

Weather Impacts on Trading Volume

—Evidence from Hang Seng Index

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Abstract—Weather impacts on stock returns have been explored by previous studies. However, trading volume has not been noticed too much. We believe it is important to test the relationship between weather phenomena and trading volume, since stock return and volatility do not fully reflect the trading activities. In particular, trading volume can additionally represent for adventurous activities. In this paper, we investigated the effect of daily weather from 2002 to 2015 on the 3,398 data points for Hang Seng Index volume. To test the hypothesis, we use linear regression model to analyze the weather and trading volume data. The results indicate that range of weather factors are significantly correlated with trading volume in Hong Kong stock market. These results are not in line with market efficiency since people's trading volume is significantly influenced by weather rather than fundamental analysis.

Keywords—Behavioural Economics; Weather; Trading Volume; Hong Kong

I. WEATHER, MOOD AND ECONOMICAL DECISIONS

Behavioral economics theory challenged the market efficiency [1], since some market anomalies have been found, such as disposition effect [2], herding behaviors [3] etc., which are against the market efficient hypothesis. Therefore, it is not surprising that if people's trading activities could be influenced by surrounding factors rather than fundamental analysis. In particular, weather is a type of environmental variable, which could lead to individuals' irrational trading activities.

Previous studies have established a link between weather and mood. For example, good weather factors, such as less cloudy cover, lower wind speed, less precipitation or lower relative humidity could significantly induce individuals' mood [4]. In contrast, bad weather factors, such as sky overcast, rainfall etc. could bring bad mood [5]. In addition, it has been demonstrated that mood could influence people's decision-making [6]. Therefore, some studies established a link between weather and decision-making via mood as the chain. For example, rainfall could lead to more accurate decision [7], while higher temperature could result in violence behaviors [8].

The link between weather and economics is firstly explored by Saunders' [9], who found that cloudiness is significantly correlated with New York stock return. In addition, Hirshleifer and Shumway [10] investigated 26 international cities and found similarly results that lower cloudy cover induced stock

returns. Furthermore, temperature [11], air pressure [12] etc. are also explored to influence the stock market.

However, the relationship between weather and trading volume has not been explored a lot. Goetzmann and Zhu [13] used individuals data to test the cloudiness impact on five US stock markets and found no correlation between cloudiness and these stock trading volume. It is surprising, since weather should significantly influence individuals' trading volume if weather factors could affect stock return and volatility. More importantly, trading volume is related to risk-taking activities. Therefore, in this paper, we try to explore the relationship between weather and trading volume. Consequently, the hypothesis in this paper is as follows:

H0: Range of weather factors can influence trading volume in Hong Kong Stock Market.

To investigate this hypothesis, we employ the daily weather data and trading volume data from Hong Kong Observatory and Yahoo Finance, respectively, with 14 years period from 2002 to 2015. We use linear regression to analyze the data. After controlling for Monday, January and seasonal patterns, we find that a range of weather factors could significantly influence the trading volume.

The reminder of this paper is organized as follows: Section II is data and methodology. The results are presented in Section III and conclusion is in Section IV.

II. DATA AND METHODOLOGY

A. Weather data and Independent

We employ the weather data from Hong Kong Observatory. The data contains daily weather raw observations, with cloudiness, rainfall, temperature, pressure, wind speed and humidity from 2002 to 2015. These raw weather data are deseasonalized by similar method to Goetzmann and Zhu [13]. More specifically, we calculate the monthly mean values of these raw weather variables first. Then we use raw weather variables subtracting by monthly mean values that we just calculated above. This process is called deseasonalized weather variables. The reason we do this is to eliminate the possible issue of multicollinearity, since raw weather factors are highly correlated with each other. Therefore, we deseasonalized 6 main weather variables in this study; as a result, the deseasonalized cloudiness, rainfall, temperature, pressure, wind

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speed and humidity are examined in this study as main independent variables.

B. Controlling variables

Trading volume could be influenced by some factors rather than weather variables. Therefore, we need to control for these possible factors that could influence trading volume, such as Monday, January and seasonal patterns. In particular, we code January as 1 if the trading activities are happened in January, 0 otherwise. Similarly, we code Monday as 1 if the trading activities are happened on Monday, 0 otherwise. In addition, to control for the seasonality, we define the Halloween as 1 if the trading active in summer season and 0 otherwise. Since summer months in Hong Kong is much longer than other countries, we then define summer from April to November, and winter from December to March. The detailed description of independent and controlling variables are illustrated in Tab. I.

TABLE I. DESCRIPTION OF INDEPENDENT AND CONTROL VARIABLES

Variable Type	Variables	Description	Raw Data Unit / Code
Intendent variable	<i>Dcloud</i>	Deseasonalized Cloudiness	Okta 0-9 (No Cloud-Overcast)
Intendent variable	<i>Drain</i>	Deseasonalized Rainfall	Millimeter (mm)
Intendent variable	<i>Dtemp</i>	Deseasonalized Temperature	Celsius (°C)
Intendent variable	<i>Dpres</i>	Deseasonalized Air Pressure	Sea level pressure (hPA)
Intendent variable	<i>Dwind</i>	Deseasonalized Wind Speed	Meter / Second
Intendent variable	<i>Dhum</i>	Deseasonalized Humidity	Humidity %
Controlling variable	<i>Halloween</i>	Halloween Dummy	1 = April to November, 0 otherwise
Controlling variable	<i>January</i>	January effect Dummy	1 = January, 0 otherwise
Controlling variable	<i>Monday</i>	Monday effect Dummy	1 = Monday, 0 otherwise

C. Stock data and dependent variables

We employed the trading volume data from Yahoo Finance, including daily trading volume details from 2002 to 2015. We use Hang Seng Index as my main explanation variable, since Hang Seng index could represent for the movement of Hong Kong Stock Exchange. Moreover, daily trading volume is time serious, and a possible auto regression issue may exist. However, after test the unit root of the data, we do not find this issue, which means the data is stationary to run the regression analysis. Consequently, with 3,398 sample sizes, we run the linear regression model to test the hypothesis as follows:

$$TradingVolume_t = \alpha_t + \beta_1 Dcloud_t + \beta_2 Drain_t + \beta_3 Dtemp_t + \beta_4 Dpres_t + \beta_5 wind_t + \beta_6 Hum_t + \beta_7 January + \beta_8 Monday + \beta_9 Halloween + \varepsilon_t \quad (1)$$

Where:

Dcloud represents for deseasonalized cloudiness

Drain represents for deseasonalized rainfall

Dtemp represents for deseasonalized temperature

Dpres represents for deseasonalized air pressure

Dwind represents for deseasonalized wind speed

Dhum represents for deseasonalized humidity

January represents for January effect dummy

Monday represents for Monday effect dummy

Halloween represents for Halloween effect dummy

III. RESULTS AND DISCUSSION

A. Correlation Test

We firstly exam the correlation between weather factors and trading volume in this study. The results are shown in Tab II. Strikingly, we could find deseasonalized rainfall; wind speed and humidity are negatively correlated with trading volume. These results indicate that there is a relationship between weather variables and trading volume in Hong Kong stock market. In particular, less rainfall, lower wind speed and lower humidity level could normally bring positive mood, which, in turn, decrease trading volume and risk taking activities. These results are consistent with literature, and more detailed analyses will be shown below in discussion section. However, in the correlation test, we cannot find significant relationship between deseasonalized cloudiness, temperature, air pressure and trading volume. To sum up, the correlation examination could bring simple picture of the relationship between weather factors and trading volume. However, more analysis (i.e. regression analysis) is needed to prove the cause-effect relationship between weather variables and trading volume.

TABLE II. CORRELATION TEST OF WEATHER VARIABLES AND TRADING VOLUME

Weather Variables	Trading Volume
Deseasonalized Cloudiness	0.00039
Deseasonalized Rainfall	-0.04361**
Deseasonalized Temperature	-0.00859
Deseasonalized Air Pressure	-0.00401
Deseasonalized Wind Speed	-0.05615***
Deseasonalized Humidity	-0.06310***

***significant at 1% level

**significant at 5% level

*significant at 10% level

B. Regression of Weather impacts on Trading volume

The linear regression results are shown in Tab. III. Strikingly, we can find that almost all weather factors are significantly correlated with trading volume, except deseasonalized temperature. In particular, deseasonalized rainfall, wind speed and humidity negatively influence trading volume, while higher cloudy cover induce trading volume. In addition, air pressure is marginal (at 10% significant level) negatively correlated with trading volume. Furthermore, we could find the controlling variables, January, Monday and Halloween dummies are all significant. In particular, January

and Halloween are positively correlated with trading volume, indicating that people are more likely to trade during January and summer months. In contrast, Monday effect negatively influences trading volume, meaning people do not prefer to trade on Monday. To sum up, we can find from the regression analysis that most weather factors could significant affect trading volume, which could strongly support my hypothesis that range of weather factors can influence trading volume in Hong Kong Stock Market.

TABLE III. RESULTS OF OLS AND LOGISTIC REGRESSIONS (T-VALUES IN BRACKETS)

Variables	Coefficient	Standard Error	t-value
Intercept	-0.2180	0.0723	-3.013***
Deseasonalized Cloudiness	0.0521	0.0123	2.542**
Deseasonalized Rainfall	-0.0521	0.0222	-2.342**
Deseasonalized Temperature	-0.0093	0.0094	-0.991
Deseasonalized Air Pressure	-0.0113	0.0063	-1.804*
Deseasonalized Wind Speed	-0.0509	0.0163	-3.112***
Deseasonalized Humidity	-0.0093	0.0024	-3.851***
January	0.1720	0.0711	2.417**
Monday	-0.1083	0.0438	-2.473**
Halloween	0.1206	0.0418	2.885***

***significant at 1% level

**significant at 5% level

*significant at 10% level

C. Discussion

The results could strongly support the hypothesis, indicating that weather could significantly influence trading volume in Hong Kong. Firstly, we find bad weather conditions, such as higher rainfall, stronger wind and higher humidity reduce trading volume. These results are consistent with psychology literature that bad weather induce bad mood, which, in turn, decrease peoples' estimation of stock market [5]. Therefore, traders do not prefer to buy stock during bad weather conditions, such as rainfall, high wind speed or wet days. However, the result of cloudiness, which is negatively correlated with trading volume, is not in line with the findings of literature [13]. Specifically, Goetzmann and Zhu [13] found no correlation between cloudiness and trading volume, while we find a positive impact of cloudiness on trading volume. As we mentioned, trading volume is a type of risk-taking activity. Therefore, my results indicate a positive impact of cloudiness on people's risk-taking level. A possible reason is because good mood, which induced by lower cloudy cover, could reduce individuals' risk-taking level, since people do not want to lose their good mood [14]. Whatever the reason is, the importance is that we find the weather factors could significantly influence trading volume in Hong Kong stock exchange. Furthermore, the controlling variables in this study are all significantly, which are also in line with the finding of

literature [11]. Finally, we believe the results in the paper are robust since we control for January, Monday and seasonal pattern and still find significant weather impacts on trading volume.

IV. CONCLUSION

Previous studies demonstrated weather could influence individuals' mood, and in turn, affect decision-making. Some studies found the weather impacts on stock return. However, trading volume has not been given much notice. We believe this is important, since trading volume can represent for risk-taking activity in stock market. Therefore, in this paper, we explore the relationship between weather and trading volume in Hong Kong Stock Exchange. We employ the daily weather and trading data from 2002 to 2015. With linear regression analysis, we find a strongly correlation between weather and trading volume in Hong Kong. However, we still suffer some limitations in this paper, since aggregate data of stock market cannot directly measure individuals' trading activities. Future study are recommended to investigate the weather impacts on trading and risk taking activities, ideally with individuals' trading data rather than aggregated stock market data if it is available.

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