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## CAUSES OF SHORT-TERM MOMENTUM ANOMALY IN DAILY RETURNS: EVIDENCE FROM TAIWAN

*This study used the daily return of stocks' market to verify short-term investment performance and found a short-term momentum phenomenon for Taiwan. Subsequently, we investigated the causes of this abnormal return by interpreting and cross-validating several models and investors' sentiments. We find that investors' sentiments, especially on the stocks' market turnover rate and the ratios of margin purchase to short-sale significantly cause Taiwan stocks' market short-term momentum effect. This implies the irrational trading behaviors of investors.*

*Keywords:* investors' sentiments; momentum strategies; zero-investment portfolio; anomaly in returns; stock market; Taiwan.

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## ПРИЧИНИ КОРОТКОСТРОКОВИХ АНОМАЛІЙ У ЩОДЕННИХ ПРИБУТКАХ НА ФОНДОВІЙ БІРЖІ: ЗА ДАНИМИ ТАЙВАНЮ

*У статті використано дані щодо щоденних прибутків на фондовій біржі для виявлення трендів короткотривалого інвестування та демонстрації явища імпульсу на фондовому ринку Тайваню. З використанням декількох математичних моделей досліджено причини аномальних прибутків та їхній зв'язок з поведінкою інвесторів на ринку. Продемонстровано, що поведінка інвесторів, особливо відносно динаміки оборотності прибутків і співвідношення угод без покриття та угод по маржі, багато в чому визначає імпульсні прояви на тайванському фондовому ринку. Висновки дослідження здебільшого вказують на ірраціональну поведінку інвесторів.*

*Ключові слова:* поведінка інвесторів; імпульсні стратегії; портфель з нульовими інвестиціями; аномальні прибутки; фондовий ринок; Тайвань.

*Табл. 2. Форм. 5. Літ. 31.*

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## ПРИЧИНЫ КРАТКОСРОЧНЫХ АНОМАЛИЙ В ЕЖЕДНЕВНЫХ ПРИБЫЛЯХ НА ФОНДОВОЙ БИРЖЕ: ПО ДАННЫМ ТАЙВАНЯ

*В статье использованы данные по ежедневным прибылям на фондовой бирже для выявления трендов краткосрочного инвестирования и демонстрации явления импульса на фондовом рынке Тайваня. С использованием нескольких математических моделей исследованы причины аномальных прибылей и их связь с поведением инвесторов на рынке. Показано, что поведение инвесторов, особенно относительно скорости оборачиваемости прибыли на рынке и соотношения сделок без покрытия и сделок на марже, во многом определяет импульсные проявления на тайваньском фондовом рынке. Выводы исследования в основном указывают на иррациональное поведение инвесторов.*

*Ключевые слова:* поведение инвесторов; импульсные стратегии; портфель с нулевыми инвестициями; аномальные прибыли; фондовый рынок; Тайвань.

### 1. Introduction

The decade of the research on momentum demonstrated that stocks which performed worse (better) in past continue to perform worse (better) in future, and this is one of the important and intriguing anomalies to account and yet to be explained in its entirety (Fama, 1998). Studies on stock price momentum have contended that:

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1. Short-term (4 weeks to 1 month) contrarian strategies facilitate excess returns (Lehmann, 1990; Lo, Mackinlay, 1990; Jegadeesh, 1990; Jegadeesh, Titman, 1995);  
2. Medium-term (3 to 12 months) momentum strategies result in abnormal returns (Jegadeesh, Titman, 1993, 2001; Conrad, Kaul, 1998; Roberto, Eric, 2008). However, Hameed and Yuanto (2002), and Chui et al. (2010) acknowledged and believed that Taiwan stocks lacked momentum. Furthermore, Roberto and Eric (2008) found results of longer-run momentum following weekly returns and showed various forms of dominant effect momentum for the US. Thus, the objectives of this study are to determine whether Taiwan stocks have short-term momentum, to verify the price momentum of Taiwan stocks using the data on daily returns, and to identify their causes. Taiwan's stock market has significant short-term momentum during most periods by using daily return samples, the highest daily results reported was obtained by adopting ( $J_{day} = 10$ ;  $K_{day} = 3$ ), and the value was 0.081%.

Subsequently, we investigate the causes for short-term momentum at stock market in Taiwan using the CAPM, three-factor (Fama, French, 1992), CRR macroeconomic factors (Chen et al., 1986), investors' sentiments (Baker, Wurgler, 2006, 2007), and four-factor (Carhart, 1997) models. The results indicate that abnormal returns can only be explained using investors' sentiments. We infer that this phenomenon is the result of investors' irrational behavior. The research findings show that only stock market turnover rates and the ratios of margin purchase to short-sale are significant. This is consistent with the previous conclusions.

This study is structured as follows: Section I is Introduction; Section II is Literature Review; Section III – Trading Strategies, Research Samples, and Empirical Strategies; Section IV – Cause of Short-Term Momentum for Taiwan Stocks; Section V contains the Conclusions.

## 2. Literature review

Studies on price momentum have stated: (1) Excess returns can be acquired by adopting four-week (or one-month) contrarian strategies (Lehmann, 1990; Lo, Mackinlay, 1990; Jegadeesh, 1990; Jegadeesh, Titman, 1995; Conrad, Kaul, 1998); (2) monthly return of 3- to 12-month stocks have positive autocorrelation, and excess return can be acquired by adopting medium-term momentum strategies (Jegadeesh, Titman, 1993; Conrad, Kaul, 1998; Roberto, Eric, 2008); (3) long-term stock prices of 3 to 5 years appear to have negative autocorrelation, and excess returns can be acquired by adopting contrarian strategies (De Bondt, Thaler, 1985, 1987; Conrad, Kaul, 1998).

A number of scholars contended that the causes of short-term stock price reversals were market microstructures, such as nonsynchronous trading, bid-ask spreads, discreteness, and transaction costs caused by investors' cognitive biases (Conrad, Kaul, 1998). Gibbons and Ferson (1985) believed that short-term stock price reversals were caused by time-varying economic risk premiums. Conrad and Kaul (1998) stated that momentum profits were possible primarily because of the cross-sectional variation in expected returns. Regarding medium-term momentum, Fama and French (1996) contended that the three-factor model could not rationally explain stock market anomalies in medium-term momentum strategies. Roberto and Eric (2008) constructed a return ranking of momentum investment portfolios for a 52-week holding period based on the weekly data of the US. stocks and found that significant reversal only occurred in Weeks 1 and 2; continuous positive returns were

observed from Weeks 4 and 52. This new momentum anomaly differed from the deduction proposed by Jegadeesh and Titman (1993).

Behavioral finance explains momentum and reversal anomalies based on psychological biases. Daniel et al. (1998) stated that overconfidence and the self-attribute bias of investors overreacting to stock prices caused continuous overreactions during the initial emerging stage; subsequently, reversals occurred because of information disclosures and adjustments. Chan et al. (1996), Barberis et al. (1998), Hong and Stein (1999), Hong et al. (2000), and Jegadeesh and Titman (2001) contended that the cause of momentum was insufficient reactions when information reached the stock market; in the long term momentum traders' overreactions result in stock price reversals (Hong, Stein, 1999; Jegadeesh, Titman, 2001).

Furthermore, the momentum anomaly cross-sectional return predictability appears to be prevalent at different markets (e.g. Rouwenhorst, 1998) and different asset classes (Asness, Moskowitz, and Pedersen, 2009) and also exists between and within industries (Moskowitz, Grinblatt, 1999). Baker and Wurgler (2006; 2007) asserted that the higher the market sentiment of noise traders is, the greater is their influence on expected future returns.

### 3. Trading strategies, research samples, and empirical strategies

This study referred to Jegadeesh and Titman (1993) for trading strategies, and ranked stock returns into deciles groups for the construction of zero-investment portfolios. The first group was called the loser, created by selling all losing stocks at equal weights combined with transaction costs. Group 10 was called the winner, created by buying all winning stocks at equal weights combined with transaction costs. The zero-investment portfolios were constructed by the winner minus loser. We established the portfolios of momentum investments using the method of overlapping holding periods and also investigated the returns by adopting each of the portfolios. Periods 2, 3, 4, 5, 10, and 20 of the formation period ( $J_T$ ) and holding period ( $K_T$ ) were selected for calculating each ( $J_T, K_T$ ) investment portfolio strategy after the transaction costs were deducted. This study used TWSE-listed companies as samples; the data were obtained from the Taiwan Economic Journal (TEJ) from January 1, 1981 to December 31, 2011. Daily returns data were collected from 8,680 sampling days. Stocks that contained missing daily return data were excluded from the study.

Referencing Jegadeesh and Titman (1993), we selected the stocks of listed companies in Taiwan as the sample and selected investment portfolios with annual returns greater than 10% to investigate returns of momentum strategies. Table 1 shows the daily data obtained based on the price momentum of Taiwan stocks. We found that most investment portfolios that adopt rebalancing and buy-and-hold strategies have significant momentum after excluding stocks that are at their rising or falling limits and deducting transaction costs. We examined significant trading strategies that provided annual returns greater than 10% and found that the annual returns for most short-term momentum strategies exceed the returns reported by Jegadeesh and Titman (1993). The highest daily returns were obtained from investment strategies of the ten-day formation period and three-day holding period ( $J_{day} = 10; K_{day} = 3$ ); the daily return was 0.081% (t-value = 4.15). Contradicting the results reported in previous studies, we infer that short-term momentum strategies are more appropriate for Taiwan stocks.

**Table 1. The average daily return of the portfolio adopting rebalance and buy-and-hold strategies to exclude portfolio ups and downs to stop**

Rebalance strategy	B&H strategy	Holding period $K_{day}$					
		K=2	K=3	K=4	K=5	K=10	K=20
Formation period $J_{day}$	J=2	0.037 (2.15)*	0.026 (1.68)	0.024 (1.76)	0.024 (1.87)	0.029 (3.19)*	0.019 (2.85)*
		0.075 (6.57)*	0.065 (6.68)*	0.063 (7.23)*	0.055 (6.96)*	0.055 (9.19)*	0.048 (10.74)*
		0.055 (3.03)*	0.046 (2.37)*	0.043 (2.89)*	0.045 (3.24)*	0.042 (4.04)*	0.018 (2.37)*
		0.053 (4.63)*	0.052 (5.21)*	0.049 (5.57)*	0.045 (5.61)*	0.057 (9.60)*	0.049 (10.96)*
	J=3	0.072 (3.78)*	0.061 (3.50)*	0.063 (3.88)*	0.053 (3.59)*	0.047 (4.17)*	0.018 (2.13)*
		0.046 (3.90)*	0.040 (4.04)*	0.038 (4.27)*	0.035 (4.24)*	0.061 (10.04)*	0.052 (11.32)*
		0.076 (3.94)*	0.063 (3.49)*	0.063 (3.74)*	0.060 (3.85)*	0.052 (4.33)*	0.021 (2.31)*
		0.037 (3.11)*	0.034 (3.33)*	0.033 (3.59)*	0.033 (3.88)*	0.065 (10.65)*	0.055 (11.79)*
	J=5	0.074 (3.55)*	0.081 (4.15)*	0.073 (3.94)*	0.075 (4.20)*	0.044 (3.01)*	0.016 (1.41)
		0.043 (3.51)*	0.058 (5.50)*	0.068 (7.14)*	0.079 (9.12)*	0.097 (15.46)*	0.067 (13.91)*
		0.041 (1.87)	0.045 (2.15)*	0.043 (2.13)*	0.034 (1.75)	0.008 (0.48)	0.003 (0.18)
		0.067 (5.43)*	0.076 (7.00)*	0.080 (8.27)*	0.083 (9.41)*	0.082 (12.69)*	0.048 (9.64)*
	J=10	0.041 (1.87)	0.045 (2.15)*	0.043 (2.13)*	0.034 (1.75)	0.008 (0.48)	0.003 (0.18)
		0.067 (5.43)*	0.076 (7.00)*	0.080 (8.27)*	0.083 (9.41)*	0.082 (12.69)*	0.048 (9.64)*
		0.041 (1.87)	0.045 (2.15)*	0.043 (2.13)*	0.034 (1.75)	0.008 (0.48)	0.003 (0.18)
		0.067 (5.43)*	0.076 (7.00)*	0.080 (8.27)*	0.083 (9.41)*	0.082 (12.69)*	0.048 (9.64)*
	J=20	0.041 (1.87)	0.045 (2.15)*	0.043 (2.13)*	0.034 (1.75)	0.008 (0.48)	0.003 (0.18)
		0.067 (5.43)*	0.076 (7.00)*	0.080 (8.27)*	0.083 (9.41)*	0.082 (12.69)*	0.048 (9.64)*
		0.041 (1.87)	0.045 (2.15)*	0.043 (2.13)*	0.034 (1.75)	0.008 (0.48)	0.003 (0.18)
		0.067 (5.43)*	0.076 (7.00)*	0.080 (8.27)*	0.083 (9.41)*	0.082 (12.69)*	0.048 (9.64)*

Notes: (1) Numbers in brackets are t-values; \* indicates 5% statistical significance. (2) the unit for returns is %; (3) items marked in boldface represent strategies that are significant and have annual returns that exceed 10%; and (4) sampling period: 8,680 sampling days from Jan 1, 1981, to Dec 31, 2011.

#### 4. Causes of short-term momentum for Taiwan stocks

To investigate the cause of short-term momentum among Taiwan stocks, we selected 6 sample investment portfolios (2, 2), (3, 3), (4, 4), (5, 5), (10, 10), (20, 20) (in Table 1) and used rebalance trading strategies to calculate abnormal returns. The CAPM, Fama-French three-factor, CRR, investors' sentiments, Carhart four-factor, and their cross combinations were adopted to identify the factors that influence the short-term momentum of Taiwan stocks. The results are shown in Table 2 panel A and B.

First, we verified the abnormal returns of the investment portfolio using the CAPM model; the regression equation is as follows:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i (R_{m,t} - R_{f,t}) + \varepsilon_{i,t}, \quad (1)$$

where  $R_{i,t} - R_{f,t}$  represent the return obtained by adopting the  $i^{\text{th}}$  short-term momentum strategy in the  $t^{\text{th}}$  month, minus the returns of the non-risk interest rate; the premium of the stock market  $R_{m,t} - R_{f,t}$  was obtained from the Taiwan Stock Exchange Index in the  $t^{\text{th}}$  month, minus the non-risk interest rate for that month;  $\alpha_i$  is the constant of the regression equation (1), and indicating that the CAPM cannot explain the cause of short-term momentum among Taiwan stocks.

Next, we verified the short-term momentum of Taiwan stocks using the Fama-French three-factor model; the regression equation is as follows:

$$R_{i,t} - R_{f,t} = \alpha_{FFI} + \beta_i (R_{m,t} - R_{f,t}) + s_i (SMB_{i,t}) + h_i (HML_{i,t}) + \varepsilon_{i,t} \quad (2)$$

The results of the three-factor model indicate that the constants  $\alpha_{FFI}$  have significant positive correlations, demonstrating that the short-term momentum of Taiwan stocks do not result from the 3 factors.

Chen et al. (1986) explained the causes of medium-term momentum using the overall business cycle model. Therefore, we adopted the CRR model to verify whether the short-term momentum of Taiwan stocks was affected by the factors of the overall business cycle (Chen et al., 1986); the regression equation is as follows:

$$R_{i,t} - R_{f,t} = \alpha_{CRR-i} + \lambda_{1i} (MP_t) + \lambda_{2i} (UI_t) + \lambda_{3i} (DEI_t) + \lambda_{2i} (UPR_t) + \lambda_{3i} (UTS_t) + \varepsilon_{i,t} \quad (3)$$

The result indicates that the constants  $\alpha_{CRR-i}$  also have significant positive correlation; however, they still cannot explain the short-term momentum of Taiwan stocks.

Furthermore, Baker and Wurgler (2006; 2007) suggested that the sentiment of noise traders would influence the expected future returns. Antoniou, Doukas and Subrahmanyam (2012) found higher momentum during periods of high investor sentiment compared to low sentiment and that sentiment is absent during pessimistic periods. We verified the abnormal return rates of Taiwan stocks using the market turnover rate (TUN) (the volume of listed stocks traded during the  $t^{\text{th}}$  period/the average number of outstanding shares during the  $t^{\text{th}}$  period), the ratio of new equity issues (NEI) (the new equity issues that occurred during the  $t^{\text{th}}$  period + capital increased with cash)/(new equity issues that occurred during the  $t^{\text{th}}$  period + capital increased with cash + newly issued bonds), and the ratio of margin purchase to margin short-sale (SMR) (the adjusted debit balance during the  $t^{\text{th}}$  period/the adjusted bearish debit balance during the  $t^{\text{th}}$  period); the regression equation is as follows:

$$R_{i,t} - R_{f,t} = \alpha_{sent-i} + \lambda_{1i} (TUN_{i,t}) + \lambda_{2i} (NEI_{i,t}) + \lambda_{3i} (SMR_{i,t}) + \varepsilon_{i,t} \quad (4)$$

The results of regression analysis indicate that the constants ( $\alpha_{sent-i}$ ) all possessed significant positive correlations (not zero). Additionally, the TUN for each investment portfolio all possessed significant positive correlations (not zero), where the value of the strategy ( $J_{day} = 3$ ;  $K_{day} = 3$ ) was the greatest. This indicated that the short-term momentum of Taiwan stocks is influenced by the turnover rate of the stock market, and the smaller is the  $K_{day} = 3$ , the greater is the coefficient of influence. Additionally, the SRM possessed significant positive correlation (not zero), and its value was similar. Similar to the findings reported by Baker and Wurgler (2006; 2007), one of the factors for abnormal returns in short-term momentum is investors' sentiments. In summary, the cause of short-term momentum among Taiwan stocks is the result of investors' irrational and sentimental behavior.

Finally, Carhart (1997) proposes a four-factor model to capture the momentum, enhanced with a momentum return, WML, on the difference between the month  $t$  returns on diversified portfolios of winners and losers of the past year. We adopted and used M (6, 6), refer to the use of ( $J_{month} = 6$ ,  $K_{month} = 6$ ) as the momentum factor, to verify the short-term momentum of Taiwan stocks, the regression equation is as follows:

$$R_{i,t} - R_{f,t} = \alpha_{Mi} + \beta_i (R_{m,t} - R_{f,t}) + s_i (SMB_{i,t}) + h_i (HML_{i,t}) + \varpi_i (WML_{i,t}) + \varepsilon_{i,t} \quad (5)$$

The outcome indicates that all constants are significant. These are indicating that the Carhart four-factor model cannot still explain the cause of short-term momentum among Taiwan stocks.

Table 2. Panel A. Verification of investment portfolios with arbitrage returns using CAPM (1), three-factor (2), CRR (3), investors' sentiments (4), calculated by the author

Descriptions: 1. CAPM model:  $R_{i,t} - R_{f,t} = \alpha_i + \beta_i(R_{m,t} - R_{f,t}) + \varepsilon_{i,t}$   
 2. Three-factors model:  $R_{i,t} - R_{f,t} = \alpha_{FFi} + \beta_i(R_{m,t} - R_{f,t}) + s_i(SMB_{i,t}) + h_i(HML_{i,t}) + \varepsilon_{i,t}$   
 3. CRR model:  $R_{i,t} - R_{f,t} = \alpha_{CRR-i} + \lambda_{1i}(MP_t) + \lambda_{2i}(UI_t) + \lambda_{3i}(DEI_t) + \lambda_{4i}(UPR_t) + \lambda_{5i}(UTS_t) + \varepsilon_{i,t}$   
 4. Investors' sentiment model:  $R_{i,t} - R_{f,t} = \alpha_{sent-i} + \lambda_{1i}(TUN_{i,t}) + \lambda_{2i}(NEI_{i,t}) + \lambda_{3i}(SMR_{i,t}) + \varepsilon_{i,t}$   
 5. Four-factor model:  $R_{i,t} - R_{f,t} = \alpha_{Mi} + \beta_i(R_{m,t} - R_{f,t}) + s_i(SMB_{i,t}) + h_i(HML_{i,t}) + \omega_i(WML_{i,t}) + \varepsilon_{i,t}$   
 where  $R_{i,t}$  represents the monthly return of the  $i$ -th investment portfolio for the  $t$ -th month;  $R_{f,t}$  represents the non-risk interest rate for the  $t$ -th month;  $R_{m,t}$  is the monthly return rate of the weighted stock index of Taiwan stock for the  $t$ -th month;  $SMB_{i,t}$  is the monthly return rate of the investment portfolio of small-scale companies for the  $t$ -th month minus the monthly return rate of the investment portfolio of large-scale companies for the  $t$ -th month;  $HML_{i,t}$  is the monthly return rate of investment portfolios with high book to market ratios for the  $t$ -th month minus the monthly return rate of investment portfolios with low book-to-market ratios;  $NEI_{i,t}$  is (the new equity issues during the  $t$ -th period + capital increased by cash)/(new equity issues during the  $t$ -th period + capital increased by cases + newly issued bonds);  $SMR_{i,t}$  is the balance of margin purchases during the  $t$ -th period/the balance of short sales during the  $t$ -th period;  $TUN_{i,t}$  is the volume of enlisted stock traded in the  $t$ -th period/the average number of outstanding shares;  $MP_t = \ln$  (the general index of industrial production during the  $t$ -th period/the general index of industrial production during the  $t-1$ th period);  $UI_t = \ln [I_t / I_{t-1}]$ ; where  $I_t = \ln CPI_t - \ln CPI_{t-1}$ ;  $E [I_t / t-1] = \ln E [CPI_t] - \ln CPI_{t-1}$ ;  $CPI_t$  is the consumer price index during the  $t$ -th period;  $E [CPI_t]$  is the expected consumer price index during the  $t$ -th period;  $DEI_t = E [I_t + 1] - E [I_t / t-1]$ ;  $UPR_t$  is the interest rate of five-year corporate bonds during the  $t$ -th period - the interest rate of seven-year government bonds during the  $t$ -th period;  $UTS_t$  is the long-term interest rate of government bonds - the known interest rate of three-month treasury bonds during the  $t$ -th period. The momentum factor,  $WML_{i,t}$ ,  $M(6,6)$ , refers to the use of (holding period 6 month, forming period 6 month) as the momentum factor in the four-factor model. Each of the regression coefficients represents the sensitivity to changes of the regression equation between explained variables and individual explained variables. The numbers in brackets are  $t$ -values; items marked with \* have the 5% statistical significance;  $\alpha_i$  is the constant of the regression equation for each investment portfolio, and the coefficients in this table should be multiplied by  $10^3$ .

	CAPM (1)		Three-factor (2)				CRR (3)					Sentiment factor (4)				
( $J_{day}$ ; $K_{day}$ )	$\alpha_i$	$\hat{\alpha}_i$	$\alpha_{FFi}$	$\hat{\alpha}_i$	SMB	HML	$\alpha_{CRR-i}$	MP	UI	DEI	UPR	UTS	$\alpha_{sent-i}$	TUN	NEI	SMR
(2,2)	0.02 (2.76)*	24.30 (3.23)*	0.02 (1.99)*	26.56 (3.44)*	0.48 (2.06)*	-0.44 (-2.15)*	-0.26 (-2.01)*	0.01 (0.15)	30.07 (0.99)	9.55 (0.38)	7.89 (0.17)	-103.10 (-1.14)	-2.33 (-1.90)	62.08 (5.31)*	0.53 (0.44)	0.04 (2.55)*
(3,3)	0.19 (2.54)*	21.44 (3.03)*	0.19 (2.34)*	23.98 (3.30)*	0.53 (2.40)*	-0.47 (-2.46)*	-0.05 (-2.15)*	0.01 (0.44)	14.44 (0.50)	21.63 (0.91)	1.02 (0.02)	-97.90 (-1.14)	-1.36 (-1.18)	55.39 (5.03)*	-0.14 (-0.12)	0.04 (2.63)*
(4,4)	0.29 (2.35)*	21.27 (3.18)*	0.29 (2.34)*	24.35 (3.55)*	0.60 (2.89)*	-0.50 (-2.75)*	0.06 (2.18)*	0.02 (0.58)	1.96 (0.07)	27.00 (1.20)	-0.59 (-0.01)	-74.35 (-0.92)	-0.59 (-0.54)	48.63 (4.67)*	-0.64 (-0.60)	0.04 (2.55)*
(5,5)	0.51 (3.68)*	16.30 (1.94)	0.51 (3.68)*	17.81 (2.07)*	0.41 (1.34)	-0.41 (-1.51)	0.38 (4.82)*	0.06 (1.31)	-49.52 (1.27)	32.31 (1.01)	42.21 (0.72)	66.07 (0.57)	-1.02 (-0.80)	45.86 (3.20)*	0.05 (0.44)	0.04 (3.14)*
(10,10)	0.51 (3.81)*	10.19 (1.26)	0.52 (3.83)*	10.23 (1.23)	0.21 (0.57)	-0.30 (-1.23)	0.19 (3.41)*	0.06 (1.46)	-29.61 (0.77)	8.00 (0.25)	16.69 (0.29)	91.71 (0.81)	-1.60 (-0.31)	39.57 (2.88)*	0.77 (0.76)	0.04 (3.29)*
(20,20)	0.38 (2.99)*	7.22 (0.95)	0.44 (3.01)*	6.41 (0.82)	-0.04 (-0.07)	-0.12 (-0.67)	0.31 (3.70)*	0.06 (1.64)	-30.54 (0.84)	-1.23 (0.04)	1.56 (0.02)	119.43 (1.10)	-2.53 (0.00)	44.80 (3.45)*	1.54 (0.86)	0.03 (3.07)*

**Table 2. Panel B. Verification of investment portfolios with arbitrage returns using four-factor (5) model and cross-validating three-factor (2), CRR (3), four-factor (5) with investors' sentiments, calculated by the author**

Descriptions: Each independent variable and definition in this table is identical to that in Table 2 Panel A																
$(J_{day}; K_{day})$	Four-factor (5)					Four-factor (5) + sentiment factor (4)										
	$\alpha_{fi}$	$\hat{a}$	SMB	HML	WML	$\alpha_{ci}$	$\hat{a}$	SMB	HML	WML	TUN	NEI	SMR			
(2,2)	0.04 (2.26)*	25.43 (3.51)*	0.36 (2.67)*	-0.42 (-2.10)*	6.87 (2.36)*	-2.24 (-1.88)	21.05 (2.84)*	0.42 (3.55)*	-0.42 (-2.11)*	2.33 (0.56)	58.93 (5.01)*	0.48 (0.48)	0.04 (2.56)*			
(3,3)	0.05 (2.32)*	27.19 (3.45)*	0.44 (2.79)*	-0.44 (-2.08)*	7.48 (2.25)*	-2.35 (-1.91)	23.51 (2.98)*	0.40 (3.60)*	-0.43 (-2.04)*	2.44 (0.69)	61.29 (5.13)*	0.54 (0.44)	0.04 (2.62)*			
(4,4)	0.32 (2.22)*	26.61 (3.29)*	0.73 (2.88)*	-0.57 (-2.65)*	3.54 (1.04)	-0.45 (-0.36)	24.00 (2.96)*	0.69 (2.73)*	-0.56 (-2.59)*	-1.74 (-0.48)	42.40 (3.46)*	-0.93 (-0.74)	0.06 (3.43)*			
(5,5)	0.58 (3.99)*	21.89 (2.71)*	0.67 (2.66)*	-0.62 (-2.89)*	3.88 (1.14)	-0.27 (-0.21)	19.34 (2.39)*	0.64 (2.51)*	-0.61 (-2.83)*	-1.51 (-0.42)	41.16 (3.36)*	-0.84 (-0.67)	0.06 (3.51)*			
(10,10)	0.52 (4.21)*	4.77 (0.63)	0.03 (0.12)	-0.19 (0.93)	-0.38 (0.11)	1.13 (0.41)	0.05 (1.26)	-18.66 (0.54)	9.28 (0.31)	-49.10 (0.83)	37.62 (0.37)	51.28 (3.33)*	-1.26 (0.48)			
(20,20)	0.39 (3.01)*	4.16 (0.52)	-0.10 (0.38)	-0.11 (0.50)	1.16 (0.30)	0.26 (0.08)	0.06 (1.53)	-34.67 (0.91)	6.42 (0.20)	-51.22 (0.77)	63.48 (0.52)	82.47 (3.78)*	-1.16 (0.41)			
$(J_{day}; K_{day})$	Three-factor (2) + sentiment factor (4)							CRR (3) + sentiment factor (4)								
	$\alpha_{fi}$	$\hat{a}$	SMB	HML	TUN	NEI	SMR	$\alpha_{ci}$	MP	UI	DEI	UPR	UTS	TUN	NEI	SMR
(2,2)	-2.17 (-1.74)	20.67 (3.11)*	0.41 (2.82)*	-0.39 (-2.00)*	46.35 (4.88)*	0.48 (0.42)	0.04 (2.39)*	-1.35 (-0.60)	0.01 (0.29)	24.88 (0.81)	11.74 (0.45)	3.07 (0.05)	-122.1 (-1.32)	21.73 (2.69)*	0.69 (0.34)	0.03 (2.87)*
(3,3)	-2.23 (-1.82)	22.87 (2.96)*	0.43 (2.85)*	-0.42 (-2.08)*	58.96 (5.02)*	0.51 (0.42)	0.04 (2.48)*	-1.48 (-0.61)	0.01 (0.26)	27.04 (0.88)	12.59 (0.50)	3.28 (0.06)	-131.9 (-1.39)	22.55 (2.62)*	0.63 (0.28)	0.03 (2.76)*
(4,4)	-0.28 (-0.23)	24.10 (3.04)*	0.70 (2.93)*	-0.54 (-2.61)*	39.31 (3.26)*	-0.96 (-0.78)	0.05 (3.22)*	2.09 (0.83)	0.03 (0.77)	-11.42 (-0.36)	34.04 (1.30)	-43.71 (-0.77)	-74.45 (-0.76)	13.12 (2.35)*	-2.22 (-0.95)	0.01 (2.27)*
(5,5)	-0.14 (-0.11)	20.10 (2.54)*	0.66 (2.73)*	-0.59 (-2.83)*	38.07 (3.16)*	-0.84 (-0.68)	0.05 (3.39)*	3.39 (1.33)	0.02 (0.58)	-32.02 (-0.99)	50.99 (1.92)	-48.60 (-0.85)	-24.22 (-0.24)	13.13 (2.34)*	-3.29 (-1.39)	0.01 (2.15)*
(10,10)	-1.81 (-1.40)	7.31 (0.86)	0.13 (0.50)	-0.21 (-0.94)	35.44 (2.92)*	1.26 (0.93)	0.03 (2.21)*	1.13 (0.41)	0.05 (1.26)	-18.12 (0.53)	9.28 (0.32)	-51.89 (0.84)	37.27 (0.36)	51.07 (3.31)*	-1.26 (0.48)	-0.04 (2.87)*
(20,20)	-2.31 (-1.86)	7.05 (0.82)	-0.04 (-0.15)	-0.10 (-0.44)	42.91 (3.39)*	1.47 (1.15)	0.03 (2.69)*	0.25 (0.09)	0.06 (1.58)	-32.92 (0.95)	5.71 (0.21)	-49.33 (0.80)	61.21 (0.56)	78.22 (3.90)*	-1.05 (0.43)	-0.03 (2.69)*

Additionally, we conducted a regression analysis on the three-factor model combined with investors' sentiments, combined with the four-factor model and investors' sentiments, and the CRR model combined with investors' sentiments, cross-validating the abnormal payoff. There are only investors' sentiments significant in each of these models. Table 2. Panel B showed the results of these cross-validating results and robustness tests indicate that the cause of short-term momentum among Taiwan stocks is investors' irrational trading behaviors.

### 5. Conclusions

Referring to the momentum strategy proposed by Jegadeesh and Titman (1993), we used the daily return data of Taiwan stocks to demonstrate the short-term momentum effects of stocks in Taiwan. Evidence of short-term momentum in Taiwan stocks was discovered after deducting transaction costs and adopting investment portfolio rebalancing strategies, excluding stocks at their rising or falling limit, and delaying the construction of momentum investment portfolios for one week.

Consistent with previous studies, we found that the anomalies of short-term momentum in Taiwan stocks cannot be explained by the CAPM, three-factor, four-factor, or CRR models; only investors' sentiments on market turnover rates and the ratios of margin purchase to margin short-sale can effectively measure abnormal returns in the short-term momentum of Taiwan stocks. We infer that the short-term momentum of Taiwan stocks originates from investors' sentiments; that is, the irrational behaviors of investors forming them.

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