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# Investor sentiment spillover effects between the futures and spot markets


## Abstract

This study investigates the spillover effects of investor sentiment between the spot and futures markets in Taiwan. This is quite a complex issue, given that there are fewer individual investors in the futures market, resulting in less price discovery in the futures market than in the spot market. By focusing on spot trades, in conjunction with individual investor sentiment, we observe more efficient messages in the spot market than in the futures market; thus, investor sentiment in Taiwan is found to have less influence on the futures market than on the spot market. The results reveal that in a bullish market, virtually all spot investor sentiment can raise spot returns, although no significant relationship is discernible between futures investor sentiment and spot returns. Finally, the findings indicate that the spillover effect of investor sentiment is characterized by a unilateral effect; that is, spot sentiment affects both spot and futures market returns, whereas futures sentiment has less effect in the financial market.


**Keywords:** sentiment, spillover effect, AS model.
**JEL Classification:** G10, G14.

## Introduction

A considerable increase in focus on the issue of the relationship between the spot and futures markets has become very obvious over recent decades, particularly in the aftermath of the financial crash of October 1987, an event which subsequently prompted a wealth of related literature[1]. Many of these studies have also begun to focus on the linkages and interactions between the returns of the spot and futures market[2], whilst at the same time, specific emphasis is also now placed on the effects of investor sentiment on the spot market. Nevertheless, despite all of this, the prior studies seem to have largely ignored the spillover effects of investor sentiment between the spot and futures markets[3].

Technical analysis appears to be the most popular, and indeed, the most efficacious index measure of investor sentiment currently in use within the financial markets. If such investor sentiment can be transmitted throughout the market, then the investor sentiment which exists in one particular market could well have predictive ability with regard to changes in another market. This would clearly be of considerable benefit to investors currently pondering their investment allocation decisions. Furthermore, it is also clear that investor sentiment can have spillover effects on the contemporaneous or lead-lag relationships which exist between various markets, and which determine the time that it takes for investor sentiment within one market to induce a complete response in the related market.

The data for our examination of this issue is obtained from the spot and futures markets in the Taiwan stock exchange (TWSE) which has become one of the major exchanges in the emerging markets since 2008. Furthermore, Taiwan's stock market comprises mainly of domestic individual investors, with such investors constituting about 67.8 per cent of all market volume in February 2009.

The results reported by Chui and Wei (1998) reveal that amongst all of the emerging markets in the Pacific-Basin region, the largest standard deviation in monthly excess returns is found in Taiwan, with Titman and Wei (1999) subsequently attributing this phenomenon of very high volatility to investor sentiment, essentially because of the extremely pervasive low level of sophistication encountered in this particular market. These characteristics, which are specific to the Taiwanese stock market, enable us to test the prevalence of behavioral biases amongst investors.

Whilst the majority of the prior studies have tended to focus on the interactions between the stock and futures markets, the present study differs from many of the related studies in several respects. Firstly, we place particular focus on overnight returns, which enables us to distinguish between the contemporaneous correlations existing between the two markets. Secondly, we estimate the spillover effects of investor sentiment within both the futures market and the spot market. Finally, we argue that there is a requirement for investors to adjust their portfolio insurance within the financial market in order to avoid taking on too much risk.

The remainder of this paper is organized as follows. Section 1 presents a review of the extant literature, followed in Section 2 by a discussion of the data source and the empirical model adopted for this study. The empirical results are presented in Section 3. The last Section concludes.



[1] Examples include Aggarwal (1988), Damodaran (1990), Lee and Ohk (1992), Antoniou and Holmes (1995), Pericli and Koutmos (1997) and Antoniou et al. (1998).

[2] See, for example, Kock and Koch (1987), Stoll and Whaley (1990), Lee and Lin (1994), Koutmos and Tucher (1996) and Wang (2001).

[3] See Brown (1999), Fisher and Statman (2000), Lee, Jiang and Indro (2002), Baker and Wurgler (2004), Brown and Cliff (2004), Baker and Stein (2004), Charoenrook (2005) and Kumar and Lee (2006).

## 1. Literature review

In the attempts within the prior literature to ascertain the relationships between the futures market and the spot market, there appears to have been no related discussion on the transmission effects of investor sentiment across these two distinct markets. Our review of the prior studies therefore focuses on the effects on the financial market arising from the interactions between volatility and investor sentiment.

In the majority of the early studies on the futures and spot markets, there has been a general tendency to focus either on the simultaneous and lead-lag relationships existing between futures and spot prices, or on their respective returns. Both Chen (1993) and Fleming et al. (1996) found that S&P 500 index futures tended to lead the spot market; and indeed, in the aftermath of the major collapse which occurred in the US spot market in 1987, one of the key points which has arisen in the subsequent studies is whether trading in the futures market could actually have resulted in an unstable spot market[1].

However, throughout this string of the research, the discussion has invariably focused on the futures market, as well as the effects that this market has on the spot market; thus, very few studies have attempted to pursue any discussion on the potential interdependence between the two markets. Consequently, in those studies discussing this relationship between the futures and spot markets, significant emphasis is invariably placed on the correlations between returns and volatility, with no obvious discussion on the transmission effects across the two markets[2].

Since it has been clearly demonstrated in many other studies that investor sentiment is capable of determining the value of financial assets, in the present study, we therefore investigate the transmission effects across the two markets in order to ensure that our examination of the futures and spot markets is more complete. We expect to find that the data will provide a valuable reference for investors when setting their future investment policy.

Numerous studies have examined the relationships between investor sentiment and the financial markets, with one particular string of this literature having discussed the interconnection with the spot market[3], whilst other studies refer to the limited effects between the spot market and investor sentiment, or even the total absence of any influence whatsoever[4]. Within most of these studies, the focus is often placed on the spot market, whereas in the present study, we go on to discuss the relationship between investor sentiment and the spot market.

From the above review of the literature, it is clear that there is general agreement in many studies of a correlation between the investor sentiment index and spot market returns[5], which suggests that this could be used to predict the returns index within the spot market. However, Lee et al. (2002) also demonstrate that the investor sentiment index has asymmetric influences on volatility within the financial market. Since there appear to be no studies within the prior literature on the investor sentiment spillover effects between the spot and futures markets, we take this issue into consideration in the present study, and expect to find support for the spillover effects and influence of investor sentiment on both the spot and futures markets.

## 2. Data and methodology

This Section provides a description of the sentiment indicators to be investigated in the present study, with additional information also being provided on their statistical properties. The indicators include the vibration ratio ($SI_{S1,t}$), the margin lending ratio ($SI_{S2,t}$), the put-call ratio ($SI_{S3,t}$), the futures open interest ratio ($SI_{F,t}$) and the buy-sell imbalance ratio ($SI_{S4,t}$). The data used in this study are daily closing observations on the spot and futures markets covering the period from August 2, 1999 to February 28, 2009. We examine the Taiwan weighted stock index (TX), the Taiwan electronic stock index (TE) and the Taiwan financial stock index (TF), all of which are obtained from the *Taiwan Economic Journal* (TEJ) database.

Some of the prior studies (for example, Wang et al., 2000; Simon and Wiggins, 2001) suggest that sentiment proxies can be effectively used as time-series variables. In the present study, we follow a similar approach, adopting the put-call ratio of the Taiwan stock exchange capitalization weighted index (TAIEX) options as a proxy for investor sentiment, and measuring the sentiment proxies of both the spot market ($SI_{S,t}$) and the futures market ($SI_{F,t}$).

The first sentiment indicator used in the present study is the vibration ratio, a measure which examines the trading index on the TWSE, and which is equal to the number of advancing stocks divided by the number of all stocks. In cases where this sentiment indicator is found to have a higher level, this would suggest that

[1] See Antoniou and Holmes (1995), Pericli and Koutmos (1997) and Antoniou et al. (1998).

[2] Examples include Brown (1999), Fisher and Statman (2000), Lee et al. (2002), Baker and Wurgler (2004), Brown and Cliff (2004), Baker and Stein (2004), Charoenrook (2005) and Kumar and Lee (2006).

[3] See Solt and Statman (1988), Clarke and Statman (1998), Elton, Gruber and Busse (1998), Barberis, Shleifer and Vishny (1998), Brown (1999), Fisher and Statman (2000), Lee et al. (2002), Baker and Wurgler (2004), Brown and Cliff (2004), Charoenrook (2005), Wang, Keswani and Taylor (2006), Kumar and Lee (2006), and Li et al. (2006).

[4] For example, Solt and Statman (1988), Clarke and Statman (1998), Elton et al. (1998), Wang et al. (2006), and Li et al. (2006).

[5] Examples include Brown (1999), Fisher and Statman (2000), Lee et al. (2002), Baker and Wurgler (2004), Baker and Stein (2004), Charoenrook (2005), and Kumar and Lee (2006).

the market tends to bullish. The second measure of spot market sentiment is the margin lending ratio, which, if the market does become bullish, is essentially reliant upon the likelihood of investors tending to lend on funds as opposed to lending on securities.

The third indicator used in this study is the put-call ratio, an indicator obtained from the TAIEX options market which measures the sentiment amongst participants within that market. Participants in a bearish market will invariably buy put options in order to effectively hedge their spot positions or to engage in bearish speculation; thus, the put-call ratio will be higher when investors become more bearish and speculation in puts becomes excessive.

The fourth spot sentiment indicator is the buy-sell imbalance ($BSI_t$), where the term $B_t$ ($S_t$ ) denotes the buy (sell) value of institutional investors on day *t*. $BS_t$ denotes $B_t - S_t$, and $ABS_t$ is the average of $B_t - S_t$, with $BSI_t$ being positive (negative) when the investor group buys (sells) more securities than it sells (buys) on day *t*.

Finally, in the present study we also use the futures open interest ratio as an indicator of investor sentiment in the Taiwan futures market. $Open_t$ is the open interest position on day *t*, and max($Open_t$) and min($Open_t$) refer to the maximum and minimum positions over the period examined in this study.

**2.1. Removing the inflation and day-of-the-week effects.** In order to avoid the noise of inflation within the market returns, we use excess profits and market returns, less the risk-free rate, to analyze both investor sentiment and the futures market. We use a day-of-the-week dummy variable to examine the effects of excess profits and to consider the day-of-the-week effect, whilst $\mu_{i,t}$ is the excess profit which removes both the inflation and week effects. We use $\mu_t$ in this study to analyze the effects of investor sentiment within the futures market ($\mu_{F,t}$) and the spot market ($\mu_{S,t}$).

Table 1 presents the descriptive statistics on the excess returns and the sentiment data, with Panel A showing that all of the markets are both leptokurtic and display excess kurtosis. The use of the GARCH model is necessary for the distributions, which effectively encompass the features of asymmetry and fat tails.

Table 1. Descriptive statistics

| Indices | | Mean (%) | Max. (%) | Min. (%) | Std. dev. | Skewness | Kurtosis | Jarque-Bera[b] | |
|---|---|---|---|---|---|---|---|---|---|
| Panel A: Excess returns[a] | | | | | | | | | |
| TX | Future | 3.64E-17 | 7.1393 | -8.3140 | 1.7098 | -0.2701 | 6.9747 | 621.4927 | ** |
| | Stocks | 3.92E-17 | 6.1601 | -5.9673 | 1.4313 | -0.3733 | 5.8112 | 326.7893 | ** |
| TXF | Future | 7.99E-17 | 7.6894 | -9.2509 | 2.0212 | -0.2568 | 6.3967 | 453.8697 | ** |
| | Stocks | -4.61E-17 | 6.7485 | -6.9370 | 1.7867 | -0.1760 | 6.1868 | 395.3342 | ** |
| TXE | Future | --5.28E-17 | 7.0980 | -9.1498 | 1.8851 | -0.2640 | 6.3388 | 440.4069 | ** |
| | Stocks | 1.44E-16 | 5.8668 | -6.2827 | 1.5845 | -0.3402 | 5.1378 | 193.9968 | ** |
| Panel B: Sentiment | | | | | | | | | |
| TX | $SI_{S1}$ | 45.5185 | 95.4023 | 1.5806 | 20.1809 | 0.1226 | 2.6476 | 7.1213 | ** |
| | $SI_{S2}$ | 3.7814 | 8.7700 | 0.7400 | 1.3559 | 0.5688 | 3.5743 | 62.7201 | ** |
| | $SI_{S3}$ | 79.6200 | 170.3305 | 22.4734 | 19.6490 | 0.6203 | 3.7530 | 81.3400 | ** |
| | $SI_{S4}$ | 100.0222 | 30198.1800 | -19578.0300 | 3554.6320 | 0.1961 | 10.3701 | 81.3400 | ** |
| | $SI_{F1}$ | 48.1818 | 100.0000 | 0.0000 | 17.6567 | 0.2899 | 3.3451 | 17.5841 | ** |
| TXE | $SI_{S1}$ | 44.4355 | 96.4744 | 0.8902 | 22.2661 | 0.1594 | 2.4206 | 16.8586 | ** |
| | $SI_{S2}$ | 4.5070 | 14.1100 | 0.5100 | 2.1077 | 1.0197 | 5.2155 | 349.4931 | ** |
| | $SI_{S3}$ | 1004.5670 | 56812.7000 | 0.0000 | 4732.4550 | 8.1569 | 77.5493 | 224456.2000 | ** |
| | $SI_{S4}$ | 115.6477 | 41944.1300 | -17879.1100 | 3027.4500 | 2.3117 | 43.6757 | 64591.4800 | ** |
| | $SI_{F1}$ | 31.0013 | 55.3521 | 0.0000 | 10.1387 | -0.4233 | 3.0275 | 27.6505 | ** |
| TXF | $SI_{S1}$ | 42.6564 | 100.0000 | 0.0000 | 27.9997 | 0.2888 | 1.9567 | 54.6888 | ** |
| | $SI_{S2}$ | 2.2559 | 13.6600 | 0.0100 | 1.9523 | 2.2690 | 10.6657 | 3051.9010 | ** |
| | $SI_{S3}$ | 308.9735 | 13804.3200 | 0.0000 | 1008.649 | 7.1392 | 70.7967 | 184610.2000 | ** |
| | $SI_{S4}$ | 5971.6670 | 1628889.0000 | -2027387.0000 | 337635.1000 | -0.2056 | 8.2352 | 1060.5490 | ** |
| | $SI_{F1}$ | 21.2566 | 66.2161 | 0.0000 | 10.2821 | 1.0461 | 5.4322 | 395.8370 | ** |

Notes: [a] The results are based upon the following model: $R_t - R_f = \alpha_0 + \sum_{i=1}^{4} \beta_i Week_i + \mu_t$, where $R_t$ represents the daily returns in the futures market at time *t*; $R_f$ is the risk-free rate; $Week_i$ are the dummy variables checking for the week effect; and $\mu_t$ refers to the excess profit which removes both inflation and the week effect. [b] The Jarque-Bera (JB) test concludes normality (or a critical value of 5%) and the series is leptokurtic. ** indicates significance at the 5% level.

The data analysis of the sentiment variable is provided in Panel B of Table 1 which shows that for the three markets, the means of $SI_{S1}$ are found to be about 40 per cent, whilst the means of $BSI_t$ are positive with large variation. The means of the put-call ratio are also found to be positive, which demonstrates that puts are generally traded more than calls; thus, we can actually view the put-call ratio as a fear indicator, with higher levels reflecting bearish sentiment. Furthermore the maximum and minimum of $BSI_t$ also indicate that it has broad distribution, whereas the spot sentiment varies over a wide range.

Overall, a preliminary investigation of the data suggests that, as expected, the sentiment indicator does respond to the market. We therefore go on in the next Section to investigate the issue of the spillover effects of investor sentiment.

**2.2. The spillover effects of investor sentiment.** We use the aggregate-shock (AS) model, initially introduced by Lin et al. (1994), and subsequently developed by Baur and Jung (2006), with our use of the model accounting for investor sentiment spillover effects between the spot and futures market. The AS model takes the following forms for different issues.

*2.2.1. The effects of spot market investor sentiment on the futures market.* In order to analyze the spot investor sentiment effects on the futures market, we propose a GARCH(1,1) model, which takes the following form:

$$\mu_{F,t} = m_F + b_1 \mu_{F,t-1} + b_2 \mu_{S,t-1} + b_3 \Delta SI_{F,t} + b_4 \Delta SI_{S,t} + \varepsilon_{Ft}, \tag{1}$$

$$h_{F,t} = c_0 + c_1 \varepsilon^2_{F,t-1} + c_2 h_{F,t-1} + c_3 (\Delta SI_{F,t})^2 + c_4 (\Delta SI_{S,t})^2,$$
$$\varepsilon_{S,t} | \Omega_{t-1} \sim N(0, h_{F,t}), \tag{2}$$

where $b_2$ refers to the spillover effects of the returns explaining the way in which returns in the spot market affect returns in the futures market; $b_3$ captures the effects of the shifts in sentiment on the formation of futures market returns within the futures market; $b_4$ measures the effects of sentiment on the formation of futures market returns within the spot market; and $\varepsilon_{i,t}$ ($i$ = spot market, futures market) is the error term, which follows normal distribution.

In general, when sentiment in the spot market is found to be higher, this can raise the overall level of confidence within the financial market; thus, in the present study, we expect to find a significantly positive coefficient on investor sentiment in the spot market affecting the price in the futures market. We use $(\Delta SI_t)^2$ to measure the volatility of investor sentiment, and Var($\Delta SI_t$) as the second moment measure of noise trader risk.

Since the mean change in sentiment is close to zero, the variance of the change in sentiment can be approximated by $(\Delta SI_t)^2$; the sentiment effect is included in the conditional volatility equation, equation (2). The coefficient on $c_0$ is the constant term, whilst $c_1$ and $c_2$ in the conditional volatility equation capture the respective effects of $\varepsilon^2_{F,t-1}$ and $h_{F,t-1}$, as shown in equation (2). Finally, the coefficient on $c_3$ ($c_4$) captures the sentiment effect of the magnitude of the shifts in the futures market (spot market) on volatility formation within the futures market.

1. The pure mean model.

We construct what is referred to in the present study as the 'pure mean' model – denoting $c_3 = c_4 = 0$ in equation (2) – to examine the ways in which the volatility of investor sentiment in the spot market can affect returns in the futures market.

2. The pure volatility model.

The 'pure volatility' model is constructed under the same assumption of $b_3 = b_4 = 0$ in equation (1), after which we go on to propose our alternative model aimed at providing an understanding of the way in which investor sentiment within the spot market affects volatility within the futures market.

3. Asymmetric futures market volatility from investor sentiment in the spot market.

With a rise or fall in investor sentiment within the spot market, we expect to find different volatility effects being discernible within the futures market. The model for examining these effects is written as follows:

$$h_{F,t} = c_0 + c_1 \varepsilon^2_{F,t-1} + c_2 h_{F,t-1} + c_3 (\Delta SI_{F,t})^2 + c_4 (\Delta SI_{S,t})^2 + d_1 (\Delta SI_{S,t})^2 D_t + d_2 (\Delta SI_{S,t})^2 (1 - D_t), \tag{3}$$

where $D_t$ is a dummy variable which is equal to 1 if $\Delta SI_{S,t} > 0$; otherwise 0. The coefficients $d_1$ and $d_2$ capture the asymmetric effects on volatility in the futures market from the magnitude of the shifts in investor sentiment in the spot market.

*2.2.2. Futures market investor sentiment effects on the spot market.* A second issue for exploration in the present study is the reverse effects on the spot market arising from investor sentiment in the futures market. The formulae outlined above are modified to explain this part of our analysis.

## 3. Empirical results

**3.1. Investor sentiment spillover effects.** Following Clarke and Statman (1998) and Fisher and Statman (2000), the primary aim in the present study is to determine whether investor sentiment has impacts on the futures and spot markets, which will enable us to determine whether investor sentiment forecasts price continuations or reversals. This Section presents the regression results relating to the determination of the investor sentiment spillover effects, all of which are reported in Tables 2 to 5.

We begin by estimating the relationship between investor sentiment and excess returns ($\mu_t$). Many of the prior studies test whether sentiment can forecast returns or volatility, and it is clear from the responses to the changes in sentiment in these studies that it does indeed affect both subsequent returns and volatility. The estimates of the model presented in the present study, based on both the spot and futures markets, are presented in Table 2.

Table 2. Investor sentiment spillover effects between the Taiwan futures and spot markets [a]

| Variables | $SI_{S1,t}$ | | $SI_{S2,t}$ | | $SI_{S3,t}$ | | $SI_{S4,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ |
| $m$ | 0.0033 | 0.0080 | 0.0422 | 0.0655 | 0.0593 | 0.0854 | 0.0720 | 0.0920 |
| | (0.0280) | (0.0230) | (0.0370) | (0.0320)** | (0.0390) | (0.0350)** | (0.0340)** | (0.0310)*** |
| $b_1$ | -0.2352 | 0.6702 | -0.1039 | -0.2526 | -0.0631 | -0.1200 | -0.3468 | 0.2155 |
| | (0.0740)*** | (0.0710)*** | (0.1060) | (0.1040)** | (0.1140) | (0.1150) | (0.0820)*** | (0.0830)*** |
| $b_2$ | 0.8665 | -0.0252 | 0.0030 | 0.1761 | 0.1034 | 0.1840 | 0.5272 | -0.0247 |
| | (0.0870)*** | (0.0610) | (0.1210) | (0.0900)** | (0.1320) | (0.0990)* | (0.0920)*** | (0.0730) |
| $b_3$ | 0.0003 | 0.0458 | 0.0017 | 3.2590 | -0.0029 | -0.0175 | 0.0002 | 0.0002 |
| | (0.0030) | (0.0010)*** | (0.0040) | (0.1850)*** | (0.0040) | (0.0020)*** | (0.0030) | (0.0000)*** |
| $b_4$ | 0.0480 | 0.0013 | 3.1189 | 0.0025 | -0.0195 | 0.0005 | 0.0000 | 0.0016 |
| | (0.0010)*** | (0.0020) | (0.1920)*** | (0.0030) | (0.0020)*** | (0.0040) | (0.0000)*** | (0.0030) |
| $c_0$ | 0.0122 | 0.0199 | 0.0163 | 0.0146 | 0.0103 | 0.0057 | 0.0294 | 0.0361 |
| | (0.0060)** | (0.0070)** | (0.0120) | (0.0130) | (0.0120) | (0.0100) | (0.0080)*** | (0.0110)*** |
| $c_1$ | 0.0772 | 0.1180 | 0.1170 | 0.1636 | 0.0802 | 0.0799 | 0.1178 | 0.1612 |
| | (0.0120)*** | (0.0210)*** | (0.0190)*** | (0.0270)*** | (0.0140)*** | (0.0140)*** | (0.0170)*** | (0.0260)*** |
| $c_2$ | 0.9145 | 0.8447 | 0.8745 | 0.8145 | 0.9185 | 0.9147 | 0.8473 | 0.7732 |
| | (0.0140)*** | (0.0250)*** | (0.0180)*** | (0.0270)*** | (0.0140)*** | (0.0150)*** | (0.0160)*** | (0.0270)*** |
| $c_3$ | -0.0000 | 0.0000 | -0.0000 | 1.5136 | -0.0000 | 0.000 | -0.0002 | 0.0000 |
| | (0.0000) | (0.0000)* | (0.0000) | (0.3380)*** | (0.0000) | (0.0000) | (0.0000)*** | (0.0000)*** |
| $c_4$ | 0.0000 | -0.0000 | 0.7291 | -0.0000 | 0.0000 | 0.0000 | 0.0000 | -0.000 |
| | (0.0000) | (0.0000) | (0.2320)*** | (0.0000) | (0.0000) | (0.0000) | (0.0000)*** | (0.0000) |

Notes: [a] The results are based upon the following model:

$$\mu_{F,t} = m_F + b_1\mu_{F,t-1} + b_2\mu_{S,t-1} + b_3\Delta SI_{F,t} + b_4\Delta SI_{S,t} + \varepsilon_{F,t},\ h_{F,t} = c_0 + c_1\varepsilon^2_{F,t-1} + c_2 h_{F,t-1} + c_3(\Delta SI_{F,t})^2 + c_4(\Delta SI_{S,t})^2,\ \varepsilon_{S,t}\left|\Omega_{t-1} \sim N(0, h_{F,t})\right.,$$

$$\mu_{S,t} = m_S + b_1\mu_{S,t-1} + b_2\mu_{F,t-1} + b_3\Delta SI_{S,t} + b_4\Delta SI_{F,t} + \varepsilon_{S,t},\ h_{S,t} = c_0 + c_1\varepsilon^2_{S,t-1} + c_2 h_{S,t-1} + c_3(\Delta SI_{S,t})^2 + c_4(\Delta SI_{F,t})^2,\ \varepsilon_{F,t}\left|\Omega_{t-1} \sim N(0, h_{S,t})\right.,$$

where $b_2$ is the spillover effect of returns; $b_3$ captures the effect of the shifts in sentiment on returns formation; and the coefficient of $b_4$ measures the effect of sentiment on returns formation within the spot or futures market. $\varepsilon_i$, $t$ is the error term ($S$ = spot market, $F$ = futures), which follows normal distribution. The coefficient on $c_3$ ($c_4$) captures the magnitude of the shifts in the spot or futures market (the sentiment effect) on volatility formation. [b] The figures in parentheses are standard errors; * indicates significance at the 10% level; ** indicates significance at the 5% level; and *** indicates significance at the 1% level. [c] Since our research reveals the same results for the TX, TXE and TXF markets, only the TX market results are reported here in order to save space.

As shown in Table 2, a positive and statistically significant relationship is found between spot investor sentiment and the returns at the 1 per cent level from both the spot market and the futures market, indicating that investor sentiment is capable of raising stock returns on days following a bullish market. DeLong et al. (1990) argue that the price pressure effect reduces the relative return expectations of noise traders, which suggests that as noise traders become more bullish, they demand more of the risky assets, thereby driving up the price.

Since the volatility of investor sentiment is found to be statistically significant, it is clear that futures sentiment (spot sentiment) volatility has impacts on the futures (spot index) market. Thus, the sentiment spillover effect between the futures market and the spot market appears to be finite. Although sentiment indicators are apparently in widespread use within the financial markets, in the present study we suggest that $SI_{s4}$ is the better indicator, since it can display the level of investor sentiment within the Taiwan market.

**3.2. Pure mean and pure volatility models.** *3.2.1. Pure mean model.* We use the pure mean model in the present study in an attempt to gain a complete understanding of the relationship between returns and sentiment. The model, shown in Table 3, reveals a positive and statistically significant relationship between futures returns and spot investor sentiment; however, we can find no evidence in this model of any relationship between returns and investor sentiment in the futures market.

Table 3. Investor sentiment spillover effects in the pure mean model [a]

| Variables | $SI_{S1,t}$ | | $SI_{S2,t}$ | | $SI_{S3,t}$ | | $SI_{S4,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ |
| $m$ | 0.0071 | 0.0146 | 0.0559 | 0.0775 | 0.0597 | 0.0820 | 0.0550 | 0.0741 |
| | (0.0270) | (0.0230) | (0.0400) | (0.0350)** | (0.0380) | (0.0340)** | (0.0350) | (0.0310)** |
| $b_1$ | -0.2274 | 0.6413 | -0.0970 | -0.2066 | -0.0617 | -0.1176 | -0.2859 | 0.1420 |
| | (0.0750)*** | (0.0710)*** | (0.0180) | (0.1100)* | (0.1140) | (0.1150) | (0.0920)*** | (0.0920) |
| $b_2$ | 0.8583 | -0.0099 | 0.014 | 0.160 | 0.015 | 0.1813 | 0.4310 | 0.0129 |
| | (0.0870)*** | (0.0610) | (0.1230) | (0.0950)* | (0.1320) | (0.0990)* | (0.1030)*** | (0.0790) |
| $b_3$ | 0.000 | 0.0452 | 0.00 | 2.3856 | -0.0025 | -0.0174 | 0.0017 | 0.0002 |
| | (0.0030) | (0.0010)*** | (0.0040) | (0.1230)*** | (0.0040) | (0.0020)*** | (0.0040) | (0.0000)*** |
| $b_4$ | 0.0480 | 0.0018 | 2.5581 | 0.003 | -0.0198 | -0.0001 | 0.0002 | 0.0042 |
| | (0.0010)*** | (0.0030) | (0.1410)*** | (0.0040) | (0.0020)*** | (0.0040) | (0.0000)*** | (0.0040) |
| $c_0$ | 0.0105 | 0.0139 | 0.0241 | 0.0217 | 0.0171 | 0.1409 | 0.0451 | 0.0336 |
| | (0.0040)** | (0.0040)*** | (0.0070)*** | (0.0070)*** | (0.0080)** | (0.0070)** | (0.0090)*** | (0.0080)*** |
| $c_1$ | 0.0742 | 0.09 | 0.0851 | 0.08 | 0.0820 | 0.0816 | 0.1155 | 0.1126 |
| | (0.0110)*** | (0.0170)*** | (0.0140)*** | (0.0140)*** | (0.0140)*** | (0.0130)*** | (0.0170)*** | (0.0160)*** |
| $c_2$ | 0.920 | 0.8917 | 0.9074 | 0.9055 | 0.9154 | 0.9143 | 0.8654 | 0.8679 |
| | (0.0120)*** | (0.0170)*** | (0.0150)*** | (0.0150)*** | (0.0140)*** | (0.0140)*** | (0.0170)*** | (0.0170)*** |

Notes: [a] The results are based upon the following model:

$$\mu_{F,t} = m_F + b_1\mu_{F,t-1} + b_2\mu_{S,t-1} + b_3\Delta SI_{F,t} + b_4\Delta SI_{S,t} + \varepsilon_{F,t},\ h_{F,t} = c_0 + c_1\varepsilon^2_{F,t-1} + c_2 h_{F,t-1},\ \varepsilon_{S,t}\left|\Omega_{t-1} \sim N(0, h_{F,t}),\right.$$

$$\mu_{S,t} = m_S + b_1\mu_{S,t-1} + b_2\mu_{F,t-1} + b_3\Delta SI_{S,t} + b_4\Delta SI_{F,t} + \varepsilon_{S,t},\ h_{S,t} = c_0 + c_1\varepsilon^2_{S,t-1} + c_2 h_{S,t-1},\ \varepsilon_{F,t}\left|\Omega_{t-1} \sim N(0, h_{S,t}),\right.$$

where the variables are the same as those in Table 2. [b] The figures in parentheses are standard errors; * indicates significance at the 10% level; ** indicates significance at the 5% level; and *** indicates significance at the 1% level. [c] Since our research reveals the same results for the TX, TXE and TXF markets, only the TX market results are reported here in order to save space.

*3.2.2. Pure volatility model.* The pure volatility model, which was designed to provide an understanding of the relationship between volatility and sentiment, is presented in Table 4. As expected, stock returns are affected by investor sentiment in the TX, TXE and TXF markets; however, there is no obvious relationship between futures investor sentiment and stock volatility, which suggests that investor sentiment spillover effects exist within the spot market, but not within the futures market. We surmise that since most of the investors in the Taiwan market are individuals, the major investments take place in the spot market. Overall, the investor sentiment spillover effects are found to be unilateral in the Taiwan stock market; that is, spot sentiment affects both spot and futures market returns, whilst futures sentiment has less effect on the financial market.

Table 4. Sentiment spillover effects in the pure volatility model [a]

| Variables | $SI_{S1,t}$ | | $SI_{S2,t}$ | | $SI_{S3,t}$ | | $SI_{S4,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ |
| $m$ | 0.0610 | 0.0150 | 0.0692 | 0.0859 | 0.0682 | 0.0882 | 0.2388 | 0.0441 |
| | (0.0420) | (0.0360) | (0.0420) | (0.0370)** | (0.0420) | (0.0370)** | (0.0640) | (0.0460) |

Table 4 (cont.). Sentiment spillover effects in the pure volatility model

| Variables | $SI_{S1,t}$ | | $SI_{S2,t}$ | | $SI_{S3,t}$ | | $SI_{S4,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ |
| $b_1$ | 0.0132 | 0.2947 | -0.0265 | 0.0258 | -0.0287 | 0.0272 | -0.0486 | 0.0424 |
| | (0.0450)*** | (0.0490)*** | (0.0360) | (0.0370) | (0.0360) | (0.0370) | (0.0450) | (0.0330) |
| $c_0$ | 0.3181 | 0.3235 | 0.0285 | 0.0286 | 0.0059 | 0.0080 | 2.7736 | 1.7841 |
| | (0.0560)*** | (0.0530)*** | (0.0110)** | (0.0110)*** | (0.0130) | (0.0120) | (0.2866)*** | (0.0700)** |
| $c_1$ | 0.2912 | 0.1639 | 0.0755 | 0.0779 | 0.0765 | 0.0803 | 0.1620 | 0.0457 |
| | (0.0410)*** | (0.0330)*** | (0.0110)*** | (0.0120)*** | (0.0120)*** | (0.0130)*** | (0.0270)*** | (0.0140)*** |
| $c_2$ | 0.1652 | 0.0693 | 0.9211 | 0.9137 | 0.9221 | 0.9142 | -0.1408 | -0.1711 |
| | (0.0430)*** | (0.0430) | (0.0120)*** | (0.0130)*** | (0.0130)*** | (0.0140)*** | (0.0370)*** | (0.0410)*** |
| $c_3$ | 0.0006 | 0.0018 | -0.0001 | -0.1213 | -0.0001 | 0.0000 | 0.0022 | 0.0000 |
| | (0.0000)*** | (0.0000)*** | (0.0000) | (0.0720)* | (0.0000) | (0.0000)* | (0.0010)*** | (0.0000)*** |
| $c_4$ | 0.0018 | 0.0003 | -0.0281 | -0.0000 | -0.0000 | -0.0000 | 0.0001 | 0.0019 |
| | (0.0000)*** | (0.0000) | (0.0960) | (0.0000) | (0.0000)** | (0.0000) | (0.0000)*** | (0.0000)*** |

Notes: [a] The results are based upon the following model:

$$\mu_{F,t} = m_F + b_1\mu_{F,t-1} + \varepsilon_{F,t},\ h_{F,t} = c_0 + c_1\varepsilon^2_{F,t-1} + c_2 h_{F,t-1} + c_3(\Delta SI_{F,t})^2 + c_4(\Delta SI_{S,t})^2,\ \varepsilon_{S,t}\,\big|\,\Omega_{t-1} \sim N(0, h_{F,t}),$$

$$\mu_{S,t} = m_S + b_1\mu_{S,t-1} + \varepsilon_{S,t},\ h_{S,t} = c_0 + c_1\varepsilon^2_{S,t-1} + c_2 h_{S,t-1} + c_3(\Delta SI_{S,t})^2 + c_4(\Delta SI_{F,t})^2,\ \varepsilon_{F,t}\,\big|\,\Omega_{t-1} \sim N(0, h_{S,t}),$$

where the variables are the same as those in Table 2. [b] The figures in parentheses are standard errors; * indicates significance at the 10% level; ** indicates significance at the 5% level; and *** indicates significance at the 1% level. [c] Since our research reveals the same results for the TX, TXE and TXF markets, only the TX market results are reported here in order to save space.

**3.3. Asymmetric volatility of investor sentiment.** We conclude with an examination of asymmetric volatility based upon changes in investor sentiment which is captured using a dummy variable. As shown in Table 5, a rise or fall in investor sentiment in the spot market has clear effects on futures volatility, particularly within the TX market. As the table shows, individual investors within the spot market can react through either bullish or bearish sentiment; thus, we argue that it is of some significant importance to be able to identify and then control for investor sentiment in order to establish a reliable stock timing strategy.

Table 5. Asymmetric spillover effects[a]

| Variables | $SI_{S1,t}$ | | $SI_{S2,t}$ | | $SI_{S3,t}$ | | $SI_{S4,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ |
| $m$ | 0.0091 | 0.0075 | 0.0310 | 0.0663 | 0.0637 | 0.0839 | 0.0110 | 0.0909 |
| | (0.0280) | (0.0230) | (0.0320) | (0.0320)** | (0.0370)* | (0.0350)** | (0.1590) | (0.0310)*** |
| $b_1$ | -0.2393 | 0.6736 | -0.0783 | -0.2480 | -0.0623 | -0.1187 | -0.5171 | 0.2191 |
| | (0.0450)*** | (0.0710)*** | (0.0960) | (0.1040)** | (0.1140) | (0.1150) | (0.2420)** | (0.0840)*** |
| $b_2$ | 0.8586 | -0.0274 | -0.0338 | 0.1718 | 0.0875 | 0.1826 | 0.6759 | -0.0272 |
| | (0.0870)*** | (0.0610) | (0.1090) | (0.0890)* | (0.1310) | (0.0990)* | (0.3040)** | (0.0740) |
| $b_3$ | 0.0003 | 0.0458 | 0.0027 | 3.2701 | -0.0045 | -0.0176 | -0.0147 | 0.0002 |
| | (0.0030) | (0.0010)*** | (0.0020) | (0.1860)*** | (0.0040) | (0.0020)*** | (0.0150) | (0.0000)*** |
| $b_4$ | 0.0472 | 0.0013 | 2.9225 | 0.0023 | -0.0180 | 0.0006 | 0.0003 | 0.0014 |
| | (0.0010)*** | (0.0020) | (0.1850)*** | (0.0030) | (0.0020)*** | (0.0040) | (0.0000)*** | (0.0040) |
| $c_0$ | 0.0126 | 0.0211 | 0.1272 | 0.0016 | 0.0071 | 0.0070 | 2.2202 | 0.0344 |
| | (0.0060)** | (0.0080)*** | (0.0180)*** | (0.0130) | (0.0110) | (0.0110) | (0.9220)** | (0.0130)*** |
| $c_1$ | 0.0730 | 0.1199 | 0.1094 | 0.1629 | 0.0730 | 0.0801 | 0.1500 | 0.1611 |
| | (0.0130)** | (0.0210)*** | (0.0160)*** | (0.0270)*** | (0.0130)*** | (0.0140)*** | (0.0460)*** | (0.0270)*** |
| $c_2$ | 0.9140 | 0.8422 | 0.8794 | 0.8145 | 0.9276 | 0.9146 | 0.6000 | 0.7724 |
| | (0.0150)*** | (0.0250)*** | (0.0150)*** | (0.0260)*** | (0.0130)*** | (0.0150)*** | (0.1540)*** | (0.0280)*** |
| $c_4$ | -0.0000 | -0.0000 | -0.0002 | 1.5673 | -0.0001 | 0.0000 | -0.0000 | 0.0000 |
| | (0.0000) | (0.0000)* | (0.0000)*** | (0.3420)*** | (0.0000) | (0.0000) | (0.0010) | (0.0000)*** |
| $d_1$ | -0.0001 | 0.0001 | 0.4933 | -0.0003 | 0.0004 | 0.0003 | 0.0001 | -0.0002 |
| | (0.0000)** | (0.0000) | (0.1660)*** | (0.0010) | (0.0000)*** | (0.0000) | (0.0000)*** | (0.0000) |

Table 5 (cont.). Asymmetric spillover effects

| Variables | $SI_{S1,t}$ | | $SI_{S2,t}$ | | $SI_{S3,t}$ | | $SI_{S4,t}$ | |
|---|---|---|---|---|---|---|---|---|
| | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ | $\mu_{F,t}$ | $\mu_{S,t}$ |
| $d_2$ | 0.0000 | -0.0001 | 0.1656 | 0.0002 | -0.0002 | -0.0001 | -0.0001 | 0.0002 |
| | (0.0000)*** | (0.0000) | (0.0250)*** | (0.0000) | (0.0000)*** | (0.0000) | (0.0000)*** | (0.0000) |

Notes: [a] The results are based upon the following model:

$$h_{F,t} = c_0 + c_1\varepsilon^2_{F,t-1} + c_2h_{F,t-1} + c_3(\Delta SI_{F,t})^2 + c_4(\Delta SI_{S,t})^2 + d_1(\Delta SI_{S,t})^2D_t + d_2(\Delta SI_{S,t})^2(1-D_t),$$

$$h_{S,t} = c_0 + c_1\varepsilon^2_{S,t-1} + c_2h_{S,t-1} + c_3(\Delta SI_{S,t})^2 + c_4(\Delta SI_{F,t})^2 + d_1(\Delta SI_{F,t})^2D_t + d_2(\Delta SI_{F,t})^2(1-D_t),$$

where $D_t$ is a dummy variable; if $\Delta SI_{S,t} \leq 0$, then $D_t$ is equal to 0; if $\Delta SI_{S,t} > 0$, then $D_t$ is equal to 1. The coefficients $d_1$ and $d_2$ capture the asymmetric effects of the futures market on volatility arising from the magnitude of the shifts in investor sentiment in the spot market. The remaining variables are the same as those in Table 2. [b] The figures in parentheses are standard errors; * indicates significance at the 10% level; ** indicates significance at the 5% level; and *** indicates significance at the 1% level. [c] Since our research reveals the same results for the TX, TXE and TXF markets, only the TX market results are reported here in order to save space.

## Summary and conclusions

Based upon a survey of daily data on the TX, TXE and TXF markets obtained from the TEJ databank, we examine the spillover effects of investor psychology on different trading indices through the use of GARCH models. Our results clearly suggest the existence of dynamic relationships between investor sentiment in both the spot and futures markets.

In particular, we demonstrate that in a bullish market, virtually all stock investor sentiment can result in raising returns; however, no significant relationship is found to exist between investor sentiment and returns in the futures market. This may be due to the relatively weaker explanatory power of the sentiment index, which may therefore be an issue worthy of future study.

No major differences are discernible between the results of the pure mean or pure volatility models. Furthermore, the returns in the futures market and investor sentiment in the spot market are both found to be positive and significant, which may well suggest that investor sentiment in the spot market has much more obvious spillover effects.

Finally, asymmetric volatility attributable to sentiment is found to exist within both the futures and spot markets, whilst we also note that sentiment may have an overall effect, in the form of either a bullish or bearish reaction. In conclusion, our empirical findings suggest that the spillover effects of sentiment between the spot and futures markets may be analyzed in terms of their overall implications on market efficiency.

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