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Weather effects on returns: Evidence from the Korean stock market

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ABSTRACT

In this study, we attempted to determine whether a relationship exists between stock returns and the weather variables of temperature, humidity, and cloud cover in the Korean stock market. We delineated three key implications with regard to weather effects. First, after the 1997 financial crisis, the presence of a weather effect disappeared. Second, the inclusion of weather variables helps to model the GJR-GARCH process in the conditional variance. Third, the interaction effects of weather variables fully demonstrate the weather effect, but the interaction effects also vanished after the crisis. Overall, the findings of this study indicate that the weather effect was weakened as the result of heightened market efficiency.

1. Introduction

Psychologists have long recognized that weather conditions influence an individual's emotional state or mood, which can create the predisposition to engage in particular behaviors [1–4]. The most essential finding in this regard is that, across a wide range of weather variables, good (bad) weather conditions induce positive (negative) mood states, which adulterates or mitigates the process of rational or optimal decision-making. Based on these perspectives, behavioral finance theory has recently argued that, to some degree, stock market anomalies may be the consequence of relevant weather factors [5–12]. The existence of a weather effect in financial markets has raised some questions as to the validity of the efficient market hypothesis (EMH), which assumes that market prices always incorporate the best available information regarding fundamental values.

Research into the weather effect has focused principally on the influence of cloud cover (or lack of sunshine) on stock returns. Saunders [12] initially reported that cloud cover exerted the most profound effects on the behavior of market traders, and this effect was correlated negatively with the daily returns of New York stock indices. Hirshleifer and Shumway [8] supported Saunders' [12] results with an analysis of index returns for 26 international stock exchanges from 1982 to 1997.

However, other researchers have asserted that there is no cloud effect, or that it is negligible and can be safely ignored. Trombley [13] re-assessed Saunders' work [12] and detected no difference between New York stock returns on clear sunny days, full-cloud days, or rainy days. Similar empirical results have been documented by Krämer and Runde [14] for the German DAX stock index, by Pardo and Valor [15] for the Madrid stock index, and by Tufan and Hamarat [16] for the Istanbul stock exchange.

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More recent studies have explored the notion of a weather effect by evaluating the influences of multiple weather variables. Keef and Roush [9,10] previously assessed weather effects on the returns of New Zealand financial securities using three local weather factors: cloud cover, temperature, and wind. Only wind was found to exert a significant influence on the returns, and the influence of other weather factors was ambiguous. Dowling and Lucey [6] evaluated weather effects in daily Irish stock returns using four weather proxy variables: cloud, rain, humidity, and geomagnetic storms. Their evidence supports the hypothesis that weather variables do, indeed, affect stock returns.

Furthermore, several studies have considered the influence of temperature on stock returns. Cao and Wei [17] and Keef and Roush [11] previously reported a negative correlation between temperature and returns. Chang et al. [5] also noted that temperature and cloud cover exerted a negative effect on returns in the Taiwan stock market. On the other hand, Jacobsen and Marquering [18] have suggested that the influence of temperature may be spurious, but market anomalies are associated with winter and summer seasonality. In summary, there is currently no general agreement in the relevant literature regarding the relationship between stock returns and weather.

We re-examined whether a relationship existed between stock returns and three specific weather variables–temperature, humidity, and cloud cover–using Korean stock market data with a linear regression model using the GJR-GARCH process on error terms. These three weather factors are crucial variables for describing seasonal weather, and thus for analyzing the presence of a weather effect in the Korean stock market. In addition, we attempted to ascertain whether the extent of a weather effect may have been weakened following the October 1997 financial crisis. In order to analyze the influence on the financial crisis, we divided the sample period into two sub-periods, then compared the empirical results.

There are two main motivations for this analysis. First, although various studies on weather effects in major stock markets have been conducted, only three empirical studies have examined the case of the Korean stock market, to the best of our knowledge [19–21]. In addition, these three studies replicated Saunders' [12] work, using only cloud cover in their analyses. Neither the moods of investors nor the weather are unitary constructs. Thus, we extended these previous studies by analyzing multiple weather factors to assess weather effects on the Korean stock market.

Second, as weather factors are not an economical explanatory variable, they are generally considered dummy variables. However, there is currently no consensus in the relevant literature regarding the construction of dummy variables. Assuming that extreme weather conditions may result in more significant effects on stock returns than would normal weather conditions, we generated two dummy variables for each weather factor, depending on extremely above-average and extremely below-average weather conditions. These two dummy variables provided additional insight into the weather effects occurring in the Korean stock market.

In Section 2, we provide the statistical characteristics of the stock return and weather data, and discuss the weather dummy variables and methodology. In Section 3, we assess the relationship between weather and stock returns and compare the results for the two sub-periods. In Section 4, we summarize the most relevant conclusions.

2. Data and methodology

2.1. Data

2.1.1. KOSPI 200 returns

We considered the daily closing prices of the Korea Composite Stock Price Index 200 (KOSPI 200) from January 15th, 1990 to December 13th, 2006, obtained from the database of the Korean Exchange (http://www.krx.co.kr). The KOSPI 200 is a capitalization-weighted index, which consists of 200 blue-chip stocks listed on the Korean Exchange. Its constituent shares cover approximately 70%–80% of domestic market capitalization, and thus the KOSPI 200 index is reflective of the overall market performance of the Korean stock market. Fig. 1 shows the daily nominal percentage return series for the KOSPI 200; that is, $r_t = \ln(P_t/P_{t-1}) \times 100$ for $t = 1, 2, \ldots, T$, where P_t is the current price and P_{t-1} is the previous day's price. After the financial crisis of October 1997, higher volatility can be observed, and occurs in bursts.

We calculated the descriptive statistics and unit root tests for sample returns (Table 1). In Panel A of Table 1, the sample mean of returns is very small, and the corresponding variance is significantly higher. The distribution of returns is not distributed normally, as is indicated by the skewness, kurtosis, and the Jarque-Bera test. The null hypothesis of no serial correlation is rejected by the Ljung–Box Q statistic, with a lag of 12 and 24 for the level of return series and the squared return series; they are denoted by $Q(n)$ and $Q_s(n)$, respectively. Thus, there is significant evidence of serial dependence in the level of returns and squared returns.

Additionally, Panel B of Table 1 provides the results of three unit root tests: the augmented-Dickey-Fuller (ADF), Phillips-Peron (PP), and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS). The null hypothesis of the ADF and PP tests is that a time series contains a unit root, $I(1)$ process, whereas the KPSS test has a null hypothesis of a stationarity, $I(0)$ process. Large negative values for the ADF and PP test statistics reject the null hypothesis of a unit root, whereas the KPSS test statistic does not reject the null hypothesis of stationarity at a significance level of 1%. Thus, the return series is a stationary process.

2.1.2. Weather variables

We explored the daily weather data for temperature (TEMPER), humidity (HUMID), and cloud cover (CLOUD) in Seoul from January 15th, 1990 to December 13th, 2006, obtained from the Korea Meteorological Administration (http://www.kma.go.kr/). We provide histograms and descriptive statistics for the three weather variables (Fig. 2).