DOI: 10.1111/eufm.12301

ORIGINAL ARTICLE

EUROPEAN FINANCIAL MANAGEMENT WILEY

Further evidence on calendar anomalies

Yuan-Teng Hsu[1] | **Kees G. Koedijk**[2,3] | **Hung-Chun Liu**[4] | **Jying-Nan Wang**[5]

[1]Research Center of Finance, Shanghai Business School, Shanghai, China

[2]School of Economics, Utrecht University, Utrecht, The Netherlands

[3]CEPR, London, United Kingdom

[4]Department of Finance, Chung Yuan Christian University, Taoyuan, Taiwan

[5]College of International Finance and Trade, Zhejiang Yuexiu University, Shaoxing, China

Correspondence
Kees G. Koedijk, School of Economics, Utrecht University, Heidelberglaan 8, 3584 CS Utrecht, The Netherlands; and CEPR, London, UK.
Email: c.g.koedijk@uu.nl

Abstract

This study aims to investigate the day-of-the-week effect of cross-market leveraged exchange-traded funds (LETFs) in the Taiwanese stock market. We find that Wednesday's overnight returns are significantly positive for bull 2X LETFs tracking major stock indices of the Chinese market, whereas no such an effect is found for ETFs tracking local or other international stock markets. The "$T+1$" trading rule and a lagged Monday effect potentially explain this anomaly. Finally, simulation analysis of various simple trading rules further shows that there exist exploitable profit opportunities in cross-market bull 2X LETF markets.

KEYWORDS

"$T+1$" trading rule, cross-market ETF, day-of-the-week effect, LETF, leveraged ETF

JEL CLASSIFICATION

C14; C22; G14; G15

We thank John Doukas (the editor) and the anonymous referees for very helpful comments and suggestions that greatly improved the paper. We also thank K. Victor Chow and Chia-Wei Huang for their insightful comments and encouragement. The authors are listed in alphabetical order and contributed equally to the manuscript.

1 | INTRODUCTION

Investors and traders are always attracted to the idea of using leverage to increase investment performance. For example, leveraged exchange-traded funds (LETFs) employ the securities comprising the underlying indices and various financial derivatives to deliver a positive (or negative) multiple of underlying index daily returns. First introduced in the United States in July 2006, LETFs have become popular trading vehicles, with an extremely large daily trading volume compared to that of unleveraged ETFs.

As of October 2019, 46 (220) LETFs (ETFs) were traded on the Taiwanese stock market with assets under management of NT$ 168 billion (NT$ 1.537 trillion). Although LETFs comprise only 10.9% of the assets under management of ETF in Taiwan, they account for around 56.7% of the total ETF trading volume and 52.2% of the total ETF trading value. In other words, these LETFs now represent a substantial portion of ETF trades, even though the assets under their management are only a small fraction of the ETF market. Given their popularity for short-term investment purposes, this study aims to explore whether there is a significant pattern in the LETFs' daily returns and whether it could be exploited.

In this study, we contribute to the literature by examining the day-of-the-week (DoW) effect of cross-market bull 2X LETFs in the Taiwanese stock market. We find that overnight returns on Wednesdays are significantly positive for bull 2X LETFs tracking the major stock indices of Chinese markets. However, our results show no evidence that the ETFs that track local or other international stock markets have such a DoW effect. The Wednesday effect appears to be unique to Taiwanese cross-market ETFs (especially bull 2X LETFs) tracking Chinese stock indices, and the "$T+1$" trading rule and a lagged Monday effect potentially explain this anomaly. Finally, simulation analysis of implied trading rules further shows that there exist exploitable profit opportunities in cross-market bull 2X LETF markets.

The DoW effect is the tendency of stocks to exhibit abnormal returns on one particular weekday, compared to the other days in the week. Kelly's (1930) study is one of the first to uncover the Monday effect in US markets, where returns are significantly negative on that day. However, this calendar[1] phenomenon started to receive extensive attention only after the introduction of the weekend effect notion by Cross (1973) and French's (1980) discussion. Both authors demonstrate that average returns on Mondays are negative and are significantly lower than those on other weekdays. The detection of DoW effects in stock markets is a critical issue in empirical finance, because such calendar anomalies in the stock markets, countering the efficient market hypothesis (Fama, 1965), suggest profit opportunities for investors on a certain single day. The DoW effect has therefore been extensively tested and confirmed in various financial markets.[2] It can be seen in areas ranging from stocks (Agrawal & Tandon, 1994; Hiraki et al., 1998; Keim & Stambaugh, 1984; Lakonishok & Levi, 1982; Lakonishok & Smidt, 1988; Zhang et al., 2017) to exchange rates (Kumar, 2016; Popović & Đurović, 2014; Yamori & Kurihara, 2004), bonds (Alexander & Ferri, 2000; Gibbons & Hess, 1981), commodities (Blose & Gondhalekar, 2013; Crain & Lee, 1996), precious metals (Ma, 1986), and cryptocurrency markets (Aharon & Qadan, 2019; Caporale & Plastun, 2019).

With the rapid proliferation of financial innovations in recent years, a variety of new financial products have been designed to deliver a multiple of the performance of the

[1]Common calendar anomalies also include the time-of-the-day, turn-of-the-month, month-of-the-year, January, and Halloween effects.

[2]See Brusa et al. (2003) for a detailed review of the literature on weekend effects from 1973 to 2000.

underlying benchmark on a daily basis. LETFs are one of the most popular innovative products that employ the securities comprising the underlying indices and various financial derivatives to provide specified positive/negative ratio daily returns on an underlying index. LETFs have received considerable attention from the media, investors, regulators, and academics since ProShares launched the first ultra/ultra-short ETFs in the United States in July 2006.

Charupat and Miu (2011) document some significant characteristics of LETFs. First, most investors tend to limit their holding periods to avoid potential tracking errors caused by the daily rebalancing mechanism of LETFs. Using Canadian LETF data, the authors further report that LETFs are traded primarily by retail traders with very short holding periods, under 15 days. Second, the trading volume of LETFs is disproportionately large compared to that of unleveraged ETFs on the same underlying benchmarks. Third, the creation and redemption provisions[3] are among the major selling points of ETFs for large specialized investors (i.e., authorized participants). These provisions establish the arbitrage boundary between the ETF market price and its net asset value for investors.[4] In practice, the creation and redemption procedures of unleveraged ETFs and leveraged ETFs are carried out in kind and in cash,[5] respectively. This distinction makes it easier and less expensive to perform an arbitrage transaction using LETFs than using unleveraged ETFs. Thus, the convenience of arbitrage transactions is one of the major reasons why LETFs attract large specialized investors.

A number of research studies on LETFs have emerged, from both theoretical and practical perspectives, due to their trading popularity, highly embedded leverage, and, hence, their highly speculative nature. For example, Lu et al. (2012) investigate the long-term performance of both ultra-bull and ultra-bear ETFs in the US markets. They conclude that LETFs are not suited for long-term investors with a buy-and-hold (BH) strategy. By contrast, Loviscek et al. (2014) find that the general perception that daily-rebalanced LETFs are not suitable for long-term strategies is not substantiated. Jarrow (2010) ascertains the risks of LETFs, showing that a k-times leveraged ETF will not earn k times the ETF's return. Using a data set from Norway, Haga and Lindset (2012) indicate that positive risk-free interest rates cause the returns of LETFs to deviate from providers' expectations. Several studies further discuss whether leveraged ETFs intensify end-of-day market volatility. On one hand, Cheng and Madhavan (2009), Charupat and Miu (2011), and Shum et al. (2016) show that the end-of-day rebalancing of funds' exposures increases trading volume and market volatility at the close of a trading day. On the other hand, Ivanov and Lenkey (2018) find that the impact of ETF rebalancing on late-day volatility is economically insignificant when capital flows and standard risk factors are taken into account. Due to their low cost and high liquidity, LETFs have undeniably become an investment vehicle for a new breed of short-horizon investors (e.g., liquidity and arbitrage traders). However, few studies have explored the DoW effect in leveraged fund markets. This study, therefore, aims to fill this knowledge gap.

In contrast with the US LETF market, where such funds have existed for a long time, the first ultra ETF in the Taiwan stock market was the Yuanta Daily Taiwan 50 Bull 2X ETF,

[3]When a traditional ETF trades at a premium, an authorized participant can buy a basket of stocks comprising the underlying index from the market and sell them to the fund provider in return for shares of the ETF. This process is called creation. Alternatively, when the ETF trades at a discount, an authorized participant can buy shares of the ETF in the market and redeem them for the underlying basket of stocks, which is called redemption.

[4]Da and Shive (2018) further show that the arbitrage activity between an ETF and its underlying basket could propagate non-fundamental shocks from ETFs to a broad cross-section of stocks held.

[5]Because leveraged ETFs typically use financial derivatives to deliver the promised ratio returns, they rarely hold the actual underlying securities (Charupat & Miu, 2011).

launched by Yuanta Funds in October 2014.[6] However, that ultra fund is not actively traded, as its daily average trading volume has been only around 4,600 thousand shares since its listing (October 2014 to December 2019). This is not surprising because when the underlying index was the domestic index, the deviation (from the net asset value) was generally small and extremely transient (Ackert & Tian, 2000), and arbitrage trading incentives were therefore lacking for large specialized investors (e.g., foreign investors and dealers). From November 2014 to May 2015, Fubon Asset Management and Yuanta Funds successively launched cross-market LETFs whose underlying benchmarks tracked China's main stock indices. Cross-market LETFs, especially bull 2X LETFs, gained tremendous popularity with market investors in Taiwan because, at that time, Morgan Stanley Capital International (MSCI) was planning to partially include China's large-cap A shares in the MSCI Emerging Markets Index.[7] More importantly, the information asymmetry implied between the two markets increasingly frequently created short-term arbitrage opportunities with cross-market LETFs. This study contributes to the literature by examining DoW effects in cross-market bull 2X LETFs, which have not been previously investigated.

The efficient market hypothesis states that stock prices fully reflect all available information and that no one can consistently beat the market on a risk-adjusted basis. However, a large volume of the empirical literature documents significantly negative returns on Mondays, but several studies report a "reverse" weekend effect in US stock markets (e.g., Brusa et al., 2000, 2003; Gu, 2004; Mehdian & Perry, 2001). Other research indicates significantly negative returns on Tuesdays in many stock markets (e.g., Aggarwal & Rivoli, 1989; Barone, 1990; Cai et al., 2006; Jaffe & Westerfield, 1985a, 1985b). Recently, Chen et al. (2017) find evidence of a negative overnight return in the Chinese market, whereas Qiao and Dam (2020) further show that the overnight returns of Chinese (other countries') stock markets are, on average, negative (positive). These results allow us to investigate whether the overnight/intraday return patterns have these DoW effects in the context of cross-market ETF markets.

Because LETFs have become one of the most successful financial innovations only in recent years, little research has been conducted on them. Meanwhile, leveraged funds have also become the fastest-growing synthetic product in stock markets worldwide. Thus, this study proposes the use of three daily return types, overnight returns, intraday returns, and total daily returns to investigate the DOW effect of the most liquid cross-market bull 2X LETFs in the Taiwan stock market from 1 June 2015 to 31 December 2019. To ascertain whether the negative/positive DOW effect is a unique phenomenon in the cross-market bull 2X LETFs, we will also include their unleveraged and bear −1X counterparts to test the robustness of the results. Finally, we further construct several simple trading strategies (e.g., long, short, and a combination thereof) to backtest profit capabilities to determine whether such a calendar anomaly-based strategy can earn abnormal returns.

The remainder of this study is organized as follows. Section 2 describes the data and econometric methodology. Section 3 presents the empirical results of the DOW effect, interprets the calendar anomaly, and describes the simulated analysis of implied trading strategies. Section 4 concludes this study.

[6] In Taiwan, only bull 2X is available, whereas bear −2X is still overlooked.

[7] MSCI started to partially include China's large-cap A shares in the MSCI Emerging Markets Index on May 31, 2018.

TABLE 1 Sample of ETFs

This table reports the exchange-traded funds (ETFs) used in the empirical study. Panel A lists the fund profiles, whereas Panel B presents their corresponding average daily trading statistics. AUM denotes the assets under management of the ETF as of 31 December 2018. The share volumes and day-trading volumes are measured in thousands of units. The volatility (%) denotes Parkinson's (1980) average daily high-low price range

Panel A: Fund profile				
Provider	Yuanta Funds		Fubon Asset Management	
Stock name	YCSI300 Bull 2X	YCSI300 ETF	FSSE180 Bull 2X	FSSE180 ETF
Ticker	00637L	0061	00633L	006205
Exposure	2X	1X	2X	1X
Inception date	2015/05/06	2009/08/04	2014/11/11	2011/8/30
Listing date	2015/05/18	2009/08/17	2014/11/25	2011/9/26
AUM (Million)	43,171	5,880	31,382	13,050
Underlying index	CSI 300 Index	CSI 300 Index	SSE180 Leveraged 2X Index	SSE180 Index
Panel B: Average daily fund trading statistics (1 June 2015 to 31 December 2018)				
Share volume	101,138	6,312	47,533	5,859
Day-trading volume	22,894	454	11,167	379
Volatility (%)	1.669	0.824	1.656	0.811

2 | DATA AND ECONOMETRIC METHODOLOGY

2.1 | Data and preliminary analysis

We centre on the DoW effects of the Yuanta Daily CSI 300 Bull 2X ETF (YCSI300 Bull 2X) and Fubon SSE180 Leveraged 2X Index ETF (FSSE180 Bull 2X), which are the most actively traded ETFs in the Taiwanese cross-market bull 2X (stock index) LETF markets.[8] Both LETFs track the major indices of Chinese markets and we choose them for empirical samples because market liquidity is the major concern of traders with extremely short-term investment purposes. The data set is retrieved from the CMoney[9] database and comprises the daily opening, high, low, and closing prices, as well as the daily share and day-trading volumes. The sample period is from 1 June 2015 to 31 December 2019, for a total of 1,119 daily observations. We use the first three and a half years of data to examine DoW effects and backtest trading strategies, whereas the last year's data is used to further investigate the persistence of DoW regularities.

Panel A of Table 1 lists the various fund profiles used in the empirical study, whereas Panel B presents their corresponding average daily trading statistics. As shown in Panel A, the FSSE180 Bull 2X, established in November 2014, was the first cross-market ETF with a positive multiple in Taiwan. Subsequently, Yuanta Funds issued the YCSI300 Bull 2X in May 2015. Since then, the number of leveraged ETFs has continued to grow. Although the FSSE180 Bull 2X was already listed in November 2014, our study period begins on 1 June 2015, because this was the day the Taiwan Stock Exchange relaxed daily stock price limits to ±10%. As of

[8] As of December 2019, the YCSI300 Bull 2X and FSSE180 Bull 2X LETFs comprise more than 92% of the monthly trading volume in the Taiwanese cross-market bull 2X stock index LETF market.

[9] The institutional investors' investment decision support system of the CMoney provides comprehensive trading data including Taiwan, Hong Kong, and Chinese stock markets. In Taiwan, CMoney is also a leading brand in practical investment: www.cmoney.com.tw/ENGLISH/default.asp.

December 2018, the assets under management of the YCSI300 Bull 2X was NT$ 43.1 billion, around 1.37 times that of the FSSE180 Bull 2X (NT$ 31.3 billion).

Panel B of Table 1 shows that the average daily trading volumes of the YCSI300 Bull 2X (YCSI300 ETF) and the FSSE180 Bull 2X (FSSE180 ETF) were 101,138 (6,312) and 47,533 (5,859), in thousands of shares, respectively. During the same period, the average daily trading volumes of their corresponding bear −1X counterparts were 1,658 (YCSI300 Bear −1X) and 5,503 (FSSE180 Bear −1X), in thousands of shares, respectively.[10] This result suggests that the trading activity of the bull LETFs was vastly greater than that of either of their unleveraged or bear counterparts. In addition, traders prefer to trade and hold bull-LETFs over bear-LETFs. Investors are likely more comfortable with instruments that generate positive profits when prices increase (Charupat & Miu, 2011).

Furthermore, the mean day-trading volumes were 22,894 (454) and 11,167 (379), in thousands of shares, for the YCSI300 Bull 2X (YCSI300 ETF) and the FSSE180 Bull 2X (FSSE180 ETF), respectively. In fact, the YCSI300 Bull 2X and FSSE180 Bull 2X were the two most actively traded of the cross-market bull (stock index) LETFs in the Taiwan stock market in terms of the share and day-trading volumes. Lastly, Parkinson's (1980) high-low price range statistics indicate that the daily average volatility of each bull 2X LETF is around twice that of its corresponding unleveraged ETF. Thus, if the underlying index increased by 1% on a given day, an investor with bull 2X LETFs who would theoretically earn twice the daily index returns would also be subject to approximately twice the return volatility (risk).

2.2 | Daily returns and the regression model

Let C_t and O_t be the closing and opening prices, respectively, of a stock on Day t. This study considers three types of daily returns (Harris, 1986; Rogalski, 1984), defined as follows:

$$R_t^{\mathrm{c}} = 100 \times \log(C_t/C_{t-1}), \tag{1}$$

$$R_t^{\mathrm{o}} = 100 \times \log(O_t/C_{t-1}), \tag{2}$$

$$R_t^{\mathrm{d}} = 100 \times \log(C_t/O_t), \tag{3}$$

where R_t^{c} denotes the daily return based on the price change of a stock from the close of Day $t-1$ to the close of Day t (i.e., close-to-close), R_t^{o} is the daily return from the close of Day $t-1$ to the open of Day t (i.e., close-to-open), and R_t^{d} is the daily return from the open of Day t to its close (i.e., open-to-close). Rogalski (1984) decomposes the daily total return (R_t^{c}) into two components: the overnight return (R_t^{o}) and the intraday return (R_t^{d}). Notably, R_t^{o} is also referred to as the daily return over the nontrading period, the return from Friday's close to Monday's open is termed the weekend return in the literature, and previous close-to-open returns for Tuesday through Friday are referred to as overnight returns. Additionally, R_t^{d} represents an intraday return that measures the return generated by a stock over regular trading hours.

To formally test for the existence of DoW effects in the returns on cross-market ETFs, we estimate the following regression model:

$$R_t^i = \alpha_{0i} + \alpha_{1i} \bullet D_{1t} + \alpha_{3i} \bullet D_{3t} + \beta_{1i} \bullet \mathrm{Ret}_{\mathrm{sp},t} + \beta_{2i} \bullet \Delta \mathrm{VIX}_t + \varepsilon_{i,t}, \tag{4}$$

[10] Here, the YCSI300 Bear −1X and FSSE180 Bear −1X refer to the Yuanta Daily CSI 300 Bear −1X ETF and the Fubon SSE180 Inversed Index ETF, respectively.

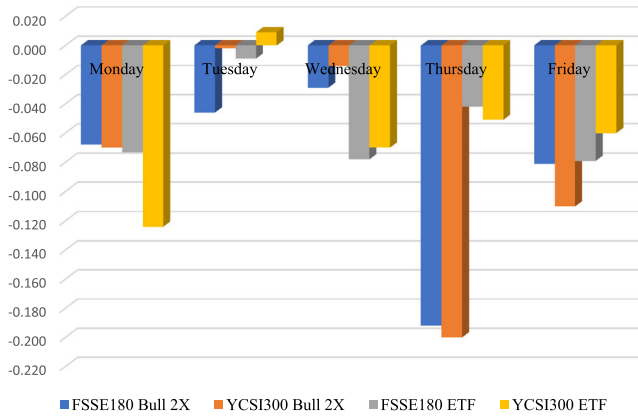

FIGURE 1 Average daily total (close-to-close) returns by day-of-the-week. This figure shows the average daily total returns of various exchange-traded funds across the days of the week. The sample period is from 1 June 2015 through 31 December 2018

where R_t^i denotes the daily returns measure i (i = o, d, c) on Day t. D_{1t} is a dummy variable that is equal to one if t falls on a Monday, and zero otherwise; the coefficient α_{1i} measures the possible Monday effect generally reported in the financial literature (e.g., Cross, 1973; French, 1980; Ma, 1986; Tong, 2000); D_{3t} is a dummy variable that is equal to one if t falls on a Wednesday, and zero otherwise; and the coefficient α_{3i} measures whether the daily returns of an ETF have a calendar anomaly on Wednesday. We include the daily returns of the S&P 500 stock index ($\text{Ret}_{\text{sp},t}$) and the natural logarithmic change in the Chicago Board Options Exchange volatility index, or VIX (ΔVIX_t), as control variables, as most international markets are affected by US stock markets.[11] Finally, $\varepsilon_{i,t}$ is the error term.

3 | EMPIRICAL RESULTS

3.1 | Summary statistics of various daily returns

For either bull 2X LETFs or unleveraged ETFs, there are 169, 175, 178, 180, and 174 observations for Monday through Friday, during the sample period (June 2015 to December 2018). Figures 1-3 roughly depict the average daily total returns, overnight returns, and intraday returns, respectively, of various ETFs across the days of the week. As shown in Figure 1, no consistent pattern is found in the average daily total returns, except that most of the values are negative. More interesting are the results for the other two prescribed returns, as evidenced in Figures 2 and 3. In addition to most of the values being positive (negative), the average overnight (intraday) returns on Wednesdays are apparently the highest (lowest) across the days of the week. Meanwhile, for all weekdays, because of leverages, the mean overnight (intraday) returns of bull 2X LETFs are obviously greater (smaller) than those of unleveraged ETFs.

Table 2 presents descriptive statistics of the daily returns for various ETFs by weekday. First, the results of Panel A show that most of the average overnight returns are positive for

[11]We are very grateful to an anonymous referee for suggesting the inclusion of control variables in our regression model that may help to explain the daily return process.

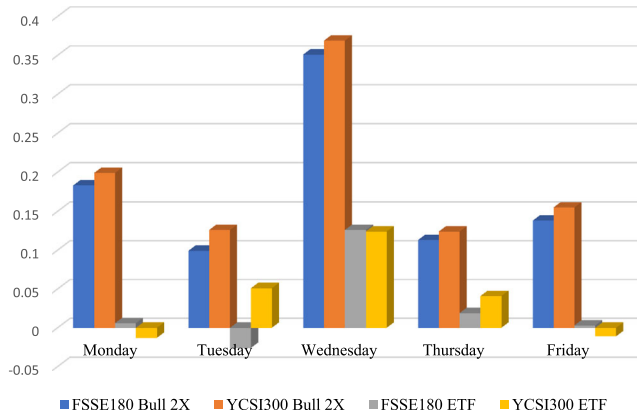

FIGURE 2 Average overnight (close-to-open) returns by day-of-the-week. This figure shows the average overnight returns of various exchange-traded funds across the days of the week. The sample period is from 1 June 2015 through 31 December 2018

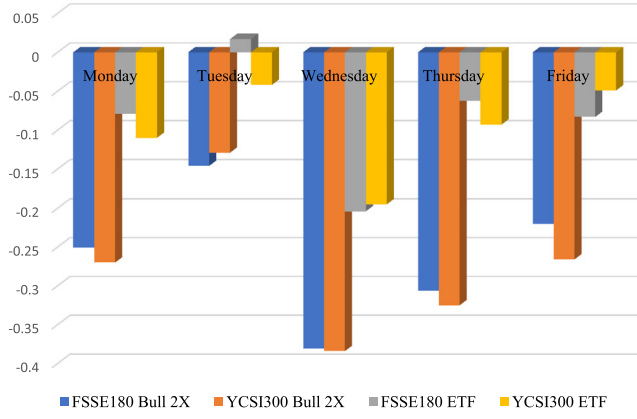

FIGURE 3 This figure shows the average intraday returns of various exchange-traded funds across the days of the week. The sample period is from 1 June 2015 through 31 December 2018

each weekday (except for unleveraged ETFs on some weekdays). Though each ETF has its highest mean on Wednesday, the average overnight returns of a bull 2X LETF exceed twice those of an unleveraged ETF. The *t*-test statistics indicate that Wednesday's overnight returns are significantly greater than zero for all the ETFs.

Second, the average intraday returns of all the ETFs listed in Panel B of Table 2 are negative for each weekday (except for the FSSE180 ETF on Tuesday), in stark contrast to the results in Panel A. We also find that the average intraday returns of a bull 2X LETF are close to twice those of an unleveraged ETF. The *t*-test statistics show that Wednesday's intraday returns for all the ETFs are significantly less than zero, whereas Thursday's intraday returns for bull 2X LETFs are significantly negative. Furthermore, the YCSI300 Bull 2X has significantly negative intraday returns on Friday. Finally, the results in Panel C show that the daily total returns of all the ETFs are, on average, negative for each weekday (except for the YCSI300 ETF on Tuesday), but none of them is significantly different from zero according to *t* tests.

TABLE 2 Descriptive statistics of the daily ETF returns by weekday

This table reports the average overnight, intraday, and daily total returns, respectively, for the exchange-traded funds (ETFs) across all five weekdays. The numbers in parentheses denote the *t*-values (based on the null hypothesis that the mean equals zero). The superscripts a, b, and c denote significance at the 10%, 5%, and 1% levels, respectively

Stock name	Ticker	Monday	Tuesday	Wednesday	Thursday	Friday
Panel A: Overnight returns (R_t^o)						
FSSE180 Bull 2X	00633L	0.183 (1.398)	0.099 (0.851)	0.351 (2.964)[c]	0.113 (0.809)	0.138 (1.105)
YCSI300 Bull 2X	00637L	0.199 (1.548)	0.126 (1.057)	0.369 (3.139)[c]	0.124 (0.940)	0.155 (1.252)
FSSE180 ETF	006205	0.006 (0.074)	−0.026 (−0.402)	0.126 (2.086)[b]	0.019 (0.272)	0.003 (0.065)
YCSI300 ETF	0061	−0.013 (−0.162)	0.051 (0.969)	0.124 (1.934)[a]	0.041 (0.589)	−0.011 (−0.167)
Panel B: Intraday returns (R_t^d)						
FSSE180 Bull 2X	00633L	−0.251 (−0.983)	−0.146 (−0.855)	−0.381 (−2.535)[b]	−0.306 (−1.698)[a]	−0.220 (−1.643)
YCSI300 Bull 2X	00637L	−0.270 (−1.043)	−0.129 (−0.757)	−0.384 (−2.690)[c]	−0.325 (−1.866)[a]	−0.266 (−1.908)[a]
FSSE180 ETF	006205	−0.079 (−0.599)	0.017 (0.209)	−0.204 (−2.583)[c]	−0.062 (−0.682)	−0.083 (−1.283)
YCSI300 ETF	0061	−0.110 (−0.866)	−0.042 (−0.541)	−0.195 (−2.079)[b]	−0.093 (−0.986)	−0.049 (−0.755)
Panel C: Daily total returns (R_t^c)						
FSSE180 Bull 2X	00633L	−0.068 (−0.224)	−0.046 (−0.232)	−0.029 (−0.154)	−0.192 (−0.919)	−0.081 (−0.422)
YCSI300 Bull 2X	00637L	−0.070 (−0.227)	−0.002 (−0.012)	−0.014 (−0.080)	−0.200 (−0.966)	−0.110 (−0.576)
FSSE180 ETF	006205	−0.073 (−0.430)	−0.009 (−0.086)	−0.078 (−0.738)	−0.042 (−0.420)	−0.079 (−0.831)
YCSI300 ETF	0061	−0.124 (−0.736)	0.009 (0.098)	−0.070 (−0.569)	−0.051 (−0.489)	−0.060 (−0.635)

In sum, our results suggest that these cross-market LETFs/ETFs tracking the major stock indices of Chinese markets could have a DoW effect in which overnight (intraday) returns on Wednesdays are positive (negative) and higher (lower) than those on the other weekdays.

Table 3 presents the proportions of the positive (negative) overnight (intraday) returns for the various ETFs by weekday. The results in Panel A show that the corresponding proportion of the bull 2X LETFs ranges from 54.44% to 66.85%, which is consistently higher than for the unleveraged ETFs (42.60%–53.37%) for each weekday. Meanwhile, the corresponding values on Wednesdays are clearly the highest among all the ETFs. The *z*-test results further show that the proportions of the unleveraged ETFs (except for the YCSI300 ETF on Monday and Friday) are consistent with the null hypothesis that half of overnight returns would be positive, but the null hypothesis cannot be accepted for either bull 2X LETF (except for the FSSE180 Bull 2X on Thursday and the YCSI300 Bull 2X on Monday). Thus, for the bull 2X LETFs, more than 50% of overnight returns are positive for almost every weekday.

The results in Panel B in Table 3 show that the corresponding proportion of the bull 2X LETFs ranges from 52.66% to 62.78%, which is higher than for the unleveraged ETFs (49.43%–57.22%) for each weekday. Meanwhile, most of these proportions are above 50% (except for the FSSE180 ETF on Friday). Further, the *z*-test statistics indicate rejection of the null hypothesis for both bull 2X LETFs on Tuesday through Thursday. This suggests that, for bull 2X LETFs, more than 50% of intraday returns are negative on those three weekdays. Our finding that more than 65.17% (60.11%) of positive (negative) overnight (intraday) returns of the bull 2X LETFs on Wednesdays potentially leads to anomalous Wednesday effects.

3.1.1 | Testing the DoW effect in cross-market ETFs

Having noted these distinctive phenomena in the overnight/intraday returns of cross-market ETFs, we run the regression model of Equation (4) to formally determine the statistical significance of the DoW effects. Table 4 reports the regression results of the DoW effects for the various ETFs.

Panel A of Table 4 first shows that the coefficient $\alpha_{3,o}$ of Wednesday's dummy variable (D_3) is positive and significant for both bull 2X LETFs and one unleveraged ETF (i.e, the FSSE180 ETF), suggesting that Wednesday's overnight returns have a positive DoW effect. However, for either ETF, the coefficient $\alpha_{1,o}$ is not significant, providing no evidence of a Monday effect. Second, as shown in Panel B, we find that the coefficient $\alpha_{3,d}$ is negative for each ETF, though it is statistically significant only for the FSSE180 ETF. Thus, the intraday return pattern exhibits negative Wednesday effects in partial unleveraged ETFs. Third, our results in Panel C show that the daily total returns do not have a Monday or Wednesday effect. Fourth, with regard to the control variable Ret_{sp} in Panels A and C, we find that the daily returns of the S&P 500 stock index have a significant and positive impact on the overnight and daily total returns of the ETFs. However, changes in the VIX (ΔVIX) have a negative but insignificant impact on each type of ETFs' return. In addition to bull 2X LETFs and unleveraged ETFs, we also test their bear −1X counterparts[12] (i.e., the FSSE180 Bear −1X and YCSI300 Bear −1X). Our results show

[12]The DoW results of the FSSE180 and YCSI300 Bear −1X LETFs are presented in Table A1 of the Online Appendix in the Supporting Information.

TABLE 3 Proportions of positive (negative) overnight (intraday) returns by weekday

This table reports the proportions of positive (negative) overnight (intraday) returns for the exchange-traded funds (ETFs) by weekday. The numbers in parentheses denote the *z*-test statistics (based on the null hypothesis that half of the daily returns are positive/negative). The superscript a indicates rejection of the null hypothesis at the 10% significance level (two-tailed test)

		Day of the week				
Stock name	**Ticker**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Panel A: Overnight returns (R_t^o)						
FSSE180 Bull 2X	00633L	59.17% (2.384)[a]	58.29% (2.193)[a]	65.17% (4.048)[a]	54.44% (1.191)	59.77% (2.578)[a]
YCSI300 Bull 2X	00637L	56.21% (1.615)	57.14% (1.889)[a]	66.85% (4.496)[a]	57.78% (2.088)[a]	58.62% (2.274)[a]
FSSE180 ETF	006205	50.30% (0.078)	48.57% (−0.378)	53.37% (0.899)	52.78% (0.746)	45.40% (−1.214)
YCSI300 ETF	0061	42.60% (−1.924)[a]	48.00% (−0.529)	52.81% (0.750)	45.56% (−1.191)	43.68% (−1.667)[a]
Panel B: Intraday returns (R_t^d)						
FSSE180 Bull 2X	00633L	53.25% (0.845)	59.43% (2.495)[a]	61.80% (3.149)[a]	61.67% (3.131)[a]	55.75% (1.517)
YCSI300 Bull 2X	00637L	52.66% (0.692)	58.29% (2.193)[a]	60.11% (2.698)[a]	62.78% (3.429)[a]	55.17% (1.364)
FSSE180 ETF	006205	51.48% (0.385)	54.29% (1.135)	55.06% (1.350)	52.22% (0.596)	49.43% (−0.150)
YCSI300 ETF	0061	51.48% (0.385)	53.14% (0.831)	55.62% (1.500)	57.22% (1.937)[a]	51.15% (0.303)

TABLE 4 DoW effects of cross-market ETFs

This table reports the DoW effects of cross-market exchange-traded funds (ETFs) (tracking the major indices of Chinese markets) based on the following regression model: $R_t^i = \alpha_{0i} + \alpha_{1i} \bullet D_{1t} + \alpha_{3i} \bullet D_{3t} + \beta_{1i} \bullet \text{Ret}_{\text{sp},t} + \beta_{2i} \bullet \Delta\text{VIX}_t + \varepsilon_{i,t}$, where R_t^i denotes the daily returns measure i (i = o, d, c) on Day t; D_{1t} (D_{3t}) is a dummy variable that is equal to one if t falls on a Monday (Wednesday), and zero otherwise; $\text{Ret}_{\text{sp},t}$ denotes daily returns of the S&P 500 stock index on Day t; and ΔVIX_t refers to the natural logarithmic change in the volatility index (VIX) on Day t. The numbers in parentheses denote standard errors. The superscripts a, b, and c denote significance at the 10%, 5%, and 1% levels, respectively

Stock name	**FSSE180 Bull 2X**	**YCSI300 Bull 2X**	**FSSE180 ETF**	**YCSI300 ETF**
Ticker	**00633L**	**00637L**	**006205**	**0061**
Panel A: Overnight returns (R_t^o)				
Intercept (α_{0o})	0.107 (0.064)[a]	0.123 (0.062)[b]	−0.002 (0.033)	0.024 (0.032)
Monday (α_{1o})	0.066 (0.132)	0.072 (0.130)	−0.003 (0.081)	−0.047 (0.083)
Wednesday (α_{3o})	0.205 (0.118)[a]	0.205 (0.116)[a]	0.111 (0.064)[a]	0.081 (0.065)
$\text{Ret}_{\text{sp},t}$ (β_{1o})	0.851 (0.131)[c]	0.869 (0.122)[c]	0.386 (0.074)[c]	0.426 (0.071)[c]
ΔVIX_t (β_{2o})	−0.007 (0.011)	−0.003 (0.011)	−0.008 (0.006)	−0.006 (0.006)
R^2	0.230	0.230	0.196	0.220
Panel B: Intraday returns (R_t^d)				
Intercept (α_{0d})	−0.212 (0.095)[b]	−0.229 (0.095)[b]	−0.039 (0.047)	−0.055 (0.046)
Monday (α_{1d})	−0.059 (0.290)	−0.060 (0.291)	−0.043 (0.148)	−0.067 (0.142)
Wednesday (α_{3d})	−0.153 (0.175)	−0.141 (0.169)	−0.160 (0.091)[a]	−0.133 (0.103)
$\text{Ret}_{\text{sp},t}$ (β_{1d})	−0.286 (0.188)	−0.253 (0.186)	−0.079 (0.089)	−0.100 (0.083)
ΔVIX_t (β_{2d})	−0.013 (0.022)	−0.012 (0.021)	−0.002 (0.010)	−0.008 (0.0102)
R^2	0.005	0.004	0.004	0.003
Panel C: Daily total returns (R_t^c)				
Intercept (α_{0c})	−0.104 (0.116)	−0.105 (0.116)	−0.042 (0.057)	−0.031 (0.055)
Monday (α_{1c})	0.006 (0.332)	0.012 (0.337)	−0.047 (0.184)	−0.114 (0.179)
Wednesday (α_{3c})	0.051 (0.217)	0.064 (0.211)	−0.048 (0.118)	−0.052 (0.133)
$\text{Ret}_{\text{sp},t}$ (β_{1c})	0.565 (0.218)[c]	0.616 (0.212)[c]	0.306 (0.109)[c]	0.325 (0.104)[c]
ΔVIX_t (β_{2c})	−0.021 (0.024)	−0.016 (0.024)	−0.011 (0.013)	−0.014 (0.011)
R^2	0.049	0.050	0.051	0.063

that only the overnight returns of the FSSE180 Bear −1X have a Wednesday effect with a negative sign, which is the opposite of its bull 2X and unleveraged 1X counterparts.

To determine that the Wednesday effect is unique to Taiwanese cross-market ETFs with underlying benchmarks that track Chinese stock indices, this study further examines the DoW effects for ETFs tracking international (e.g., Hong Kong, Japan, and United States) and local market indices. Meanwhile, we extend our empirical sample to bull 2X LETFs, unleveraged ETFs, and bear −1X LETFs. Our results show no evidence of a Wednesday effect in the overnight returns of ETFs tracking either international or local stock markets.[13]

[13]We thank an anonymous referee for suggesting that we test whether the Wednesday effect is specific to cross-market ETFs. The DoW results of ETFs tracking international and local stock markets are presented in Tables A2 to A4 of the Online Appendix in the Supporting Information.

3.1.2 | Potential explanations for the Wednesday effect

In January 1995, the China Securities Regulatory Commission adopted a unique "$T+1$" trading rule that allowed investors to sell only stocks they purchased at least 1 day before and prevented them from selling stocks bought the same day. Qiao and Dam (2020) indicate that overnight returns in Chinese stock markets are, on average, negative and that this finding is unique to Chinese markets. The authors argue that as the "$T+1$" trading rule prohibits buyers from selling stocks they bought the same day, the discount (i.e., negative overnight returns) acts as an incentive for very short-term buyers.

We find that the overnight returns[14] of the CSI300 and SSE180 stock indices (the underlying indices of the YCSI300 and FSSE180 Bull 2X LETFs, respectively) are significantly negative and consistent with Chen et al.'s (2017) and Qiao and Dam's (2020) findings. We further find that the overnight (intraday) returns[15] of these two stock indices on Tuesdays are significantly negative (positive) and lower (higher) than those for the other weekdays. It is well documented that the average return for Monday is significantly negative in the US stock markets. Due to time zone differences, the pattern of daily returns in Asian stock markets could be identical to but one day ahead of the pattern in the United States (Jaffe & Westerfield, 1985a). The overnight returns of the CSI300/SSE180 stock index that are significantly negative on Tuesdays[16] also support this argument. Due to the fall of the stock index at the opening on Tuesday, the price bounce in response to possible overreactions often leads to positive intraday returns that day. As the Chinese stock market closes one and a half hours later than the Taiwanese market, the Wednesday overnight returns of a Taiwanese cross-market ETF tracking a Chinese stock index could partially reflect the lagged positive intraday returns of its underlying benchmark the previous trading day. Thus, the "$T+1$" trading rule and a lagged Monday (i.e., Tuesday) effect potentially explain the Wednesday effect we observe in cross-market (bull 2X) LETFs.

3.2 | Trading simulation analysis

In light of the significantly positive DoW effect on Wednesday found in Section 3.2, we develop a simple long trading strategy (LTS), LTS(Wed), that buys an ETF at the close of the trading day previous to Wednesday and sells it at the opening price on Wednesday. We also develop a short trading strategy (STS), STS(Wed, 0.3%), and a combined trading strategy (CTS), CTS(Wed), because Table 2 shows that the average intraday returns of the ETFs on Wednesday are negative and apparently lower than those on the other weekdays. Specifically, STS(Wed, 0.3%) denotes a conditional STS: If Wednesday's overnight return is greater than 0.3%, the STS sells the ETF at the opening on Wednesday and then buys it back at the closing price. The strategy CTS(Wed) incorporates the LTS with the STS.[17] We backtest the profit-making potentials of these three simple trading rules.

[14]The average overnight returns of the CSI300 and SSE180 stock indices during our sample period are −0.133% and −0.140%, respectively.

[15]The average overnight (intraday) returns of the CSI300 and SSE180 stock indices on Tuesday are −0.229% (0.326%) and −0.230% (0.308%), respectively, significantly smaller (greater) than zero.

[16]The negative stock returns on Tuesdays in international markets are also explained by a spillover effect from the drop of the United States and other developed markets on Monday (e.g., Aggarwal & Rivoli, 1989; Cai et al., 2006).

[17]In this study, we also consider as a benchmark the BH trading strategy that buys an ETF on 1 June 2015 and sells it on 31 December 2018. The annualized returns (total profits) of buying the FSSE180 Bull 2X, YCSI300 Bull 2X, FSSE180 ETF, and YCSI300 ETF according to the BH strategy are −21.3% (−5,232), −20.3% (−5,064), −14.3% (−3,913), and −15.0% (−4,064), respectively.

TABLE 5 Simulation results of alternative trading strategies without transactions costs

This table reports the summary results based on LTS(Wed), STS(Wed, 0.3%), and CTS(Wed). The strategy LTS (Wed) is an LTS that buys an ETF at the close of the trading day previous to Wednesday and sells it at the opening price on Wednesday. The strategy STS(Wed, 0.3%) denotes a conditional STS. If Wednesday's overnight return is greater than 0.3%, the STS sells the ETF at the opening on Wednesday and then buys it back at the closing price. Finally, CTS(Wed) denotes a CTS that incorporates the LTS with the STS. The initial funding is assumed to be 10,000

Stock name	FSSE180 Bull 2X	YCSI300 Bull 2X	FSSE180 ETF	YCSI300 ETF
Ticker	**00633L**	**00637L**	**006205**	**0061**
Panel A: LTS(Wed)				
Annualized return	0.180	0.189	0.065	0.064
Standard deviation	0.116	0.115	0.058	0.062
Total net profit	8,706	9,295	2,520	2,485
Number of trades	178	178	178	178
Average profit per trade	49	52	14	14
Profit trades (% of total)	65.17%	67.42%	53.37%	53.37%
Panel B: STS(Wed, 0.3%)				
Annualized return	0.125	0.112	0.048	0.030
Standard deviation	0.098	0.102	0.042	0.038
Total net profit	5,457	4,759	1,803	1,108
Number of trades	93	100	59	54
Average profit per trade	59	48	31	21
Profit trades (% of total)	64.52%	59.00%	54.24%	55.56%
Panel C: CTS(Wed)				
Annualized return	0.305	0.301	0.112	0.094
Standard deviation	0.158	0.159	0.073	0.074
Total net profit	18,914	18,478	4,777	3,868
Number of trades	178	178	178	178
Average profit per trade	106	104	27	22
Profit trades (% of total)	55.06%	56.18%	49.44%	47.75%

Abbreviations: CTS, combined trading strategy; ETF, exchange-traded fund; LTS, long trading strategy; STS, short trading strategy.

Table 5 lists the simulation results of alternative trading strategies without transaction costs with an initial funding of 10,000. The empirical results first show that each trading strategy generates satisfactory performance in trading both bull 2X LETFs and unleveraged ETFs according to positively annualized returns, total net profits, average profit per trade, and profit trades statistics. Second, the performance in trading bull 2X LETFs using these three strategies is consistently superior to that of trading unleveraged counterparts. For example, LTS(Wed) generates the highest annualized return on trading the YCSI300 Bull 2X and the second-highest value on trading the FSSE180 Bull 2X, followed by the FSSE180 ETF and the YCSI300 ETF. As for STS(Wed, 0.3%) and CTS(Wed), both produce the highest total net profits on trading the FSSE180 Bull 2X and the second-highest on trading the YCSI300 Bull 2X, followed by the FSSE180 and YCSI300 ETFs. Third, both LTS(Wed) and CTS(Wed) are used for 178 trades, as transactions are made every Wednesday during the empirical period, whereas STS(Wed, 0.3%)

TABLE 6 Simulation results of alternative trading strategies with transactions costs

This table reports the summary results based on LTS(Wed), STS(Wed, 0.3%), and CTS(Wed). The strategy LTS (Wed) is an LTS that buys an ETF at the close of the trading day previous to Wednesday and sells it at the opening price on Wednesday. The strategy STS(Wed, 0.3%) denotes a conditional STS. If Wednesday's overnight return is greater than 0.3%, the STS sells the ETF at the opening on Wednesday and then buys it back at the closing price. The strategy CTS(Wed) denotes a CTS that incorporates the LTS with the STS. The initial funding and round-trip transaction costs are assumed to be 10,000 and 0.271%, respectively

Stock name	**FSSE180 Bull 2X**	**YCSI300 Bull 2X**	**FSSE180 ETF**	**YCSI300 ETF**
Ticker	**00633L**	**00637L**	**006205**	**0061**
Panel A: LTS(Wed)				
Annualized return	0.041	0.050	−0.074	−0.075
Standard deviation	0.113	0.113	0.059	0.062
Total net profit	1,543	1,907	−2,274	−2,296
Number of trades	178	178	178	178
Average profit per trade	9	11	−13	−13
Profit trades (% of total)	54.49%	57.30%	33.15%	30.34%
Panel B: STS(Wed, 0.3%)				
Annualized return	0.076	0.059	0.016	0.001
Standard deviation	0.096	0.101	0.041	0.037
Total net profit	3,023	2,273	584	52
Number of trades	93	100	59	54
Average profit per trade	33	23	10	1
Profit trades (% of total)	58.06%	57.00%	50.85%	44.44%
Panel C: CTS(Wed)				
Annualized return	0.117	0.109	−0.058	−0.074
Standard deviation	0.150	0.152	0.068	0.070
Total net profit	5,033	4,613	−1,823	−2,256
Number of trades	178	178	178	178
Average profit per trade	28	26	−10	−13
Profit trades (% of total)	41.01%	41.57%	24.16%	21.35%

Abbreviations: CTS, combined trading strategy; ETF, exchange-traded fund; LTS, long trading strategy; STS, short trading strategy.

is used for 54 to 100 trades because it is a conditional strategy that depends on Wednesday overnight returns. Lastly, the profit trades statistics show that the probability of profits in terms of trading bull 2X LETFs using one of these three strategies is greater than in trading unleveraged ETFs. Although the probability of a profit with an LTS/STS is apparently greater than with a CTS, the total net profit with either an LTS or a STS is vastly lower than with a CTS. This finding suggests that the CTS has the advantage of small losses and big gains in trading on these cross-market ETFs.

Table 6 lists the simulation results of alternative trading strategies with transaction costs where a round-trip transaction cost is assumed to be 0.271%.[18] First, we find evidence that all

[18]The round-trip transaction cost of trading an ETF includes two commissions (0.1425% × 2) and a transaction tax (0.1%). Thus, the cost of the transactions is assumed to be 0.271%, because electronic orders offer a 40% discount on commissions (i.e., 0.1425% × 2 × 60% + 0.1%).

FIGURE 4 Balance dynamics on trading the FSSE180 Bull 2X under alternative strategies. This figure shows the balance dynamics in trading the FSSE180 Bull 2X according to the LTS(Wed), STS(Wed, 0.3%), CTS (Wed), and BH strategies, respectively. BH, buy-and-hold; CTS, combined trading strategy; LTS, long trading strategy; STS, short trading strategy

trading strategies consistently generate satisfactory performance in trading bull 2X LETFs. By contrast, the strategies in this study yield poor performance in trading unleveraged ETFs if transaction costs are considered. Second, the performance in trading bull 2X LETFs with a DoW-based strategy is clearly and greatly superior to that in trading unleveraged ETFs, due to calendar anomalies strongly exhibited in the bull 2X LETF market. Third, the average profit per trade on bull 2X LETFs for each strategy is positive, whereas that on unleveraged ETFs (except for the STS) is negative. Fourth, the probability of profits on trading bull 2X LETFs using one of the three strategies ranges from 41.01% to 58.06%, which is considerably greater than for trading unleveraged ETFs (21.35%–50.85%), especially with the LTS and CTS strategies. Finally, though the probability of profits on trading bull 2X LETFs with a simple LTS/STS is apparently greater than with a CTS, the total net profit on trading bull 2X LETFs with either the LTS or the STS is much lower than with the CTS. Thus, the CTS still retains its superiority in terms of producing small losses and big gains in trading on bull 2X LETFs.[19]

In sum, although there does exist an overnight return anomaly on Wednesday for the FSSE180 ETF, the DoW-based strategies are applicable for only the bull 2X LETFs. Our results suggest that because of transaction costs, even if there exist potential market mispricing opportunities in an unleveraged ETF, it would be difficult for investors to exploit such a relationship. In contrast, once overnight return anomalies are found, investors could fully take advantage of these opportunities to profit from the trading of the bull 2X LETFs.

Figures 4-7 depict the balance dynamics in trading various ETFs under alternative strategies, which can help us to further examine the stability of the profitability with the proposed strategies within a certain investment horizon. For bull 2X LETFs, Figures 4 and 5 indicate that the balance dynamics of each strategy are mostly above 10,000 (the initial funding) during the empirical period. As for unleveraged ETFs, only the balance dynamics of STS(Wed, 0.3%) are (slightly) higher than the initial funding during the empirical period, as shown in Figures 6

[19]We also conducted simulations of the same trading strategies applied to weekdays other than Wednesday. The results show that these three strategies fail to generate profits when applied to either Monday, Tuesday, Thursday, or Friday, in almost all cases. These results provide additional supportive evidence of a Wednesday effect in the cross-market bull 2X LETFs.

FIGURE 5 Balance dynamics on trading the YCSI300 Bull 2X under alternative strategies. This figure shows the balance dynamics in trading the YCSI300 Bull 2X according to the LTS(Wed), STS(Wed, 0.3%), CTS (Wed), and BH strategies, respectively. BH, buy-and-hold; CTS, combined trading strategy; LTS, long trading strategy; STS, short trading strategy

FIGURE 6 Balance dynamics on trading the FSSE180 ETF under alternative strategies. This figure shows the balance dynamics in trading the FSSE180 ETF according to the LTS(Wed), STS(Wed, 0.3%), CTS (Wed), and BH strategies, respectively. BH, buy-and-hold; CTS, combined trading strategy; ETF, exchange-traded fund; LTS, long trading strategy; STS, short trading strategy

and 7. However, for either ETF, the balance of the BH strategy exhibits large fluctuations and is mostly under the initial funding during the empirical period. In sum, these three simple trading strategies not only achieve satisfactory performance but also ensure stability of the profitability of trading cross-market bull 2X LETFs.

3.3 | Updating to the latest observable year

Table 7 reports the results of DoW effects for the various ETFs over the latest observable period according to the regression model in Equation (4). This allows us to further examine the persistence of DoW effects and explore whether investors have become aware of the calendar anomalies in cross-market bull 2X LETFs. The results show that the coefficient $\alpha_{3,i}$ for

FIGURE 7 Balance dynamics on trading the YCSI300 ETF under alternative strategies. This figure shows the balance dynamics in trading the YCSI300 ETF according to the LTS(Wed), STS(Wed, 0.3%), CTS (Wed), and BH strategies, respectively. BH, buy-and-hold; CTS, combined trading strategy; ETF, exchange-traded fund; LTS, long trading strategy; STS, short trading strategy

TABLE 7 Reexamining DoW effects of cross-market ETFs during 2019

This table reports the DoW results of cross-market ETFs from January 2019 to December 2019 according to the following regression model: $R_t^i = \alpha_{0i} + \alpha_{1i} \bullet D_{1t} + \alpha_{3i} \bullet D_{3t} + \beta_{1i} \bullet \text{Ret}_{\text{sp},t} + \beta_{2i} \bullet \Delta\text{VIX}_t + \varepsilon_{i,t}$, where R_t^i denotes the daily returns measure i (i = o, d, c) on Day t; D_{1t} (D_{3t}) is a dummy variable that is equal to one if t falls on a Monday (Wednesday), and zero otherwise; $\text{Ret}_{\text{sp},t}$ denotes daily returns of the S&P 500 stock index on Day t; and ΔVIX_t refers to the natural logarithmic change in the volatility index (VIX) on Day t. The numbers in parentheses denote standard errors. The superscripts a, b, and c denote significance at the 10%, 5%, and 1% levels, respectively

Stock name	**FSSE180 Bull 2X**	**YCSI300 Bull 2X**	**FSSE180 ETF**	**YCSI300 ETF**
Ticker	**00633L**	**00637L**	**006205**	**0061**
Panel A: Overnight returns (R_i^o)				
Intercept (α_{0o})	0.081 (0.085)	0.080 (0.082)	−0.007 (0.038)	−0.002 (0.035)
Monday (α_{1o})	−0.029 (0.240)	−0.004 (0.234)	−0.032 (0.111)	0.014 (0.104)
Wednesday (α_{3o})	−0.124 (0.159)	−0.040 (0.149)	−0.044 (0.069)	0.004 (0.067)
$\text{Ret}_{\text{sp},t}$ (β_{1o})	1.114 (0.186)^c	1.102 (0.180)^c	0.447 (0.080)^c	0.384 (0.074)^c
ΔVIX_t (β_{2o})	0.004 (0.023)	0.008 (0.021)	0.002 (0.009)	0.004 (0.007)
R^2	0.346	0.344	0.285	0.246
Panel B: Intraday returns (R_t^d)				
Intercept (α_{0d})	0.040 (0.151)	0.030 (0.152)	0.067 (0.070)	0.044 (0.073)
Monday (α_{1d})	0.249 (0.342)	0.248 (0.349)	0.045 (0.186)	−0.026 (0.193)
Wednesday (α_{3d})	0.002 (0.244)	−0.030 (0.245)	−0.016 (0.117)	0.095 (0.117)
$\text{Ret}_{\text{sp},t}$ (β_{1d})	−0.254 (0.259)	−0.225 (0.268)	−0.068 (0.130)	−0.018 (0.131)
ΔVIX_t (β_{2d})	0.003 (0.028)	0.001 (0.029)	−0.008 (0.013)	−0.011 (0.013)
R^2	0.016	0.012	0.002	0.008
Panel C: Daily total returns (R_t^c)				
Intercept (α_{0c})	0.121 (0.173)	0.111 (0.176)	0.060 (0.081)	0.041 (0.085)
Monday (α_{1c})	0.219 (0.452)	0.243 (0.458)	0.013 (0.240)	−0.012 (0.229)
Wednesday (α_{3c})	−0.122 (0.263)	−0.070 (0.271)	−0.061 (0.128)	0.100 (0.127)
$\text{Ret}_{\text{sp},t}$ (β_{1c})	0.859 (0.328)^c	0.876 (0.338)^c	0.378 (0.157)^b	0.365 (0.164)^b
ΔVIX_t (β_{2c})	0.007 (0.033)	0.010 (0.034)	−0.006 (0.016)	−0.007 (0.016)
R^2	0.088	0.084	0.093	0.093

TABLE 8 Summary of the trading simulation results over 2019

This table reports the summary results of the three simple trading strategies from January 2019 to December 2019. The strategy LTS(Wed) denotes an LTS that buys an ETF at the close of the trading day previous to Wednesday and sells it at the opening price on Wednesday. The strategy STS(Wed, 0.3%) denotes a conditional STS. If Wednesday's overnight return is greater than 0.3%, the STS sells the ETF at the opening on Wednesday and then buys it back at the closing price. The strategy CTS(Wed) denotes a CTS that incorporates the LTS with the STS. The initial funding and round-trip transaction costs are assumed to be 10,000 and 0.271%, respectively

Stock name	**FSSE180 Bull 2X**	**YCSI300 Bull 2X**	**FSSE180 ETF**	**YCSI300 ETF**
Ticker	**00633L**	**00637L**	**006205**	**0061**
Panel A: LTS(Wed)				
Annualized return	−0.133	−0.092	−0.159	−0.129
Standard deviation	0.093	0.087	0.042	0.038
Total net profit	−1,190	−839	−1,409	−1,159
Number of trades	49	49	49	49
Average profit per trade	−24	−17	−29	−24
Profit trades (% of total)	46.94%	46.94%	20.41%	24.49%
Panel B: STS(Wed, 0.3%)				
Annualized return	0.005	−0.017	−0.007	−0.065
Standard deviation	0.062	0.063	0.020	0.035
Total net profit	44	−164	−64	−603
Number of trades	22	22	9	12
Average profit per trade	2	−7	−7	−50
Profit trades (% of total)	63.64%	59.09%	33.33%	33.33%
Panel C: CTS(Wed)				
Annualized return	−0.128	−0.109	−0.165	−0.194
Standard deviation	0.115	0.107	0.045	0.049
Total net profit	−1,151	−989	−1,464	−1,692
Number of trades	49	49	49	49
Average profit per trade	−23	−20	−30	−35
Profit trades (% of total)	34.69%	34.69%	14.29%	10.20%

Abbreviations: CTS, combined trading strategy; ETF, exchange-traded fund; LTS, long trading strategy; STS, short trading strategy.

Wednesday's dummy variable (D_3) in each panel is not significant, suggesting no evidence of a DoW effect during the latest observable year. No significant pattern of returns has been found for the ETFs' corresponding bear −1X counterparts (see Table A1 for more details). Regarding the control variable Ret_{sp} in Panels A and C, we find that the daily returns of the S&P 500 stock index have a significant and positive impact on the overnight and daily total returns of the ETFs.

Table 8 reports the summary results of the three simple trading strategies with transaction costs from 1 January 2019 to 31 December 2019. The results show that, regardless of the ETF, none of the trading strategies generates satisfactory performance, given negatively annualized returns, total net profits, average profit per trade, and profit trades statistics (except for the STS for FSSE180 Bull 2X). Moreover, the number of profit trades under each strategy during the

empirical period of 2019 drop considerably compared to the results of Table 6 (except for the STS on bull 2X LETFs).

In sum, the DoW effects do not persist during the latest observable year, and the DoW-based trading strategies proposed in this study fail to deliver opportunities for profit. This could indicate that investors have observed and learned such market anomalies, thus improving market efficiency. Another possible explanation is that investors could have adjusted their perspectives on the holding period in response to changes in Chinese stock market conditions. Specifically, because the Chinese stock market was trending up during 2019, investors could have lengthened their holding periods, thereby leading to a reduction in the impact of the "$T+1$" trading rule on the DoW effect.

4 | CONCLUSIONS

In recent years, growth in the scale of mutual funds worldwide has begun to slow down and even stagnate. However, the scale of various types of ETFs continues to grow, especially in the Asia Pacific markets, whereas leveraged funds are now the fastest-growing segment of ETF markets. Due to the daily rebalancing of funds' exposures, LETF returns compounded over any holding period longer than 1 day will deviate from the ratio that was promised. Therefore, LETFs are primarily marketed as short-term trading vehicles. The fact that LETFs are clearly an instrument mainly used for swing trading rather than BH trading makes analysis of LETF-related topics from a short-term perspective particularly interesting. To this end, this study uses overnight, intraday, and daily total returns to examine the DOW effect of the two most liquid cross-market bull 2X LETFs listed on the Taiwanese stock market. We also compare the results to those for unleveraged (bear −1X) ETFs (LETFs) on the same underlying benchmarks.

In this study, we uncover a DoW effect in Taiwanese cross-market ETFs. Specifically, Wednesday's overnight returns are significantly positive (negative) for bull 2X LETFs and some unleveraged ETFs (some bear −1X LETFs) tracking the major stock indices of the Chinese market, whereas no significant pattern is found in these ETFs for either intraday or daily total returns (except for the FSSE180 ETF). Our results show no evidence that the ETFs that track local or other international stock markets have an overnight return anomaly on Wednesday. Thus, the Wednesday effect appears to be unique to Taiwanese cross-market ETFs (especially bull 2X LETFs) tracking Chinese stock indices. The "$T+1$" trading rule and a lagged Monday effect potentially explain this anomaly. Moreover, simulation analysis of various simple trading rules based on DoW regularity further shows that there exist exploitable profit opportunities in cross-market bull 2X LETF markets. Due to transaction costs, even if there exist potential market mispricing opportunities in an unleveraged ETF, it would be difficult for investors to exploit such a relationship.

However, DoW-based trading strategies fail to deliver opportunities for profit during the latest observable year. This finding could indicate that investors have observed and learned about this anomalous regularity. In addition, investors could adjust their perspectives on the holding period in response to changes in Chinese stock market conditions (looking like a rising market) during 2019, thereby reducing the impact of the "$T+1$" trading rule on the DoW effect.

Finally, it should be noted that the Taiwanese (Chinese) stock market opens at 9:00 AM (9:30 AM) and closes at 1:30 PM (3:00 PM). The intraday return pattern of a Taiwanese cross-market ETF (the underlying index of a Taiwanese cross-market ETF) during nonsynchronized trading hours is an interesting issue that we leave for future research.

REFERENCES

Ackert, L. F., & Tian, Y. S. (2000). Arbitrage and valuation in the market for Standard and Poor's depositary receipts. *Financial Management*, *29*(3), 71–87.

Aggarwal, R., & Rivoli, P. (1989). Seasonal and day-of-the-week effects in four emerging stock markets. *Financial Review*, *24*, 541–550.

Agrawal, A., & Tandon, K. (1994). Anomalies or illusions? Evidence from stock markets in eighteen countries. *Journal of International Money and Finance*, *13*(1), 83–106.

Aharon, D. Y., & Qadan, M. (2019). Bitcoin and the day-of-the-week effect. *Finance Research Letters*, *31*, 415–424.

Alexander, G. J., & Ferri, M. G. (2000). Day-of-the-week patterns in volume and prices of Nasdaq high-yield bonds. *Journal of Portfolio Management*, *26*(3), 33–40.

Barone, E. (1990). The Italian stock market efficiency and calendar anomalies. *Journal of Banking and Finance*, *14*, 483–510.

Blose, L. E., & Gondhalekar, V. (2013). Weekend gold returns in bull and bear markets. *Accounting and Finance*, *53*(3), 609–622.

Brusa, J., Liu, P., & Schulman, C. (2000). The weekend effect, "reverse" weekend effect, and firm size. *Journal of Business Finance and Accounting*, *27*, 555–574.

Brusa, J., Liu, P., & Schulman, C. (2003). The "reverse" weekend effect: The U.S. market versus international markets. *International Review of Financial Analysis*, *12*, 267–286.

Cai, J., Li, Y., & Qi, Y. (2006). The day-of-the-week effect: New evidence from the Chinese stock market. *The Chinese Economy*, *39*(2), 71–88.

Caporale, G. M., & Plastun, A. (2019). The day of the week effect in the cryptocurrency market. *Finance Research Letters*, *31*, 258–269.

Charupat, N., & Miu, P. (2011). The pricing and performance of leveraged exchange-traded funds. *Journal of Banking and Finance*, *35*(4), 966–977.

Chen, J., Jiang, F., Liu, Y., & Tu, J. (2017). International volatility risk and Chinese stock return predictability. *Journal of International Money and Finance*, *70*, 183–203.

Cheng, M., & Madhavan, A. (2009). The dynamics of leveraged and inverse exchange-traded funds. *Journal of Investment Management*, *7*(4), 43–62.

Crain, S., & Lee, J. H. (1996). Volatility in wheat spot and futures markets, 1950-1993: Government farm programs, seasonality, and causality. *Journal of Finance*, *51*(1), 325–343.

Cross, F. (1973). The behavior of stock prices on Fridays and Mondays. *Financial Analysts Journal*, *4*, 67–69.

Da, Z., & Shive, S. (2018). Exchange traded funds and asset return correlations. *European Financial Management*, *24*(1), 136–168.

Fama, E. (1965). The behavior of stock-market prices. *Journal of Business*, *38*(1), 34–105.

French, K. (1980). Stock returns and the weekend effect. *Journal of Financial Economics*, *8*, 55–70.

Gibbons, M., & Hess, P. (1981). Day of the week effects and asset returns. *Journal of Business*, *54*, 579–596.

Gu, A. (2004). The reversing weekend effect: Evidence from the U.S. equity markets. *Review of Quantitative Finance and Accounting*, *22*, 5–14.

Haga, R., & Lindset, S. (2012). Understanding bull and bear ETFs. *The European Journal of Finance*, *18*(2), 149–165.

Harris, L. (1986). A transaction data study of weekly and intradaily patterns in stock returns. *Journal of Financial Economics*, *16*, 59–117.

Hiraki, T., Maberly, E. D., & Taube, P. M. (1998). The impact of index futures trading on day-of-the-week effects in Japan. *Pacific-Basin Finance Journal*, *6*(5), 493–506.

Ivanov, I., & Lenkey, S. (2018). Do leveraged ETFs really amplify late-day returns and volatility? *Journal of Financial Markets*, *41*, 36–56.

Jaffe, J., & Westerfield, R. (1985a). The weekend effect in common stock returns: The international evidence. *Journal of Finance*, *40*, 433–454.

Jaffe, J., & Westerfield, R. (1985b). Patterns in Japanese common stock returns: Day of the week and turn of the year effects. *Journal of Financial and Quantitative Analysis*, *20*, 243–260.

Jarrow, R. A. (2010). Understanding the risk of leveraged ETFs. *Finance Research Letters*, *7*(3), 135–139.

Keim, D. B., & Stambaugh, R. F. (1984). A further investigation of the weekend effect in stock returns. *Journal of Finance*, *39*(3), 819–835.

Kelly, F. (1930). *Why you win or lose: The psychology of speculation*. Houghton Mifflin.

Kumar, S. (2016). Revisiting calendar anomalies: Three decades of multicurrency evidence. *Journal of Economics and Business*, *86*, 16–32.

Lakonishok, J., & Levi, M. (1982). Weekend effects on stock returns: A note. *Journal of Finance*, *37*(3), 883–889.

Lakonishok, J., & Smidt, S. (1988). Are seasonal anomalies real? A ninety-year perspective. *The Review of Financial Studies*, *1*(4), 403–425.

Loviscek, A., Tang, H., & Xu, X. E. (2014). Do leveraged exchange-traded products deliver their stated multiples? *Journal of Banking and Finance*, *43*(1), 29–47.

Lu, L., Wang, J. J., & Zhang, G. (2012). Long term performance of leveraged ETFs. *Financial Services Review*, *21*, 63–80.

Ma, C. (1986). A further investigation of the day-of-the-week effect in the gold market. *Journal of Futures Markets*, *6*(3), 409–419.

Mehdian, S., & Perry, M. (2001). The reversal of the Monday Effect: New evidence from US equity markets. *Journal of Business Finance and Accounting*, *28*, 1043–1065.

Parkinson, M. (1980). The extreme value method for estimating the variance of the rate of return. *Journal of Business*, *53*, 61–65.

Popović, S., & Đurović, A. (2014). Intraweek and intraday trade anomalies: Evidence from FOREX market. *Applied Economics*, *46*(32), 3968–3979.

Qiao, K., & Dam, L. (2020). The overnight return puzzle and the "*T*+1" trading rule in Chinese stock markets. *Journal of Financial Markets*, *50*, 100534.

Rogalski, R. (1984). New findings regarding day of the week returns over trading and non-trading periods: A note. *Journal of Finance*, *39*, 1603–1614.

Shum, P., Hejazi, W., Haryanto, E., & Rodier, A. (2016). Intraday share price volatility and leveraged ETF rebalancing. *Review of Finance*, *20*(6), 2379–2409.

Tong, W. (2000). International evidence on weekend anomalies. *Journal of Financial Research*, *23*(4), 495–522.

Yamori, N., & Kurihara, Y. (2004). The day-of-the-week effect in foreign exchange markets: Multi-currency evidence. *Research in International Business and Finance*, *18*(1), 51–57.

Zhang, J., Lai, Y., & Lin, J. (2017). The day-of-the-week effects of stock markets in different countries. *Finance Research Letters*, *20*, 47–62.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

How to cite this article: Hsu, Y.-T., Koedijk, K. G., Liu, H.-C., & Wang, J.-N. (2022). Further evidence on calendar anomalies. *European Financial Management*, 28, 545–566. https://doi.org/10.1111/eufm.12301