-0.031 [-1.230]

Table 3 reports the results based on the regression model of Equation (6).

The results are consistent with our expectation. The Spread at the previous-day market close has a negative effect on the opening price of the KOSPI 200 for the case of the  $2\times$ leveraged ETF. In contrast, it has a positive effect on the opening price of the KOSPI 200 for the case of the inverse ETF. In order to measure the magnitude of the impact, regressions with dummy variables with different choice of p for the definition of Dum L, and Dum U are also considered. First of all, the signs of the dummy variables are consistent. The coefficients on Dum L for the leveraged ETF are all positive and the coefficients on Dum U are all negative. Since Dum L = 1 means that the leveraged ETF outperformed its tracking index during the previous day, the leveraged ETF managers would want to buy more stocks at the market opening. On the other hand, when the Spread is positively large, i.e. when Dum U=1, the leveraged ETF managers would want to sell more stocks at the market opening. The coefficient signs on Dum U are flipped when we consider the inverse ETF, which is also as expected. Moreover, when we change the value of p from 25% to 10%, the magnitude of the coefficients becomes larger, implying that the size of discrepancy has a positive correlation with the magnitude of impacts on the opening price of the underlying index. Hence, the results provide evidence that there exists a significant impact on the opening price of the underlying market stemming from the discrepancies between leveraged ETFs and their benchmark index at the previous-day market close and that the larger the discrepancy, the higher the impact.<sup>9</sup>

# VI. Conclusion

The recent development of ETFs is considered a financial innovation. However, the security has also ignited a debate over whether ETFs cause market instability. In this paper, the question of whether leveraged and inverse ETFs move or influence the underlying market is addressed by using data from Korean financial markets. The Korean stock and futures markets provide a unique context to address the question as explained in the introduction. Using the Hasbrouck information shares, we find that for the continuous price processes based on daily close-to-close prices, the contribution of the underlying market to price discovery is approximately the same as those of the leveraged ETFs. However, when it comes to the question of whether leveraged ETFs influence the opening price of the underlying market, we find evidence that the opening price of the KOSPI200 index is substantially influenced by the daily return mismatch between leveraged ETFs and their benchmark index at the previous-day market close. These findings based on the close-to-open returns indicate that the leveraged ETFs contribute significantly to price discovery, or they wag the market, in terms of the overnight price discovery. However, the findings based on the close-to-close returns also indicate that the effect of the leveraged ETFs on the underlying market disappears during the day-time trading hours.

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<sup>&</sup>lt;sup>9</sup> In order to examine whether there is any month-end window dressing effect, we also considered an extended regression model of Equation (6) which adds two dummy variables of *Dum\_MEND* and *Dum\_MBEG* to the regression model of Equation (6). Here, *Dum\_MEND* and *Dum\_MBEG* represent the dummy variables for the month-end and month-beginning trading days, respectively. Table A1 in the Appendix section shows that the coefficients on these two dummy variables are insignificantly different from zero across all model specifications considered. We thank the anonymous referee for proposing an analysis of calendar effects.

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As a final comment, we admit that the process of price discovery between the leveraged/inverse ETFs and underlying spot market should be very quick and thus intraday price processes should provide a more decisive answer to the question about the relative price discovery contribution between them.<sup>10</sup> However, intraday price data are not available to us, so we would like to leave intraday analysis for a future research topic.

# Appendix

### TABLE A1. THE EFFECTS OF THE END-OF-MONTH WINDOW DRESSING

This table reports the results of an extended regression model of Equation (6). Two dummy variables of *Dum\_MEND* and *Dum\_MBEG* are added to the regression model of Equation (6), where *Dum\_MEND* and *Dum\_MBEG* are the dummy variables for the month-end and month-beginning trading days, respectively.

Panel A: Leveraged ETF

	Entire sample	Spread <sup>Lev</sup> <sub>t-1</sub> belonging to lower or upper 25%	$Spread^{Lev}_{t-1}$ belonging to lower or upper 10%
g 1Lev	-0.264**		
Spread <sub>t-1</sub>	[-5.654]		
Dur I Lev		0.165**	0.277**
$Dum_L$ t-1		[3.318]	[4.034]
D IILev		-0.117*	-0.250**
$Dum_{t-1}$		[-2.367]	[-3.669]
VOCDI <sup>C0</sup>	0.022	0.015	0.024
KOSP1 t-1	[0.609]	[0.408]	[0.665]
VODGICC	-0.004	-0.011	-0.009
KOPSI t-1	[-0.168]	[-0.412]	[-0.351]
D MEND	-0.015	-0.034	-0.013
$Dum_MEND_{t-1}$	[-0.164]	[-0.364]	[-0.143]
Dum MREC	0.300	0.028	0.033
	[0.319]	[0.301]	[0.354]

Panel B: Inverse ETF

	Entire sample	Spread $^{Inv}{}_{t-1}$ belonging to lower or upper 25%	$Spread^{Inv}_{t-1}$ belonging to lower or upper 10%
c Inv	0.485**		
Spread <sup>m</sup> <sub>t-1</sub>	[5.742]		
Dura I Inv		-0.156**	-0.214**
$Dum_L$ t-1		[-3.142]	[-3.133]
Dum Ulnv		0.155**	0.160*
$Dum_{t-1}$		[3.109]	[2.356]
VODCI <sup>CO</sup>	0.031	0.029	0.033
KOPSI t-1	[0.873]	[0.807]	[0.920]
VOCDI <sup>CC</sup>	-0.032	-0.036	-0.031
KOSFI t-1	[-1.257]	[-1.405]	[-1.229]
Dum MEND	-0.002	-0.016	-0.021
$Dum_MEND_{t-1}$	[-0.025]	[-0.169]	[-0.226]
	0.043	0.036	0.038
$Dum\_MBEG_{t-1}$	[0.456]	[0.386]	[0.687]

<sup>10</sup> We thank the anonymous referee for raising the issue.

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