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Weekly Seasonality in Overnight Effects of the Stock Market

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Abstract

This paper provides a comprehensive study of the weekly seasonality of the overnight effect in US large-cap stocks and index exchange-traded funds (ETFs). We identify a distinct pattern: a statistically significant positive Monday-to-Tuesday and negative Friday-to-next-Monday overnight (close to next open) return in large-cap US equities and index ETFs. We find overnight effect exhibits statistically significant patterns depending on the day of the week. This paper focuses on the weekly seasonality of this effect, exploring how the overnight return patterns vary across the weekdays. A short-term trading model is built to buy these stocks and ETFs before the market close and sell at the opening of the next trading day, and skips Wednesday and/or Friday. This model outperforms the market in both bull and bear conditions with higher Sharpe ratio.

Keywords: weekly seasonality, day-of-week effect, weekly anomaly, overnight returns anomaly

1. Introduction

1.1 The Overnight Effect

The "overnight effect" — the phenomenon where stock returns disproportionately accrue during non-trading hours — has persisted across global equity markets since the first study by French & Roll (French & Roll, 1986). And yet, just a handful of papers over the years have explored this effect leaving the overnight effect an overlooked and largely unexplained anomaly in the stock markets research.

1.2 Explore Importance of the Problem

The day of week overnight return anomaly has been studied in academic finance because it challenges the Efficient Market Hypothesis (EMH), which posits that asset prices fully reflect all available information and should not follow predictable patterns.

If returns can be predicted based on the day of the week, it suggests inefficiencies in how markets process information. Studies have found that Monday overnight returns tend to be abnormally high, possibly due to weekend information accumulation.

Similar patterns have been found in international markets (Qui & Cai, 2022), suggesting the phenomenon may be more than a U.S.-centric quirk. Research by Qiao & Dam (2020) discovered a negativce overnight return in the Chinese T+1 stock market, which restricts selling shares on the same day they were bought. This overnight effect has great impact on the trading strategies for investors, especially short-term investors. We have built a simple model that buys before the close of a trading day and exit the next morning. This model captures almost 98% of all the gains of the Nasdaq index ETF (QQQ) from its inception.

2. Literature Review

The search for an explanation for the overnight effect has focused on (1) risk-return trade-off, such as whether the level and nature of overnight risk compared to intraday risk warrants a higher overnight return; (2) Volatility issue, Wang, Cheng, Yin & Yu (2022) confirmed that volatility is higher when the market is open, volatility is lower when the market is closed. (3) market manipulation hypothesis, which attributes the overnight effect to market manipulation by large Wall Street firms and market makers (Knuteson, 2019); and (4) Risk management by investors and market makers associated with the investment environments, portfolio optimization and market arbitrage.

Explanation number 1 is widely accepted empirically. Our study on the index ETFs, futures and forex ETFs shows that overnight effect does exist not only in the US stock market, but also in the major world capital market ETFs, such as Japan, Singapore, Switzerland and Hong Kong. However, we found overnight effect does not exist in small-cap index

ETFs (IWM) and index ETFs of some countries, like China (FXI), Australia (EWA), France (EWQ), Mexico (EWW) and Canada (EWC).

Explanation number 2 is not persistent because volatility is sometimes lower when the market is open for trading. Lin (2023) proved that volatility is higher over the weekend compared to other trading days of a week.

Explanation number 3 is not receiving much attention since there is not sufficient evidence and no clear beneficiary and without analyzing the market momentum. This is confirmed by Basdekidou (2017).

Explanation number 4 is accepted by researchers including Tompkins & Wiener (2008), Cliff, Cooper & Gulen (2008). A recent study by Akbas, Boehmer, Jiang & Koch (2022) revealed a tendency for persistent patterns of positive overnight returns followed by negative daytime reversals in US stocks. They further confirmed the predictive power of higher returns in month t+1 when such daytime-overnight reversals happen more frequently in month t.

Lachance (2015) established a model that identifies one fifth of stocks having positive and statistically significant overnight biases, and invests overnight in these stocks in the next year. This model yields twice the market's return for a third of the market's beta. Lachance's model is for long term investors. It ignored weekly seasonality (it analyzes only aggregate overnight returns).

Our model is designed for short term traders. It starts from a day trading (overnight) time frame and skips the nights that have negative overnight returns. It invests in the nights with positive overnight return biases. Our model does not use any financial indicators such as moving average, RSI or oscillators.

Bartolini (2020) concerns about the trading costs (bid-ask spread and commission). We think the transaction cost can be saved by trading ETFs and active stocks with lower bid-ask spreads. Our model only makes one trade a day (overnight) and skips days (nights) with negative overnight return profile. This will significantly reduce the transaction costs.

Our contribution and practical implication

We analyze overnight returns through a day-of-the-week lens, revealing that: (a) Monday-to-Tuesday overnight returns are consistently positive for US stocks, ETFs, and select international index ETFs (Japan, Hong Kong, Singapore, Switzerland). (b) Friday-to-Monday returns are negative, suggesting a weekend risk premium. (c) Crypto ETFs exhibit inverse patterns (negative Monday overnight returns and positive weekend returns), highlighting asset-class specificity. (d) Overnight seasonality is not strong in small-cap stocks (this is not confirming with market manipulation hypothesis since small-cap stocks are easier to be manipulated).

We propose a trading model that exploits these patterns to beat the market without relying on any technical indicators, achieving higher Sharpe ratios (7.75 vs. 1.24 for buy-and-hold) and reduced drawdowns during bear markets.

In search of clues to the underlying causes of the superior performance of the stock market overnight, we examined the behavior of individual large-cap stocks in the overnight sessions (when the stock market is closed while the futures market is still open), as well as the ETFs on major indexes, future and forex ETFs. Our research validates the overnight anomaly using US index ETFs from 1993 (the year that US ETFs were first introduced) to 2024, as well as some actively traded large-cap stocks from 1968 to 2024.

The purpose of our study is not to explain the effect, instead we are exploring the possibility of a potentially profitable trading model that buys index ETFs such as SPY, QQQ and DIA in the afternoon of Monday when their overnight returns are positive and skips (will not buy) these ETFs when their overnight returns are negative, and close the position at the open of Tuesday or the next trading day. We examined major index ETFs of all markets worldwide. The results are stunning. This model consistently outperforms the market with lower beta (higher Sharpe ratios). We extended our study on selected large-cap stocks, the futures ETFs, crypto ETFs and some forex market ETFs. All returns on these assets are beating the buy-and-hold strategy in both bull markets and bear markets such as 1987, 2000 and 2008.

3. Methodology and Data

The data consist of daily observations of the opening and closing prices for a broad sample of US large-cap equities, index ETFs, futures ETFs, Treasury bond ETFs, forex ETFs, and index ETFs of other countries. The main difference between intraday (daytime: 09:30 am – 04:00 pm EST) and overnight periods is that much of the overnight return has the earnings announcements functionality (at least for the US stock markets) and therefore may reflect information surprises.

The total daily close-to-close return is calculated as $CCt = Ct – Ct\text{-}1$ where Ct is the closing price on day t. The closing price is a cum dividend price of the ETFs. The daytime return (open to close return) is $COt = Ct - Ot$ where Ot is the opening price on day t. The overnight return (previous close to open return) is $OCt = Ot – Ct\text{-}1$.

3.1 The Samples

We have selected 105 assets from large-cap stocks to ETFs with a total sample size of 606,989. We included four major

US index ETFs, 12 world index ETFS, 14 sector ETFs, 8 Treasury, crypto, forex and futures ETFs, the magnificent 7 high tech stocks, and 60 large-cap US stocks with historical data back to 1968.

Data	Sample Period	Number of Assets	Sample Size
US Index ETFs	1993 to 2024	4	26,220
Treasury ETFs	2002 to 2024	1	3,627
Sector ETFs	1991 to 2024	14	65,734
US Stocks	1968 to 2024	67	416,971
World Index ETFs	1991 to 2024	12	69,010
Futures ETFs	2006 to 2024	3	13,289
Forex ETFs	2008 to 2024	1	4,096
Crypto ETFs	2017 to 2024	3	8,042
Total		**105**	**606,989**

3.2 Characteristics

Futures, forex and cryptos are traded 24 hours around the clock. Their ETFs and US large-cap stocks have trading hours from 9:30am to 4:00pm Eastern Standard Time without night time trading activities. In our robustness check, we used 99 years of daily data of Dow Jones Industrial Average futures from 1926 to 2024.

3.3 ANOVA test

To assess the statistical significance of day-of-the-week patterns in overnight returns, we conducted a one-way ANOVA test comparing return variances across all five trading days (Monday to Friday). This analysis tested the null hypothesis that mean overnight returns are equal for all weekdays, with post-hoc Tukey HSD tests identifying pairwise differences. The ANOVA results ($p < 0.01$) rejected the null hypothesis, confirming that return distributions vary significantly by weekday. Notably, Monday overnight exhibited higher returns than other days, aligning with prior findings on Monday market anomalies (French & Roll, 1986). Robustness checks using non-parametric Kruskal-Wallis tests yielded consistent results ($p < 0.001$), reinforcing the seasonality conclusion.

4. Results

The results are presented in the tables below, highlighting key patterns in overnight returns:

Table 1 summarizes the average overnight returns (OCt = [Open - Previous Close]) by weekday across our full sample period (1968-2024). Panel A1 reveals distinct seasonal variations, with Monday overnight returns showing statistically significant positive returns while Friday returns were consistently negative ($p < 0.05$). Panel A2 shows the assets with strong overnight return variance despite their overall declining price trajectories. Panel B1 shows the assets with strong Monday overnight return that lack conventional statistical significance ($p > 0.05$). Panel B2 shows the assets with overnight returns underperforming the buy-and-hold strategy. Panel C shows assets with negative overnight returns; Panel D, E, F and G show the overnight return patterns of crypto ETFs, the magnificent seven stocks, the volatility index ETF (VIX) and some Forex ETFs respectively.

Table 1 Summary of Overnight Returns by Assets for the Sample Period Classified by Day of the Week

Panel A1. Assets with Positive Gains and Strong Overnight Return Anomaly ($p < 0.05$)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
AAPL	1980	54.36	18.48	-6.58	16.42	-69.84	12.84	223.62	0.038
BA	1968	167.58	199.62	-10.27	115.99	-164.10	308.82	176.24	0.004
BAC	1972	46.61	-2.94	9.52	37.66	-7.88	82.97	39.58	0.011
BRX	2013	11.22	2.12	-10.01	2.66	-5.16	10.83	5.60	0.0008
BSJQ	2018	0.09	1.08	0.57	0.75	-2.02	0.47	0.59	0.0002
DEEP	2014	10.36	18.9	-2.11	23.05	-6.79	43.46	7.29	0.014
DURA	2018	8.25	2.12	-5.14	9.46	-1.40	13.29	5.15	0.027
EPR	1997	27.78	8.97	-22.79	28.21	31.45	73.62	31.61	0.039

EWH	1991	9.76	11.01	-11.02	1.5	-13.42	17.87	13.82	0.014
EWJ	1991	46.82	-25.55	-2.2	-14.21	-52.99	-48.13	21.62	0.041
EWS	1991	15.30	14.96	-9.67	26.19	-17.27	29.51	15.90	0.007
EWW	199	37.52	30.53	27.70	64.09	-11.45	148.39	46.51	0.041
FCPT	2015	8.22	2.20	-16.78	11.00	7.89	12.53	10.85	0.015
FRAF	1997	-3.94	-0.6	29.12	-17.32	-32.89	-25.68	15.22	0.021
FREL	2015	16.53	11.54	3.34	5.28	9.58	46.27	2.73	0.050
GLPI	2013	21.5	13.19	-28.87	21.74	9.08	36.66	10.41	0.002
GOOG	2004	47.57	34.45	18.01	27.79	-65.72	62.10	153.55	0.034
HYDB	2017	9.05	9.54	-1.78	-0.96	-12.08	3.77	-3.08	0.0004
IHY	2012	3.76	3.73	1.41	1.76	-5.70	4.96	-4.48	0.032
JCPB	2019	8.26	10.25	11.83	14.71	-1.30	43.75	-3.49	0.037
JQUA	2017	10.23	15.47	5.08	11.01	-5.26	36.53	32.54	0.044
KALU	2006	39.46	29.78	-73.8	50.50	49.67	95.55	31.59	0.010
KO	1968	29.00	-10.62	-31.98	6.56	-15.36	-22.40	69.69	0.0007
MSFT	1986	107.73	166.75	4.07	63.04	-96.99	244.60	378.71	0.006
NOC	1968	118.60	95.57	-126.20	98.15	116.91	303.03	511.46	0.026
NVDA	1999	23.71	47.09	69.88	24.43	-17.73	147.38	111.39	0.039
PCN	2001	9.42	1.52	-1.60	7.68	21.02	38.04	1.05	0.001
SCHD	2011	10.01	1.48	2.14	8.38	1.35	23.36	19.25	0.046
SDOG	2012	20.55	8.03	-15.21	16.61	5.07	35.05	32.20	0.002
SPGI	1968	194.49	78.93	10.79	67.11	-68.43	282.89	508.17	0.045
SPSC	2010	20.87	40.59	24.40	117.93	-33.89	169.90	128.20	0.002
Tech	1989	41.5	42.48	9.86	6.43	-19.74	80.61	51.63	0.013
TKR	2014	29.15	20.30	-33.43	24.00	2.92	42.94	28.22	0.035
TSM	1997	90.21	82.32	107.48	60.14	-32.79	307.36	156.55	0.039
WSBF	2005	9.56	1.11	-6.46	-0.35	0.86	4.72	6.67	0.022
XLK	1999	81.21	67.18	50.60	27.32	-43.59	182.72	171.28	0.008
XLRE	2015	19.44	7.33	-2.40	6.94	-3.44	27.87	11.40	0.023
XLV	1999	50.61	38.54	-1.65	9.78	-2.87	94.41	119.07	0.028
YCS	2008	0.90	12.69	-11.34	14.62	16.62	33.49	26.76	0.023

Panel A2. Declining Assets with Strong Overnight Return Anomaly ($p < 0.05$)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
ARI	2009	3.98	-2.57	-6.48	4.99	5.19	5.11	-9.78	0.044
BLRX	2011	3,759	650	409	189	2,957	7,964	-3,350	0.042
BND	2007	9.09	8.05	0.01	6.18	-11.06	12.27	-1.72	0.067
DLY	2020	5.17	-4.92	-1.32	2.50	0.80	2.23	-3.60	0.00009
DMO	2010	6.52	-7.47	-4.34	9.70	5.73	10.14	-7.90	0.00001
EXG	2007	8.33	-2.81	-0.88	3.01	-0.7	6.86	-11.62	0.028
FFC	2003	1.6	-10.06	-8.09	0.62	-11.04	-26.96	-8.72	0.032
FSLY	2019	11.42	9.47	-89.69	-6.53	13.01	-62.32	-16.95	0.018
HYGV	2018	-15.32	5.88	2.34	-3.13	-2.60	-12.83	-9.33	*0.0016*

JSM	2003	-2.02	-26.74	-31.66	-18.5	-9.30	-88.23	-5.75	0.005
LE	2014	12.74	3.45	-30.85	7.84	2.50	-4.32	-22.69	*0.0082*
MIN	2018	7.44	3.41	-2.68	-2.58	-17.13	-11.54	-9.20	0.00003
NAOV	2015	-1,207	78.87	-1,694	439	817	-1,566	-765	0.0056
ORC	2013	28.80	26.72	-13.41	1.33	25.87	69.31	-65.69	0.0021
USO	2006	17.45	11.28	69.98	-45.22	-402	-349	-469	0.027
VRP	2014	7.49	2.53	0.84	6.96	-5.29	12.53	-7.10	0.00007
VUSB	2021	-0.10	-0.05	0.67	-0.39	-2.09	-1.96	-0.74	0.0021
WEAT	2011	-2.36	-3.92	3.33	7.68	9.48	14.21	-19.80	0.011

Panel B1. Assets with Significant Return Realized Overnight but Weak Weekly Anomaly (p > 0.05)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
AMD	1972	50.84	69.70	96.50	53.66	35.31	306.01	106.13	0.759
BRK.B	1996	202.01	136.44	84.70	124.50	168.28	715.93	510.12	0.239
CMG	2006	16.59	20.56	1.61	11.35	-1.60	48.51	46.39	0.159
DOCU	2018	68.94	67.59	-0.11	-41.13	-57.57	37.72	34.21	0.281
EEM	2003	24.69	21.45	-8.75	24.45	-17.15	44.69	32.65	0.091
ENZL	2010	19.74	23.67	0.14	3.04	-19.92	26.67	6.05	0.086
EWC	1991	12.22	11.46	-0.99	12.44	7.96	43.09	32.32	0.763
EWT	2000	9.49	29.15	0.90	9.53	-24.24	24.88	9.07	0.206
EWY	2000	45.15	39.65	-21.78	17.15	-41.00	39.17	37.44	0.061
FIVA	2018	11.55	8.11	0.16	0.06	2.63	22.51	2.35	0.081
FKU	2012	20.95	22.19	3.44	-11.54	1.00	36.04	6.45	0.136
GLOF	2015	14.89	7.79	2.23	14.08	-1.00	37.99	16.73	0.194
GLD	2004	49.38	59.09	27.76	103.09	11.68	251.00	237.54	0.331
HDV	2011	32.14	14.16	-3.80	34.05	-2.88	73.67	68.72	0.061
IWM	2000	82.05	62.01	31.12	88.33	61.39	324.90	153.67	0.762
LW	2016	33.38	-13.53	-24.02	42.62	5.90	44.35	21.02	0.055
OXY	1968	59.76	30.44	39.71	61.84	-20.68	171.07	33.83	0.098
QEFA	2014	34.11	12.56	-3.41	-4.55	-8.45	30.26	13.62	0.079
SPXL	2008	52.60	70.65	23.53	37.83	-31.40	153.21	141.99	0.205
USD	2007	17.30	36.63	50.37	21.05	-11.82	113.53	41.28	0.083
XLU	1998	29.39	19.88	4.83	-4.10	14.23	64.23	46.95	0.098

Panel B2. Assets with Overnight Returns Underperforming Buy and-Hold (p > 0.05)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
AAXJ	2008	24.72	32.97	-11.89	10.54	-36.80	19.54	25.83	0.073
DIA	2004	125.08	105.99	7.97	-9.58	-0.36	229.10	320.66	0.079
DLTR	1995	0.73	-8.56	-53.76	9.16	63.79	21.36	71.58	0.169
ESGD	2016	20.12	15.58	-12.12	13.36	-18.05	18.89	31.15	0.069
EWL	1991	11.59	13.53	-7.19	-2.21	-14.40	1.32	38.28	0.090
EWP	1991	11.68	-4.98	2.35	-24.47	-45.87	-61.29	27.92	0.094
EXR	2004	36.74	27.90	-4.48	32.60	-1.17	91.59	125.45	0.519

FXI	2004	1.79	15.19	-34.45	16.98	-9.52	-10.01	29.01	0.301
INDA	2012	11.68	17.00	-3.06	13.98	-16.06	23.54	24.56	0.061
IWY	2000	39.35	37.31	27.64	15.15	-25.64	93.81	113.06	0.056
LMT	1995	140.90	78.28	-43.27	97.10	111.10	384.11	416.40	0.321
NKE	1987	52.52	15.42	-0.24	-4.73	-32.40	30.57	57.07	0.36
PEP	1968	28.16	-41.00	-63.57	-23.40	-17.91	-117.72	145.90	0.074
PLTR	2020	24.33	9.47	2.42	4.67	3.48	44.37	80.09	0.771
QQQ	2004	126.64	141.10	80.20	55.76	-48.77	354.93	383.34	0.070
SPY	1993	183.64	149.24	59.36	47.50	40.83	480.57	530.53	0.255
TMO	1972	134.19	130.64	144.6	124.5	-162.1	371.9	509.87	0.058
UHT	1986	11.68	0.61	-51.61	4.50	-11.92	-46.74	28.65	0.063
VOO	2010	128.7	111.1	34.01	79.97	-31.77	322.1	418.71	0.152
WFC	1968	33.58	15.69	-3.07	15.72	-3.04	58.88	70.34	0.425
WMT	1997	19.95	-4.38	9.90	10.92	2.59	38.98	85.13	0.409
XLC	2018	18.53	18.15	3.10	10.09	-15.51	34.36	46.04	0.095

Panel C. Assets with Negative Overnight Returns (p > 0.05)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
ATHM	2013	-3.3	36.8	-41.4	-11.6	-37.7	-57.26	-1.58	0.067
IBM	1968	-16.0	-74.47	-14.51	-47.3	-37.6	-189.9	229.35	0.892

Panel D. Overnight Returns of Crypto ETFs and Related Companies (p > 0.05)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
COIN	2021	-41.93	34.73	47.52	88.73	34.39	163.44	-193	0.791
IBIT	2024	-6.74	12.18	16.52	14.12	4.30	40.38	19.62	0.29
MSTR	1998	-49.71	88.87	223.03	142.4	28.47	533.06	316.59	0.21

Panel E. Overnight Returns of the Magnificent Seven stocks

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
AAPL	1980	54.36	18.48	-6.58	16.42	-69.84	12.84	223.62	0.038
AMZN	1997	66.07	92.16	66.65	51.60	-8.45	268.03	201.24	0.351
GOOG	2004	47.57	34.45	18.01	27.79	-65.72	62.10	153.55	0.034
META	2012	107.44	132.05	114.86	94.64	-91.44	357.55	534.69	0.487
MSFT	1986	107.73	166.75	4.07	63.04	-96.99	244.60	378.71	0.006
NVDA	1999	23.71	47.09	69.88	24.43	-17.73	147.38	111.39	0.039
TSLA	2010	139.59	97.44	41.85	57.52	110.27	446.67	271.86	0.901

Panel F. Overnight Returns of the VIX (volatility index) ETFs (p < 0.05)

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value
VIX	2018	-21.54	-4.40	15.70	-14.25	12.08	-12.41	16.91	0.036

Panel G. Overnight Returns of Forex ETFs

Symbol	From	Mon	Tue	Wed	Thu	Fri	Overnight	Buy-n-Hold	p value

YCS	2008	0.90	12.69	-11.34	14.62	16.62	26.76	33.49	0.023
YCL	2008	1.53	-16.01	12.80	-36.61	-5.72	-43.55	-82.37	0.723

5. Discussion

5.1 Some Interesting Patterns Are Revealed

A strong overnight effect is found on all major index ETFs of the US and index ETFs in many other countries and US large-cap stocks, that returns on Monday and Tuesday nights are positive while returns on Friday nights are negative. Some gains are extended to the opening of Wednesday, resulting in consecutive overnight gains of Monday and Tuesday.

Remarkably, the overnight return anomaly persists even during periods of overall price decline (Panel A.2). Specifically, stocks with negative cumulative returns still exhibit significantly positive Monday overnight returns ($p < 0.05$), suggesting this seasonal effect operates independently of bull or bear price trends.

Our analysis reveals a distinctive crypto-specific pattern: Bitcoin ETF (IBIT) and correlated equities (COIN, MSTR) exhibit significantly negative Monday overnight returns and strongly positive Friday overnight returns. This inverse weekly seasonality - directly opposing traditional equity patterns - suggests unique crypto market microstructure drivers, potentially reflecting investor behavior patterns specific to digital assets.

Negative overnight effects are strong in some individual stocks such as ATHM and IBM. All losses are realized overnight for IBM.

5.1.1 Overnight vs Buy-and-Hold

Karatas & Hirsa (2021) used a two-stage methodology of AI to predict the future rate of return of sector ETFs, and proved that two-stage sector rotation method can beat the market in a long run. We have studied the day of the week seasonality of these sector ETFs and found simply trading the overnight seasonality can also beat the market. We have compared the overnight returns with the Buy-and-Hold performance of major index ETFs, most actively traded large-cap stocks and sector ETFs. We found that majority of returns were realized overnight, while some overnight returns significantly outperformed the buy-and-hold strategy. For example, in the past 26 years, QQQ gained 461.97 points since its inception in 1999, but the overnight return gained 428.93 points, 92.85% of QQQ gains were realized overnight.

A striking example emerges from the real estate sector: While the FREL (Fifelity MSCI Real Estate Index ETF) generated modest total returns of just 2.73 points since its 2015 inception, overnight positions alone captured 46.27 points - representing 1,695% of the fund's total gains and demonstrating the overwhelming dominance of overnight returns in this sector.

The compasisons are presented in table 2 and table 3 below:

Table 2. Majority of Returns Being Realized Overnight

Symbol	Names	From	Buy-Hold Returns	Overnight Returns	Percent Realized Overnight
DIA	SPDR Dow Jones Ind Avg	2004	320.66	229.1	71.45%
GOOG	Alphabet (Google)	2004	153.5	62.1	40.46%
INDA	iShares MSCI India ETF	2012	24.56	23.54	95.85%
IWY	iShares US Tech ETF (AI)	2000	113.06	93.81	82.97%
LMT	Lockheed Martin	1995	416.4	384.11	92.25%
META	Meta Platforms	2012	534.69	357.55	66.87%
MSFT	Microsoft	1986	378.7	244.6	64.59%
PLTR	Palantir Tech	2020	80.09	30.57	38.17%
QQQ	Invesco QQQ Trust	1999	461.97	428.93	92.85%
SGOV	iShares 0-3 Mo T-Bond ETF	2020	0.67	0.65	97.01%
SPGI	S&P Global Inc	1968	508.17	282.89	55.67%
SPY	SPDR S&P 500	1993	530.53	480.57	90.58%
TMO	Thermo Fisher Scientific	1972	509.87	317.9	62.35%

VOO	Vanguard S&P 500 ETF	2010	418.71	322.1	76.93%
WFC	Wells Fargo	1968	70.34	58.88	83.71%
XLC	S&P Select Com SPDR	2018	46.04	34.36	74.63%
	Total		**4567.96**	**3351.66**	**73.37%**

Table 3. Overnight Returns Significantly Outperformed the Buy-and-Hold strategy

Symbol	Names	From	Buy-Hold Returns	Overnight Returns	Percent Realized Overnight
AMD	Advanced Micro Devices	1972	106.13	306.01	288.34%
AMZN	Amazon	1997	201.24	268.03	133.19%
BA	Boeing	1968	176.24	308.82	175.23%
BAC	Bank of America	1972	39.58	82.97	209.63%
BRK.B	Berkshire Hathaway B	1996	510.12	715.93	140.35%
EEM	iShares MSCI Emg Mkt	2003	32.65	44.69	136.88%
ENZL	iShares MSCI New Zealand	2010	6.05	26.67	440.83%
EWC	iShares MSCI Canada ETF	1991	32.32	43.09	133.32%
EWS	iShares MSCI Singapore ETF	1991	15.9	29.51	185.60%
EWT	iShares MSCI Taiwan ETF	2000	9.07	24.88	274.31%
EWW	iShares MSCI Mexico ETF	1991	46.51	148.39	319.05%
EWY	iShares MSCI South Korea	2000	37.44	39.17	104.62%
FIVA	Fidelity Intl Value Fctr ETF	2018	2.35	22.51	957.87%
FREL	Fifelity MSCI Real Estate	2015	2.73	46.27	1694.87%
FKUFT	United Kingdom DEX	2012	6.45	36.04	558.76%
GLD	SPDR Gold Trust	2004	237.54	251.10	5.67%
GLOF	iShares Global Equity ETF	2015	16.73	37.99	227.08%
IBIT	iShares Bitcoin Trust ETF	2024	19.62	40.38	205.81%
IWM	iShares Russell 2000 ETF	2000	153.67	324.9	211.43%
LW	Lamb Weston Holdings	2016	21.02	44.35	210.99%
MSTR	MicroStrategy	1998	316.59	533.06	168.38%
NVDA	Nvidia Corp	1999	111.39	147.38	132.31%
OXY	Occidental Petro Corp	1968	33.83	171.07	505.68%
QEFA	SPDR MSCI EAFE	2014	13.62	30.26	222.17%
SPSC	SPS Commerce	2010	128.2	169.9	132.53%
Tech	BioTech Corp	1989	51.63	90.61	175.50%
TSLA	Tesla	2010	271.86	446.67	164.30%
TSM	Taiwan SemiConductors	1997	156.55	307.36	196.33%
USD	Ultra SemiConductors	2007	41.28	113.53	275.02%
XLB	S&P Select Material SPDR	1997	63.11	76.61	121.39%
XLE	S&P Select Energy SPDR	1999	21.49	136.12	633.41%
XLF	S&P Select Financial SPDR	1999	30.41	50.41	165.77%
XLI	S&P Select Ind SPDR Fd	1999	105.56	109.64	103.87%
XLRE	S&P Select Real Estate	2015	11.4	27.87	244.47%
XLU	S&P Select Utilities SPDR	1998	46.95	64.23	136.81%

XLY	S&P Select Consr SPDR	1999	170.88	180.59	105.68%
XSD	SPDR S&P Semiconductor	2006	144.47	311.75	215.79%
	Total		**3392.58**	**5808.66**	**171.22%**

5.1.2 Overnight Performance in the Bear Markets

Our analysis of four major US index ETFs demonstrates consistent outperformance of overnight strategies versus the buy-and-hold strategy. This advantage proves particularly valuable during bear markets:

2008 Financial Crisis Case Study

The Dow Jones Industrial Index ETF (DIA)'s decline of -44.95 points reveals a critical divergence:

- **Buy-and-hold strategy**: Realized the full -44.95 point loss
- **Overnight strategy**: Limited losses to -19.36 points

This 56.9% reduction in losses stems from two key factors:

1. **Intraday vulnerability**: 72% of DIA's 2008 losses occurred during day time trading hours;
2. **Overnight resilience**: Evening sessions showed partial recovery after daytime selloffs.

Table 4. Overnight Loss vs Buy-and-Hold Loss in 2008 (Loss in points)

		Buy-n-Hold Returns	Percent Declined	Overnight Returns	% Gain or Loss	Risk Reduction
DIA	2008	-44.95	-33.99%	-19.36	-14.64%	25.59
IWM	2008	-26.91	-35.33	-9.82	-12.86%	17.09
QQQ	2008	-21.53	-42.48%	-6.43	-12.68%	15.1
SPY	2008	-56.29	-38.42%	-24.46	-24.46%	31.83
Total		**-149.68**		**-60.07**		**89.61**

2000 Tech Bubble Crisis Case Study

Our analysis reveals the remarkable defensive properties of overnight strategies during the dot-com collapse. In 2000, QQQ dropped 39.94%, while the overnight strategy gained 35.19%. Microsoft dropped 63.02%, while the overnight strategy dropped only 18.61%. The overnight strategy on DIA, IWM and SPY also recorded gains during this period when the market was declining sharply.

Table 5. Overnight Loss vs Buy-and-Hold Loss in 2000 (Loss in points)

		Buy-n-Hold Returns	Percent Loss	Overnight Returns	Percent Gain/Loss	Risk Reduction
DIA	2000	-9.29	-8%	6.55	5.70%	15.84
IWM	2000	-3.06	-6%	8.72	17%	11.78
MSFT	2000	-33.28	-63.02%	-9.86	-18.61%	23.42
QQQ	2000	-38.1	-39.94%	33.65	35.19%	71.84
SPY	2000	-17.06	-11.51%	30.42	20.52%	47.48
Total		**-100.88**		**69.48**		**170.36**

1987 Market Crash Case Study

During the historic 1987 market crash, AMD dropped 28% while EMF dropped 57%. The overnight trading strategy only lost 6% and 13% respectively.

Table 6. Overnight Loss vs Buy-and-Hold Loss in 1987 (Loss in points)

		Buy-n-Hold Returns	Percent Dropped	Overnight Returns	Percent Gain/Loss	Risk Reduction
AMD	1987	-1.94	-28%	-0.42	-6%	1.52
BA	1987	-3.2	-28%	-2.04	-18%	1.16
BAC	1987	-1.13	-21%	-0.84	-15%	0.29
EMF	1987	-7.88	-57%	-1.75	-13%	6.13
FLXS	1987	-2.27	-19%	-1.5	-12%	0.77
LMT	1987	-1.68	-12.3%	0.19	1.30%	1.87
NOC	1987	-6.88	-35.0%	-3.63	-18.40%	3.25
OXY	1987	-1.69	-12.0%	0.19	1.40%	1.88
SPGI	1987	-0.81	-18.6%	1.12	25.80%	1.93
TMO	1987	-0.97	-21%	-0.7	-15.00%	0.27
WFC	1987	-0.01	-2%	0.25	18.00%	0.26
Total		**-28.46**		**-9.13**		**19.33**

In the overnight return variances of the three bear markets above, we can see the overnight loss is much less than the buy-and-hold strategy during market crash. SPGI even recorded 25.8% gain in overnight trading while the buy-and-hold strategy declined 18.6%. This proves that overnight risk is not so high as many investors might think. Our study indicates that the volatility risk premium (VRP) serving as compensation for investors bearing overnight risks has strong day-of-the-week bias.

5.2 Correlation Analysis

Liu & Tse (2017) found strong correlation between overnight returns and first half-hour (negative relation) and last trading hour (positive relation) returns of the next trading day. Tori (2003) in her article “Re-examining Return Auto-correlation and Monday Returns” revealed a very strong relations between Monday returns and returns of the previous Friday in S&P 500, but not so strong in Nasdaq. Tori finds that the reversal of the Monday effect for the S&P disappeared after 2001. Lin (2023) found there is a strong correlation between Friday overnight returns and Monday volatility.

Our study shows no strong correlations in the overnight returns of five trading days in a week among each other. But among intraday returns and overnight returns, we did find a negative correlation between Tuesday intraday returns and Tuesday overnight returns on the ETF of S&P 500 (SPY).

This means if Tuesday intraday is down, Tuesday overnight return may be positive, and vice versa. This can be used as a non-financial indicator to filter out Tuesday overnight losing trades on SPY.

Table 7. Panel A. Correlation analysis of the overnight and day trading returns

	MonCO	TueCO	WedCO	ThuCO	FriCO	MonOC	TueOC	WedOC	ThuOC	FriOC
MonCO	1									
TueCO	0.05738	1								
WedCO	0.00193	0.0164	1							
ThuCO	0.00267	-0.102	-0.005	1						
FriCO	-0.0014	0.0460	0.1002	0.0724	1					
MonOC	-0.0202	0.0500	0.0161	0.0804	0.0637	1				
TueOC	-0.0091	**-0.193**	0.0262	0.0189	-0.0309	-0.006	1			
WedOC	-0.0458	0.0811	0.0426	-0.0253	0.0104	0.119	0.026	1		
ThuOC	-0.0057	-0.006	-0.026	0.00813	0.0075	-0.117	-0.062	0.049	1	
FriOC	0.00140	-0.004	-0.036	-0.0075	-0.0347	0.019	-0.071	-0.026	-0.004	1

To further study the negative correlation between Tuesday intraday return and Tuesday overnight return, we performed a t-test. The p value is 0.00001, meaning the negative correlation between Tuesday intraday and overnight returns is statistically significant. Here are the t-test results:

Table 7. Panel B. t-test of the Correlation between Tuesday day and overnight returns.

	Tuesday Intraday	Tuesday Overnight
Mean	-0.031252433	0.07092148
Variance	2.780877586	1.402404735
Observations	1541	1541
df	15401540	
f	1.982935109	
P(F<=f) one-tail	0.00001	
F Critical one-tail	1.087471624	

Chart 1 illustrates the statistically significant negative correlation ($p < 0.01$) between Tuesday intraday returns and subsequent Tuesday overnight returns, revealing a consistent mean-reversion pattern that can improve our overnight trading strategy.

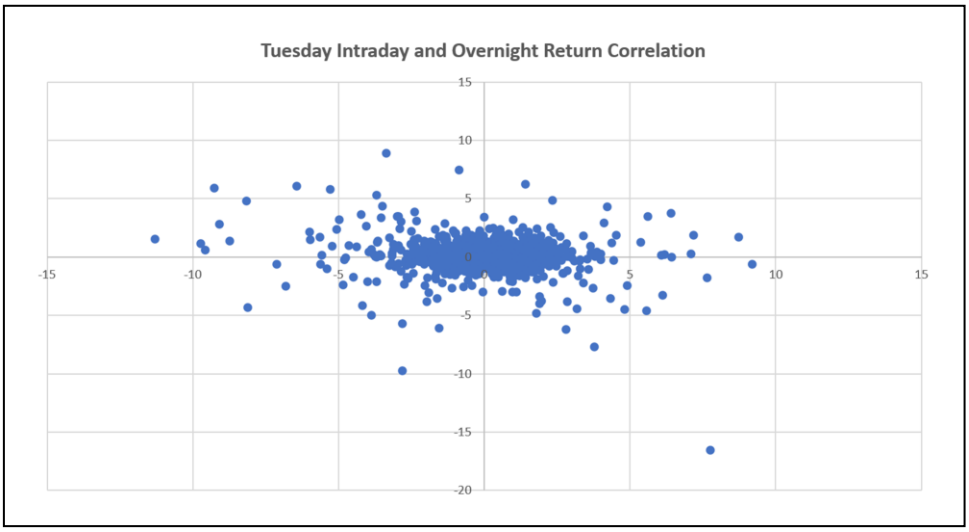

Chart 1. Correlation between Tuesday intraday returns and Tuesday overnight returns

Tuesday intraday return can be used to filter our losing trades in Tuesday overnight trading of SPY. If Tuesday intraday return is positive, we will skip the Tuesday overnight long trade. This will filter our most overnight losing trades of SPY in our overnight trading model on SPY or credit put spreads on 1 DTE options on XSP.

5.3 Trading Models

The purpose of this study is not to explain the reason of the overnight effect. Instead, we are trying to build a consistent short-term trading model to capture this seasonality return anomaly without using any financial indicators. We have built three profitable trading models based on the overnight return anomaly.

5.3.1 The 3-Night-a-Week Model

This model is to buy (Long) a stock or an index ETF (for example, QQQ that shows strong overnight effects) at the close of Monday, Tuesday and Thursday, and close the long position in the opening of the next trading day. There will be no trades on Wednesday and Friday nights. This model consistently beats the market without using any financial indicators.

Table 8. Returns of the 3-Night Model vs the All-Nights model and the Buy-and-Hold model

Symbol	From	Buy-n-Hold	Mon-Fri Return	Mon-Tue-Thu Return	Excess Return
BA	1968	176.24	308.82	483.19	174.37
EEM	2003	32.65	44.69	70.59	25.90
EWH	1991	13.82	17.87	42.32	24.45
EWS	1991	15.90	29.51	56.45	26.94
EWY	2000	37.44	39.17	101.95	62.78
GLPI	2013	10.41	36.66	56.45	19.79
HDV	2011	68.72	73.67	80.35	6.68
SDOG	2012	32.20	35.05	45.19	10.14
TKR	2014	28.22	42.94	73.45	30.51
Total		**415.60**	**628.38**	**1009.94**	**381.56**

5.3.2 The 4-Night-a-Week Model

The following stocks and ETFs have strong performance using this 4-nights-a-week overnight trading model: simply buying before the closing bell on Monday and exit in the morning of Friday. This model does not hold position over the weekends (skipping the overnight trade on Fridays).

Table 9. Returns of the 4-Night Model vs the All-Nights model and Buy-and-Hold

Symbol	From	Buy-n-Hold	Mon-Fri 5 Nights	Mon-Tue-Wed-Thu 4 Nights	Excess Return
BA	1968	176.24	308.82	472.92	164.10
BAC	1972	39.58	82.97	90.85	7.88
DEEP	2014	7.29	43.46	50.25	6.79
EEM	2003	32.65	44.69	70.59	25.90
EWH	1991	13.82	17.87	31.29	13.42
EWS	1991	15.9	29.51	46.78	17.27
EWW	1991	46.51	148.39	159.84	11.45
EWY	2000	37.44	39.17	101.95	62.78
HDV	2011	68.72	73.67	80.35	6.68
LW	2016	21.02	44.35	62.47	18.12
NVDA	1999	111.39	147.38	165.11	17.73
QEFA	20141	3.62	30.26	42.12	11.86
QQQ	1999	435.77	386.77	429.91	43.41
SPSC	2010	128.2	169.9	203.79	33.89
SPXL	2008	141.99	153.21	161.08	7.87
TECH	1989	51.63	80.61	100.35	19.74
TSM	1997	156.55	307.36	340.15	32.79
XLK	1999	171.28	182.72	226.31	43.59
Total		**1588.76**	**2287.68**	**2809.9**	**545.00**

Chart 2 is the overnight return of QQQ from Mar 10, 1999 to Dec 31, 2024 (26 years). About 426.86 points (92.58%) were realized overnight, while QQQ gains 461.1 points during this period. By skipping Friday nights, the overnight returns become 439.46 points (95.31%). No day trading is required for this model. This means day trading QQQ is not so profitable as many day traders may think.

This model does not use any financial indicators. It simply buys before the closing bell and sells the next morning. This 4-night-a-week model captures 95.31% of all returns of QQQ in the past 26 years. Less than 5% gains of QQQ are realized during day trading hours.

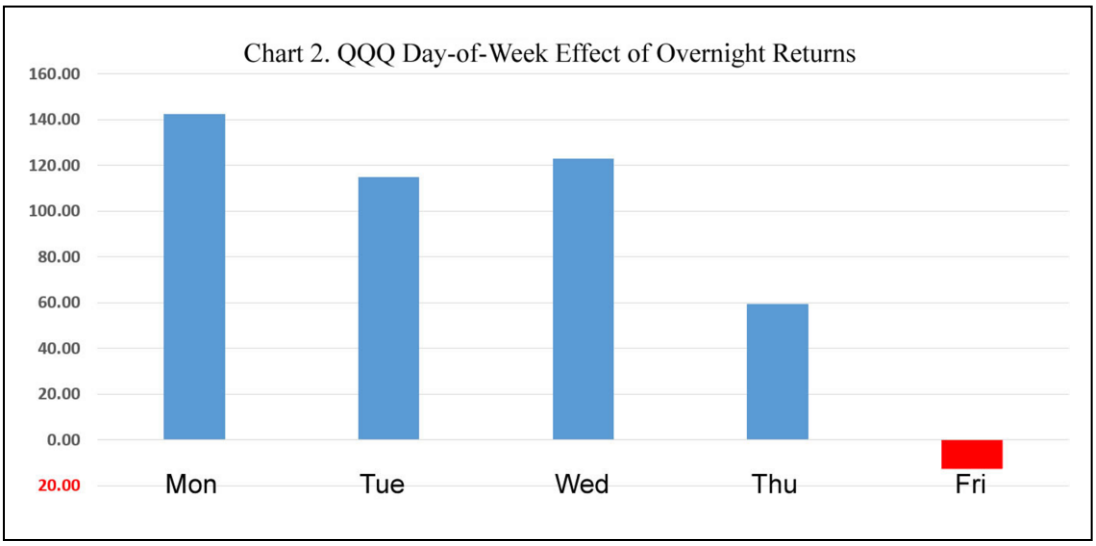

Chart 2. QQQ Day-of-Week Effect of Overnight Returns

This model has a higher Sharpe ratio compared to the Buy-and-Hold strategy of QQQ.

Table 10. Summary of the Return Variances of Overnight vs Buy-and-Hold Strategy

Groups	Years	Sum	Average	Variance	Sharpe Ratio
Overnight	26	1.978501	0.086022	0.011099	7.75
Buy and Hold	26	2.226649	0.096811	0.077609	1.24

The Buy-and-Hold strategy trading QQQ recorded a higher average return 9.68% with a large variance of 7.76% and 1.24 Sharpe ratio. Our 4-Night-a-Week model results in a smooth return of 8.6% and much lower variance of 1.10% and higher Sharpe ratio of 7.75.

5.3.3 The VIX Premium Selling Model

Since VIX ETF has a strong overnight return variance (option implied volatility is high after hours of Wednesday and Friday, p value < 0.05), we can sell high premium 1 DTE S&P 500 index options and buy low premium (further expiration) options as protection before the closing of Wednesday and Friday, and close the position the next day when VIX drops.

5.4 Robustness Check

5.4.1 The Futures Market

In order to examine the robustness of the week-day effect to error distributional assumptions, we (1) tested 99 years of historical data of the Dow Jones Industrial Index futures which closes at 17:00 EST and opens one hour later at 18:00 EST. There is only one hour close of the market to see if the overnight effect exists; and (2) compared the percentage of positive returns and the percentage of positive return over means in Monday nights.

Here are the results of the day of week effect of the overnight return variances of Dow Jones Industrial Index futures in the past 99 years.

Table 11. Overnight return effect of Dow Jones Industrial Index Futures in the Past 99 Years

Symbol	From	Mon	Tue	Wed	Thu	Fri	Buy-n-Hold	3-Day-Model	p value
$INDU	1926	8103	4836	-3571	4799	-1717	38173	43462	0.024

In the past 99 years, Dow gains 38,173 points. If we stay out of the market on Wednesday and Friday nights, the gain will be 43,462 points (5,289 points were lost during this one hour of market close on Wednesday and the whole weekend).

5.4.2 Positive Return Percentage Analysis

In some previous studies using daily price data, it has been established that the distributional properties of the data are significantly nonnormal (McFarland, Pettit, and Sung, 1982). In order to assure that our results are robust, nonparametric tests are performed. The results of the non-parametric procedures generally support our previous conclusions.

Since most Monday overnight returns are positive, we further compared the percentages of positive overnight returns and positive returns over means to total sample size on Monday nights. For each night of Monday, the number of positive and negative returns is computed. A z-statistic is performed to test the null hypothesis that positive and negative returns are equally likely events.

The results show that about 50% of the returns on Mondays were positive, with 50% returns below means (lower than mean return or negative). The results are presented in Table 5.

Table 12. Monday Percent Positive and Percent over Means

Assets	**Monday Positive Sample Size**	**% Positive**	**% Over Means**
AAPL	1,994	30.99%	18.45%
BA	2,621	33.27%	25.87%
BAC	2,424	38.49%	35.78%
BRK.B	1,259	56.95%	39.95%
DIA	1,175	55.36%	46.68%
EWH	1,425	49.40%	47.78%
EWJ	1,398	49.21%	48.57%
EWL	1,412	50.61%	48.30%
EWS	1,414	48.73%	47.38%
OXY	2,615	30.78%	29.25%
QQQ	1,121	56.77%	41.48%
SPGI	2,621	31.02%	20.52%
SPY	1,409	55.78%	45.07%
TMO	2,425	40.12%	27.68%
TQQQ	605	53.72%	37.05
UDOW	648	53.25%	37.81%
UPRO	637	55.26%	39.25%
USO	839	54.11%	53.86%
WEAT	566	47.78%	43.98%

5.4.3 Options Market Analysis

We also tested an overnight bullish put credit spread strategy in the 1-DTE options market using 3 years of options pricing data from May 2022 to April 2025 at www.optionalpha.com. The results are robust. We simply sell a put credit spread on XSP 30 minutes before the closing of each day, and close the position at the open of next morning. This strategy generated 73,615 profits trading 5 contracts of bullish XSP put credit spread in the past 3 years from 2022 to April 30 2025.

Chart 3. Results of Overnight 1-DTE Put Credit Spread on XSP

5.4.4 Lookahead Bias

In our study, we used data of the US four index ETFs up to the last trading day of 2024. In order to ensure our model can perform in the future, we use the data from January to April of 2025. The results are shown below:

Table 13. Lookahead Test in 2025

Symbol	From	Mon	Tue	Wed	Thu	Fri	Buy-n-Hold	3-Day-Model
DIA	2025	13.51	3.92	-28.29	-11.61	-14.15	-11.15	5.82
IWM	2025	1.94	0.6	-16.1	-2.35	-10.4	-20.53	0.19
QQQ	2025	13.34	4.85	-30.4	0.59	-30.54	-38.83	18.78
SPY	2025	12.45	3.82	-32.72	-4.71	-27.88	-34.85	11.56
Total		**41.24**	**13.19**	**-107.51**	**-18.08**	**-82.97**	**-105.36**	**36.35**

Amid broad market weakness in early 2025, our strategy demonstrated strong defensive characteristics: the four index ETFs declined 105.36 points, while our 3-night-a-week model recorded a gain of 36.35 points.

6. Summary and Conclusions

This study provides a comprehensive investigation of the weekly seasonals of the overnight effect in the US large-cap stocks and ETFs and some world capital market index ETFs. We found significant weekly seasonal patterns in the US index ETFs and large-cap stocks. The results are significant in two respects. First it shows the seasonal patterns found in these stocks and ETFs are not the result of market manipulation since small cap stocks, which are easier to be manipulated, have very weak overnight seasonality (IWM). Second, seasonal patterns exist in the US stocks and ETFs, similar patterns also exist in some futures ETFs and index ETFs of four world capital markets: Japan, Hong Kong, Singapore and Switzerland.

This study reveals that the observed seasonal patterns in the overnight effect of the US stocks, ETFs and world markets ETFs are not so complex than previous believed. From this phenomenon, we can build a short-term overnight trading model to trade the stock and ETFs markets without using a financial indicator such as moving average or stochastic oscillators. In fact, these financial indicators will filter out most winning trades in our overnight model. It can also serve as a market timing indicator for short term traders. For example, if a trader is using his or her model to buy the stocks and ETFs, he or she can skip some timeframes during which negative overnight returns are recorded. For US index ETFs, skipping Wednesday and Friday nights can significantly improve the investment returns for the buy-side investors. Short-sellers can profit over the weekends by shorting before the closing bell on Friday and exit the position at the opening of next Monday.

These findings have implications for trading strategies and deepen our understanding of intraday and overnight market

dynamic. However, our models on inactively traded individual stocks seem not so robust, especially small cap stocks. Future work may extend this analysis to small-cap stocks and international markets or incorporate volatility and volume metrics to further understand the underlying mechanisms.

Recently, most ETFs and actively traded stocks have premarket and afterhours trading. Traders will have enough time to react to financial news and capture more profits utilizing the overnight return effect.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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