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Does the weather affect stock market volatility?

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ABSTRACT

This paper investigates the empirical association between stock market volatility and investor mood-proxies related to the weather (cloudiness, temperature and precipitation) and the environment (nighttime length). Overall, our results suggest that cloudiness and length of nighttime are inversely related to historical, implied and realized measures of volatility. The strength of association seems to vary with the location of an exchange on Earth with respect to the equator. Weather deviations from seasonal norms and dummies representing extreme weather conditions do not offer additional explanatory power in our datasets.

1. Introduction

Investment professionals appear to have been well aware of the behavioral effects of the weather for over a century now. Characteristically, Nelson (1902, p. 163) reports: '*During normal markets, brokers have observed that the psychological factor is so strong that speculators are not disposed to trade as freely and confidently in wet and stormy weather as they are during the dry days when the sun is shining,*

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and mankind is cheerful and optimistic'.[2] More recently, several papers have investigated in depth the links between stock market returns and prevailing weather conditions. The main empirical finding in this literature is the so-called 'sunshine effect' according to which cloudiness, as measured by cloud cover, has a significant negative correlation with daily equity index returns (see Saunders, 1993; Hirshleifer and Shumway, 2003; Chang et al., 2008 among others). This relationship has been explained using arguments from psychology on the basis of 'mood misattribution'. Simply put, sunny weather is thought to influence the mood of some investors making them more optimistic and thus more willing to enter into long positions, which in turn leads to higher returns. Other weather and environmental variables which have been considered in the financial literature as mood-proxies include, among others, temperature (e.g., Cao and Wei, 2005), daylight savings time changes (see, e.g., Kamstra et al., 2000) and the 'Seasonal Affective Disorder' (SAD, see, e.g., Kamstra et al., 2003; Garrett et al., 2005).

Rather than concentrating on expected returns, a recent strand of research has examined the effect of weather and environmental factors on volatility. This is of great academic and practical interest since volatility underlies a variety of key financial decisions, problems and applications in asset valuation, portfolio theory, derivatives pricing, risk management, etc. The main obstacle in this research is that volatility is largely unobservable. In the present paper, we consider all three of the most widely used proxies: historical, implied and realized volatility (for a detailed description of these and relevant references see Poon and Granger (2003) and Mills and Markellos (2008)). Specifically, we extend in four main directions the empirical literature which examines the impact on volatility of cloudiness, variation in nighttime hours, temperature and precipitation, respectively. First, in addition to the three deseasonalized weather variables, we consider also the effect of absolute deviations from seasonal norms and of dummies which reflect extreme weather conditions. This is because mood variations could be potentially better correlated with the magnitudes of deviations, or, with extreme deviations of weather, from seasonal norms, respectively. For example, we may feel particularly uncomfortable when the weather is (significantly) hotter or colder than expected during a particular season. In this manner, deviations of weather variables from seasonal averages may then lead to variations in mood states and to shifts in volatility. Since the strength of association between weather/environmental variables and stock market returns has been found to depend also on stock exchange location (see, e.g., Keef and Roush, 2007), we also consider the effect of latitude when looking at international data. Second, we analyze the effects on historical volatility using an ARCH-type model on the extensive dataset of Hirshleifer and Shumway (2003) which consists of stock market index returns for 26 stock exchanges internationally between 1982 and 1997. Third, we analyze four implied volatility indices for the CBOE (namely: VIX, VXO, VXN and VXD) along with the term structure of the VIX volatility index (seven volatility duration buckets). Implied volatility is derived from traded options and is a measure of expected volatility as this is perceived by investors in the derivatives market. The variety of indices used enhances the robustness of our results and allows us to see if the effect of weather and of environmental factors depends on the composition of the volatility index and the underlying option market investment horizon. Finally, we analyze realized volatility which is constructed on the basis of high-frequency returns for the S&P 500 index. Realized volatility offers a great advantage in that it is considered as the most accurate representation of the unobserved volatility process.

Empirical evidence is mixed between the existing studies that have investigated the effects of weather and environmental conditions on volatility. Chang et al. (2008) show that New York City cloudiness has a significant positive effect on intraday volatility of NYSE firms over the entire trading day. Two volatility proxies are used by these authors: one based on the range of the intraday prices and the other on the basis of the standard deviation of the bid-ask mid-point returns. Both of these proxies are uncommon in the literature and their accuracy is unknown. Dowling and Lucey (2008) study the empirical effect of seven mood-proxies on both the returns and variances of 37 national equity market indices and 21 small capitalization indices. They employ GARCH-type processes to approximate and model the variations in the conditional variance of returns. Their results show that wind, precipitation, geomagnetic storms, daylight savings time changes and the

[2] Nelson collected and published the Wall Street Journal editorials of the legendary Charles H. Dow in a book which formed the basis of what later became known as Dow Theory and Technical Analysis.