

## MOOD MISATTRIBUTION AND INVESTMENT DECISIONS

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**Abstract.** The ability of the human mind to understand and process large amounts of information is limited. Gender, age, genetic makeup and individual personality traits as well as psychological factors are important determinants of decision making, including investment decisions. This paper surveys the literature on the influence of mood misattribution, caused by weather and biorhythm variables, on investor's decisions and equity pricing. The mixed evidence emerging from the large body of existing empirical work can be explained by data inadequacy, particularly when taking into account conflicting results from alternative psychological models on the effects of mood misattribution. We propose a multidisciplinary research agenda, in the complexity theory perspective, to shed further light on the effects of weather and biorhythm variables on mood and human behavior in taking decisions under uncertainty.

**Key words:** investor's behavior, mood, weather, biorhythm

## 1. INTRODUCTION

Classical finance theory seems unable to explain why individuals have apparently irrational attitudes in their investment decisions. If agents were self-interested, rational and utility maximizers as the classical finances theories postulate, there would be no speculative bubbles, panics, herd behavior and financial crises. The inability of economists to understand the current global crisis cannot be simply justified by an assumed financial illiteracy on the part of agents, but it rather provides further evidence of the inadequacy of reductionist approaches to understand human behavior. A large number of studies conducted in economic psychology, cognitive sciences and behavioral finances support the idea that, in fact, human economic actions seem to be largely driven by “animal spirits” (a term coined by Keynes, 1936/1973 and revived by Akerlof & Shiller, 2009) rather than being a result of rational utility maximizing behavior. Economic behavior is influenced by genetic and biologic status, personality, past experiences, social context and personal habits (Lea, Tarpy, & Webley, 1987). The strict sense of rationality implied by the Homo Economicus concept seems to be unrealistic since decisions are proven to depend both on the cognitive and affective system (Camerer, Loewenstein, & Prelec, 2005) irrespective of the education and decision-maker’s training (Lo & Repin, 2002).

The role of feelings, emotions and mood in financial decisions should not be neglected. Ignoring the pain of a loss or the regret of a mistake as decisions’ fundamentals leads to an unrealistic choice theory. Emotions are considered responsible for generating behavioral responses that are very far away from what the individual considers being the best alternative, according to the risk-as-feelings hypothesis (Loewenstein, Weber, Hsee, & Welch, 2001). However, several studies support the importance of emotions as an informational input into decision making and show the negative consequences which might

occur if such inputs were blocked (Damasio, 1994; Bechara, Damasio, Tranel, & Damasio, 1997; Bechara & Damasio, 2005; Peterson, 2007; Spinella, Yang, & Lester, 2008)<sup>1</sup>. Mood, as a diffuse, non-specific mental state Forgas(1995) seems to be important too in decision. According to the *mood- as –information theory*, developed by Schwarz (1990) people tend to take decisions depending on their mood, even when the source of mood state is unrelated to those specific decisions: *mood misattribution*. Mood also affects information processing, making investors react to salient or irrelevant information when they are in a good mood.

Mood and potential changes of mood seem to influence decision making and securities prices through two main channels: *cognitive-evaluation* and *risk-tolerance*.

Good mood is considered responsible for an increase in the ability of categorization, creativity in response-generation tasks and efficiency in solving multiattribute decision problems (Pham, 2007). In the case of problem-solving tasks that require ingenuity, individuals in better mood seem to perform better (Greene & Noice, 1988). On the other hand, positive mood individuals tend to rely on stereotypes and judgmental heuristics and have a higher propensity to optimism and overconfidence biases (Barberis & Thaler, 2003; Hoffrage, 2004). A negative mood seems to produce different effects depending on its cause. Sadness decreases the use of scripts and stereotypes and triggers a more systematic, data-driven form of reasoning since sad moods represent a signal for the individual that a more vigilant form of processing is required (Schwarz, 2002). Anger and disgust lead to heuristic rather than systematic processing (Triedens & Linton, 2001; Lerner & Keltner, 2001).

Evidence that mood affects individual's risk taking is overwhelming, even though there is no agreement on the nature of the effect<sup>2</sup> (Andrade & Cohen, 2007). It is important to note that emotional and mood states can have a self-reinforcing effect over risk attitude. Affect could modify the cognitive evaluation of risk: for instance bad mood could lead to a

higher perceived risk associated with a line of action. This cognitive evaluation could, in turn, determine a self-reinforcing feedback effect on the initial mood in such a way that even a relatively mild fear could generate a severe panic reaction (Lang, 1995). We attempt to show that a proper investigation of the influence of non economic variables such as weather and biorhythm on capital markets should explicitly take into account the impact of changes in mood.

This paper has a twofold aim: it reviews the empirical literature on the connection between mood, induced by non-economic variables (in particular weather and biorhythm and investment decision-making) and shows that multidisciplinary approach should be used to properly investigate such a link. Genetics, psychological and neurological tests and experiments could be combined to better understand the relationship between mood misattribution and individual behavior. The paper is organized as follows: Section 2 describes the theoretical and empirical arguments for the influence of weather on mood. Section 3 discusses the existing empirical evidence on the effects of mood misattribution, generated by weather variables, on capital markets. Section 4 analyses the changes generated in investor's mood by biorhythm variables such as seasonal affective disorder, lunar phases and daylight saving time changes. Section 5 reviews the empirical evidence on the effects of mood misattribution, generated by biorhythm variables, on capital markets. Section 6 assesses the empirical results on the effects of mood misattribution on capital markets and offers possible explanations for the main findings. Section 7 concludes and suggests further lines of research.

## **2. WEATHER AND MOOD**

Weather variables are among main determinants of changes in mood.

Good weather induces positive mood states while bad weather induces negative mood states for a large proportion of individuals. According to Kals (1982) approximately one-third of people are weather sensitive. Winds (Larson, Craine, Thomas, & Wilson, 1971) or severe tropospheric weather storms (Prasad & Schneck, 1975) determine infrasonic signals that generate biorhythm disruptions, emotional responses and changes in behavior (Mika, Veröci, Fülöp, Hirsch, & Düll, 2009). The main weather variables considered in the literature are temperature, humidity, sunshine, barometric pressure and geomagnetic storms.

Hot temperatures are found to have different effects on mood and task -performing abilities: significant propensity to hysteria and apathy (Wyndham ,1969); increased aggression (Howarth & Hoffman ,1984; Anderson ,1989);increased hostility and hostile cognition (Anderson, Deuser, & DeNeve ,1995); reduced task-performing abilities (Allen & Fisher,1978; Pilcher, 2002). Extreme low temperatures, associated with low relative humidity, extreme photoperiod length and increased electromagnetic radiation (a situation specific in Antarctica and other northern areas) are shown to determine a hormonal response that increase the propensity to depression, tension, anger, lack of vigor.

The humidity effect on mood has been studied by, among others, Allen & Fisher (1978) and Horwath & Hoffman (1984) who point out that high level of humidity depress concentration and increase sleepiness. Mawson & Smith (1981) observe a negative correlation between maniac admission and relative humidity. Their findings are confirmed by Amr & Volpe (2012), who show that the number of admissions for depression is negatively correlated to temperature and luminosity and positively correlated to low humidity.

The sunshine effect on mood is widely discussed (Cunningham,1979; Persinger & Levesque, 1983; Parrott & Sabini,1990). Denissen, Butalid, Penke, & Van Aken (2008) find a significant negative effect of temperature, wind power and sunlight on mood. The main explanation offered for the negative effect of sunlight may be due to the role vitamin D3

(produced when the skin is exposed to sunlight) plays in changing the serotonin level in the brain (Lambert, Reid, Kaye, Jennings, & Esler, 2002).

Barometric pressure is shown to have an impact on mood and mental disorders. Digon & Bock (1966) demonstrated the increase of suicide rate in low pressure cases. Schory, Piecznski, Nair, & El-Mallakh (2003) show that low pressure is significantly associated with the increase of acts of violence and emergency psychiatric visits while Prince, Rapoport, Sheftell, Tepper, & Bigal (2004) show that barometric pressure along with temperature, humidity and changing weather patterns exert a large influence on headaches and indirectly on general mood .

Severe disturbances of geomagnetic field significantly impair the brain functionality, affect the cardio-vascular system and amplify the negative emotional individual background. Mulligan, Hunter & Persinger (2010) have demonstrated that an increase in geomagnetic activity generates a change in right hemispheric electroencephalographic activity correlated with increased incidence of emotional liability, unusual perceptions and false experience reconstructions. Geomagnetic storms increase the number of acute cardiac events (Babayev, 2007) and affect the regulating system related with high cortical mechanisms of control and sub-cortical integrative apparatuses. As a result, depressed and anxious individuals become more depressed and anxious during the days with major geomagnetic disturbances (Nastos, Paliatsos, Tritakis, & Bergiannaki, 2006).

On the other hand, Watson (2000), Keller, Fredrickson, Ybarra, Côté, Johnson, Mikels, Conway, & Wager(2005) and Huibers, de Graaf, Peeters, & Arntz (2010) found no significant link between mood and weather variables.

This inconsistency could be generated by two factors that moderate the weather variables effect on affective states: the season and time spent outside (Keller, Fredrickson, Ybarra, Côté, Johnson, Mikels, Conway, & Wager, 2005). The different degree of

adaptability to weather variables around the globe or in different periods of time and the particular moment in individual biorhythm when meteorological events occur could also represent a valid explanation for the discrepancies among the reported results. Understanding the effects of weather on mood is important but it is arguably more important for our analysis to verify the impact of changes in weather on financial markets, channeled by mood. The next section reviews the econometric studies on the influence of weather variables on capital markets.

### **3. WEATHER AND CAPITAL MARKETS - EMPIRICAL EVIDENCE**

#### **ACROSS COUNTRIES**

Saunders (1993) is the first, to our knowledge, to test the potential connection between weather variables, mood, investment decisions and capital market variables, even if the idea is much older. (Nelson, 1902, p.163 had stated almost one century ago: “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, and mankind is cheerful and optimistic”). Saunders (1993) notes that cloud cover has a significant negative correlation with stock prices because the investors’ bad mood determines a less optimistic evaluation of future prospects and a decreased willingness to choose risky investments.

The results obtained in cross-countries studies are mixed. Hirshleifer & Shumway (2003) confirm Saunders’ results on 26 stock exchanges, both individual, for each country, and global using cross-city tests. Krivelyova & Robotti (unpublished results) analyzed the impact of geomagnetic storms on stock market returns in nine countries, channeled by depression and anxiety. The main results have pointed out that, especially in the small

capitalization stocks, geomagnetic storms seem to have a profound effect on risk aversion and indirectly to equity returns. The same results regarding the impact of geomagnetic storms on risk were confirmed by Dowling & Lucey (2008b) on an extended sample of 37 countries. Results obtained testing temperature effects on equity returns are more contradictory. On the one hand, Cao & Wei(2005) and Dowling & Lucey (2008b) show that stock returns are negatively correlated with temperature, but, on the other hand, Jacobsen & Marquering (2008) infirm those results and support the idea that the correlation between stock returns and the weather induced mood shifts might be data-driven inference (temperature explanation does not hold in their opinion).

These conflicting results can be explained if one considers different local weather patterns, the degree of adaptability to weather conditions in each region and, not in the last place, specific macroeconomic conditions. In each country there is a specific weather pattern and particular weather elements that decrease the robustness in a cross-country analysis. The climate could be predominantly dry or humid, hot or cold, the discrepancies between day and night temperatures could be important, the incidence of extreme event as tornados, tsunami, blisters and cyclones could be extremely different, etc. In several countries there are specific elements such as the Wellington wind in New Zeeland that is found to be particularly important for the mood of local inhabitants (Keef & Roush, 2005). The adaptability to different weather condition is extremely different across the globe (a very low temperature for instance could generate a shift in mood in Italy, Greece or other Mediterranean countries but maybe will not affect many individuals from Antarctica or Northern countries). Furthermore, each country has specific macroeconomic conditions that affect capital markets returns and volatility conditions which are not taken into account in this kind of studies. Hence, cross-country analysis can hardly be used to analyze the relation between weather and capital markets.

The differences among countries and regions and the peculiarities of capital markets from different parts of the globe make an analysis of the effect of weather variables on capital markets possible only if restricted to more homogeneous areas: American capital markets, Asian capital markets, European capital markets and Australasian capital markets.

With the exception of Saunders (1993) and Akhtari (2011), who pointed out a strong connection between weather variables (especially cloud cover) and capital market returns, the studies conducted on American capital markets do not find a significant correlation between weather and aggregated capital market variables, despite the fact that weather is found to impact on individual risk taking attitude (Bassi, Colacito, & Fulghieri, unpublished results). Goetzmann & Zhu (2005), using the trading records of individual investors from five major US cities, find no evidence of any difference in individual propensity to buy or sell securities, and as the result in the equity returns, on cloudy days compared with sunny days, even if cloudiness seem to be associated with wider bid-ask spreads. They asseverate the idea that, if weather effect really exists, then the market-makers are the mechanism by which weather changes influence stock returns. Gerlach (2007) finds out a rain and temperature effect on returns (days with heavy rainfall or extreme temperatures have associated significantly lower returns) but this effect is shown to be more a result of the macroeconomic announcement. Saporoschenko (2011) analyzed the effect of Santa Ana wind and cloudiness on stock returns of Southern California-headquarter corporation and concluded that there is no evidence of a correlation between cloudiness or Santa Ana wind and stock returns.

Extending the temporal depth of the analysis to the intra-day data does not lead to more satisfactory results. Loughran & Schultz (2004) analyzed the relationship between weather and intraday stock returns, trading volume and price, in 25 cities of residence of the Nasdaq's companies, based on the bias toward local trading (investors hold and trade substantially more shares in local companies than in other firms). Despite the strong local

component observed in the trading of Nasdaq, the results of their study show no proof of a relation between cloud cover near the company headquarters and its stock returns. Chang, Chen, Chou & Lin (2008) found out that the impact of weather variables is significant around opening hours but the effect becomes less important during the trading day (cloud cover has a significantly negative impact on returns during the first 15 minute period of the trading day).

The reason for the scarce influence of weather variables may be due to the fact that foreign investors play a very important role in the American capital markets. The structure of the major foreign investors in corporate stocks on the American markets (Jackson, 2010) shows a large geographic dispersion: UK, Hong Kong, Canada, France, Japan, Singapore, Sweden and Switzerland. The idea of investors being sensitive to weather conditions in the capital market they trade seems unrealistic. Due to the large proportion of foreign investors in American capital markets, equity prices and returns are likely to be independent of the local weather conditions.

The studies conducted on Europe reach contrasting conclusions, even when evaluating the impact of the same weather descriptors on capital markets variables. For instance, temperature was found positively correlated with returns in UK markets and Finnish market (Dowling & Lucey, 2008a; Kaustia & Rantapuska, unpublished results) and negatively correlated with returns in Portugal and Israel (Floros, 2011; Nissim, Liran & Eshel, 2012). Some econometric studies are in conflict with psychological findings. Dowling & Lucey (2005), for example, are in conflict with the results of psychology since humidity is positively related with returns on the Irish stock market. A possible reason for this finding could be represented by the non-extreme nature of Irish weather (humidity is more possible to affect mood at extreme temperatures). Finally, several authors do not even find any correlation between weather variables and the stock exchange (Pardo & Valor, 2003; Tufan & Hamarat, unpublished results; Theissen, unpublished results).

These results seem to be confusing. However in addition of the local weather differences in patterns and tolerance, a further explanation is the different nature and methodology involved by those studies. For instance, Theissen (unpublished results) use a database with brokers predictions regarding the returns instead of the more common indexes use, Kaustia and Rantapuska (unpublished results) use trading records of all domestic investors on Helsinki Exchanges and not aggregate prices. Even using the same indexes results are likely depend on the different methodology employed.

The studies conducted in Asian capital markets reflect the pattern of Asian economies and also the effects of capital control and regulation policies introduced after the 1997 crisis. The nature of Asian corporation (extensive cross-subsidisation of subsidiaries) and the relation between banks and governments are just two elements that contribute to an inadequate disclosure of information and lack of transparency in capital markets (Singh, 1998). In countries like Pakistan, civil wars and the changes in the political regime have heavily impacted on foreign investments and equity market returns (Hasan, Subhani, Hasan, Farooqi, Saleem, & Kumar, 2011). In Nepal the foreign investors still have no access to the national capital market. Hence capital control measures may be the reason for presence of the weather effect found by Joshi & Bhattarai (2007). In China, studies conducted separately on the A-Share and B-shares sectors reveal the presence of weather effect only for the shares traded by domestic investors (Kang, Jiang & Yoon, unpublished results; Kang, Jiang, Lee, & Yoon, 2010). Comparing order-driven market with quote driven markets in China, Lu, & Chou (2012) have found an unexpectedly higher weather effect in the quote driven markets, despite the higher specialization of the traders. This confirms the idea that dealers, market analysts and professionals working in financial sectors are also influenced by psychological factors and do not appear to be rational in their decisions ( Mortier, 2002; Goetzman & Zhu, 2005). As a special part of China, it is worth to notice that in Hong Kong the market

internationalization (due to the influence Great Britain had until 1997) may explain the absence of weather effects (Kang, Jiang & Yoon, unpublished results).

After the 1997 crisis, following the International Monetary Fund recommendations, countries like Taiwan, Indonesia and Korea had to increase financial disclosure, take all the measures to structurally reform their economies and abolish the restrictions imposed to foreign investors<sup>3</sup>. As a result, analyzing the effect of weather variables on equity returns in the Korean market, one can see a change in regime in 1997, when the weather effect disappears (see Yoon & Kang, 2009). There is no weather effect after 1997 also in Indonesia (Brahmana, Hooy, & Ahmad, 2011). In the case of Taiwan, on the other hand, the weather effect seems to appear only after 1997 (Chang, Nieh, Yang, & Yang, 2006; Lee & Wang, 2010). These results can however be explained by the strong influence of Japan and the United States on Taiwan prior to 1997.

In Commonwealth countries like New Zealand and Australia weather effects on equity markets are extremely weak, with the exception of the Wellington wind in New Zealand (Keef & Roush, 2005) and a negative correlation of temperature with returns (Keef & Roush, 2007) which however seems to disappear for longer data sets (Worthington, unpublished results).

The empirical results, in spite of the presence of correlation between weather variables and capital markets, are mixed. However, in order to assess the impact of mood misattribution on investment decisions we must take into consideration also variables, other than weather, affecting mood states. In the next section we analyze the evidence on the relation between biorhythm variables and mood.

#### **4. BIORHYTHM VARIABLES AND MOOD**

The idea of different biorhythm cycles that influence human behavior can be traced back to the German surgeon Wilhelm Fliess in the 1890s who proposed a 23 day male period and a 28 day female period (in Hines, 1988). More recent studies identified three different biorhythm cycles: a 23-day cycle influences physical aspects such as energy, resistance to disease, endurance; a 28-day cycle influences emotions such as sadness, elation, moodiness, creativity and a 33-day cycle influences intellectual functions such as alertness, memory and reasoning ability (Thommen, 1968).

Great attention has been paid to what influence human biorhythm. Photoperiod (numbers of hours of daylight), disruption of sleeping patterns due to the Daylight Saving Time (DST) and the lunar cycle have been proved to be among the main factors. As a direct result our biological balances are influenced, the adaptation mechanisms are impaired and the appearance of different mood disorders, especially depression and anxiety, is facilitated affecting also the decision mechanism.

The photoperiod is connected with the seasonal affective disorder (SAD), a subtype of depression characterized by changes in mood, energy, sleep, eating habits and social activities at the change of season. There are two types of SAD: winter-type and summer type, with rather distinctive features (Wehr, Giesen, Schulz, Anderson, Joseph-Vanderpool, Kelly, Kasper, & Rosenthal, 1991). Winter type SAD is triggered by light deficiency during fall and winter and is characterized by such symptoms as lack of energy, oversleeping, overeating and especially carbohydrate craving, due to the serotonin deregulation in the brain that cause several brain anomalies (for further details one could see Cohen, Gross, Nordahl, Semple, Oren, & Rosenthal, 1992; Liotti & Mayberg, 2001). Summer type SAD is determined by heat and humidity. In this case the most common symptoms include agitation, insomnia and weight loss.

The intensity and prevalence of winter type SAD or summer type SAD were found to be dependent of several factors. Both winter type and summer type are more severe at extreme, higher or lower latitudes (Rosenthal, Sack, Gillin, Lewy, Goodwin, Davenport, Mueller, Newsome, & Wehr, 1984; Potkin, Zetin, Stamenkovic, Kripke, & Bunney, 1986). Genetic type is found to influence the SAD prevalence. Caucasians for instance are more prone to winter-type SAD (Rosen & Rosenthal, 1991; Magnússon & Axelsson, 1993; Soriano, Ciupagea, Rohan, Neculai, Yousufi, Guzman, & Postolache, 2007) whereas Asians are suffering most from summer SAD type (Ito, Ichihara, Hisanaga, Ono, Kayukawa, Ohta, Okada, & Ozaki, 1992; Han, Wang, Cheng, Du, Rosenthal, & Primeau, 2000). Gender and age seems to influence the effects of seasonal changes on mood: women and younger individuals are more prone to SAD than men and older individuals (Hedge & Woodson, 1996).

The adoption of the Daylight Saving Time (DST), introduced first in April 1916 in Germany as a way of saving energy and increase productivity by extending the daily working hours, was proven also to induce changes in biorhythm. Neurological studies have proved that, strange as it might seem, even the one hour time change has strong effects on human physical and emotional state of health, since the circadian rhythm is adjusted to the Earth's rotations (Roenneberg, Kumar, & Mellow, 2007). The circadian clock coordinates all the cellular clocks and regulates all internal processes from gene expressions to metabolism, sleep patterns and other complex behaviors. The artificial intrusion generated by DST generates severe disequilibrium in circadian rhythm. One of the results consists in sleep imbalances (reduction in sleep duration and efficiency) that are known to cause several damaging effects on the physical and emotional state of health. Lack of quality sleep generates drowsiness and tiredness, weakens the immune system, diminishes motor skills, slows mental performances

and causes errors in judgments, less efficient processing of information, loss of attention, anxiety and depression (Lahti, Leppämäki, Lönnqvist, & Partonen, 2006).

Another alleged biorhythm variable capable to produce mood alterations is the lunar cycle. The belief that the moon exerts an influence on human behavior is widespread both among specialists and the general public, in spite of the little empirical evidence from psychology and medicine. For instance Vance (1995) reported that 81% of mental health professionals believe that full moon alters individual behavior. Out of the eight moon phases observed by Galileo Galilei both superstitious beliefs and academic studies take into consideration only two: full moon and new moon. Due to the extra-light the full moon produces, the quantity and quality of sleep is prone to decrease. This lead to various behavioral changes, including mania through sleep deprivation. Conforming to Hippocrates's view that "no physician should be entrusted with the treatment of disease who was ignorant of the science of astronomy" (White, 1914), several studies claim that moon alters human behavior and increases the propensity for violence, suicides, accidents and aggression (Russell & Bernal, 1977; Snoyman & Holdstock, 1980; Thakur, Singh, & Kumar, 1987; Hicks-Caskey & Potter, 1992). On the other hand, no influence of the moon phases was found in any of the following studies, investigating the frequency of calls reporting disturbing behavior (Byrnes & Kelly, 1992), suicidal tendency (Mathew, Lindsay, Shanmuganathan, & Eapen, 1991; Martin, Kelly, & Saklofske, 1992; Biermann, Estel, Sperling, Bleich, Kornhuber, & Reulbach, 2005), hospital admission due to mental health emergencies and antisocial behavior (Gorvin & Roberts, 1994; Adamou, 2001; Zargar, Khaji, Kaviani, Karbakhsh, Yunesian, & Abdollahi., 2004), increase in incidence and severity of traumatic injuries (Coates, Jehle, & Cottingham, 1989), madness (Iosif & Ballon, 2012).

Having established the relevance of biorhythm variables on mood states, we examine, in the next section, the impact of mood misattribution generated by biorhythm variables on capital markets.

## **5. BIORHYTHM VARIABLES AND CAPITAL MARKETS**

Starting from psychological and medical evidences, empirical researches have tested whether biorhythm variables have an impact, channeled by mood, on capital markets <sup>4</sup>.

Due to the large proportion of individuals affected by sadness affective disorder (for instance in USA, according to Rosenthal (1998) more than 10 million Americans are severely affected by SAD and a further 15 millions are suffering a milder form), finance researchers have tried to establish a relation between the number of hours of daylight and equity returns based on psychological evidences (Horvath & Zuckerman, 1993; Smoski, Lynch, Rosenthal, Cheavens, Chapman, & Krishman, 2008). Through the link between SAD and depression and between depression and lowered risk aversion, Kamstra, Kramer & Levi (2003) find that seasonal depression, in a nine countries sample, is strongly linked to seasonal variations in stock returns. Dowling and Lucey (2005) found a correlation, in the same direction as Kamstra, Kramer & Levi (2003), between Irish equity returns and SAD but only between the Winter Solstice and the Spring Equinox. The same authors (Dowling & Lucey, 2008a), testing SAD effect on the UK stock market have found evidences of a SAD effect for the UK Small Index and in the opposite direction for the UK Main Index. A SAD effect for small caps is also found by Dowling & Lucey (2008b) on a sample of 37 countries; the effect is more pronounced for countries which are farther away from the equator, but there is no control for the January effect which is rather important in the small firms' case.

However, several studies have found no evidence of a significant relationship between SAD variable and stock returns in the sense Kamstra, Kramer, & Levi (2003) have described. Joshi & Bhattarai (2007) argue that equity returns are not influenced by SAD in the Nepalese stock market. Jacobsen & Marquering (2008) using a 48 countries sample show that a simple seasonal dummy explains better the seasonality in returns than the SAD effect. Gerlach (2010) basically confirms Kamstra, Kramer, & Levi (2003)'s results even if there are some differences among those two studies: the fall dummy variable is replaced with a winter dummy variable, the December effect is introduced, the countries sample is enlarged for the Southern Hemisphere with three more countries<sup>5</sup> and the SAD hypothesis is tested using predicted returns based on macroeconomic news. Despite the geographical position of Finland, Kaustia, & Rantapuska (unpublished results) were unable to find a SAD effect in the trading record of domestic investors in the Helsinki stock exchange. There is weak evidence that the length of day has a positive effect on the demand for stocks. Individual trading seems to be connected to vacations periods: individuals sell stock before and during the summer holidays and in December, prior to the holiday seasons. After the holiday period has passed they start buying stocks again.

The introduction of DST was proven to influence risk aversion and equity prices. Kamstra, Kramer, & Levi (2000), using a four country sample, state that desynchronized sleep makes market participants become anxious and prefer safer investment during the days that follows the disturbance in sleep pattern. As a consequence, stock prices are pushed down in the day that follows the daylight –saving shifts, especially in the fall, even if intuitively the effect in spring should be higher because of the loss of one hour of sleep. The effect seems to be stronger for small firms that have large representation in the equally weighted index, used in the study.

On the other hand, Pinegar (2002) argues, using a Bayesian approach (regarded as inadequate by Kamstra, Kramer, & Levi (2002), given the small number of observations) that the DST effect is driven by outliers associated with international stock market crisis and that daylight –saving shifts have just the effect of worsening the impact of international events. Similar results were obtained by Müller, Schiereck, Simpson, & Voigt (2009).

Worthington (2003) does not find any significant DST or weekend effect in the Australian equity market. Lamb, Zuber, & Gandar (2004), in a study conducted in US markets, find lower returns only on half of the total DST change weekends and significant only for the fall DST change. Dowling & Lucey (2005) have proved that DST is significantly correlated with the Irish stock exchange. For the UK market, results are inconsistent between the Small index and the Main index: the results show a prevalent negative correlation in the case of the Main index and positive in the case of the small index (Dowling & Lucey, 2008a).

As to the effects of full moon on capital markets, Dichev & Janes(2003) observe lower returns around the full moon due to the heightened risk-aversion and more pessimistic prospects of future cash-flows, in US market and 24 other countries over a 30 year period. Gerlach (2007) finds a lunar pattern in the US market, with higher returns associated with full moon days, mainly due to the announcement days. The findings by Dichev & Janes(2003) are basically confirmed in Yuan, Zheng & Zhu (2006), Wang, Lin & Chen (2010), Keef & Khaled (2011), Nissim, Liran, & Eshel (2012). Yuan, Zheng, & Zhu (2006) state that lunar effect is independent of announcements of macroeconomic indicators, global shocks or other calendar related anomalies, but that it is stronger for emerging economies. Opposite results are found by Liu (2009), who shows that for most of his sample of emergent Asian economies the full moon effect determines not lower but higher returns, whereas they are inversely related to company size in the US case. Opposite results have also been found in UK by

Dowling & Lucey (2008a), who show that the correlation between lunar phases and equity returns is higher for the main index compared with the small capitalization index.

The contrasting results emerging also from the studies investigating the link between biorhythm variables and equity returns are not surprising and suggest the need for a different approach. In the next section we provide an assessment of the relation between mood, individual financial decision and aggregated capital market variables in order to better explain the inconsistencies found in the reviewed studies.

## **6. WEATHER AND BIORHYTHM EFFECTS ON CAPITAL MARKETS: AN ASSESSMENT.**

According to the vast empirical literature, weather and biorhythm variables are two of the major non-economic variables affecting the investor's risk taking attitude and trading behavior. Such an influence at the individual level may not, however, be reflected in the aggregate market prices and returns. Although in some cases there appears to be a correlation between weather and biorhythm and capital market aggregate variables, the empirical results are overall highly inconclusive. The correlations are not significant both in cross-country studies and in country focused studies, suggesting the need for a multidisciplinary approach to study the effects of non-economic variables on the decision making process.

It must be noticed that results from cross-country studies can hardly be reliable due to the differences among countries in weather pattern, weather adaptability, capital market features, macroeconomic and institutional environment. The different results obtained in different countries are unsurprising, since the methodologies employed are different and several studies did not take into account additional independent variables that affect mood and financial markets. The studies reviewed, with the exception of Bassi, Colacito, & Fulghieri

(unpublished results), do not investigate the direct effect of weather and biorhythm on mood but focus instead on their influence on the value of stock indexes based on psychological evidences that link those factors to mood and mood to risk taking.

As suggested by Mehra & Sah (2002), a connection between investor's feelings and equity prices is present, only if investor's subjective evaluations vary unconsciously over time due to a change in mood and if these effects are widely and uniformly experienced by all market players. However, due to the high degree of internationalization in the capital markets it is difficult to think of a uniformly distributed weather effect among a large proportion of market participants because they are not exposed to the same weather conditions. In addition, the more open and efficient the capital market is, the less the impact of weather effects on equity prices. Another crucial issue is to understand the true nature of the effects that a certain mood could induce in risk taking attitude among. The same factor (a strong wind, a sunny day, a Daylight Saving Time (DST) change or a lunar phase change) typically produces different effects on mood and on risk-taking attitude, for different individuals.

Two main frameworks have been proposed in the past decades in order to describe the link between mood and risk taking: the Mood Maintenance Hypothesis (MMH) proposed by Ise, Nygren, & Ashby (1998) and the Affect Diffusion Model (AIM) proposed by Forgas (1995)

The MMH model is based on the idea that, independently of the current mood, the main goal of any individual is to achieve and maintain well-being. In a good mood, the individual will avoid risky situations in order to preserve the good state. In the case of a bad mood situation, the individual will choose riskier alternatives hoping that the possible gains will lift his spirit. This idea is also supported by Parker & Tavassoli (2000) and Kliger & Levy(2002) who demonstrate that individuals with a better mood have a higher risk aversion.

The AIM model suggests instead that subjects in bad mood have a more pessimistic view of the world, perceive situations as riskier, and have, as a result, a lower propensity toward risk taking. On the other hand, individuals in a positive affective state, who usually have a more optimistic view and perceive a safer environment, should be more prone to risk taking. The key assumption in the AIM model is that the effects of mood tend to be exacerbated in complex situations (HAIS – high affect infusion strategies) that demand substantial cognitive processing, comparing with little generative, constructive processing (LAIS-low affect infusion strategies). In other words, as situations become more complicated and unanticipated, mood becomes more influential in driving evaluations and responses. Consistent with the principles of AIM, Yuen & Lee (2003), Kamstra, Kramer, & Levi (2003), Kuvaas & Kaufmann (2004), Dolvin & Pyles (2007) and De Vries, Holland, Corneille, Rondeel, & Witteman (2010) found strong connections between mood and assumed risk.

Individuals are pretty different. Hence, the impact of changes of mood may have heterogeneous effects on the risk taking attitude. The relation between mood and risk taking has been demonstrated to be influenced by several factors such as gender, age, genetic heritage, functioning of the endocrine system and personality traits. Due to its complex nature, human attitude towards risk cannot be explained using the knowledge from a single research field. The complexity of the human behavior clearly represents a further motivation for the integrative approach proposed in the final section.

The different impact of mood according to gender is found by Fehr-Duda, Epper, Bruhin, & Schubert (2011), who, on the basis of a laboratory experiment, demonstrate that women in elated mood are tempted to weigh probabilities more optimistically and take more risk as a consequence. Conversely, a large proportion of men is apparently not influenced by mood effects and tends to apply criteria such as maximization of expected utility.

Age also seems to matter: Chou, Lee, & Ho (2007) have identified an asymmetrical

effect of positive and negative mood on risk taking tendency in the participants to their experiment, depending on age. They have found that there is a tendency not to take risky decisions when in a bad mood compared with the cases when in a good or neutral mood, thus supporting the AIM model. What makes the difference between older and younger participants is in the way their propensity towards risk varies, when the mood is changing. These findings are consistent with the phenomenon of negativity bias documented for younger persons by Cacioppo, Gardner & Berntson (1999) and Wood & Kisley (2006) and with the prediction of the socioemotional selectivity theory (Carstensen, 1993; Carstensen, Isaacowitz & Charles, 1999; Mather & Carstensen, 2005; Pruzan & Isaacowitz, 2006; Carstensen, 2006). Extreme negative events or images produce greater brain reaction than equally extreme positive events in younger adults. In older adults cognitive functioning and positive emotion plays a more important role.

Genetic studies have proved that risk-taking attitude could be also associated with the presence of certain types of genes. (Ebstein, Novick, Umansky, Priel, Osher, Blaine, Bennet, Nemanov, Katz, & Blemaker, 1996; Ronai, Szekely, Nemoda, Lakatos, Gervai, Staub, & Sasvari-Szekely, 2001; Roe, Tilley, Gu, Beversdorf, Sadee, Haab, & Papp, 2009; Kuhnen & Chiao, 2009). As a consequence the same mood could affect differently two individuals with different genetic heritage.

Recent work in Neuroeconomics has shown that the endocrine system plays a very important role in financial risk-taking. A higher level of testosterone reduces anxiety through decrease in fear and stress resilience. As a result, the motivation to act and the ability to acquire and defend social status increase (Eisenegger, Haushofer, & Fehr, 2011). Plus, a raised testosterone level was proven to affect bargaining behavior by increasing the frequency of higher offers and decreasing the risk of social conflict occurrence (Eisenegger, Naef, Snozzi, Heinrichs, & Fehr, 2010). Coates & Herbert (2008), using a group of male traders in

London City, have shown that traders' testosterone rises on days when they make more money than average and as a result their risk-aversion is lowered. When markets are more volatile the level of cortisol increases and risk-aversion increases as a result, despite the general mood influence.

Personality influences the impact of mood on risky behaviors, both in a direct and indirect fashion. Individuals characterized by a high openness to feelings<sup>6</sup> have a more mood influenced risky behavior. Conversely, individuals with low openness to feelings are better at controlling their feelings and show a weaker mood effect on risk taking tendency (Berkowitz, Jaffee, Jo, & Troccoli, 2000; Chuang & Chang, 2007). Personality also influences behavior indirectly. A risky behavior could be generated by the desire to obtain or enhance a well-being status (enhancement motives) or by the desire to avoid a negative emotional state (coping motives). Cooper, Agocha, & Sheldon (2000) show that neurotic individuals are predominantly driven by coping motives and engage in risky behaviors as a way to cope with negative mood states. By contrast, extravert individuals are more likely to take more risk as a way to enhance positive mood states. Impulsivity increases the probability that a neurotic individual will take more risks as a result of a negative mood while an extravert individual takes more risks as a result of a positive mood (Cooper, Agocha, & Sheldon; Cyders, Smith, Spillane, Fisher, Annus, & Peterson, 2007).

The need for a new multidisciplinary research agenda to understand the complex relation between weather and biorhythm variables on mood and financial markets appears to be undisputable.

In the concluding section we attempt to suggest a new comprehensive framework which might prove useful for future research.

## **6. Conclusions**

The influence of weather and biorhythm variables on individual behavior and risk taking attitude appears to be strong, although it may not be reflected by the dynamics of prices and aggregate variables. Aggregate econometric models cannot capture the determinants of individual human decisions. Cross country analyses are even more difficult to interpret, given the differences in climate, institutions and economic environment across different states.

Individual reactions to changes in mood induced by weather and biorhythm variables and the capital markets reactions remain an extremely important topic in the research agenda. The most important question to be answered is what approach to use to shed further light on this issue.

An important element to be considered is the dynamic nature of the decision making process in capital markets. Decisions are interdependent (each decision could be both determined by previous decisions and determinant for futures decisions) and they have to be taken in real time (bringing extra-stress and decreasing the decision performances). The investors' decisions and the current changes in the capital market determine in turn, modifications in the state of the decision problem.

The complexity of the problem might explain why the standard econometric tests reviewed in the present paper can provide only limited information. A potential solution could be the use of an agent-based-model as a bottom-up tool to understand the complexity of the problem. The main criticism of agent-based-modeling is that the initial conditions, crucial for the creation of the artificial market where agents interact, are just as arbitrary and unrealistic as the assumption of rationality and utility maximizing behavior. However, interdisciplinary research, combining genetic, psychological and neurological tests and experiments may be used to define deep parameters and the set of rules governing the artificial markets.

A possible research plan could be to: design an experiment where molecular genetic tests could be used to assess the genetic predisposition towards risk and to divide the participants to the experiment into two categories: genetically predominant risk-averse individuals; and, risk-seekers individuals. Both groups should include individuals that usually trade on capital markets and are used to taking dynamic decisions. Psychological tests might then, reveal the effects of weather and biorhythm variables on mood during several non-consecutive periods. The impact of changes of mood on individual financial decisions could at this stage be investigated by means of experimental economics and neurological tests. Neuroimaging using functional Magnetic Resonance Imaging (fMRI) could be used in order to assess the effects of enhancing mood states on individual risk taking. The results obtained by psychological tests and fMRI tests should be compared with the participants' actual trading behavior for the analyzed period (trading volume, bid-ask spread, return volatility).

In conclusion the reductionist approach should be replaced by interdisciplinary work in order to shed new light on the complex and important issue of the effects of mood misattribution on investment decisions.

### **Footnotes:**

<sup>1</sup>The multidimensional interactions between feelings and investor decision making are extensively discussed in the comprehensive survey by Lucey & Dowling (2005)

<sup>2</sup> More details can be found in Section 5

<sup>3</sup> According to Poret (1998), no more than 49% of non-resident purchases were previously allowed on the stock market

<sup>4</sup>The possible interaction between such "mood proxy" variables and equity returns is extensively discussed by Lucey & Dowling (2005)

<sup>5</sup> Kamstra, Kramer & Levi (2003) did not include Chile in their sample. Gerlach (2010) includes in his study Chile and other two countries, Argentina and Brazil.

<sup>6</sup> Costa & McCrae (1985) have developed a scale to measure the intensity of feelings

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