Volatility in Chinese and European Stock Markets under the "black swan" of the Russia-Ukraine War - An Empirical Test based on the GARCH Family Models and Investor Sentiment

Qingchuan Du

Taiyuan University of Technology
Mechanical and Transport Engineering
**Corresponding author. Email: duqingchuan3455@link.tyut.edu.cn*

ABSTRACT

The financial markets in Central Europe were shaken violently in February and March 2022 by the Russian war in Ukraine. In the background, the paper uses GARCH to model and research, figuring out how volatility characteristic shocks to financial markets from war. The paper specifically estimates the GARCH model parameters and validates the model with the stock market performance in February and March. Besides, the paper finds that the investor's sentiment will create a positive feedback mechanism on the share price, increasing the volatility. The results indicate that the incident resulted in more dramatic fluctuations in the stock markets in China and European. According to the research, the paper presents some recommendations: improve the financial market information disclosure system, market supervision system and laws and regulations; strengthen capital supervision and cultivate a rational capital market.

Keywords: *Black Swan Events, GARCH Model, Financial Fluctuations, Investor's sentiment, Stock Market*

1. INTRODUCTION

Extreme financial events are generally considered to be "black swan" events with a very low probability of occurrence and are ignored by mainstream research. But in fact, it will happen at any time and any place. In the early morning of February 24, Russian President Vladimir Putin made a televised speech indicating his decision to launch a special military operation in the Donbas region, which influenced financial and industrial capital in China and the world. The war was sudden and a typical "black swan" event. In today's highly globalized world, the interdependence of global financial markets has constantly increased, so that financial market volatility in one region can quickly spread to other regions. The risk of resonance in financial markets is heightened. The SSE Index and Hang Seng Index, suffered a large drop. Besides, British, French, and German stocks fell across the board.

This paper presents an empirical modeling and econometric analysis of stock market volatility trends in China and Europe in the aftermath of the epidemic, intending to further quantify the impact of a major emergency event such as the new crown epidemic on the European and Chinese stock markets. After reviewing the literature relevant to this paper, the following section discusses the GARCH models and how black swan events are formed. Then the paper will discuss what could be done to minimize the negative impact on the stock market.

2. THEORETICAL MODEL OF GARCH

Bollerslev proposed a useful generalized form, called the generalized ARCH model [1]. For a log return serious r_t , let $\alpha_t = r_t - \mu_t$ be the innovation at time t, then α_t follows a GARCH (m, s) model:

$$a_t=\sigma_t \in_t, \text{ and } \sigma_t^2=\alpha_0+\sum_{i=1}^{m}\alpha_i \alpha_{t-i}^2 + \sum_{j=1}^{s}\beta_j \sigma_{t-j}^2 \quad (1)$$

There are several conditions, $\{\in_t\}$ is a sequence of iid random variables with mean 0 and variance 1.0, $\alpha_0>0$, $\alpha_i \geq 0$, $\beta_j \geq 0$, To ensure that the GARCH model is weakly smooth, so that $\sum_{i=1}^{\max(m,s)}(\alpha_i + \beta_j)<1$ [2].

The strengths and weaknesses of the GARCH model can be seen in the analysis of the simplest GARCH (1,1) model. Firstly, it shows the famous 'volatility

Y. Jiang et al. (Eds.): ICEDBC 2022, AEBMR 225, pp. 1464–1470, 2022.
https://doi.org/10.2991/978-94-6463-036-7_217

aggregation' phenomenon in financial time series when there is a bigger α_{i-1},and then it will be followed closely by α_i .

Secondly, it was proved that the tails of the GARCH (1,1) process distribution are thicker than the tails of the normal distribution. Thirdly, this model gives a simple parametric function to describe the evolution of volatility. The latter paper focuses on an empirical analysis of the volatility trends in the European and Chinese equity markets in the context of the new crown epidemic based on the GARCH model. [3]

3. THE IMPACT OF BLACK SWAN EVENTS IN HISTORY

Black Swan events are rare events and their occurrence is random [4]. An unknown risk shocks existing perceptions and is unpredictable but can be averted by observing the signals leading up to its arrival, emphasizing that prevention of black swans is more important than reacting to them afterward. Domestic and international research on "black swan" events has focused on the extent of the impact of unexpected events on the stock market. Whether it is a natural disaster or a man-made event, research findings consistently show that unexpected events have different degrees of impact on the stock market [5]. China's 2003 SARS epidemic had a short-term and limited impact on the Chinese stock market[6]. However, the impact of the 2008 Wenchuan earthquake on the stock market was gradual and persistent. There is the same conclusion with man-made emergencies. In the eyes of a Chinese scholar, the black swan is a small probability event. According to Xuemei Yu [7], small-probability events have three characteristics: firstly, the probability is extremely low but does not mean that they do not occur; secondly, they are sudden; thirdly, the dual nature of development and extinction.

Another essential reason causing black swan is Investor sentiment [8]. Rao Yulei et al. [9] argue that investor sentiment is a bias in stock market expectations due to the limitations of investors' quality. From the perspective of investor expectations, Baker et al [10] argue that investor sentiment is a belief formed by investors' self-weighting of future risks and returns. If people feel panic, they have negative attitudes toward the stock market, and prices fall. However, if people find out that they have overreacted to the bad situation, then they will regain confidence in the stock market, and stock prices will rebound. But this belief does not fully reflect current facts. It shows that Investors' systematic bias in expected stock returns due to insufficient information and their Systematic bias in investors' expected returns on equities due to insufficient information and their own psychological perception bias. And it will make some white noise in the stock market. In some situations, investors' wrong decisions can greatly affect the direction of the stock market.

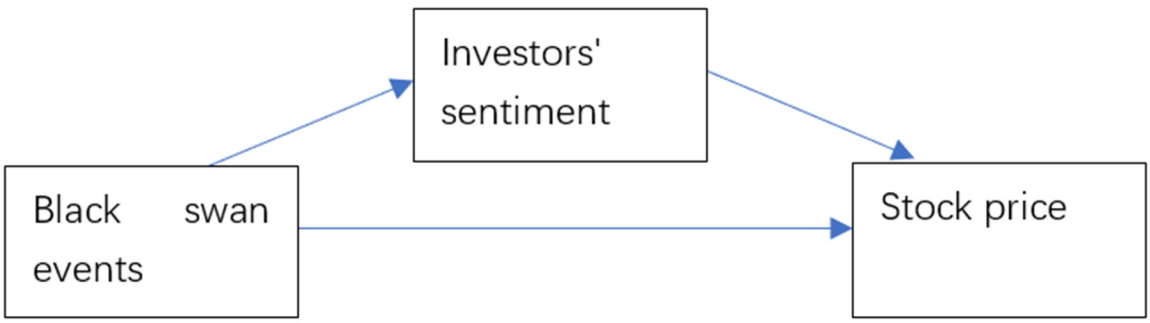

Figure 1. Mode of influence

Considering the historical impact on the stock market, most of them had some negative influences, like continuing downturn in the stock market, the mass exodus of capital, etc. The black swan events can't be forecasted, but after the events, how to avoid this crisis is the subject of this paper.

4. MODELLING THE VOLATILITY CHARACTERISTICS OF CHINESE AND EUROPEAN STOCK MARKETS UNDER THE RUSSIAN-UKRAINIAN WAR.

4.1. Data selection

People commonly use the daily data to study the volatility in the stock market. The period of this study was February 9 to March 11, 2022. This period was selected for specific reasons. According to the news, the war began on February 24, 2022, so the paper chose 15 days before and 15 days after the outbreak of the war. The war is still going on, and it can't forecast when it will end. [11]

The additional reason that the author selects this period is that he is particularly interested in what happens after the "black swan" event mentioned in the introduction. There is a massive drop in value, on February 24, 2022.

Figure 2. SSE Closing Price

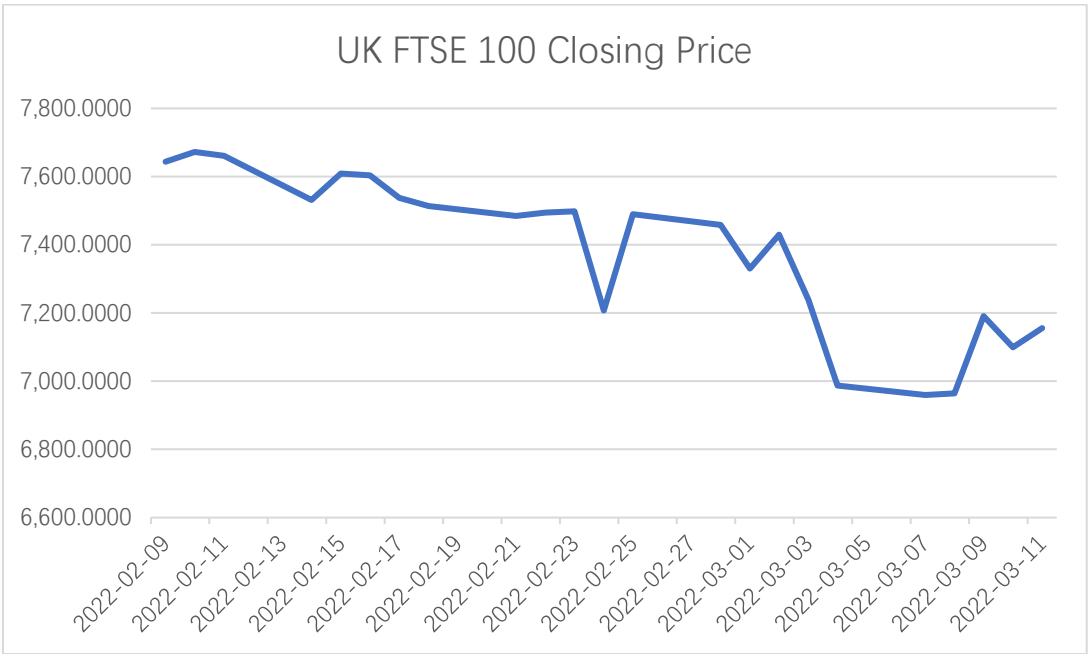

Figure 3. UK FTSE 100 Closing Price

After modeling the data using EViews software, the arch effect was found not to be significant. Therefore, a longer time frame of 9/01/2021 to 3/25/2022 has been chosen for this paper.

4.2. Descriptive analysis of equity index returns

In this paper, the author uses the logarithmic stock index return (R_t) as an indicator to examine the volatility characteristics of the stock market and construct the following formula.

$$R_t=\ln(p_t)-\ln(p_{t-1}) \quad (2)$$

The above equation $\ln(p_t)$ and $\ln(p_{t-1})$ represents the closing price of the index on day t, t-1 respectively. The data comes from the Choice Financial terminal.

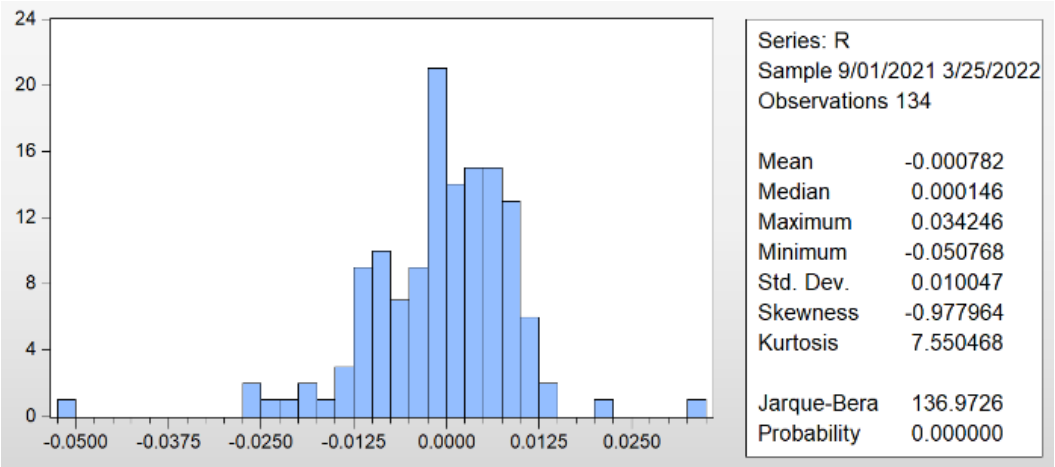

Figure 4. Various figures for log returns

According to the Figure 4, the skewness is -0.977964, which means there is a left bias characteristic. The Kurtosis is 7.550468, higher than 3. As a result, the return series of the SSE index is characterized by a distinctly "spiky, thick-tailed" distribution, rather than a normal distribution. In addition, the standard deviation of the index is also small, further implying possible clustered volatility. In addition, an ADF unit root test was performed on the stock index series of the SSE index, and the results showed that R_t serials are stable. The paper then performs serial autocorrelation and partial autocorrelation tests.

4.3. GARCH model empirical test

The result shows that R_t has no significant relevance. The mean-variance is therefore set to white noise. Then, De-averaging R_t, and the author gets w. Establish the squared equation for w and test the squared correlation plot for the residuals. As Figure5 shows, sequences are autocorrelated, so there is an ARCH effect.

Sample: 9/01/2021 3/25/2022
Included observations: 134

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.507	0.507	35.260	0.000
		2	0.137	-0.162	37.842	0.000
		3	0.016	0.025	37.879	0.000
		4	0.030	0.044	38.007	0.000
		5	0.107	0.096	39.610	0.000
		6	0.122	0.025	41.738	0.000
		7	0.043	-0.048	42.006	0.000
		8	-0.004	0.008	42.009	0.000
		9	-0.017	-0.011	42.048	0.000
		10	-0.027	-0.032	42.158	0.000
		11	-0.026	-0.015	42.260	0.000
		12	-0.015	0.004	42.292	0.000

Figure 5. Autocorrelation and Partial Correlation

The paper uses the GARCH (1,1) model to forecast the future stock price. The mean value model is

$$R_t = -0.000289557879694R_{t-1} + \mu_t \quad (3).$$

Covariance equation is:

$$\sigma^2 = 3.83261304134\times10\text{^-}5 + 0.347828328249\mu_{t-1} + 0.229133450925\sigma^2_{t-1} \quad (4)$$

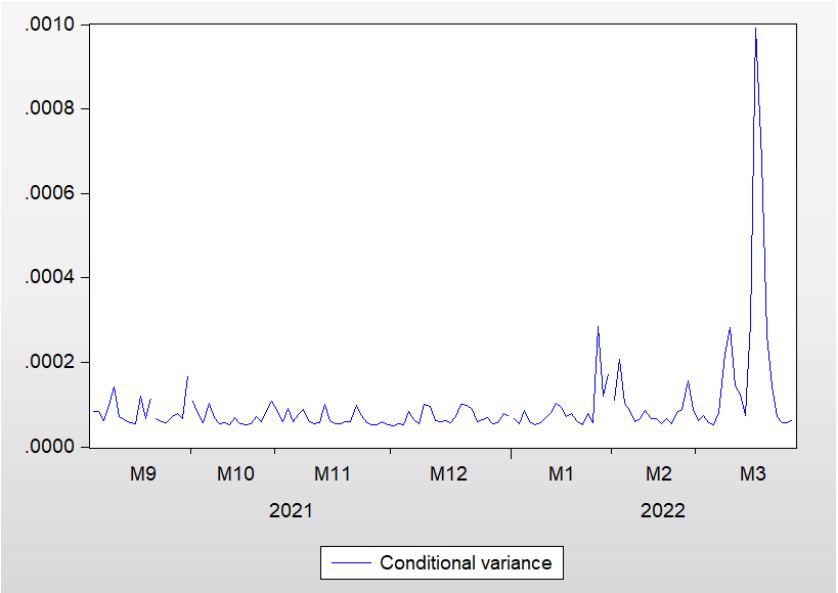

Figure 6. Conditional variance

Figure 6 shows that the conditional variance series of the SSE began to fluctuate up and down in mid-February. and peaked in late February with a conditional variance close to 0.01.

This suggests that the impact of the epidemic on the Chinese equity market starts at the end of February 2022, with more volatile fluctuations. The war exacerbated the volatility of the stock market to a greater extent. Also, the war made the European stock market fluctuate up and down. Here the paper will not show the data due to the space limitation.

5. DISCUSSION AND RECOMMENDATIONS

5.1. Discussion

Black Swan events cannot be predicted but can be prevented. Due to a lack of information about them, sampling bias and cognitive bias make it easy to underestimate or even ignore black swan events. This is inherent in the unexpected nature of Black Swan events and makes them impossible to predict. But people can learn from the past black swan incidents and use the correct GARCH model to guess reasonably how things will go on after the unexpected happens.

A Black Swan event can have a negative short-term impact on the share price of the listed company affected by the event, and investor sentiment can further exacerbate the impact of the event on the share price. The negative black swan event will first cause the share price to fall, and then the fall in share price within the market will generate bearish investor sentiment. As a result of the contagion effect, multiple bearish changes in investor sentiment can cause share prices to fall further, and can ultimately have an extreme impact.

5.2. Recommendations

The construction of the information disclosure system, market supervision system, laws and regulations in our financial market is not perfect. Compared with developed countries in Europe and the United States, the information disclosure of listed companies in China is not sound, which leads to investors not being able to obtain perfect information about the company. In addition, China's stock market has been developed for a short period. A systematic and perfect regulatory system has not yet been formed, which can lead to the emergence of speculators in the market, avoiding market regulation to buy and sell assets for profit. Therefore, it is necessary to improve the financial market information disclosure system, market supervision system, and laws and regulations to regulate market transactions, reducing the probability of a Black Swan event. While accelerating capital market reform, governments need to strengthen the regulation and monitoring of capital, improve the institutional reform of the capital market, and slow down the pace of opening up the capital market to the outside world. It also needs to reduce the influence of external markets on China's stock market and market sentiment, and cultivate rationality in the capital market.

For investors, whatever kinds of black swan events happen, they are in an unfavorable location for taking information. In the case of that, investors should enhance their abilities to get information and their degree of expertise. On the other hand, investors should analyse the situation rationally and realize the role of self-sentiment in influencing share prices. The unexpected nature of a black swan event means that it is impossible to predict, and to reduce losses in the event of a black swan, precautions need to be put in place in advance. Therefore, investors can also build in redundancies to enhance their

ability to cope with risk and can use the 'barbell strategy' as a guideline for dealing with black swans.

6. CONCLUSION

In this paper, the daily closing prices of the Shanghai Stock Exchange Index and the UK FTSE 100 from February 9 2022 to March 11 2022 are selected as representative samples to study the volatility characteristics of stock returns in the Chinese and European stock markets by using a GARCH model. Through analysis, the author finds that black swan events about wars have had a negative impact on the stock market in the short term; in the aftermath of the Black Swan, some of the reasons for further market turmoil were attributed to a blind lack of confidence in investor sentiment towards the market. Therefore, governments should strengthen risk monitoring in financial markets to minimize "herding effects" and “overreaction”. Besides, it should improve capital market institutional development, weaken outside market interference and market sentiment aspects of China's stock market, and cultivate capital market rationality.

The war between Russia and Ukraine started recently and hasn't ended yet. But as the readers can see, the paper has done some research about the black swan events in history. The war hasn’t shown its whole effect on the global market. Only after the event ends, people could figure out it. Future research could collect more data over a broader period of time, to verify how the model works.

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