Journal of Computers Vol. 32 No. 4, 2021, pp. 57-66
doi:10.53106/199115992021083204005

Does CBOE Volatility Index Jumped or Located at a Higher Level Matter for Evaluating DJ 30, NASDAQ, and S&P500 Index Subsequent Performance

Yulu Liao[1], Min-Yuh Day[2], Yirung Cheng[3], Paoyu Huang[4*], Yensen Ni[3]

[1] Department of Accounting, Ming Chuan University, Taipei 111, Taiwan, ROC
yoru716@gmail.com, yoruliao@mail.mcu.edu.tw

[2] Graduate Institute of Information Management, National Taipei University, New Taipei 23741, Taiwan, ROC
myday@gm.ntpu.edu.tw

[3] Department of Management Sciences, Tamkang University, New Taipei 25137, Taiwan, ROC
yirungcheng@gmail.com, ysni@mail.tku.edu.tw

[4] Department of International Business, Soochow University, Taipei 100, Taiwan, ROC
hpy@scu.edu.tw

Received 6 December 2020; Revised 4 April 2021; Accepted 22 April 2021

Abstract. Nowadays, the VIX index has become the most popular measure for the market's expectation of volatility over the near-term future. Studies have addressed that the sharp movement in the VIX index might affect stock markets. However, the subsequent performances for stock markets when the VIX index jumps a relatively high point in a day or is located at a relatively high level remain unclear in the present literature. With the motivation to solve these puzzles, we conduct this study by taking "flow concern" and "stock concern" to evaluate the interaction among Dow Jones, NASDAQ, and S&P500 and VIX indices. The revealed results show that the subsequent performances for these stock indices would rise in a few days, but the above results would be reversed in a month. These findings might be beneficial for investors in evaluating DJ 30, NASDAQ, and S&P500 index subsequent performance while trading these index futures or index ETFs as the above VIX index phenomena occurred. Additionally, we argue that the above concerns in terms of investors' panic and stock index performance, to our knowledge, seems rarely explored before and the outcomes of this study might enhance the robustness of the existing literature.

Keywords: investing strategies, investor sentiments, VIX index

1 Introduction

Established by the Chicago Board Options Exchange (CBOE) in 1993, the CBOE Volatility Index (VIX) is measured by the weighted implied volatilities of various S&P500 index options and reflects the degree of volatility for the stock index. In fact, the VIX index might represent future economic change [1] and become a significant indicator of stock market volatility consequently [2]. Especially, financial services routinely report the VIX index [3], indicating that the VIX index has drawn people's attention in the financial area. Besides, due to the rapid transmission of message, the stock markets around the world seem to interact more closely than before. For example, the stock market crisis in 2008 induces a global

* Corresponding Author

economic downturn and intensifies the panic in global capital markets. Thus, we speculate that the importance of the VIX index is highly enhanced recently.

Usually, the VIX is recognized as a fear index for stock market and has been largely used in academic researches to predict the volatilities of stock markets globally [4-7]. For instance, it has been pointed out that the VIX tends to rise during falling markets [8]. In other words, the VIX index rises with a decrease in stock index and decreases with an increase in the stock index. Furthermore, the VIX index reports the extent of investors' willingness to pay for the inherent risks and signifies the degree of investors' panic in terms of futures. As a matter of fact, VIX index is usually found to have better predictive power than other indices and regarded as a well-known index to measure the market's expectation of future volatility of the S&P 500 index, which is the leading indicator of the broad U.S. stock market [9]. Consequently, regarded as the premier gauge of investor sentiment, the VIX index is the most popular measure of the market's expectation of volatility over the near-term future.

Originally, the VIX index is designed to mirror investors' expectations for the future of the market [10]. However, with the deepening of research, people gradually found that the VIX index also has a wider range of applications [11]. For example, The VIX index exhibits powerful predictive ability for eight international stock markets [12]. By employing VIX futures, the current volatility is considerably reduced relative to the past volatility [13]. In addition, the VIX index might influence the attitudes of market participants for investment. When the VIX index is high, market participants might assume the stock volatility increased and become hesitative to invest. Essentially, a sharp rise in the VIX index indicates that market participants might buy options and sell shares, although such action might transmit a reverse signal. Besides, value stocks outperform growth stocks when the VIX index is high and, on the contrary, growth stocks are slightly better than value stocks when the VIX index is low [5]. In general, changes in the VIX index are the statistically significant indicators of daily market returns [14]. Furthermore, the importance of risk concepts for stock market indices is stressed when assessing risk with formally modeling the negative returns measured by VIX index [6]. Besides, the increase (decrease) in the VIX index reveals that the portfolios of large-capitalization stocks outperform (underperform) the portfolios of small-capitalization stocks and that value-based portfolio outperforms (underperform) growth-based portfolios.

Recently, arbitrage between cash index and future index, holiday effect, and the performance of large-cap or small-cap stock in terms of VIX index are explored. For example, the relation between the VIX cash index and the VIX futures is not arbitraged [15]. The VIX index declines before holidays due to the declines of trading activity [16]. Moreover, when the change in VIX index is positive, large-capitalization stocks (the S&P 500) outperform small-capitalization stocks (the S&P 600) and, in contrast, when the change in VIX index is negative, small-cap stocks outperform [4].

In this study, we aim to investigate the subsequent performance of several representative stock indices, including Dow Jones, NASDAQ, and S&P500, right after either the VIX index jumping onto a relatively high point in a day or locating at a rather high level. As Warren Buffett said, investors are wise to be fearful when people are greedy but are greedy when people are fearful. We explore whether contrarian strategies would be effective as the aforementioned VIX index phenomena shown for a few days or even a month.

Generally, a deterministic trading strategy can be deemed as a signal processing element that utilizes external information and past prices as inputs and incorporates them into future prices [17]. Therefore, forming appropriate investment strategies are important for investors. In fact, momentum and contrarian strategies are two major investment strategies widely debated across the world [18] and can be adopted for the purpose of profits making [19]. The accepted definitions of momentum (buying positive return stocks and selling negative return stocks) or contrarian (selling positive return stocks and buying negative return stocks) trading strategies imply that investors use the same strategies to both sides of their trades (i.e. to their buys and sells) [20]. In other words, investors employ momentum strategies when adding stocks to their portfolios and contrarian strategies when selling stocks.

As for the momentum strategies, it has been found that the momentum strategies are used in the foreign exchange market and reveal a significant cross-sectional spread in excess returns between past winner and loser currencies [7]. Other study reports that momentum profits are positively related to analyst forecast dispersion, transaction costs, and the familiarity of the market with foreigners and are negatively related to firm size and volatility [21]. Besides, stock returns are positively related to the subsequent book-to-market premium and negatively related to the subsequent momentum premium [22].

The premia of momentum returns exist across diverse markets [23]. In sum, momentum strategies are appropriately employed in trading international equity indices, commodities, and currencies [24].

With regard to the contrarian strategies, it has been revealed that contrarian profits outweigh the increased costs for portfolios measured by various variables, such as book-to-market, cash flow-to-price, earnings-to-price, and past returns [25]. Contrarian strategies in intraday limit-hit stocks generate superior returns relative to benchmark index returns [26]. In fact, the reversal of long-term returns may be stronger and more persistent than that generally understood for international equity markets [27]. A long-term contrarian is entirely attributable to the classic January size effect rather than to investor overreaction [28-29]. Besides, the well-documented contrarian profits are revealed for value and growth stocks [30]. More interestingly, Dutch institutional investors, such as those dealing with pension funds, life insurers, and non-life insurers, tend to be contrarian traders [31].

After surveying the relevant literature as mentioned above, we realize that the sharp movement in the VIX index might affect stock markets. However, the subsequent performances for stock markets when the VIX index jumps a relatively high point in a day or is located at a relatively high level remain unclear in the present studies. This ambiguity arouses our interest to conduct a research. Therefore, with the motivations to solve these puzzles and to enhance the robustness of existing literature, we organize this study to examine the interactions among markets by collecting the daily data of the VIX index and several representative stock indices in the world.

In this study, we reveal several valuable findings. First, when the VIX index jumps up, investors might profit by investing the shares for a few days, such as five days, but the profit might be reversed when holding for more days, such as a month. Hence, employing the VIX index as a measure of investor sentiments, investors had better take long positions in a few days only when the VIX index considerably increases in a day, such as ΔVIX index ≥ 10. The same strategies might be used as the VIX index is located at a rather high level, such as VIX index ≥ 60, since the above results might not be shown for a month. Second, by employing time series models, we reveal that VIX index at lag 1 negatively affects the stock returns of DJ 30, NASDAQ, and S&P 500 based on monthly data, which might be accorded with the revealed results mentioned above.

In addition, we believe that this study might contribute to the present literature in several aspects. First, we evaluate the subsequent performance of stock indices after the VIX index rises up certain points in a day, such as ΔVIX index ≥ 10, ΔVIX index ≥ 7.5, ΔVIX index ≥ 5, and ΔVIX index ≥ 2.5, as well as VIX index located at a rather higher level, including VIX index ≥ 60, VIX index ≥ 40, and VIX index ≥ 20 by observing VIX index deliberately. To our knowledge, this evaluation seems rarely concerned in the existing literature. Second, we reveal that the subsequent performance of these stock indices would be enhanced in a few days only as the VIX index jumps a relatively high point in a day or when the value of VIX index is located at a relatively high level. This finding might be beneficial for investors in evaluating DJ 30, NASDAQ, and S&P500 index subsequent performance while trading these index futures or index ETFs as the above VIX index phenomena occurred. Third, we infer that the results might be interpreted as an overreaction in the short run due to investor sentiments aroused; nevertheless, mean reversion might be shown later when investors' sentiments have cooled down. Four, as employed huge volume of data aforementioned, we set models to calculate the numerous subsequent performances of stock indices after VIX index rises over different points in a day. As shown in Table 2 and Table 4, we also accomplish the technical achievement for generating the empirical results statistically.

The rest of this study Section 3 is organized by several sections. Section 2 presents the data and empirical results. Section 3 shows the further investigation. Section 4 provides the conclusions.

2 Data and Empirical Results

2.1 Data and Descriptive Statistics

The variables employed in this study are derived from DataStream. We employ the daily data from Jan. 1990 to Dec. 2014 for the VIX index and several representative indices, including Dow Jones, NASDAQ, and S&P 500, as our samples. Then we examine the subsequent performance for 1- to 5-day as well as 10-, 20-, and 30-day as either VIX index jumps a relatively high point in a day or the value of VIX index is located at a relatively high level.

Table 1. Descriptive statistics

The table reports the means, standard deviations, maxima, and minima of the variables, including Dow Jones index, NASDAQ index, S&P500 index, and VIX index by employing daily data from 1990 to 2014.

Variables	Obs.	Mean	Median	Std. Dev.	Min.	Max.
Dow Jones index	6301	8996.28	9973.46	3857.49	2365.1	18053.71
NASDAQ index	6301	1954.05	1962.44	1046.58	325.4	5048.62
S&P500 index	6301	1029.88	1113.56	424.26	295.46	2090.57
VIX index	6299	19.95	18.16	8.01	9.31	80.86

Table 1 shows the means, medians, standard deviations, minima, and maxima for the four indices over the data period of 1990-2014. In fact, there are several black-swan events during this period, including the Asian financial crisis in 1997, the tech bubble in 2000, and the global financial crisis in 2008. These black-swan events might result in quite volatile standard deviations for these indices. Besides, Table 1 reveals that the mean of VIX index is 19.95 but the maximum is over 80, indicating that investors indeed bear huge panic during this period.

2.2 Empirical Results

In this study, we take "flow concern" (i.e., exploring the subsequent performance after VIX INDEX rises over 2.5, 5, 7.5, and 10 points in a day) as well as "stock concern" (i.e., investigating the subsequent performance as the VIX INDEX value is over 20, 40, and 60 points in a day) into account. The subsequent stock index performance includes 1- to 5-day performance and 10-, 20-, and 30-day performance when either VIX INDEX jumps a relatively high point in a day or the VIX INDEX value is located at a relatively high level. The 1- to 5-day outcomes are defined as the short-run performance and 10-, 20-, and 30-day results are defined as the long-run performance. In Table 2, Panel A presents the outcomes of the "flow concern" and Panel B shows the results of "stock concern".

Table 2. Empirical results

Panel A reports the subsequent performance, including the 1-, 2-, 3-, 4-, 5-day returns as well as the 10-, 20-, and 30-day returns after VIX INDEX rises over 2.5, 5, 7.5, and 10 points in a day. We also investigate the subsequent performance, that is, either VIX INDEX rises (i.e., ΔVIX INDEX > 0) or VIX INDEX falls (i.e., ΔVIX INDEX < 0). Panel B shows the subsequent performance when the value of VIX INDEX is over 20, 40, and 60 on any trading day.

Panel A:									
DJ30	N	Day 1	Day 2	Day 3	Day 4	Day 5	Day 10	Day 20	Day 30
ΔVIX INDEX ≥ 10	9	2.16%	2.20%	2.37%	3.92%	3.80%	2.20%	-2.41%	-2.17%
ΔVIX INDEX ≥ 7.5	19	1.69%	1.66%	1.67%	1.87%	2.46%	-0.51%	-1.44%	-0.99%
ΔVIX INDEX ≥ 5	54	0.91%	1.21%	0.72%	0.88%	1.11%	0.13%	-0.64%	-0.36%
ΔVIX INDEX ≥ 2.5	247	0.38%	0.61%	0.63%	0.76%	0.84%	0.98%	1.42%	1.83%
ΔVIX INDEX ≥ 0	2864	0.03%	0.08%	0.13%	0.16%	0.24%	0.40%	0.72%	1.15%
ΔVIX INDEX < 0	3136	0.04%	0.06%	0.08%	0.12%	0.11%	0.28%	0.66%	0.93%
NASDAQ									
ΔVIX INDEX ≥ 10	9	2.21%	2.24%	2.56%	3.88%	4.09%	2.80%	-2.70%	-2.99%
ΔVIX INDEX ≥ 7.5	19	1.42%	1.34%	1.58%	1.71%	2.34%	-1.43%	-2.34%	-1.86%
ΔVIX INDEX ≥ 5	54	0.83%	0.92%	0.43%	0.63%	0.86%	-0.65%	-1.51%	-1.39%
ΔVIX INDEX ≥ 2.5	247	0.42%	0.69%	0.71%	0.75%	0.74%	1.16%	1.77%	2.31%
ΔVIX INDEX ≥ 0	2864	0.01%	0.09%	0.14%	0.14%	0.22%	0.49%	0.90%	1.47%
ΔVIX INDEX < 0	3136	0.08%	0.10%	0.14%	0.23%	0.25%	0.44%	1.01%	1.44%
S&P500									
ΔVIX INDEX ≥ 10	9	2.30%	2.43%	2.64%	4.19%	4.13%	2.39%	-2.91%	-3.04%
ΔVIX INDEX ≥ 7.5	19	1.76%	1.67%	1.80%	1.97%	2.56%	-0.72%	-1.84%	-1.46%
ΔVIX INDEX ≥ 5	54	0.97%	1.28%	0.73%	0.86%	1.08%	-0.09%	-0.97%	-0.87%
ΔVIX INDEX ≥ 2.5	247	0.43%	0.68%	0.69%	0.82%	0.88%	1.08%	1.56%	1.90%
ΔVIX INDEX ≥ 0	2864	0.03%	0.08%	0.13%	0.15%	0.22%	0.39%	0.68%	1.07%
ΔVIX INDEX < 0	3136	0.04%	0.05%	0.07%	0.11%	0.11%	0.26%	0.63%	0.90%

Table 2. Empirical results (continue)

Panel B:									
DJ30	N	Day 1	Day 2	Day 3	Day 4	Day 5	Day 10	Day 20	Day 30
VIX INDEX < 20	3446	0.03%	0.05%	0.08%	0.11%	0.14%	0.35%	0.67%	0.96%
VIX INDEX ≥ 20	2554	0.04%	0.09%	0.13%	0.17%	0.20%	0.32%	0.71%	1.13%
VIX INDEX ≥ 40	168	0.18%	0.34%	0.36%	0.46%	0.65%	0.81%	1.16%	1.22%
VIX INDEX ≥ 60	27	1.53%	2.75%	2.40%	2.63%	2.85%	2.30%	1.16%	0.77%
NASDAQ									
VIX INDEX < 20	3446	0.04%	0.08%	0.11%	0.16%	0.19%	0.40%	0.74%	1.05%
VIX INDEX ≥ 20	2554	0.06%	0.12%	0.18%	0.23%	0.29%	0.55%	1.24%	1.99%
VIX INDEX ≥ 40	168	0.20%	0.35%	0.37%	0.51%	0.73%	1.48%	2.80%	3.54%
VIX INDEX ≥ 60	27	1.52%	2.50%	1.93%	2.07%	2.27%	1.24%	-0.18%	-0.13%
S&P500									
VIX INDEX < 20	3446	0.03%	0.05%	0.08%	0.11%	0.14%	0.33%	0.61%	0.86%
VIX INDEX ≥ 20	2554	0.04%	0.08%	0.12%	0.16%	0.19%	0.30%	0.71%	1.14%
VIX INDEX ≥ 40	168	0.18%	0.33%	0.36%	0.48%	0.68%	0.95%	1.42%	1.57%
VIX INDEX ≥ 60	27	1.54%	2.76%	2.30%	2.43%	2.65%	1.88%	0.50%	0.14%

In Table 2, Panel A reports that the subsequent performance would be enhanced after VIX INDEX jumps relatively high points in a day. The results show positive index returns after the VIX INDEX rising 10 points, 7.5 points, as well as 5% in a day (about 2%, 1.5%, and 1%, respectively), and even about 4% for 5-day returns. Panel B presents that the subsequent index returns are over 1.5% for 1- to 5-day returns when the VIX INDEX value is located at a relatively high level, such as VIX INDEX ≥ 60. In addition, the subsequent index returns are over 0.5% for 5-day returns while the VIX INDEX ≥ 40.

We argue that the subsequent results might be caused by the overreaction as the VIX INDEX rises to a relatively high point in a day and the value of VIX INDEX is located at a relatively high level. However, the results might not be applied for 10-, 20-, and 30-day due to the mean reversion that is positive returns revealed in a few days (i.e. 1-5 days) turning to negative returns afterward (i.e. 10-30 days).

In addition, the results imply that stock indices often significantly decline as VIX INDEX sharply rises, which might result from the bad news released. However, stock indices would be rebounded rather quickly in a few days right after the VIX INDEX jumping onto a high point in a day due to the overreaction of stock market. Additionally, stock indices would decline later when negative returns revealed in 10-30 days. We infer that the overreaction is also shown when the stock prices rebound after VIX INDEX jumps a relatively high point in a day or as the VIX INDEX value locates at a relatively high level. The phenomenon that the overreaction occurs twice might be interpreted by the investor sentiments in terms of behavioral finance.

3 Further Investigation

We further explore whether stock indices would be affected by VIX INDEX and other relevant variables with the use of monthly data, instead of daily data, due to the frequency of the macroeconomic data. We collect the variables, including VIX, VIX INDEX volatility (i.e., standard deviation of the daily VIX index in a month), VIX_over_20[1] and other relevant macroeconomic variables (i.e., Treasury bill rate, U.S. dollar index, industrial production growth rate, unemployment rate, and inflation rate). We argue that stock market performances closely related to the economic activities. Thus, we explore whether the performances of these indices would be affected by the variables that are related to VIX, including VIX, VIX_SD, and VIX_over_20, as well as other controlled variables.

Prior to processing our models, we use the log differencing, based on the unit root tests, to examine if these variables applied in this study are stationary due to employing time series data. Besides, the multicollinearity is not detected among these independent variables because the VIF (Variance Inflation Factor) values of these independent variables are all less than 3.5. We also incorporate the lag 1 of the

[1] In fact, investors are generally more optimistic about the market outlook when VIX is below 20 points. In contrast, investors would lack confidence when VIX is over 20 points. Thus, we also include VIX_over_20, defined as the trading days whose VIX value is over 20 over the total trading days in a month, in our models.

stock index into our models, according to the statistics revealed by AIC lag-length tests. Therefore, given the issue of whether the information released by VIX INDEX would affect the stock index performance, we propose the model as below.

$$\text{Stock index}_{j,t} = \beta_0 + \beta_1 \text{Stock Index}_{j,t-1} + \beta_2 \text{VIX}_t + \beta_3 \text{VIX}_{t-1} + \beta_4 \text{VIX\_SD}_t + \beta_5 \text{VIX\_over\_20 ratio}_t + \beta_6 \text{Treasury bill rate}_t + \beta_7 \text{U.S. dollar index}_t + \beta_8 \text{Industry production growth rate}_t + \beta_9 \text{Inflation rate}_t + \beta_{10} \text{Unemployment rate}_t + \varepsilon_t, \; j = 1, 2, 3. \quad \textbf{(1)}$$

Where $\text{Stock index}_{j,t}$ denotes Dow Jones index as j=1, NASDAQ index as j=2, and S&P 500 index as j=3.

3.1 Data and descriptive statistics

In this study, we collect 300 monthly data from Jan. 1990 to Dec. 2014 and the means, standard deviations, minima, and maxima for the variables employed in this study are presented in Table 3. The results show that the ranges of Dow Jones, NASDAQ, and S&P500 indices are relatively broad because these stock indices exhibit upward trends during the data period. Concerning the relevant variables related to VIX, we incorporate VIX, VIX_SD, and VIX_over_20 because these variables might affect the stock indices incorporated in this study. Table 3 shows that the range of VIX_over_20 is from 0 to 1 and the mean is approximately 0.4, indicating that most of the daily VIX INDEX might be less than 20 within a month; however, some of them are more than 20. As for the macroeconomic variables, the inflation rate and unemployment rate are 2.63% and 6.13% during the data period, respectively.

Table 3. Descriptive statistics

The table reports the means, standard deviations, maxima, and minima of the variables, including DJ30 index, NASDAQ index, S&P500 index, VIX, VIX_SD (i.e., the standard deviation of daily VIX index in a month), VIX_over_20 ratio (i.e., ratio of the day of VIX INDEX over 20 within a month over the total trading day), Treasury bill rate, U.S. dollar index, unemployment rate, industry production growth rate, and inflation rate.

Variables	Obs.	Mean	Median	Std. Dev.	Min.	Max.
Dow Jones index	300	9015.72	9947.98	3870.76	2442.33	17828.24
NASDAQ index	300	1961.38	1967.62	1052.93	329.80	4791.63
S&P500 index	300	10.32.80	1111.83	425.73	304.01	2067.56
VIX INDEX	300	19.96	18.33	7.63	10.42	59.89
VIX_SD	300	1.7469	1.7469	1.3143	0.3029	10.6850
VIX_over_20 ratio	300	0.4072	0.4072	0.4447	0	1
Treasury bill rate	300	3.0498	3.0498	2.2693	0.01	7.87
US dollar index	300	89.8904	89.8904	10.7274	72.369	119.79
Unemployment rate	300	6.1287	6.1287	1.5802	3.8	10
Industry production growth rate	300	2.2123	2.2123	4.1056	-14.8	8.7
Inflation rate	300	2.6317	2.6317	1.2608	-2.1	6.3

3.2 Further Empirical Results

We utilize log differencing for the variables employed in this study because of the stationarity concerns. In addition, we apply the models to explore if the information retrieved from VIX INDEX would affect the stock index performance. We then estimate our models by fitting the residual with GARCH (1, 1) due to the concerns about the presence of clustered volatilities in residuals revealed by the LM tests.

Table 4. Empirical results

We employ the Dow Jones, NASDAQ, and S&P500 indices as dependent variables, the results of which are shown in Equations (1), (2), and (3), respectively. The independent variables include DJ30_lag1, NASDAW_lag1, and S&P500_lag1 (i.e., the lag1 of these stock indices) for Equations (1) to (3), VIX, VIX_lag1 (the lag1 of VIX), VIX_SD, VIX_over_20, Treasury bill rate, U.S. dollar index, unemployment rate, industry production growth rate, and inflation rate. In addition, these macroeconomic variables are seasonally adjusted series. Given the stationarity concerns shown in the unit root tests, we adopt log-differencing for the variables employed in our models. Moreover, due to concerning the volatilities clustered existing in the residual revealed in the LM tests, we also employ the models by fitting the residuals with GARCH (1.1). The standard errors of the estimated coefficients are shown in parentheses. Columns (1a) to (3a) show the results for the ADSL models. Columns (1b) to (3b) present the results of these models by fitting the residuals with GARCH (1, 1), that is, $h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}$. Statistical significance set as the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.

Dependent	Equation (1)		Equation (2)		Equation (3)	
Variables	DJ30		NASDAQ		S&P500	
Independent Variables	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Dow Jones _lag1	-0.0385 (0.0595)	-0.0442 (0.0714)				
NASDAQ_lag1			0.1431** (0.0593)	0.1465** (0.0646)		
S&P500_lag1					0.0439 (0.0595)	-0.0209 (0.0715)
VIX INDEX	-0.1289*** (0.0107)	-0.1129*** (0.0078)	-0.1930*** (0.0177)	-0.1278*** (0.0113)	-0.1419*** (0.0102)	-0.1153*** (0.0082)
VIX_lag1	-0.0258* (0.0135)	-0.0210 (0.0142)	-0.0056 (0.0215)	-0.0162 (0.0171)	-0.0209 (0.0134)	-0.0199 (0.0131)
VIX_SD	-0.0029 (0.0019)	-0.0018 (0.0017)	-0.0031 (0.0032)	-0.0065** (0.0026)	-0.0022 (0.0019)	-0.0020 (0.0016)
VIX_over_20	-0.0053 (0.0052)	-0.0060 (0.0057)	–0.0041 (0.0086)	0.0006 (0.0077)	-0.0056 (0.0050)	-0.0066 (0.0052)
Treasury bill rate	-0.0110* (0.0059)	0.0004 (0.0050)	–0.0036 (0.0098)	0.0089 (0.0065)	-0.0060 (0.0056)	0.0056 (0.0045)
US dollar index	-0.1304* (0.0769)	-0.2036*** (0.0740)	–0.1739 (0.1283)	–0.2406** (0.1081)	-0.1855** (0.0737)	-0.2183*** (0.0682)
Unemployment rate	-0.1077 (0.0735)	-0.0176 (0.0670)	0.0738 (0.1222)	0.0354 (0.1049)	-0.0793 (0.0711)	-0.0051 (0.0701)
Industrial production	0.0005 (0.0021)	-0.0002 (0.0025)	0.0077** (0.0035)	0.0028 (0.0040)	0.0033 (0.0020)	0.0020 (0.0018)
Inflation rate	-0.0031 (0.0030)	-0.0033 (0.0096)	–0.0007 (0.0049)	–0.0034 (0.0066)	-0.0023 (0.0028)	-0.0024 (0.0088)
Constant	0.0172*** (0.0034)	0.0151*** (0.0031)	0.0191*** (0.0057)	0.0220*** (0.0044)	0.0158*** (0.0033)	0.0158*** (0.0029)
α_1		0.1192*** (0.0460)		0.1471*** (0.0456)		0.1457*** (0.0493)
β_1		0.8537*** (0.0514)		0.8242*** (0.0490)		0.8230*** (0.0534)
α_0		0.00003 (0.00002)		0.00007 (0.00004)		0.00003 (0.00002)
AIC	-1199		-894		-1224	
DW	2.041		2.016		2.038	
P vaue for LM	0.0429		0.0001		0.0033	
N	299	299	299	299	299	299
Adj R^2 / wald X^2	0.4013	291.44	0.3401	198.55	0.4688	360.46
Coefficient estimates	OLS	ARCH	OLS	ARCH	OLS	ARCH

Table 4 shows that VIX INDEX is negatively related to Dow Jones, NASDAQ, and S&P500 indices, indicating that these stock indices incline to fall as VIX INDEX rises. Eventually, the results imply that stock indices are likely to fall when investors feel panic.

In Table 2, as VIX INDEX jumps a relatively high point in a day or as the value of VIX INDEX is located at a rather high level, investors would make profits in five days. However, the above results are not shown even reversed in a month, which is somewhat consistent with that VIX INDEX negatively affects these indices by using monthly data in Table 4. In other words, Table 2 indicates that short-term investments, such as holding a few days instead of holding a month, would be appropriate when VIX INDEX jumps a relatively high point in a day or the value of VIX INDEX is located at a rather high level due to short-term overreaction and long-term mean reversion.

3.3 Summary of Empirical Results

In this study, we explore the immediate subsequent performance of several stock indices, including Dow Jones, NASDAQ, and S&P 500, after VIX INDEX jumps a relatively high point in a day as well as when the VIX INDEX value is located at a relatively high level. The results show that subsequent returns of these indices would be enhanced in the short run due to stock price overreaction. Nevertheless, the results might not last in the long run, which might ensue from mean reversion.

Furthermore, while employing monthly data, we reveal that VIX INDEX would be negatively related to the stock index performances of Dow Jones, NASDAQ, and S&P 500. However, by using daily data, we argue that contrarian strategies might be appropriate for investors in the short run as VIX INDEX jumps high points in a day or when the VIX INDEX value is located at a high level in a day. We infer that stock indices generally decline significantly as VIX INDEX sharply rises. Nevertheless, due to the effect of stock market overreaction, the stock indices might be over under-evaluated and would rebound right after the VIX INDEX jumping rather high points in a day.

In this study, we suggest that investors might observe the movement of VIX INDEX, such as VIX INDEX jumping a relatively high point in a day or VIX INDEX located at a rather high level, because these phenomena might not be occurred at random. As a matter of fact, we argue that investors might trade index futures or ETF of these stock indices right after these phenomena released since history often repeats itself.

4 Conclusions

We investigate the subsequent performance of several representative indices, including Dow Jones, S&P 500, and NASDAQ index, when either VIX INDEX jumps a relatively high point in a day or the value of VIX INDEX is located at a relatively high level. Since the above issue seems rarely explored in the relevant studies, we argue that these issues merit investigation because VIX, as an indicator of investor sentiment, might affect movements of stock indices.

This study contributes to the existing literature in several aspects. First, we further explore whether investors can make profits through the deliberate use of VIX. Second, we argue that the results revealed via the use of daily data might be interpreted by overreaction in the short run but mean reversion is likely to be demonstrated afterward. Third, we reveal conflicting outcomes, that is, VIX INDEX negatively affects stock index with the use of monthly data as investors employ VIX INDEX in investments, or the stock index would rise immediately after VIX INDEX jumps a relatively high point in a day. Four, we accomplish the technical achievement for generating the empirical results as shown in Table 2 and Table 4 by utilizing the models to calculate the numerous subsequent performances of stock indices after VIX index rises over different points in a day.

Due to VIX INDEX values revealed in 1990, we collect daily VIX INDEX data over the period 1990 to 2014. Thus, the samples accorded with the condition that either VIX INDEX jumps a relatively high point in a day (i.e. $\Delta VIX \geq 10$ and $\Delta VIX \geq 7.5$) or the VIX INDEX is located at a rather higher level ($VIX \geq 60$) would be limited, which might be a limitation of this study. However, the positive results still appear when $\Delta VIX \geq 5$ and $VIX \geq 40$ due to the evidence of abundant samples.

References

[1] S. Mayhew, C. Stivers, Stock return dynamics, option volume, and the information content of implied volatility, Journal of

Futures Markets: Futures, Options, and Other Derivative Products 23(7)(2003) 615-646.

[2] P. Carr, L. Wu, A tale of two indices, The Journal of Derivatives 13(3)(2006) 13-29.

[3] R.E. Whaley, Understanding the VIX, The Journal of Portfolio Management 35(3)(2009) 98-105.

[4] M. Copeland, T. Copeland, VIX versus size, Journal of Portfolio Management 42(3)(2016) 76-83.

[5] Y.W. Lee, Z. Song, S. Bear, When do value stocks outperform growth stocks? Investor sentiment and equity style rotation strategies, Investor Sentiment and Equity Style Rotation Strategies (2003).

[6] B.V. De Melo Mendes, V. R. Brandi, Modeling drawdowns and drawups in financial markets, Journal of Risk 6(3)(2004) 53-70.

[7] L. Menkhoff, L. Sarno, M. Schmeling, A. Schrimpf, Carry trades and global foreign exchange volatility, The Journal of Finance 67(2)(2012) 681-718.

[8] A. Saha, B.G. Malkiel, A. Rinaudo, Has the VIX index been manipulated?, Journal of Asset Management 20(1)(2019) 1-14.

[9] S. Zhu, Q. Liu, Y. Wang, Y. Wei, G. Wei, Which fear index matters for predicting US stock market volatilities: Text-counts or option based measurement?, Physica A: Statistical Mechanics and its Application 536(2019) 122567.

[10] T. Dimpfl, S. Jank, Can Internet Search Queries Help to Predict Stock Market Volatility?, European Financial Management. 22(2)(2016) 171–192.

[11] L. Ruan, Research on Sustainable Development of the Stock Market Based on VIX Index, Sustainability 10(11)(2018) 4113.

[12] C. Liang, Y. Wei, Y. Zhang, Is implied volatility more informative for forecasting realized volatility: An international perspective, Journal of Forecasting 39(8)(2020) 1253-1276.

[13] J.E. Zhang, Y. Zhu, VIX futures, Journal of Futures Markets: Futures, Options, and Other Derivative Products 26(6)(2006) 521-531.

[14] M.M. Copeland, T.E. Copeland, Market timing: Style and size rotation using the VIX, Financial Analysts Journal 55(2)(1999) 73-81.

[15] N.P. Bollen, M.J. O'Neill, R.E. Whaley, Tail wags dog: Intraday price discovery in VIX markets, Journal of Futures Markets 37(5)(2017) 431-451.

[16] T. Feldman, A. Jung, VIX Christmas effect, The Journal of Alternative Investments 20(2)(2017) 65-75.

[17] J.D. Farmer, S. Joshi, The price dynamics of common trading strategies, Journal of Economic Behavior & Organization 49(2)(2002) 149-171.

[18] M. Aravind, Contrarian and momentum strategies: An investigation with reference to sectoral Portfolios in NSE, The Quarterly Journal of Economics 29(1)(2016) 102-117.

[19] C.C. Liao, Momentum trading, contrarian trading and smart money manipulation, International Business Research 10(2)(2017) 53-62.

[20] D. Duxbury, S. Yao, Are investors consistent in their trading strategies? An examination of individual investor-level data, International Review of Financial Analysis 52(2017) 77-87.

[21] A.C.W. Chui, S. Titman, K.C.J. Wei, Individualism and momentum around the world, The Journal of Finance 65(1)(2010) 361-392.

[22] C. Stivers, L. Sun, Cross-sectional return dispersion and time variation in value and momentum premiums, Journal of Financial and Quantitative Analysis 45(4)(2010) 987-1014.

[23] C.S. Asness, T.J. Moskowitz, L.H. Pedersen, Value and momentum everywhere, The Journal of Finance 68(3)(2013) 929-985.

[24] R. Novy-Marx, Is momentum really momentum?, Journal of Financial Economics 103(3)(2012) 429-453.

[25] G. Dissanaike, K.H. Lim, The sophisticated and the simple: the profitability of contrarian strategies, European Financial Management 16(2)(2010) 229-255.

[26] A.Y. Lin, P. Swanson, Contrarian strategies and investor overreaction under price limits, Journal of Economics and Finance 34(4)(2010) 430-454.

[27] M. Malin, G. Bornholt, Long-term return reversal: Evidence from international market indices, Journal of International Financial Markets, Institutions and Money 25(2013) 1-17.

[28] Y. Yao, Momentum, contrarian, and the January seasonality, Journal of Banking & Finance 36(10)(2012) 2757-2769.

[29] W.F.M. De Bondt, R. Thaler, Does the stock market overreact?, The Journal of Finance 40(3)(1985) 793-805.

[30] T.G. Bali, K.O. Demirtas, A. Hovakimian, Corporate financing activities and contrarian investment, Review of Finance 14(3)(2010) 543-584.

[31] L. De Haan, J. Kakes, Momentum or contrarian investment strategies: Evidence from Dutch institutional investors, Journal of Banking & Finance 35(9)(2011) 2245-2251.