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Research Article

THE IMPACT OF DAILY WEATHER ON THE RETURNS OF STOCK MARKET ASSETS: CASE OF THE CASABLANCA STOCK EXCHANGE

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Abstract

Our study focuses on the impact of weather on the returns of the Casablanca Stock Exchange, using the GJR GARCH model and over a period between 02/01/2012 and 29/01/2021, we tested the impact of temperature and precipitation on the performance of the MASI. The results of the estimation of this model confirmed the impact of the weather on investor mood and then on price formation in the Moroccan case, and that high temperature have a negative impact on MASI's performance. So, we should introduce behavioral variables to explain financial phenomenon which traditional finance has not been able to do.

Keywords: GJR GARCH, MASI, Mood, Behavioral Finance.

INTRODUCTION

Traditional finance assumes that markets are efficient and agents are rational and their objective is to maximize their profit, and the only thing that can influence price formation is information. Since the 1980s, several studies have shown the insufficiency of traditional finance in explaining several financial phenomenon, such as the equity premium puzzle and the volatility puzzle. This insufficiency has given rise to a new theory called behavioral finance theory, which uses psychology and sociology to explain financial phenomena. Behavioral finance is concerned with studying the impact of behavioral biases on asset price formation, and the investor's mood is one of these biases. Indeed, the investor's mood is the set of expectations that are not explained by a method, and studying the impact of the investor's mood on price formation involves studying mood measures. There is a two-way causal relationship between mood and price formation, i.e. investor mood impacts price change, and price change in turn impacts investor mood. Several studies have been done on the impact of investor mood on price formation in financial markets, good mood allows us to react favorably to new events, but bad mood creates a feeling of pessimism and negatively influences our reactions to new events. Indeed, the variables that impact investor mood must satisfy the following conditions: they must have a sufficient effect to appear in asset prices, they must have a significant influence on the majority of the population and finally they must be correlated to the majority of people in the country. And most studies have identified weather, season and sport as mood measures. Our study focuses on the impact of the weather on the Casablanca stock exchange, whose temperature impact and daily precipitation will be tested on the MASI's performance. In the following section we will present the various studies that have tested the impact of weather on price formation in financial markets. In the third section we will present the data and methodology usedto study the impact. In the fourth section we will discuss the results of our study, and finally a conclusion in the fifth section.

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LITERATURE REVIEW

The study of the behavior of financial markets is like studying the behavior of agents, several studies have shown the impact of weather on the behavior of agents which in turn influences price formation, psychologists have found that temperature, precipitation and humidity have a large impact on the investor's mood. One of the first studies to test the impact of weather on investor behavior and then on asset returns was that of E. Howarth and M. S. Hoffman 1984, whose impact of weather on mood was tested using 7 weather variables and 10 mood variables, and they found a significant impact of weather on mood using multiple regression model as well as, they calculated the correlation to know the relationship between the mood and weather variables. Edward and Saunders 1993 studied the impact of New York daily weather on the change in indices listed on the New York Stock Exchange and found that weather influences daily returns, and suggested the introduction of psychological variables in explaining price formation. Indeed, David Hirshleifer and Tyler Shumway 2003, studied the relationship between weather and price formation in the financial markets of 26 countries over a period between 1982 and 1997, and found that sunny days are positively correlated with asset returns, as well as other weather conditions (rain and snow) have no influence on financial asset returns. Angel Pardo, Enric Valor, 2003, tested the impact of humidity and sunshine hours on the Madrid Stock Exchange, and reversed the impact of weather on the Madrid Stock Exchange's returns. Andrew Worthington, 2009, tested the impact of weather on the Australian stock market over a 47-year period between 1958 and 2005 using multiple regression and reversed the impact of weather on the performance of the Australian stock market. Hyein Shim, Maria H. Kim, Doojin Ryu 2017, studied the impact of weather on returns and volatility in the Korean equity and derivatives market and found a significant impact using the GJR GARCH model. Yi-Hsien Wang, Kuang-Hsun Shih and Je-Wei Jang 2018, tested the impact of weather on the return on assets in the Taiwan, Hong Kong and Japanese stock markets, and they found a significant impact, also using the GJR GARCH model, of weather on downward trends, which

explains that market returns change with changing weather. Anya Khanthavit, 2018, studied the impact of weather on the Thailand Stock Exchange over a period between 17/02/1992 and 30/12/2016 and found a significant effect of weather on asset returns and volatility, using the main component analysis. Chinnadurai Kathiravan et al, 2018, tested the relationship between weather and stock market performance using the Granger correlation and causality test and found a significant impact of weather on performance.

Hou J, Shi W, Sun J, 2019, tested the impact of weather on the New York Stock Exchange by comparing Dow Johns' performance before and after the installation of the air conditioning system in the New York Stock Exchange in 1903, and found that before the installation of this system the temperature increase has a negative effect on performance.

DATA AND METHODOLOGY

To study the impact of weather on stock market returns, we will use the *Glosten, Jagannathan, and Runkle-generalized Autoregressive Conditional Heteroskedastic (GJR-GARCH)* model, an asymmetric GARCH model, which allows the variance to react differently depending on the sign or size of the shock it receives. The explanatory variables are integrated into the GJR GARCH model to detect weather effects as follows:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 PP_t + \alpha_3 Th_t + \alpha_4 Tl_t + \varepsilon_t$$

$$h_t = \beta_0 + b_1 h_{t-1} + b_2 {\varepsilon^2}_{t-1} + b_3 S_{t-1} {\varepsilon^2}_{t-1}$$

With $S_{t-1} = \begin{cases} 1; \text{ if } \varepsilon_{t-1} < 0 \\ 0; \text{ if } \varepsilon_{t-1} \geq 0 \end{cases}$

The first equation is the mean equation that describes the relationship between the variable to be explained and the explanatory variables in our study, and the second equation is the variance equation.

R_t: Is the return of the MASI (Moroccan All Share Index) on day t, calculated by the following method $R_t = \ln(\frac{P_{t+1}}{P_t})$with P_t closing index price on day t;

PP_t: Precipitation in day t;

Th_t : the first dichotomous variable of temperature, it equals 0 when the temperature is lower than 28°, and 1 when the temperature is higher than 28°;

Tl_t:second dichotomous variable of temperature, it equals 1 when the temperature is lower than 20°, and 0 when the temperature is higher than 20°;

h_t : is theconditional variance over time t ;

ε_t: the error term**.**

The MASI performance data are extracted from the official website of the Casablanca Stock Exchange (http://www. casablanca-bourse.com) over a period ranging from 02/01/2012 to 29/01/2021. As well as weather-related data are extracted from a French database specialized in the collection of meteorological data (https://fr.tutiempo.net). And the analysis of its data is done using the Eviews 10 software.

EMPIRICAL RESULTS

Descriptive statistics

The first table below provides a statistical summary of the variables used in this study.

Table 1. Descriptive statistics

	Performance	PP	Tl (<20)	Th (> 28)
Average	0.0000529	1.138237	0.561382	0.009155
Median	0.0000964	0.000000	1.000000	0.000000
Maximum	0.032955	45.97000	1.000000	1.000000
Minimum	-0.030338	0.000000	0.000000	0.000000
Standard deviation	0.006028	3.961681	0.496321	0.095264
Observations	2403	2403	2403	2403

The stationarity test:

We used the ADF (Augmented Dickey Fuller) test to test the stationarity of the series, which takes as a null hypothesis the non-stationarity of the series. The results of this test, presented in Table 2, reject the null hypothesis for all series in zero order, i.e. the series are stationary in their levels.

Table 2. ADF test results

Variable	ADF	Probable
Yield	-41.82185	0.0000
Th Th	-37.30988	0.0000
Tl	-4.575453	0.0001
PP	-25.63518	0.0000

Estimation of the GJR-GARCH model

The table below presents estimates of the coefficients of the two equations mentioned above (mean equation and variance equation) using Eviews 10 software.

Table 3. Estimate of the GJR GARCH model

Variable	Equation of the average			
		Std. Error	z-Statistics	Prob.
PP	-0,0000279	0,0000278	-1.004736	0.3150
Tl	-0,0000751	0.000225	-0.334467	0.7380
Th Th	-0.003128	0.001127	-2.775260	0.0055
C	0,0000313	0.000179	0.174841	0.8612
YIELD (-1)	0.109686	0.025139	4.363273	0.0000
	Equation of Variance			
β_0	0,00000959	0,0000012	7.996969	0.0000
b_2	0.230539	0.028057	8.216890	0.0000
b_3	-0.003832	0.032965	-0.116238	0.9075
b_1	0.499553	0.048053	10.39579	0.0000

The second table presents the regression results of the GJR GARCH model (1.1), to explain the reaction of MASI's performance to an unexpected weather change. The coefficients of the mean equation show that low precipitation and temperatures have a negative effect on MASI performance but not significant, while temperature increases also have a negative but significant effect. As well as, in the variance equation, the coefficient is negative and insignificant, which implies that positive shocks increase volatility more than negative shocks, the coefficient is positive and significant, means that if yesterday's conditional variance increases by 1%, then today's variance increases by 50%. And finally, the coefficient is also significant and positive, and means that a 1% increase in yesterday's square error implies a 23% increase in today's variance.

Conclusion

In this study we studied the impact of daily weather including precipitation and temperature on the Casablanca stock exchange, and we found a negative and significant impact of temperature increases on the yield of the MASI. The results of our study support studies that tested the impact of weather on agent behavior and subsequently on price formation in financial markets (Hou J et al (2019), ChinnaduraiKathiravan et al (2018), Anya Khanthavit (2018), Yi-Hsien Wang et al (2018)) and allowed us to verify whether Moroccan investor behavior is influenced by weather. So, to better understand price formation in financial markets and the decision-making process we need to introduce behavioral variables into our analysis and not limit ourselves to traditional finance to do so.

And finally, we recommend using intraday data in future studies to properly detect the impact of weather on investor behavior.

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