

“Chemical Reaction” Between Extreme Weather and Stock Market

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Abstract: Weather plays quite an important role in our daily life, so what interests us most is whether there is a certain relationship between extreme weather and the stock market. This paper takes the meteorological data of Shanghai Hongqiao from 2019 to 2021 and the trading volume of the Shanghai Stock Index within the same time as the research object and uses STATA data analysis software and sample linear regression analysis methods to study the weather factors' mechanism of action on the stock market trading. Through the verification of regression analysis and the application of behavioral finance theory, we find that although extreme weather is extremely destructive to production and life, it does not have the expected negative effect on the stock market.

Keywords: weather effect, stock market, behavioral finance

1. Introduction

Hundreds of years ago, before computers were widely used, foreign countries established market maker rules to improve stock liquidity and stabilize the stock market. These traditional and time-honored capital market trading mechanisms mean that legal persons with a certain strength and reputation act as market makers, constantly provide investors with buying and selling prices, accept investors' requirements according to the prices they provide, and trade with investors with their funds and securities, thus providing immediacy and liquidity for the market. And through the bid-ask spread to achieve a certain profit. In simple terms: by allowing traders to match buy and sell orders in an open bidding process in a trading pool, buyers and sellers can buy or sell at that price without waiting for a counterparty to appear.

The existing research always chose the capitalist market as the main object to explain the relationship between weather and stock trading behavior, such as the NYSE stock price formation is given priority to with market makers quotation, because of the Manhattan district focus of the world's leading financial institutions and investors, these market makers offices also concentrated near Manhattan, So it's easy to argue that the bid-offer behavior of market makers is affected by the weather in Manhattan.

However, the stock exchanges in mainland China were established relatively late, and have fully adopted the electronic order-driven trading system from the very beginning. At present, securities and futures trading adopts the bidding trading system -- investors transmit the buy and sell orders to the

exchange through the network, and the computer host of the exchange matches the buy and sell orders according to the principle of time priority and price priority.

By reviewing literature and materials, there is still a lack of scientific and rigorous conclusions on the relationship between weather and stock trading in mainland stock exchanges. The reason is that in addition to the late start and short course of development of stock trading in China, in the OR driven trading system, if weather affects stock trading, stock trading should reflect the weather conditions of all parts of the country. The huge difference between stock price formation mode and foreign countries makes it impossible for us to learn from the existing research results of foreign financial markets in the early stage.

The research seeks to explore whether extreme weather can have an impact on the stock market, and whether it can be quantitatively studied with data. If we can dig out the relationship between extreme weather and changes in the stock market, it will be of great help to our research on the stock market, help to control market risks, protect small and medium investors, and further enrich the theory and practical application of behavioral finance.

2. Literature Review

In the environment in which we live, the weather, as an important part of the atmospheric environment, has a great impact on our life and production activities. Any significant change in the weather can affect our production plan and the consequences of life. Weather and people's mood are always closely related. In our daily life, believe that everyone has this experience, when the weather is sunny and bright, our mood also follows up. On the contrary, we always feel tired and depressed on rainy days.

Cunningham, M. R [1] conducted field studies on the relationship between weather variables to people's helping behavior. The results profoundly demonstrate the relationship between people's willingness and the amount of sunshine reaching the earth. Smaller relationships were also found between helping and temperature, humidity, wind velocity, and lunar phase. Howarth, E. and Hoffman, MS [2] focused on the weather variables including hours of sunshine, precipitation, temperature, wind direction, wind velocity, humidity, change in barometric pressure, and absolute barometric pressure. The experiment showed that humidity, temperature, and hours of sunshine had the greatest effect on mood. Although there are some differences in the selection and division of weather indicators and emotion indicators, most of the studies have verified that there is a certain connection between different elements of weather and human emotions in the conclusion.

In the past, the theory of capital asset pricing was the mainstream thought of the fiscal session, which presented the actor as a rational person in a complete sense. Such a rational person not only has rationality but also can use rationality to the situation and compare according to the cost and income, to decide to maximize utility. However, with the continuous development of behavioral finance theory research, more and more trading behaviors can be explained by people's psychological changes.

Academically, there has not been a unified definition of investor sentiment. For example, Baker and Stein [3] believed that the definition of investor sentiment was a misestimation of the future fundamental value of assets. Barberis et al. [4] argued that investor sentiment is the wrong prior belief of investors on future returns. Han [5] defined investor sentiment as the overall error of investor belief. Now, the definition of investor sentiment proposed by Baker and Wurgler [6] is the most widely accepted. They defined investor sentiment as "the investor belief that does not judge the future cash flow and risks based on reasonable facts in hand".

But in the field of behavioral finance, what will affect people's psychological factors has become the most noteworthy topic. And investor sentiment is regarded as the decisive factor in asset prices by more and more people. Saunders [7] pioneeringly studied the relationship between cloud coverage

in Manhattan and the New York Stock Exchange (NYSE) and found a significant negative relationship. Since then, the relationship between weather and the stock market has attracted extensive attention from scholars. According to Hirshleifer, D., and Shumway, T. [8], sunshine is significantly correlated with stock returns after examining the relationship between morning sunshine in the city of a country's leading stock exchange and daily market index returns across 26 countries from 1982 to 1997. After drawing on literature from the fields of decision-making and economic psychology, Lucey B and Dowling M [9] discussed the misattribution of environmental factors, such as weather, and the influence of the image projected by equities on investor feelings and, in turn, investor decision-making. Daniel K et al. [10] tried to utilize Ensemble Empirical Mode Decomposition (EEMD) to explore the correlations between investor sentiment and stock index and macro economy, as well as the prediction capacity of the short-term fluctuation, medium-term fluctuation, and long-term trend of investor sentiment in the future stock market return. They all proved that when people are in a good mood, they tend to be more optimistic about the future and that their risk tolerance is strengthened. Jacobsen, Ben, and Wessel Marquering [11] found that temperature level does not explain the market returns movements, but influences the irrational behavior of the market. Suleyman et al. [12] demonstrated that the level of cloudiness and temperature were influential on investor behaviors. Kathiravan and Chinnadurai [13] selected three influencing factors including temperature, humidity, and wind speed, and found that different factors recorded a statistically significant influence on the returns of different indices. It was Peillex, Jonathan, et al. [14] who observed the negative association between maximum daily temperatures and trading volumes by analyzing the trading volumes on the French stock market on days when the weather in Paris is excessively hot over the period 1995-2019.

After the in-depth study of scholars, the linkage relationship between weather and investors' decisions has become a consensus, that is, the change in weather will bring about a change in people's mood, resulting in the bias of decision making, thus causing an impact on trading behavior.

Aiming to explore whether and how extreme weather can affect investors' moods and trading behavior, even cause stock market volatility, this paper provides a synthesis of the previous research on the influence of mood on investor stock market, then develops a linear regularized model to prove the hypothesis by applying statistical tools and data. Generally, the study does contribute to the behavioral finance literature. Also, the findings of this study could help investors in making better investment management decisions.

3. Hypothesis

Based on the study and analysis of previous literature of scholars, we have sufficient reasons to believe that extreme weather will affect investor sentiment, and then drive abnormal trading in the entire stock market, which is represented by abnormal trading volume and abnormal rise and fall. Therefore, we propose to establish unitary linear models of stock trading volume, Stocks that rose or fell in absolute terms, and whether the day is extreme weather, respectively, to determine the quantitative relationship between the two variables. Before data validation, we propose hypotheses.

Hypothesis 1: There is a unitary linear relationship between stock trading volume and whether extreme weather occurs. When extreme weather occurs on the same day, stock trading volume will significantly decrease.

Hypothesis 2: There is a unitary linear relationship between the amount of increase and amount of decrease and whether it is extreme weather. When extreme weather occurs on that day, the rise and fall of stocks will increase abnormally.

4. Data

4.1. Data Selecting

As we all know, mood, as a kind of subjective emotion, is difficult to describe by data. How to accurately measure investor sentiment becomes the key to investor sentiment research, the construction of quantifiable indicators particularly important.

The existing literature has established several different measures of investor sentiment. The first is a traditional index based on direct subjective surveys by researchers, such as the University of Michigan Consumer Sentiment Index and the UBS/GALLUP Index of Investor Optimism. Such indices are straightforward but costly in terms of manpower, materials, and construction. The second way is an indirect method to measure investor sentiment, using proxy variables such as market trading volume, closed-end fund discount, IPO first-day returns, and IPO issuance quantity. However, such indicators are always the result of many economic forces, thus the noise in such variables may profoundly affect the results of empirical research. In addition, with the vigorous development of Big Data, data mining technology and other emerging technology is also more and more widely applied in the study of investor sentiment. A more objective, real-time, high-frequency, and precise emotion measurement index is synthesized by extracting investor emotion from network user behavior.

After the statistics and comparison of the stock trading amount of the Shanghai Stock Exchange in previous years, we find that the trading volume initiated by the securities business department located in Shanghai accounts for the majority of the total trading volume. Although not all the trading orders of the Shanghai Stock Exchange come from the Shanghai area, the local weather in Shanghai can indeed affect the stock market. Therefore, we choose the weather conditions and stock trading volume in Shanghai as the research objects.

4.2. Data Source

The weather data used in this study are from <https://rp5.ru/>, covering the weather data of Shanghai Hongqiao Airport meteorological station from 2019 to 2021, including precipitation, wind speed, temperature, visibility, and so on. Meanwhile, the trading volume of the Shanghai Composite Index in the same period was collected from Yahoo Finance website as the research object.

4.3. Data Processing

The paper is based on "precipitation greater than 15mm in 12 hours or precipitation greater than 25mm in 24 hours. More than 3.0mm snow within 12 hours or more than 5.0mm snow within 24 hours or 50mm snow depth. The maximum temperature of the day is above 35°C or the minimum temperature is below 5°C. The wind scale is greater than level 7, that is, the wind speed is greater than 13.9m/s ", to determine whether the day belongs to the category of extreme weather. If the weather conditions of the day meet one or more of these criteria, then they are classified as extreme weather.

4.4. Empirical Analysis

Stata software was used to analyze the regression between extreme weather data and the trading volume of the SSE index.

Table 1:Linear regression.

AMOUNT	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
extremeweather	-.259	.158	-1.64	.101	-.57	.051	
Constant	1.87	.105	17.88	0	1.665	2.076	***
Mean dependent var		1.757		SD dependent var		2.161	
R-squared		0.004		Number of obs		757	
F-test		2.691		Prob > F		0.101	
Akaike crit. (AIC)		3315.163		Bayesian crit. (BIC)		3324.422	

*** p<.01, ** p<.05, * p<.1

4.5. Analysis of Regression Results

As can be seen from the above figure, we can see that the sample size is 757, containing the data of all trading days from 2019 to 2021.

In the unitary linear relationship between stock trading volume and extreme weather, the regression results of Stata software output showed that the R2 between stock trading volume and extreme weather was 0. F value was 0.01, Prob>F=0.9356; The t value of the variable is 0.08. The above data indicate that the unary linear model cannot fit the relationship between stock trading volume and extreme weather well. By constructing a unitary linear regression model, we cannot obtain direct evidence to strongly prove that there is a unitary linear relationship between stock trading volume and whether the weather is extreme on the day, so null hypothesis 1 is not valid.

In the unitary linear relationship between stock fluctuation and extreme weather, the regression results of STATA software showed that the R2 between the absolute value of stock fluctuation and extreme weather was 0.0036. F value was 2.69, Prob>F=0.1014; Variable t value is 1.64, $P > |t| = 0.101$, the above data shows that constructing a unitary linear regression model can't better fitting of the relationship between stock price and extreme weather. By constructing a unitary linear regression model, we cannot obtain direct evidence to strongly prove that there is a unitary linear relationship between stock fluctuation and extreme weather on the day, so null hypothesis 2 is not valid.

5. Conclusion

For thousands of years, human beings have lived in a suitable living environment on the earth, and the survival and reproduction of human beings are closely related to the atmospheric environment. In previous studies, weather can always affect people's moods and affect the decision-making behavior of investors. But through data collecting, processing and researching, we found that extreme weather, including high temperature, low temperature, and strong wind, do not play a significant role in stock trading volume and the amount of increase and decrease. By comparing the trading behavior under the market maker system and the order-driven system, it is found that the trading volume in the domestic and foreign stock markets to the weather change is quite different. Therefore, we attribute the reason to the characteristics of the trading system mode. In foreign market makers' markets, bid and bid quotes are provided by market makers in almost the same region, so local weather indirectly affects stock market trading through its effect on the sentiment of these participants. On the contrary, the Shanghai stock exchange is an order-driven trading system, the potential trade order is submitted directly by the scattered investors, although the Shanghai stock exchange stock trading across the country has an advantage, it is not enough to significantly affect the whole stock market, so the interpretation of stock market trading volume change ability is weak. In addition, extreme weather is a transient weather phenomenon that has less persistence in affecting people and therefore less impact

on mood and behavior. And, with the advancing science and technology of human society, the prediction of time by people is increasingly accurate. The timely forecasting of extreme weather and the implementation of preventive measures reduce the fear of extreme weather, at the same time, the impact of extreme weather on people is effectively controlled. While extreme weather is a bad event in itself, it has little impact on the stock market.

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