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Expiration Effect of Leveraged and Inverse ETFs

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Abstract

This study aims to examine whether there is a maturity effect in the leveraged and reverse ETFs on the maturity date of the underlying index futures or on the trading day before and after the maturity date and to investigate whether the maturity effect of different types of ETF commodities is more prominent issue. The sample is leverage and inverse ETFs tracking the Taiwan Stock Exchange Capitalization Weighted Stock Index from October 31, 2014 to January 15, 2018. Empirical model used bivariate GARCH model to captures the variations of maturity effects. The study shows that all ETFs present significant maturity effects before expiration. In particular, the volatility and trading volume present abnormal phenomenon.

Keywords: Leveraged and reverse ETFs, maturity effect, bivariate GARCH model.

1. Introduction

Since the development of the global capital market, diversified investment channels meet the demand of market investors. In recent years, the Exchange Traded Fund (ETF) has become one of the main investment vehicles for investors to track the variation of the target index to obtain the same return. Since the introduction of SPDR by the US Stock Exchange in 1993, the world's first ETF has led the global ETF market to flourish. As of July 2017, the total assets of ETF in the world have reached USD 4.05 trillion, covering not only ETFs tracking different target assets, but also leveraged and reverse ETFs for the first time in 2005. In the Asian market, in 2014, Taiwan launched ETFs tracking the forward single return and reverse dual return of Taiwan 50 index, providing investors with new options for passive investment. Due to the characteristics of ETFs without margin pressure and maturity transfer cost, they provide investors with more flexible trading strategies.

On the other hand, in terms of leveraged or reverse ETFs, the stock holding portfolio is composed of some or all of the commodities synthesized for futures or other derivative financial commodities. However, due to the limitation of the maturity date, futures must be settled at spot prices on the maturity date. Although all countries have their complete settlement systems and regulations, in the trading days around the settlement maturity date of the futures, the price volatility and volume of both spot and futures markets still have abnormal trend, which results in greater price risk for investors and is called maturity effect of portfolio investment. Intuitionistic inference shows that spot or futures maturity effect is prevalent in the market, ETF commodities with stock price index as the tracking target will have a certain degree of maturity effect risk besides tracking error risk. Especially, in addition to the characteristics of the multiple effect, whether leveraged or reverse ETF commodities have the same risk nature and then affect the hedging efficiency is at present a gap to be filled in the literature and also the main motivation for this study to explore this topic.

To synthesize the above arguments, this study establishes three main research purposes for checking. Firstly, it explores whether leveraged and reverse ETF commodities in Taiwan have maturity effects on tracking the maturity date or the trading days before or after the maturity date of target index futures. Since futures price has a close dependence with its target spot price, ETF is an investment that tracks an index and purchases a basket of stocks in the spot market, while the leveraged ETF purchases the spot and purchases futures with part of the capital to achieve multiple leverage. Therefore, the maturity effect will occur to the futures price around the settlement date. In theory, the price of ETF should also be affected by the futures effect. Therefore, it is necessary for investors of short-term arbitrage or hedge trading to understand whether the maturity effect of ETF is significant and what is the impact of maturity effect to provide investment judgment, which is the first purpose of this study. Secondly, whether the risk variation and maturity effect of leveraged or reverse ETFs are doubled when a particular major event occurs is the second purpose of this study. In other words, will systemic risk increase the risk of new-type ETF and produce more drastic maturity effect or variation of risk structure when a major event impact occurs in the market? Do leveraged ETFs or reverse ETFs have inconsistent price and volatility trends? This is the topic that this institute intends to explore. Finally, considering the volatility clustering of financial asset return volatility and the time-varying behavior, and the common variation structure of ETF, which mainly tracks financial commodities with target index, this study will conduct an empirical study with the General Autoregressive Conditional Heteroskedasticity (GARCH) model proposed by Bollerslev, Engle, and Wooldridge [3].

Finally, since leveraged or reverse ETFs simulate the tracking index with derivative financial commodities, coupled with the daily rebalancing characteristics, how to adjust the portfolio held by arbitrage or hedge investors is a topic of concern to investors, and relevant analysis results will also be revealed in this study.

This study is organized as follows: in the first part, the current situation of global ETF market development is introduced and the main research objectives and work are explained. The second part is a literature review, which summarizes the research conclusions of relevant stock markets and leveraged or reverse ETF maturity effect, ETF tracking error characteristics, as the theoretical basis of this empirical study. The third part is the research method setting, including Bi-variables GARCH model setting and empirical model building. The fourth part describes the source and processing of the sample data and provides the analysis results of the basic system of variables. The fifth part is empirical results and analysis. Finally, the sixth part is conclusions and suggestions.

2. Literature Reviews

2.1. Tracking performance of leveraged and inverse ETFs

A review of the literature suggests that previous scholars generally have a deep understanding of returns and volatility of the ETF market. In terms of performance, Lu, Wang, and Zhang [11] took the US ETF market as the research object to explore the long-term performance of leveraged ETF and reverse ETF commodities in market transactions. Their empirical results show that when investors hold for more than one month, such ETFs had an obvious deviation exceeding the multiple results from spot performance. Similar results were obtained from the study of Charupat and Miu [4], which analyzed and tracked that leveraged ETFs had end-of-day rebalancing mechanism and the short-term traders participating in, their trading behavior model would increase the error between market volatility and tracking target index. The tracking error was very small when holding for one week, but it would increase when holding for more than one week. On the other hand, the empirical results showed that with the increase of holding time, the tracking error of investment performance on tracking index would increase significantly, especially for reverse leverage ETF. The major reason was the rebalance on an end-of-day basis. The performance not as good as the multiple expectations became more significant with the increase of volatility and the extension of the holding period. Bansal, Marshall, and John [2] argued that besides the end-of-day rebalancing, the main causes of leveraged ETFs tracking errors included the volatility of linking objectives, fund management costs and financing costs, all of which affected the error of leveraged ETFs.

In addition, in terms of volatility research, Rompotis [13] tracked the return of leveraged and reverse ETFs in emerging markets. Empirical results showed that the spillover effect of return and volatility was quite significant between leveraged ETFs and tracking index. Dulaney, Husson, and McCann [10] provided different opinions. They held that ETF mainly leveraged passive investment to obtain various target asset tracking returns. However, ETF's return behavior will become more and more complex over time, which can be attributed to the fact that the new-type ETF purchases spot through futures contracts or other derivatives rather than through physical transactions to track the multiple-day performance of the target index, leading to great deviation of the expected return of investors and significant losses. Especially, most of the performance of ETFs is significantly lower than the spot price of their related assets.

Finally, besides the tracking error caused by the end-of-day rebalancing, management costs and liquidity in major events also affect the performance of leveraged ETF investment. Shum and Kang [14] studied the performance of leveraged ETF return during the financial tsunami and found that market leverage was caused by liquidity during the financial tsunami, leading to the net value of the leveraged ETF seriously distorted relative to the return of the tracer index, which indicates that major events or special periods in the market will also affect the investment performance of the leveraged ETF. In this paper, further research will be carried out on such effect.

Based on the above arguments, many previous studies showed that different ETF commodities had different performances in tracking the spot market. At the same time, they also had more significant differences depending on the different holding periods of investors. However, although previous literature provides multi-level explanation and analysis for different commodities, it has not made an in-depth analysis of the characteristics of derivative commodities such as index futures with maturity settlement; moreover, although ETF provides a channel for investors to invest in the trend of the market, when the market has the limitation of short-selling and rising or falling, it will cause a twist on the fluctuation or price trend of forward and reverse ETF commodities. In this way, it also stimulates the motivation of this study to fill the gap in the literature. At the same time, it also serves as a topic to be understood by the industry, government, and academia. Therefore, specific suggestions for improvement will be provided in the following chapters of this study.

2.2 Maturity effect of stock market

The abnormal volatility of the stock market near the settlement date is often considered to be the impact of the maturity of derivatives linked to the spot market. However, the degree of maturity effect varies with the different settlement systems of countries. However, there is no consistent conclusion. Fung, Joseph and Yung [8] did not find the evidence of an abnormal increase in spot market volatility as a result of variation in spot prices and volume data, indicating that the Hong Kong market did not have a significant maturity effect when derivatives expired. However, in the research of maturity effect between the futures market and spot market in Taiwan, other scholars put forward different opinions. For example, Chou, Chen and Chen [5] found that compared with Hong Kong, after 2002, since other derivative commodity instruments have been launched one after another, the maturity effect has doubled significantly for future commodities. In addition, a similar study of Hsieh [10] took Taiwan stock index futures as the research sample and found that the volatility and trading volume of Taiwanese stock market on maturity day and weighted stock on settlement day were significantly higher than those of small and medium-sized stocks. It showed that there was a way of manipulating the weighted stock price and trading volume on maturity day for the purpose of increasing the effect of spot maturity in the market. Chung and Hseu [6] compared the maturity date effect of Taiwan stock index futures and Singapore Mortail Index futures. The study also showed that not only Taiwan stock futures, but also Singapore Mortail Index futures with the same target also had the maturity effect of increasing volatility and abnormal trading volume on the maturity date. It can be inferred that leveraged and reverse ETF commodities tracking target index are more likely to have maturity effect and proving this is also one of the main purposes of this study.

On the other hand, since ETF is purchased and sold on the exchange in the same way as stocks, it takes the market price as the transaction price and the latest transaction price as the quotation. Although the mechanism of ETF's application for purchase in kind makes the discount premium of ETF less than that of closed funds, whether long-term discount or premium is more significant or not in leveraged or reverse ETFs is also a topic to be discussed in this study. In the past, scholars Rompotis [13] have found that there is a long-term average discount or premium of 0.059% between market price and net value of ETFs, and the biggest factor contributing to it is the daily ETF trading volume and its volatility, among which trading volume is considered to be the most critical factor affecting discount or premium of ETFs. In addition, Aber, Li, and Can [1] also studied the traditional funds and ETFs tracking the same target. Although the tracking correlation between them is approximately the same, ETFs are more volatile than traditional funds in daily fluctuation and are more prone to discount or premium between market price and net value.

3. Empirical Model

3.1. Variables definitions

The main purpose of this study is to explore the impact of different ETFs, especially leveraged and reverse ETFs, on tracking the interaction of stock market index. Whether and to what extent the abnormal trading volume or volatility of the stock market on several trading days before the settlement day will have a positive or negative impact on ETF return performance or trading volume, are of concern to investors. The topic of this study is whether ETF has maturity effect before and after the settlement day of the stock market, which is the intended direction of this study. Therefore, the variables of this study are defined as follows:

1. Stock market returns (SR_t^i)

The return rate is the most direct data of the profitability of the investment target concerned by market investors and is also the ultimate goal of all investment actions. Referring to Holzhauer et al. [9] approach, the following formula of stock market returns (SR_t^i) is defined to measure the performance of the investment target:

$$SR_t^i = \log\left(\frac{P_t}{P_{t-1}}\right) \times 100\%. \tag{3.1}$$

In Formula (3.1), P_t represents the closing price of the stock market in Tth period and SR_t^i the return rate of the stock market in Tth period of commodity I. For example, weighted index rate of return: SR_t^{Stock}, traditional Taiwan 50 ETF rate of return: SR_t^{ETF}, leveraged ETF rate of return: SR_t^{ETFL} and reverse ETF rate of return: SR_t^{ETFI}.

2. Trading Volume (Vol_t^i)

In terms of trading volume, as the variation of trading volume is the focus of many investors and an important reference index of investment strategy, the variation of trading volume has a great influence on the liquidity risk of investors' positions. To influence the return rate of the stock market, by referring to Holzhauer et al. [9] approach and the definition of trading volume variable is defined with the formula of trading volume (Vol_t^i):

$$\Delta Vol_t^i = Vol_t^i - Vol_{t-1}^i. \tag{3.2}$$

In Formula (3.2), Vol_t^i refers to the volume variation of commodity I in the Tth period, including Vol_t^{Stock}, Vol_t^{ETF}, Vol_t^{ETFL}, and Vol_t^{ETFI}, which refer to the stock market, traditional Taiwan 50 ETF, leveraged and reverse ETF volume variation, respectively.

3.2. Bi-variables GARCH model

If the general research method is to extend from the single variable GARCH model to multivariable GARCH model, the theory should allow the conditional covariance matrix of a random variable ε_t with zero as the average. Influenced by information set elements, the multivariable GARCH model can be expressed as follows:

$$Y_t = X_t B + \varepsilon_t,\ \varepsilon_t \mid \Omega_{t-1} \sim N(0, H_t). \tag{3.3}$$

All elements in the conditional covariance matrix are affected not only by the cross terms of the square of the previous p error term and the error term but also by the weak exogenous variables of the values and $J \times 1$ vectors of the elements in the previous q conditional covariance matrix. Assuming that X_t only includes exogenous variables of the current and previous periods, and defining:

$$h_t = \text{vec} H_t \chi_t = \text{vec}(x_t x_t')\eta_t = \text{vec}(\varepsilon_t \varepsilon_t')$$

where vec$(\cdot)$ refers to the superposition vector, h_t can be expressed as:

$$h_t = C_0 + C_1\chi_t + A_1\eta_{t-1} + \cdots + A_q\eta_{t-q} + G_1 h_{t-1} + \cdots + G_p h_{t-p} \tag{3.4}$$

where C_0 refers to the parametric vector of $n^2 \times 1$, C_1 refers to the parametric matrix of $n^2 \times J^2$, A_i and G_i are the parametric matrices of $n^2 \times n^2$. In the bivariate GARCH (1,1) model without the influence of exogenous variables, the covariance matrix can be written as:

$$h_t = \begin{bmatrix} h_{11,t} \\ h_{12,t} \\ h_{22,t} \end{bmatrix} = \begin{bmatrix} c_{01} \\ c_{02} \\ c_{03} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_{11,t}^2 \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}^2 \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{bmatrix} \begin{bmatrix} h_{11,t-1} \\ h_{12,t-1} \\ h_{22,t-1} \end{bmatrix}. \tag{3.5}$$

It can be seen from the above formula that $h_{21,t}$ is the same as $h_{12,t}$, so $h_{21,t}$ cannot be considered. Therefore, the matrix A_1 and G_1 each have nine parameters, and totally have twenty-one parameters. However, to simplify the number of estimated parameters in empirical analysis, it is necessary to restrict this parameterized form. Thus, Bollerslev, Engle and Wooldridge [3] put forward the diagonal representation, which defined the variance only affected by the square of the error term in the backward period and the variance in the previous period, and the covariance only affected by the cross term of the error term in the backward period and the covariance in the previous period. In the case of two variables, the bivariate GARCH (1,1) diagonal model can be expressed as follows:

$$h_t = \begin{bmatrix} h_{11,t} \\ h_{12,t} \\ h_{22,t} \end{bmatrix} = \begin{bmatrix} c_{01} \\ c_{02} \\ c_{03} \end{bmatrix} + \begin{bmatrix} a_{11} & 0 & 0 \\ 0 & a_{22} & 0 \\ 0 & 0 & a_{33} \end{bmatrix} \begin{bmatrix} \varepsilon^2_{11,t} \\ \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon^2_{2,t-1} \end{bmatrix} + \begin{bmatrix} g_{11} & 0 & 0 \\ 0 & g_{22} & 0 \\ 0 & 0 & g_{33} \end{bmatrix} \begin{bmatrix} h_{11,t-1} \\ h_{12,t-1} \\ h_{22,t-1} \end{bmatrix} \tag{3.6}$$

or

$$\begin{aligned} h_{11,t} &= c_{01} + a_{11}\varepsilon^2_{1,t-1} + g_{11}h_{11,t-1}, \\ h_{12,t} &= c_{02} + a_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + g_{22}h_{12,t-1}, \\ h_{13,t} &= c_{01} + a_{33}\varepsilon^2_{2,t-1} + g_{22}h_{22,t-1}. \end{aligned}$$

From the above formula, it can be seen that in the diagonal model of GARCH (1,1) with two variables, the matrix A_1 and G_1 each have three parameters. Where H_t must be positive definite, which cannot be set in the estimation formula in empirical analysis. Engle and Kroner (1995) proposed a new parameterized form to solve the positive definite problem with the model as follows:

$$H_t = C_0^{*'}C_0^* + \sum_{k=1}^{K} C_{1k}^{*'} x_t x_t' C_{1k}^* + \sum_{k=1}^{K}\sum_{i=1}^{p} A_{ik}^{*'}\varepsilon_{t-1}\varepsilon_{t-1}' A_{ik}^* + \sum_{k=1}^{K} G_{ik}^* \cdots \sum_{i=1}^{q} G_{ik}^{*'} H_{t-i}. \tag{3.7}$$

Among them, C_0^*, A_{ik}^* and G_{ik}^* refer to the parametric matrix of $n\times n$, and C_0^* is the upper triangular matrix and C_{1k}^* refers to the parametric matrix of $J \times n$, while K depends on the degree of generalization of the process and will be positive definite under the above settings. This was called BEKK representation by Engle and Kroner. Under $K = 1$ and without the effect of exogenous variables, the BEKK model of simple GARCH (1,1) is expressed as:

$$H_t = C_0^{*'}C_0^* + A_{11}^{*'}\varepsilon_{t-1}\varepsilon_{t-1}' A_{11}^* + G_{11}^{*'} H_{t-1} G_{11}^*. \tag{3.8}$$

By comparing BEKK model with VEC representation model, it can be seen that the parameters of BEKK model are simpler. In the case of bivariate and $K = 2$, a simple parameterized model can be obtained, and assuming

$$A_1 = \begin{bmatrix} a_{1,11} & 0 \\ 0 & a_{1,22} \end{bmatrix}, \quad A_2 = \begin{bmatrix} 0 & 0 \\ 0 & a_{2,22} \end{bmatrix}, \quad G_1 = \begin{bmatrix} g_{1,11} & 0 \\ 0 & g_{1,22} \end{bmatrix}, \quad G_2 = \begin{bmatrix} 0 & 0 \\ 0 & g_{2,22} \end{bmatrix}.$$

Under the above settings,

$$\begin{aligned} h_{11,t} &= c^2_{11} + a^2_{1,11}\varepsilon^2_{1,t-1} + g^2_{1,11}h_{11,t-1}, \\ h_{12,t} &= c_{12}c_{11} + a_{1,11}a_{1,22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + g_{1,11}g_{1,22}h_{12,t-1}, \\ h_{22,t} &= c^2_{22} + c^2_{12} + (a^2_{1,22} + a^2_{2,22})\varepsilon^2_{2,t-1} + (g^2_{1,22} + g^2_{2,22})h_{22,t-1}. \end{aligned}$$

In this study, the bivariate GARCH model proposed by Engle and Kroner [7] is used as the main empirical model. The relevant important variables are selected as follows:

traditional ETF return: ETFR_t, leveraged ETF return: ETFLR_t, and reverse ETF return: ETFIR_t, the model is defined as follows:

$$\begin{aligned}
\mathrm{ETFR}_t &= \beta_{10} + \beta_{11}\mathrm{ETFR}_{t-1} + \beta_{12}\mathrm{ETFLR}_{t-1} + \beta_{13}\mathrm{STOCKR}_{t-1} + \beta_{14}\mathrm{ETFVOL}_{t-1} \\
&\quad + \beta_{15}\mathrm{DUM} + \beta_{16}\mathrm{DUM} \times \mathrm{ETFVOL}_{t-1} + \varepsilon_{\mathrm{ETFR},T}, \\
\mathrm{ETFLR}_t &= \gamma_{10} + \gamma_{11}\mathrm{ETFLR}_{t-1} + \gamma_{12}\mathrm{ETFR}_{t-1} + \gamma_{13}\mathrm{STOCKR}_{t-1} + \gamma_{14}\mathrm{ETFLVOL}_{t-1} \\
&\quad + \gamma_{15}\mathrm{DUM} + \gamma_{16}\mathrm{DUM} \times \mathrm{ETFLVOL}_{t-1} + \varepsilon_{\mathrm{ETFLR},t}, \\
\mathrm{ETFIR}_t &= \alpha_{10} + \alpha_{11}\mathrm{ETFIR}_{t-1} + \alpha_{12}\mathrm{ETFR}_{t-1} + \alpha_{13}\mathrm{STOCKR}_{t-1} + \alpha_{14}ETFIVOL_{t-1} \\
&\quad + \alpha_{15}\mathrm{DUM} + \alpha_{16}\mathrm{DUM} \times \mathrm{ETFIVOL}_{t-1} + \varepsilon_{\mathrm{ETFIR},t}.
\end{aligned}$$

The defined equation of the variance matrix is listed as follows:

$$\begin{aligned}
H_{11,t} &= c_{11}^2 + a_{1,11}^2\varepsilon_{1,t-1}^2 + g_{1,11}^2 H_{11,t-1}, \\
H_{12,t} &= c_{11}c_{12} + a_{1,11}a_{1,22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + g_{1,11}g_{1,12}H_{12,t-1}, \\
H_{22,t} &= c_{22}^2 c_{12}^2 + (a_{1,12}^2 + a_{2,22}^2)\varepsilon_{2,t-1}^2 + (g_{1,22}^2 + g_{2,22}^2)H_{22,t-1}.
\end{aligned}$$

Among them, STOCKR_t is the market return in the period, ETFR_t and ETFLR_t refer to the return of traditional ETFs and leveraged ETFs in the tth period, respectively; ETFVOL_t refer s to the transaction volume of the traditional ETF in the Tth period.

4. Data

4.1. Data sources

The leveraged and reverse ETFs to be explored in this study have obvious maturity effects in several trading days before the maturity date of the tracking index. Therefore, the data selected in this paper are the data of the Taiwan weighted index date, including the opening price, the highest price, the lowest price and the closing price on that day. The traditional ETF (Taiwan 50 ETF), the leveraged ETF and the reverse ETF with the largest trading volume in Taiwan are selected, among which the leveraged ETF and the reverse ETF are selected. Leverage ETF and reverse ETF are used as samples for this study. The original data is from the daily closing date of the Taiwan Stock Exchange. The data period is from the open leveraged ETF and the reverse ETF in 2014 as the starting point of samples. To unify the data reference, the data interception period is from October 31, 2014, to January 15, 2018. The frequency of data transactions is 786 per day.

4.2. Basic statistics for all variables

Table 1 and Table 2 are the basic descriptive statistics of the variables in the data samples of this study. In Table 1, it can be observed that the narrative statistics of the single-day return rates of the market-weighted index, traditional ETFs, leveraged ETFs and reverse ETFs are listed respectively. First, their average and standard deviations are observed to be (0.0254%+0.8063), (0.0331%+0.8896), (0.0776%+1.7127), (0.0551%+0.8332), respectively. It shows that leveraged ETF indeed fluctuates significantly in the single-day return, indicating the standard deviation of the volatility is about twice that of reverse ETF, which proves that leveraged ETF does meet its definition in terms of single-day returns that give leveraged ETF investors a chance to achieve higher returns on investment and bear relatively high volatility risks; the standard deviation of Taiwan weighted index 50 ETF and reverse ETF is close to each other, which means that under fixed leverage, the volatility of the index and ETF is the same. The bias of Taiwan 50 ETF and its reverse ETF in Taiwan are negative and positive, respectively. Finally, the Jarque-Bera test is used to verify the normal distribution. The results show that at 1% significant level, all return variables reject the assumption of normal distribution.

Table 1: Basic Statistics of Return Series in Stock and ETF Markets.

	SR_t^{Stock}	SR_t^{ETF}	SR_t^{ETFL}	SR_t^{ETFI}
Mean(%)	0.0254	0.0331	0.0776	-0.0551
Max	3.5175	4.3000	8.9782	5.6724
Min	-4.9569	-3.9220	-11.1917	-4.9877
Std.	0.8063	0.8896	1.7127	0.8332
Skewness	-0.46257	0.0737	-0.3322	0.2230
Kurtosis(excess)	3.5317	2.6327	4.6591	5.6806
Jarque-Bera	435.9663***	227.4136***	724.4516***	1061.9828***
$Q(20)$	36.2200**	27.944	32.2510**	37.5870***
$Q(20)^2$	197.1130**	89.0790***	149.5920***	178.0790***

Note: The asterisk *, **, *** present the 10%, 5%, and 1% significant level. The Jarque-Bera statistics is normal distribution test.

Then, in Table 2, the narrative statistics of one-day trading volume of the market-weighted index, traditional ETF, leveraged ETF, and reverse ETF are listed. First, it can be observed that the standard deviation representing volatility in ETFs including Taiwan 50, leveraged ETF or reverse ETF, is greater than the weighted index, which shows that ETF investors use ETF tools as short-term hedging or arbitrage for short purchasing or selling. The characteristics, especially for the reverse ETF, are more obvious. Under special circumstances, the trading volume increases or decreases dramatically. For the turnover skewness of Taiwan 50 ETF and its reverse ETF, Taiwan 50 ETF and leveraged ETF have positive skewness, which means that most of the samples are on the left side of the average; while the reverse ETF has negative skewness, which shows that most of the samples are on the right side of the average; while the normal distribution verification is based on Jarque-Bera statistics, and the results show that at a significant level of 1%, all the turnover variables also totally reject the assumption of normal distribution.

Table 2: Basic Statistics of Trading Volume in Stock and ETF Markets.

	Vol_t^{Stock}	Vol_t^{ETF}	Vol_t^{ETFL}	Vol_t^{ETFI}
Mean	15.3284	8.7369	8.2429	10.2246
Max	15.9854	11.0238	10.9186	12.6955
Min	14.4466	6.6958	5.6095	7.4348
Std.	0.2167	0.8067	0.9485	1.0305
Skewness	-0.3024	0.0347	0.1051	-0.5675
Kurtosis(excess)	0.4415	-0.5644	-0.5061	-0.2252
Jarque-Bera	18.3646***	10.5907***	9.8335***	43.8429***
$Q(20)$	103.3580***	192.2650***	18.9400***	146.979***
$Q(20)^2$	79.7380***	33.0770**	13.1840	26.1780

Note: The asterisk *, **, *** present the 10%, 5%, and 1% significant level. The Jarque-Bera statistics is normal distribution test.

5. Estimated Results

5.1. Estimated results from Bi-variables GARCH

Empirically, before the regression analysis, it is necessary to check whether the data are stationary. In this section, ADF verification and PP verification are used. To improve the self-correlation of regression errors, ADF verification affects its verification ability. After verification, it showed that all variables are stationary data. In ADF single-root verification, although the possible sequence correlation of error items has been taken into account, it still does not exclude the possibility of heterogeneity. Therefore, Phillips and Perron [12] relaxed the basic assumptions of the ADF verification method and developed PP verification to correct the sequence correlation and heterogeneity caused by error items. After verification, all variables meet stationary sequence under a significant level of 1%.

In this study, the bivariate GARCH model is used for empirical research, and the traditional ETF, leveraged ETF and reverse ETF that tracks the weighted index of Taiwan are selected as the research objectives. Variables of index ETF return and trading volume are introduced into the model to analyze the interaction of each variable five days before the maturity date. The estimated results of the bivariate GARCH model are collected in Table 3, which explains the change. However, before estimating the results of the anomalous and mean equation, first the suitability of GARCH model must be confirmed and whether the test conforms to the standard error and has no self-correlation must be verified. From the Q statistics of Ljung-Box in Table 3, the squares of the residual items and the residual items are not significant below 1% level, which means that the information in ε has been recovered and ε has no self-correlation; but the Q^2 statistics are not significant, which means that the model has captured the heterogeneity of ε and Q_ε^2 has no heterogeneity, which proves that the model is well matched and can support the evidence used in this study. The empirical results in the sample period, as shown in Table 3, show the causal relationship between traditional ETF and leveraged ETF.

At the significant level of 1%, the return of leveraged ETF in the previous period shows a negative relationship of coefficient -0.2716, while the return of traditional ETF in the previous period also shows a positive relationship of coefficient 0.9577 at the 1% significant level of leveraged ETF. The results of the two-way influence show that the traditional ETF and leveraged ETF do have the characteristics of mutual influence; since the commodities of the two ETFs are exponential commodities with the same direction and different leveraged coefficients. As mentioned earlier in this study, traditional ETFs are generally the investment choice of long-term investors, while leveraged ETFs are mostly the target of short-term investors' speculation or hedging. Therefore, in practice, once market fluctuations increase sharply and investors are optimistic about future trends, since they are substitutes for each other, investors will choose leveraged ETF as short-term investment to pursue higher profits; the main reason for the negative relationship between leveraged ETFs and traditional ETFs is the crowding-out effect of leveraged ETFs; when long-term investors are still optimistic about the long-term trend in the future, they will invest the capital in the weighted stocks of the index or gradually invest the capital in the traditional ETFs to pursue the profits of the overall stock market, which, at the same time, will be raised and push up the net value of leveraged ETF. This also explains why traditional ETFs have a positive impact on leveraged ETFs.

Therefore, the relationship between the two ETF types should be different attributes of investors attracted by commodity characteristics: traditional ETF investors are mostly long-term investors; leveraged ETF investors are mostly short-term investors; secondly, different trading purposes: traditional ETF investors pursue long-term participation in the performance of the market index and dividend distribution, while leveraged ETF investors mostly take the purpose of speculation or hedge demand as the starting point and their trading frequency and holding period are different from those of long-term investors; different entry timings: when volatility increases, leveraged ETF holders will benefit since they can get multiple excess returns, but when the market situation is not in obvious consolidation, traditional ETFs will benefit holders due to low total cost rate and low tracking error. Therefore, different investors will select different commodities for the transaction when their volatility is different, which will also cause different interaction. In addition, the impact of the market index on the ETF is observed. The return rate of the market index has a positive correlation of 0.2963% for the traditional ETF at a significant level of 1%, and a positive correlation of 0.6357% for the leveraged ETF and the positive correlation coefficient of leveraged ETFs is multiple of traditional ETFs, which should be in line with investors' expectations. At the same time, if the market index increases for a long time, investors may purchase leveraged ETFs, which leads to a premium and a short-term return multiple of traditional ETFs.

Secondly, the trading volume is observed. The trading volume of traditional ETFs and leveraged ETFs showed a positive correlation of 0.001% and 0.003%, respectively, which means that the increase of the volume will contribute to the increase of the ETF's return, the volume price and the price, which is the same as the expectation of ordinary

Table 3: Estimated Results from Traditional and Leveraged ETFs.

	ETFR		ETFLR
PANEL-A: Mean Equations			
	Coeff. (Std. error)		Coeff. (Std. error)
B_{10}	-0.0013***	γ_{10}	-0.0022***
	(0.0001)		(0.0001)
B_{11}	0.2323***	γ_{11}	-0.7854***
	(0.0093)		(0.0108)
B_{12}	-0.2716***	γ_{12}	0.9577***
	(0.0049)		(0.018)
β_{13}	0.2963***	γ_{13}	0.6357***
	(0.0100)		(0.0200)
β_{14}	0.0001***	γ_{14}	0.0003***
	(0.0000)		(0.0001)
β_{15}	-0.0007***	γ_{15}	0.0025***
	(0.0001)		(0.0002)
β_{16}	0.0001***	γ_{16}	-0.0003***
	(0.0000)		(0.0001)
PANEL-B: Covairnace Structure			
C_{11}		0.0043***	
		(0.0001)	
C_{12}		0.0081***	
		(0.0001)	
C_{22}		-0.0016***	
		(0.0000)	
$A_{1,11}$		-0.3671***	
		(0.0048)	
$A_{1,22}$		-0.4686***	
		(0.0031)	
$A_{2,22}$		-0.0001	
		(-0.0000)	
$G_{1,11}$		0.8066***	
		(0.0010)	
$G_{1,22}$		0.7675***	
		(0.0017)	
$G_{2,22}$		-0.0000	
		(-0.0000)	
$Q(20)$		38.8640	
$Q(20)^2$		94.4860	
Log Likelihood Value			5706.4359

Note: The asterisk *, **, *** present the 10%, 5%, and 1% significant level.

investors upon observing the volume of trading. Price follows volume, the increasing volume of trading will push the commodity prices up at the same time. Finally, the short-term return and trading volume variation of traditional ETFs and leveraged ETF before maturity date are also observed. At the same time, it is found that the traditional ETFs show a negative correlation of -0.0007 before maturity, while leveraged ETFs show a positive correlation of 0.0025 before the maturity date, and the traditional ETFs show a positive correlation of 0.001 before the maturity date. However, leveraged ETFs show a negative correlation of -0.0003; From this data, it shows that both traditional ETFs and leveraged ETFs do have significant maturity effect. Hsieh [10] opinion on the maturity effect of Taiwan index futures shows that the same results exist in the ETFs of the tracking index in this study. On the trading day before maturity, the return of traditional ETFs decreases, but trading volume increases; leveraged ETFs, on the contrary, exhibit abnormal maturity effect in which the return increases while the volume of trading decreases.

Since leveraged ETFs are composed of derivatives, the daily rebalancing leads to higher transaction costs and other total costs than traditional ETF. In addition, the tracking errors caused by different index tracking techniques of managers will lead to the discount of leveraged ETFs when the market value is lower than its net value in usual, and the derivative financial commodities which are dominated by the futures option will be transferred before the date of maturity to avoid the profit and loss on the account, which makes the current underestimated leveraged ETFs return to the mean value. Therefore, there is a positive correlation in the return. It can be inferred that under the impetus of the maturity effect, the market price of traditional or leveraged ETF will return to the net value before the maturity date, whether in the form of discount or premium, which is one of the results of maturity effect. However, as mentioned above, traditional ETFs and leveraged ETFs are commodities with different attributes and have investors with different attributes. Although they share the same direction, they will be excluded from each other in the adjustment of asset allocation. When investors expect the intensified fluctuation of the market situation before maturity, investors with different risk tolerance will adjust their asset positions in time. The result of capital crowding out is that the investors with different risk tolerance will adjust their asset positions in time. They will show a significant negative correlation in the trading volume. Table 4 shows the empirical relationship between traditional ETFs and reverse ETFs. The study finds that under 1% confidence level, the average return rate of reverse ETF is significantly higher than that of traditional ETF in the long run, and there is a negative correlation between them; at the same confidence level of 1%, the return rate of market index is positively correlated with traditional ETF by 0.1744, while negatively correlated with reverse ETF by -0.2096. Since the two are ETF commodities with different directions, it is reasonable for them to have different impacts. However, the reverse ETF is an exponential commodity with the same multiples, and an exponential commodity with a larger impact, which confirms the conclusion in the literature of Charupat and Miu [4] that the net value loss of reverse ETF is more serious when the trend is opposite. However, at the confidence level of 1%, reverse ETFs have no significant maturity effect, and there is no obvious anomaly in the return before maturity, and the trading volume before maturity has increased significantly.

5.2. Covariance structures and major event

Under special events, when the market fluctuates abnormally and sharply, the covariability of traditional ETFs and leveraged ETFs will be greatly increased, which means that different types of ETFs are also facing systemic risks. Observing the stock market disasters in mainland China in 2015, the Taiwan stock market also suffered the same impact, while the co-variability of traditional ETF and reverse ETF undergoes the same situation at the same time. When the impact of events fades away, the forward leveraged ETF will recover the mean in a shorter time, while the reverse ETF will be affected in a wider and far-reaching range, and the average must be restored in a long time. It shows that when systemic risk occurs in the market, the characteristics of long-term investors who dare to buy at a low price will make the forward ETFs recover to the average more quickly, while speculating and risk-avoiding demand will increase the reverse ETF demand until the systemic risk is confirmed to be removed, then the reverse ETF demand will recover at a slower rate than the forward ETF. The same event happened in the US presidential election. When the market returned to the fundamentals quickly, forward ETFs returned to the mean faster than reverse ETFs. This result shows that the attributes of the forward and reverse investors are different. When the market falls, the long-term investors will think that the purchasing point emerges and can be purchased or overweighted at a low price, while the speculative investors will take reverse commodities as the short-term profit target under the risk of events.

6. Conclusions

In recent years, ETF has gradually attracted the attention of investors in the fund investment market, and the proportion of leveraged ETFs simulating multiple index returns with derivatives has risen sharply. In this study, leveraged ETFs and reverse ETFs have different volatility or trading volume in the spot and futures markets on the maturity date or around the trading date of futures contracts, whether there is maturity effect or not, and at the same time, whether the maturity effect of leveraged ETFs and reverse ETFs doubles significantly during a particular event or a specific period of time are discussed. The empirical results of this study show that traditional ETFs and leveraged ETFs do have the same maturity effect as spot commodities before the maturity date with a significant maturity effect. Secondly, ETF will return to a net value in the form discount or premium before maturity; and the results of capital crowding out before maturity will show a significant negative correlation in trading volume.

Finally, the maturity effect of reverse ETFs is not as obvious as that of forwarding ETFs, but there is a positive correlation between reverse ETFs and forward ETFs in terms of trading volume before maturity. Leveraged ETFs and reverse ETFs have a high degree of co-variability with traditional ETFs when the systemic risk of market

Table 4: Estimated Results from Traditional and Inverse ETFs.

	ETFR		ETFLR
PANEL-A: Mean Equations			
	Coeff. (Std. error)		Coeff. (Std. error)
B_{10}	0.0002***	α_{10}	0.0008***
	(0.0001)		(0.0001)
B_{11}	-0.0805***	α_{11}	-0.1767***
	(0.0109)		(0.0108)
B_{12}	-0.0304***	α_{12}	-0.0377***
	(0.0051)		(0.0103)
β_{13}	0.1744***	α_{13}	-0.2096***
	(0.0110)		(0.0109)
β_{14}	0.0001***	α_{14}	-0.0001***
	(0.0000)		(0.0001)
β_{15}	-0.0023***	α_{15}	-0.0001
	(0.0002)		(0.0001)
β_{16}	0.0002***	α_{16}	0.0001***
	(0.0002)		(0.0001)
PANEL-B: Covairnace Structure			
C_{11}		-0.0025***	
		(0.0001)	
C_{12}		0.0017***	
		(0.0001)	
C_{22}		-0.0004***	
		(0.0000)	
$A_{1,11}$		0.2676***	
		(0.0038)	
$A_{1,22}$		0.2980***	
		(0.0023)	
$A_{2,22}$		0.0001	
		(0.0000)	
$G_{1,11}$		0.9196***	
		(0.0015)	
$G_{1,22}$		0.9299***	
		(0.0008)	
$G_{2,22}$		-0.0000	
		(-0.0000)	
$Q(20)$		22.6410	
$Q(20)^2$		21.3500	
Log Likelihood Value			6137.1864

Note: The asterisk *, **, *** present the 10%, 5%, and 1% significant level.

special events occurs, and the average recovery speed of forwarding leveraged ETFs is faster than that of reverse ETFs. In conclusion, although this study has proved that the maturity effects do exist in leveraged ETFs and reverse ETFs, the above empirical results are expected to provide ETF investors with a better understanding and recognition in investment decision-making, so as to achieve the goal of maximizing investment profits or minimizing investment risks, developing the tracking target of ETF into the stock type known by investors and formally stepping into bonds, energy, precious metals, exchange rates and other asset areas. Whether the same results can be applied to different objectives and settlement systems remains to be further studied and proved by scholars in the future.

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