DOES WEATHER AFFECT STOCK RETURNS ACROSS EMERGING MARKETS?

by

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Abstract

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This paper tests the relationship between stock market variables (indices returns, individual stocks' returns, spreads and trading volumes) and the weather in transition countries of Central and Eastern Europe and CIS. Weather is considered to be a proxy for the mood factors that affect decisions of investors and traders. It is hypothesized that they tend to be more optimistic about the market prospects if the weather is warm and sunny and are more pessimistic if it is rainy and cloudy. Hence, market players are more predisposed to buy stocks when the weather if fine and sell them when the weather is bad. While some significant effects are found, the overall impression the results give is that there is little evidence of a systematic effect of weather on stock markets in Eastern Europe, and hence, that it is unlikely one could make money on the stock market from accurate weather forecasts.

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GLOSSARY

Bid-Ask Spread – difference between bid and ask prices; indicator of liquidity of an asset.

CEE - Central and Eastern Europe.

CIS – Commonwealth of Independent States.

NY – New-York.

Chapter 1

INTRODUCTION

The most common assumption in economic models is that markets are driven by rational individuals who make inferences and rational choices based on available information. However, is this really so? People often tend to be driven by their mood in their deeds and behaviour. Many psychological studies confirm the fact that depending on the mood individuals are more predisposed to either pessimistic or optimistic expectations (Arkes et al., 1988; Etzioni, 1988; Romer, 2000). Therefore, economic agents including investors and stock market traders also should be influenced by subjective stances (e. g. mood, feelings etc) when making their decisions. Moreover, weather influences people's mood in such a way that sunny days are associated with positive perception of the world and information while rainy or cloudy days are often associated with depressed mood and pessimism (Cunningham, 1979; Howarth et al., 1984). The psychological literature argues that people feel happier during sunny days while lack of sunshine has an opposite effect (Schwarz et al., 1983; Eagles, 1994). This is mainly due to perception of bright colours and sunlight as irritants that influence and evoke positive feelings while grey sky and darkness are connected with negative emotions. There is even a special sunlight treatment method that claims to cure depression, apathy and melancholy (McAndrew, 1993). Hence, weather can affect stock market players like any other people in their decisions through psychological channels of mood and perception. This in turn might impact stock returns as investors are more willing to buy stocks during sunny weather and are more predisposed to sell if there are bad weather conditions. This is known as deficient market hypothesis theory that predicts movements of the stock market based on psychological factors.

The paper aims at investigating whether there is any significant impact of weather on daily stock returns in the following transition countries: Ukraine (PFTS Index), Poland (WIG Index), Russia (RTS Index), Hungary (BUX, RAX Indices), Czech Republic (PX Index), Romania (BET Index), Croatia (CROBEX Index), Slovenia (SBITOP Index), Bulgaria (SOFIX Index), Slovakia (SAX Index), Estonia (TALSE Index), Latvia (RIGSE Index), Lithuania (VILSE Index). It is to be tested whether there is a relationship between stock returns and the following weather indicators: temperature, cloud cover, atmospheric pressure, wind, precipitation, humidity, and visibility. Also the impact of weather variables on individual stock returns, their spreads and daily trading volumes of Blue Chip stocks of Central and Eastern European (CEE) countries is to be estimated.

The impact of weather on stock returns has not been researched yet for Ukraine, Romania, Croatia, Slovenia, Bulgaria, Slovakia, and Baltic States. It is the first time that someone tries to test how weather related variables affect Russian RTS Index, polish WIG Index, Hungarian BUX Index, and Czech PX Index. Jacobsen et al. (2008) used data for these and other emerging markets in the investigation of weather impact on MSCI (Morgan Stanley Capital International) Indices returns[1] but not on the RTS, WIG, BUX, PX Indices this research is looking at. It is especially interesting to compare results for CEE stock exchanges with those for Ukraine as it might give a deeper understanding of the reasoning behind certain investors' sentiments in the neighbouring markets. Financial markets in these countries grow very fast and promise great returns in the future. However, they have not been studied yet as much as other countries'. Moreover, the weather impact on stock

[1] MSCI Indices are developed by Mogran Stanley to track performance of most liquid and attractable for investment purposes equities within almost 100 markets worldwide. They differ from national indices by basket composition, weights assigned to each stock within the basket and calculation techniques. www.mscibarra.com/products/indices/equity/index.jsp

market is investigated in only dozen of papers so far in the world and none of them studies CEE and CIS states. Results of these studies find a significant impact of weather on stock returns for some countries and none for others. Thus, this paper is to check if transition countries in the consideration are weather sensitive. The investigation of a degree to which market players in transition economies make their business decisions based on weather related mood factors is challenging and very interesting from the academic point of view as psychological factors are likely to impact investors more in countries with less developed financial markets like CEE and CIS states, where the uncertainty is greater.

The rest of this paper consists of five parts. First, a review of relevant academic literature on the impact of weather on stock returns is presented. Second, the data on weather variables and stock market data is described. Next there is a detailed explanation of the methodology used to evaluate the effect of weather on stock returns, trading volumes and spreads. Fourth, a regression analysis is performed the results of which are discussed. Finally, conclusions and suggestions for future research are made.

C h a p t e r   2

LITERATURE REVIEW

There exists a sizable academic literature on the effect of weather on stock returns. Researchers argue that good weather impacts investors' mood and they, in turn, might wrongly attribute positive feelings as such that indicate about favourable prospects of financial markets (even though it is just a good weather effect). The opposite reasoning holds for bad weather conditions. Some researchers have found a significant negative relationship between cloud cover and returns on stocks (Saunders, 1993; Hirshleifer and Shumway, 2003; Chang, Shao-Chi et al., 2008; Chang, Tsangyao et al. 2006; Dowling et al., 2005; etc). Others, however, argue that there is no such a relationship and find it to be insignificant (Loughran et al., 2004; Jacobsen et al., 2008; Krämer et al., 1997; etc).

Investors in countries of transition could be influenced more by psychological factors than those in developed economies due to a lower level of development of financial markets. Iarina (2008) finds that subjective perception of a current situation has the greatest influence on formation of positive expectations in developing economies and not that great in developed ones. Hence, market players in developing economies could be driven by mood and subjective stances with a higher probability than those in the developed ones. Therefore, the impact of weather on investors and traders might be higher in Ukraine and its neighbouring countries under consideration than in European and North American nations being researched so far.

From here, we will first focus on psychological studies about the impact of weather on human behaviour, then proceed with the overview of the existing literature about the influence of weather on stock returns, and finally, conclude with a discussion of empirical methods used by researchers.

The efficient market hypothesis is a theory claiming that given rational behaviour of all investors, current market prices reflect the discounted future cash flows (Fama, 1970). That is market players account for all possible events in their decision making and set prices accordingly. However, Hirshleifer (2001) argues that investors are irrational and their decisions are affected by different subjective factors. This theory is often referred to as Deficient Market Hypothesis. The main idea of it is that wrong decisions by market participants cause securities to be priced incorrectly. In this research we are interested in factors that influence investors' choices such as climate and weather; and emotions through which these two operate.

In their research Lo et al. (2001) concentrated on the role of emotions in stock market traders' behaviour and decision-making. They find a significant correlation between psychological stances and the way markets move (e.g. upward/downward) and claim that emotions improve traders' performance and ability to adjust to volatile environment. Another research conducted by Ashbury at al. (1999) also suggests that people in a good mood perform better as they tend to superimpose current positive outlook on an assignment being carried out at the moment.

Environmental psychology tries to explain how surroundings affect human behaviour. Weather is one of the main factors that influence a person's mood and the way one feels. Experiments of Bell et al. (2003) have shown that cold makes people be more predisposed to sadness and melancholy but its influence is slight and almost insignificant. Scientists (Bell et al., 2003) argue that heat, on the other hand, has a strong negative impact on human behaviour and claim that violence increases rapidly during the high-temperature periods of a year.

Psychologists also say that people become more optimistic during sunny weather and more pessimistic during rainy or cloudy days (Eagles, 1994; Rind, 1996). Good mood and positive outlook in turn positively affect the perception of reality and future. (Herren et al., 1988). Such a positive feeling affects people's decisions that are usually made in accord with their mood (Schwarz, 1990). Thus, investors that are in a good mood are inclined to invest in riskier projects as they believe in a success of their ventures (Herren et al., 1988).

The pioneer in the field of exploring the impact of weather on stock returns was Saunders (1993) who investigated how local weather affects New-York City Exchange indices. The author found a strong negative relationship between cloud cover and returns on stocks. Later on Hirshleifer and Shumway (2003) have repeated Saunder's research but using data on stock indices of 26 countries. They have confirmed previous developments and found that sunshine has a significant positive correlation with stock returns. However, they have concluded that using weather as a determinant of a pattern of stock trades is efficient only for low transaction costs investors.

Similar results are obtained for the Irish Stock Market by Dowling and Lucey (2005). These authors have found that a 'rain' variable is significant while estimating the model of weather effects on stock returns.

The impact of weather on trading volume is studies by Loughran et al. (2004) who have found a negative relationship between the amount of blizzard strokes and trading volumes. Chang et al. (2008) research the extent to which cloud cover influenced spread measures of New-York Stock Exchange during 1994-2004 and conclude that there is little correlation between these variables.

A critical view on Saunder's findings is expressed by Krämer and Runde (1997). They used German stock index data and found that local weather does not affect short-term stock returns. Also Loughran and Schultz (2004) argue that it is better to use data on local weather in home-cities of investors listed on New-York City Exchanges in Saunder's study. That is due to the fact that many investors are located in different parts of the USA even though they trade on New-York Stock Market. Loughran and Schultz (2004) have found no significant relationship between the local weather in the home-city of a company and stock returns. Pardo et al. (2003) confirmed the above argument and found no effect of weather variables (sunshine and humidity) on stock returns for Madrid Stock Exchange. Worthington (2006) came to the same conclusion using Australian stock market data as well as Tufan (2004) using data for the Istanbul Stock Exchange.

It is argued by Chang et al. (2008) that it is the intraday weather pattern that influences investors' behaviour. They have found that cloud cover affects the returns on stocks only at the beginning of the trading day, specifically, only during the first 12-15 minutes of the working day. They explain this finding by the fact that traders and investors are impacted by the weather conditions only on their way to work and, then, while at the office they do not really feel the weather influence due to the presence of air-conditioners and lack of windows (as is most probably the case). Hence, the effect of cloud cover declines very quickly.

Locke et al. (2007) suggest that traders' afternoon behaviour is influenced by morning weather more than by the weather during other parts of the day. In this research authors found that wind causes the effective bid-ask spread to widen. They explain this conclusion claiming that ion imbalance caused by the wind affects the mood of market players and, as a consequence, market quotes.

Whether there is any effect of temperature on stock returns was examined by Cao and Wei (2005). Researchers argue that aggressive behaviour is often a result of low temperature while both apathy and aggression can be consequences of high temperature. Therefore, they have hypothesised negative relationship between stock returns and temperature and have actually found it to be significant.

Using Taiwanese stock market data Chang et al. (2006) have confirmed an existence of a significant relationship between temperature, cloud cover and stock returns. They included temperature as an explanatory variable into their model and found that stock returns are higher when the temperature is within normal bounds; though, they tend to be lower when it is extremely hot or cold and when the cloud cover is heavier.

The most recent paper of Jacobsen et al. (2008) argue there is no negative effect of temperature on stock returns, though authors do not reject that there is a strong seasonal anomaly: stock returns appear to be lower in summer and autumn and higher in winter and spring months. Thus, seasonality issue is closely related to our debate about the weather impact on stock returns. One has to account for so-called calendar effects that are thought by some researchers to have a significant impact on financial markets. In general winter and spring months are associated with higher stock market returns than summer and autumn months (Bouman et al., 2002). Saunders (1993) argues that market usually shows an upward movement in January as investors' activity increases due to holiday rush. Others explain the significance of January effect by the fact that at the end of a tax year (December) prices tend to decrease, but then rise again during the first month of a new year (Al-Khazali et al., 2008). Scientists explain existence of calendar anomalies due to errors in data and methods used to evaluate the impact, as well as due to micro-market and information flow effects (Pettengill, 2003).

As for the estimation techniques, linear models are mostly used to trace the effect of weather on stock returns (Saunders, 1993; Hirshleifer and Shumway, 2003 Dowling et al., 2005 Krämer et al., 1997). Some researchers use GARCH technique (Chang et al., 2006).

The literature examined above can be divided into two categories: the one that finds that weather affects stock returns, and the other that argues that there is no such an effect. However, none of them studies CEE and CIS states. Thus, the paper aims at checking if transition countries in the consideration fall under the category of weather sensitive or weather proof ones. An effect of weather on stock market variables is expected to be found, because psychological factors are expected to impact investors more in countries with less developed financial markets like those of the CEE and CIS states.

Chapter 3

DATA DESCRIPTION

The present research considers 13 CIS and CEE countries that are situated in close proximity with each other, have integrated markets and are culturally and historically interconnected. Daily weather data for home cities of stock exchanges (all capitals) of the specified above countries is used and is available from GisMeteo[2] and RussianWeather[3] historical archives that contain countries' weather stations datasets. Only capitals are considered in the analysis as traders outside a capital city are usually small players and their trading volumes do not have significant influence on stock prices and returns. This is true for emerging markets considered in the present research, though not necessarily so for developed economies. Available sample periods differ across countries, but are not less than 6 years (see table 1 below). The reason why sample periods differ is because different countries have introduced their indices at different times, as well as different stocks have gone public at different times. Stock market daily data (historical values of indices, individual stock prices, and trading volumes) is available from Bloomberg database and from the corresponding exchange web-sites.

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[2] http://www.gismeteo.ru/salist.htm

[3] http://meteo.infospace.ru/koi/wcarch/html/r_index.sht

Table 1. Returns data general description

Variable	Obs	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
PFTS	2 323	0.00153	0.02000	-0.151	0.222	0.351	15.039
WIG	1 846	0.00050	0.01548	-0.074	0.064	-0.023	4.268
RTS	1 762	0.00163	0.02239	-0.162	0.168	-0.102	7.952
BUX	1 907	0.00045	0.01657	-0.106	0.077	-0.222	4.881
PX	972	0.00061	0.01507	-0.056	0.106	0.168	5.809
BET	1 850	0.00079	0.01900	-0.189	0.155	-0.233	14.340
CROBEX	345	0.00040	0.01440	-0.087	0.074	-0.848	10.605
SBITOP	1 061	0.00117	0.01106	-0.063	0.067	0.068	7.416
SOFIX	1 482	0.00217	0.01974	-0.192	0.232	1.007	30.674
SAX	3 112	0.00003	0.01300	-0.069	0.068	-0.064	6.756
TALSE	1 878	0.00107	0.01221	-0.056	0.081	0.336	7.150
VILSE	866	0.00132	0.00972	-0.043	0.047	0.339	5.451
RIGSE	921	0.00152	0.01854	-0.137	0.099	-0.528	17.099

Note: see detailed indices description in Appendix A.

Index returns are calculated as follows:

$IndexRet_t = (IndexPrice_t / IndexPrice_{t-1}) - 1$

Individual stocks taken into consideration are the most liquid stocks of the corresponding exchanges. Individual stock returns are calculated as follows:

$StockRet_t = (StockPrice_t / StockPrice_{t-1}) - 1$

It can be seen from table 1 that stock returns exhibit high volatility. It is especially evident for countries like Ukraine (PFTS), Russia (RTS), Latvia (RIGSE), Bulgaria (SOFIX) and Romania (BET) that have the highest standard deviation values. Statistics on kurtosis is higher than 8 for Ukraine (PFTS), Romania (BET), Croatia (CROBEX), Bulgaria (SOFIX) and Latvia (RIGSE) and suggests that distribution of returns is leptokurtic. Values of skewness are high as well and are positive for some indices returns but negative for others. Clearly, data on stock returns exhibit non-normality.

Weather data includes the following parameters: temperature, cloud cover, atmospheric pressure, wind, precipitation, visibility and humidity measured at

12 pm daily. Sample periods and number of observations are matched with those for the indices and individual stocks. *Wind* variable ranges from 0 to 33 where 0 is no wind level. *Cloud Cover* ranges from zero (clear skies) to 3000 (heavy clouds). *Precipitation* is measured from zero (dry weather) and above in mm. There are fewer observations on *precipitation* than on other weather variables for most of the countries due to data unavailability. *Visibility* is the distance away at which a target can be seen regardless of weather conditions. Its values range from 0 (objects not visible at 20 miles distance) to 60 (objects are not visible at above 50 yards distance). Descriptive statistics of weather variables can be found in Appendix B.

Chapter 4

METHODOLOGY

Linear models (OLS) are used to test the relationship between stock returns, spreads and trading volumes and weather variables. However, it is argued by Chang et al. (2006) that a GARCH model may be a better tool for estimation as stock market data exhibits heteroscedasticity (see Appendix D for results of a heteroscedasticity test). Also stock returns are characterized by the so-called "volatility clustering" when observations are high during some periods of time and low during others causing time variability of amplitude of returns (Engle, 2001). Hence, GARCH technique is used along with OLS. Threshold estimation is implemented to test if weather variables higher (or lower) than a threshold value have more significant effect on human behaviour, hence, stock returns. It is hypothesized that extreme weather conditions (like much higher than normal temperature or much stronger than normal wind level etc) are more likely to impact people's mood. Therefore, threshold values are calculated to account for the effect of large deviations from normal weather conditions. Threshold values are found following Chang et al. (2006) and Chan (1993). First, observations are sorted in the ascending order and then 5% of the highest and 5% of the lowest values are deleted. Remaining observations are used to determine threshold values which minimize the residual sum of squares[4]. Threshold values are estimated in such a way because there is no priory knowledge about them, and the method described above gives consistent estimates as proven by Chan (1993). Threshold values for each country can be found in Appendix E. First, models without a threshold are evaluated and then threshold estimation is performed. Only

[4] The value that minimizes RSS is found using macros programming (loop function) in Excel.

OLS is used in case if $\beta_1 = \beta_2$ and $W^{up} = W^{down} = 1$, where W^{up} is a dummy variable equal to 1 if $v_t > \tau$ (threshold); W^{down} is a dummy variable equal to 1 if $v_t < \tau$ (threshold). v_t is the vector of weather variables that includes *temperature, atmospheric pressure*, *humidity, cloud cover*, *wind*, *visibility* and *precipitation.*

No threshold models are:

OLS

$IndexRet_t = \beta_0 + \beta_1 v_t + u_t$

GARCH

$IndexRet_t = \beta_0 + \beta_1 v_t + u_t$

$\sigma^2_t = \alpha_0 + \alpha_1 \sigma^2_{t-1} + \alpha_2 IndexRet^2_{t-1}$

Threshold models are:

OLS

$IndexRet_t = \beta_0 + \beta_1 W^{up} v_t + \beta_2 W^{down} v_t + u_t$

GARCH

$IndexRet_t = \beta_0 + \beta_1 W^{up} v_t + \beta_2 W^{down} v_t + u_t$

$\sigma^2_t = \alpha_0 + \alpha_1 \sigma^2_{t-1} + \alpha_2 IndexRet^2_{t-1}$

where σ^2_t is a conditional time dependent variance.

The essence of GARCH model is that it uses heteroscedastic errors to model variance. "The GARCH updating formula takes the weighted average of the unconditional variance, the squared residual for the first observation and the starting variance and estimates the variance of the second observation. This is input into the forecast of the third variance, and so forth. Eventually, an entire time series of variance forecasts is constructed" (Engle, 2001). Hence, GARCH uses heteroscedasticity to produce robust variance estimators that are used in computation of t-statistics.

Also, the impact of weather variables on individual companies' stock returns, bid-ask spreads and trading volumes is to be estimated. GARCH is not used in estimation of the impact of weather on individual stocks' returns, spreads and trading volumes as number of observations are sometimes too small for some of the companies and volatility of data is not large (while GARCH assumes volatility clustering discussed above). Hence, it is hard for Stata (or other statistical packages) to find an uphill direction where a maximum of the loglikelihood function can be found to obtain regression results.

No threshold models are:

OLS

$StockRet_t = \beta_0 + \beta_1 v_t + u_t$

$Spread_t = \beta_0 + \beta_1 v_t + u_t$

$TrVol_t = \beta_0 + \beta_1 v_t + u_t$

Threshold models are:

OLS

$StockRet_t = \beta_0 + \beta_1 W^{up} v_t + \beta_2 W^{down} v_t + u_t$

$Spread_t = \beta_0 + \beta_1 W^{up} v_t + \beta_2 W^{down} v_t + u_t$

$TrVol_t = \beta_0 + \beta_1 W^{up} v_t + \beta_2 W^{down} v_t + u_t$

where $Spread_t = 1 - (BidPrice_t / AskPrice_t)$

Bid-ask spread is an indicator of liquidity of an asset: the smaller the spread, the more liquid the stock is.

Seasonal dummies (like *Winter, Spring, Autumn*, *January, December)* are included into the regressions to control for seasonality. *January* and *December* dummies are needed (following Saunders, 1993) to account for the so-called "Holidays effect" when stock market shows upward movements in stock prices due to increased investor activity (possibly connected with holiday rush).

It is also tried to include New-York (NY) weather variables and S&P 500 Index returns into the regressions to control for exogenous effects. If the majority of investors that trade stocks of Ukraine and other countries being analyzed are located in New-York, the main financial centre of the world, then it is reasonable to conclude that NY's weather affects stock markets in these countries. Statistics on the amount of portfolio investment from USA to analyzed countries can be found in Appendix F. According to it, significant share of investment indeed comes from USA for almost all of the countries. First, only NY weather variables are included into the regressions. Then S&P 500 Index returns are added to account for external shocks to national economies.

It should be stressed that all weather variables represent exogenous influence on stock returns; hence, the model avoids endogeneity problems as stock indices obviously can not be expected to influence the weather. The analysis tries to reveal possible relationship between the returns on stocks/indices and psychological factors having weather variables as proxies for the mood of the stock market players. Also based on the assumption that weather variables are not correlated with other possible factors that affect stock returns, omitted variable bias is not an issue.

In general if the relationship is present, it is expected that wind, cloud cover, precipitation affect stock market variables negatively, while visibility and temperature, on the other hand, positively as is the case in studies conducted by Saunders (1993), Hirshleifer and Shumway (2003), Chang, Shao-Chi et al. (2008), Chang, Tsangyao et al. (2006), and Dowling et al. (2005), Loughran et al. (2004), Jacobsen et al. (2008), Krämer et al. (1997). In case a relationship between the specified variables is found, it would mean that investors in transition countries are influenced by their mood and the weather in the decision-making process. Therefore, asset pricing models used for companies in emerging markets should account for this impact.

Finally, low R-squared value is expected as variation in weather variables can not encompass all variation in stock returns.

Chapter 5

RESULTS

First, stock market and weather data series are tested for stationarity and autocorrelation using ADF and Durbin-Watson tests. Unit root tests are essential as previous studies have found that stock returns and weather time series might exhibit non-stationarity and autocorrelation. The results of the tests (see table 2 below) show that series are stationary which can also be seen from the Figure below for PFTS stock returns (all other stock market data exhibits a similar pattern – see Appendix C).

Figure 1. Time series of PFTS stock returns.

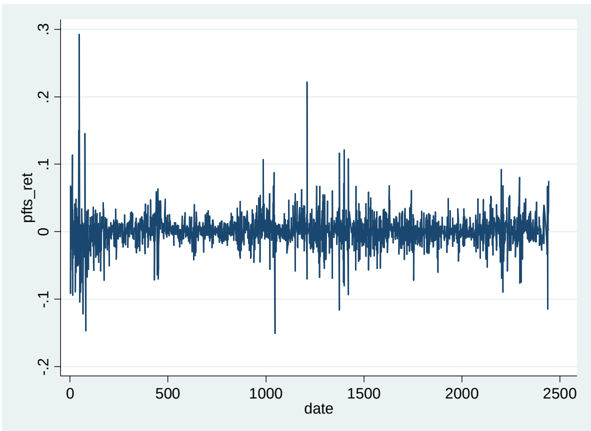

Table 2. Results of tests for stationarity and a unit root.

Variable	ADF	DFGLS	Pperron	KPSS
PFTS	-25.711(2)***	-	-51.874(8)***	-
WIG	-27.247(2)***	-20.959(1)***	-46.059(8)***	0.223(26)
RTS	-29.311(2)***	-32.755 (1)***	-44.844(8)***	0.11(1)***
BUX	-30.022(2)***	-28.457(1)***	-44.766(8)***	0.197(1)***
PX	-37.431(1)***	-21.062(1)***	-48.034(8)***	0.255(26)
BET	-33.262(1)***	-29.026(1)***	-47.335(8)***	0.412(26)
CROBEX	-11.726(1)***	-11.018(1)***	-15.423(4)***	0.107(1)***
SBITOP	-26.518(1)***	-23.333(1)***	-30.468(7)***	0.37(26)
SOFIX	-31.047(2)***	-29.691(1)***	-48.714(8)***	0.185(1)***
SAX	-32.535(1)***	-21.987(1)***	-44.734(8)***	0.318(26)
TALSE	-32.535(1)***	-21.987(1)***	-44.734(8)***	.318(26)
VILSE	-20.842(3)***	-20.337(1)***	-42.885(7)***	0.455(26)
RIGSE	-28.767(1)***	-24.696(1)***	-43.624(8)***	0.212(1)***

*Notes: *** - significance at 1% level; number of lags in parentheses; number of lags of ADF test ensures no autocorrelation based on Durbin-Watson test for autocorrelation.*

First, linear models (OLS) are used to test the relationship between stock returns, spreads and trading volumes and weather variables. However, due to heteroscedasticity of stock market data GARCH model is used to investigate the issue more closely. If maximum loglikelihood function does not converge to its maximum when GARCH is run, only OLS results are reported.

INDICES RETURNS RESULTS

Table 3[5] reports OLS regressions results of threshold model estimation for stock indices. According to it, no effect of weather variables on indices returns is found for Romania (BET), Slovenia (SBITOP), Latvia (RIGSE), Bulgaria (SOFIX), Lithuania (VILSE), and Croatia (CROBEX). There is a positive effect of *wind* level lower than a threshold value of 4 and 3 on returns for Czech Republic (PX) and Estonia (TALSE) correspondingly. *Precipitation*

[5] Some weather variables are missing form the regression results for some countries (e.g. $visibilit^{up}$ for *PFTS* is missing as the threshold value for *visibility* in Ukraine is equal to 50 which is also a maximum value of this variable; hence, there are no observations for $visibilit^{up}$ in this case). Another reason for some weather variables to be missing is that there are not sufficient observations on weather variables to run a regression when they are merged with stock market data (i. e. data on *precipitation*).

above a threshold affects returns on BUX (Hungary) positively while returns on RTS (Russia) negatively. Returns on TALSE (Estonia) fall as *humidity* above a threshold rises, however returns on WIG (Poland) fall as *humidity* below a threshold decreases. *Temperature* above a threshold has a negative effect on Estonian (TALSE) and Polish (WIG) indices. The higher the *visibility* (above a threshold), the higher the returns on SAX (Slovakia) and BUX (Hungary) indices. OLS results suggest that TALSE is affected by the largest number of weather variables while PFTS is impacted by none (no weather variable is significant).

A test for heteroscedastcity (hettest) is applied after OLS regressions to check if this problem is present in the model. The results can be found in Appendix D. They suggest that heteroscedasticity is indeed present for most of the indices returns; hence, OLS regressions with robust standard errors are run. However, their results are practically the same as in the case of simple OLS.

Table 4 gives results of GARCH estimation. According to it, there is no effect of weather variables on indices returns of Romania (BET), Czech Republic (PX), Latvia (RIGSE), Lithuania (VILSE), and Poland (WIG). Now *wind* higher than a threshold negatively affects RTS (Russia) returns; and *pressure* lower than a threshold negatively affects TALSE (Estonia) returns. As in the case of OLS estimation, *precipitation* higher than a threshold affects Hungarian index returns (BUX) positively while Russian RTS - negatively. Higher *humidity* levels make CROBEX (Croatia) returns fall while SOFIX (Bulgaria) returns decrease only if *humidity* lower than a threshold increases. *Temperature* higher than a threshold has a negative impact on SOFIX and TALSE returns. *Visibility* positively affects returns on SAX (Slovakia), BUX (Hungary) and SOFIX (Bulgaria). According to GARCH regression results Bulgarian index is the most sensitive to weather variables variation.

The size of the effect of weather variables is very small as the dependant variable (returns on indices) is pretty small itself. For example, in case of Ukrainian PFTS Index returns (based on GARCH threshold model estimation), PFTS returns decrease by 2.14e^{-03} when *temperature* falls by 1^{o}C below the threshold which is equal to 5 ^{o}C. Hence, returns on Ukrainian Index tend to be lower when it is "extremely" cold: PFTS average daily returns (equal to 1.53e^{-03}) experience almost 140% decrease if temperature falls below the threshold by 1^{o}C.

Results of no threshold models estimation (where *wind* variable is used instead of $wind^{up}$ and $wind^{down}$, the same applies to all other weather variables) can be found in Appendix H. Results are practically the same as those of threshold models.

Table 3. OLS results

	Dependent Variables, IndexRet, %												
	SAX	**BET**	**BUX**	**PFTS**	**SBITOP**	**RTS**	**PX**	**RIGSE**	**SOFIX**	**TALSE**	**VILSE**	**WIG**	**CROBEX**
wind_up	-1.02e-04	-1.64e-04	-3.52e-04	4.95e-04	-4.64e-04	-6.15e-04	1.14e-04	3.21e-04	-7.73e-04	-1.14e-04	-1.12e-04	4.37e-05	-1.58e-05
	(1.73e-04)	(2.52e-04)	(3.05e-04)	(3.76e-04)	(4.59e-04)	(6.14e-04)	(2.36e-04)	(3.67e-04)	(5.10e-04)	(1.99e-04)	(1.64e-04)	(1.78e-04)	(5.96e-04)
wind_down	-8.57e-04	-2.56e-04		3.41e-04		-4.23e-04	-1.23e-03	-3.16e-04	3.39e-04	-1.45e-03	5.98e-05	1.48e-04	0.00e+00
	(1.73e-03)	(6.13e-04)		(8.10e-04)		(1.08e-03)	(5.17e-04)**	(4.28e-04)	(7.91e-04)	(6.88e-04)**	(2.29e-04)	(3.50e-04)	(0.00e+00)
cloud_up	-2.87e-07		-4.50e-07		-2.23e-07	0.00e+00	3.36e-07	-4.06e-07	-6.84e-07	-3.01e-07	4.57e-07	-5.42e-07	1.32e-07
	(4.51e-07)		(6.15e-07)		(9.17e-07)	(0.00e+00)	(6.39e-07)	(6.65e-07)	(1.03e-06)	(5.92e-07)	(3.72e-07)	(5.21e-07)	(9.23e-07)
cloud_down	-5.89e-06	8.05e-07	-1.29e-06	1.11e-06	0.00e+00	-7.64e-07	3.02e-06	-2.90e-05	-6.93e-06	1.88e-06	-1.13e-06	1.21e-07	1.44e-06
	(5.99e-06)	(7.61e-07)	(1.25e-06)	(8.84e-07)	(0.00e+00)	(1.21e-06)	(9.36e-06)	(4.79e-05)	(4.53e-06)	(6.85e-06)	(5.39e-06)	(1.20e-06)	(7.00e-06)
pressure_up			5.17e-06	-7.30e-06	3.23e-06	4.31e-06	3.22e-06	-1.88e-07	2.33e-06	1.20e-06	-2.45e-06	-1.70e-06	4.80e-06
			(3.92e-06)	(7.00e-06)	(3.20e-06)	(3.24e-06)	(3.27e-06)	(2.79e-06)	(2.57e-05)	(3.94e-06)	(4.46e-06)	(3.49e-06)	(4.42e-06)
pressure_down	-2.92e-06	6.13e-07	3.64e-06		1.28e-06	5.27e-06	2.84e-06	-6.76e-07	1.94e-07	-2.67e-07	-5.08e-06	-2.88e-06	0.00e+00
	(3.24e-06)	(2.60e-06)	(4.10e-06)		(4.02e-06)	(3.55e-06)	(5.08e-06)	(2.87e-06)	(2.59e-05)	(4.17e-06)	(4.61e-06)	(3.57e-06)	(0.00e+00)
precipit_up	-2.17e-05	1.53e-04	5.47e-04	-1.13e-04	-1.02e-05	-5.15e-04	6.61e-04	-2.14e-04	-4.15e-04	2.39e-04	-6.42e-05	7.55e-05	1.41e-04
	(1.67e-04)	(3.47e-04)	(2.08e-04)***	(2.25e-04)	(9.19e-05)	(3.00e-04)*	(6.22e-04)	(1.68e-04)	(4.35e-04)	(1.60e-04)	(1.67e-04)	(1.85e-04)	(3.06e-04)
humidity_up	4.30e-05	-8.87e-06	-4.14e-05	3.07e-05	2.13e-05	3.33e-05	-1.98e-05	2.43e-05	-5.26e-06	-6.25e-05	2.66e-05	2.42e-05	3.48e-05
	(3.41e-05)	(2.44e-05)	(3.74e-05)	(5.93e-05)	(3.77e-05)	(4.90e-05)	(3.46e-05)	(3.82e-05)	(9.27e-05)	(3.67e-05)*	(1.85e-05)	(3.13e-05)	(1.39e-04)
humidity_down	5.07e-05	2.08e-05	-8.90e-05	3.81e-05	3.21e-04	-1.86e-05	0.00e+00	6.44e-05	-1.26e-04	-5.57e-05	2.03e-05	9.22e-05	4.94e-05
	(4.57e-05)	(2.92e-05)	(1.05e-04)	(1.01e-04)	(2.29e-04)	(6.16e-05)	(0.00e+00)	(4.51e-05)	(8.80e-05)	(7.60e-05)	(2.10e-05)	(4.52e-05)**	(2.02e-04)
temp_up	-4.18e-05	-3.43e-05	-3.10e-05	5.59e-05	5.50e-05	5.13e-06	9.20e-05	-5.26e-05	-1.91e-04	-1.73e-04	-1.40e-05	-1.47e-04	6.26e-05
	(6.15e-05)	(7.46e-05)	(9.50e-05)	(1.27e-04)	(8.04e-05)	(1.21e-04)	(7.94e-05)	(1.38e-04)	(1.82e-04)	(8.78e-05)**	(6.92e-05)	(8.42e-05)*	(1.60e-04)
temp_down	7.79e-05	-2.91e-05	-5.60e-05	7.01e-04	-5.04e-05	1.69e-05	8.97e-05	2.60e-04	-3.36e-05	-1.71e-04	-8.08e-05	-3.44e-05	-5.75e-04
	(1.21e-04)	(2.77e-04)	(8.97e-05)	(4.91e-04)	(1.26e-04)	(1.97e-04)	(8.86e-05)	(1.95e-04)	(2.09e-04)	(1.74e-04)	(1.35e-04)	(1.23e-04)	(5.44e-04)
visibility_up	1.07e-04	4.43e-05	2.26e-04			-8.71e-06	-4.56e-05	3.24e-05	5.01e-05	-3.52e-07	-9.29e-05	1.31e-04	9.12e-05
	(5.19e-05)**	(8.69e-05)	(8.15e-05)***			(3.29e-04)	(6.10e-05)	(1.20e-04)	(2.17e-04)	(8.39e-05)	(1.06e-04)	(1.02e-04)	(1.08e-04)
visibility_down	-8.16e-08	-1.76e-04	3.16e-04	-7.26e-05	-9.91e-05	-3.76e-04	-3.92e-05	3.37e-03	7.55e-04	-2.42e-04	2.97e-04	7.65e-05	-1.04e-04
	(7.70e-05)	(2.41e-04)	(5.73e-04)	(1.48e-04)	(8.81e-05)	(6.21e-04)	(7.84e-05)	(3.80e-03)	(6.86e-04)	(1.61e-04)	(2.54e-04)	(2.40e-04)	(3.95e-04)
winter	-5.34e-04		-1.87e-03	5.48e-03	3.77e-04	8.08e-04					1.32e-03	-4.45e-03	
	(1.60e-03)		(2.22e-03)	(3.72e-03)	(2.82e-03)	(4.08e-03)					(1.80e-03)	(2.27e-03)**	
spring	-1.06e-04	1.48e-04	2.24e-03	3.95e-03	2.05e-03	1.42e-03	1.55e-04	1.20e-05	1.92e-03	2.11e-03	9.54e-04	-3.98e-04	1.74e-04
	(1.11e-03)	(2.03e-03)	(1.64e-03)	(2.04e-03)*	(1.68e-03)	(2.60e-03)	(1.89e-03)	(1.49e-03)	(4.14e-03)	(2.04e-03)	(1.19e-03)	(1.69e-03)	(2.91e-03)
autumn	2.36e-04	4.36e-04	1.57e-03	7.75e-04	5.09e-03	-3.72e-03	7.76e-04	5.24e-05	3.37e-03	2.92e-03	2.29e-04	-4.55e-04	-1.35e-03
	(1.27e-03)	(1.93e-03)	(1.80e-03)	(2.14e-03)	(1.94e-03)***	(2.85e-03)	(1.89e-03)	(1.78e-03)	(4.14e-03)	(1.96e-03)	(1.41e-03)	(1.86e-03)	(3.34e-03)
dec	5.00e-04	3.03e-03	6.84e-03	9.32e-04	2.88e-03	-1.06e-03	2.97e-03	1.57e-03	6.33e-03	5.47e-03	2.84e-04	6.12e-03	3.39e-03
	(1.52e-03)	(2.35e-03)	(2.67e-03)**	(4.21e-03)	(3.39e-03)	(4.13e-03)	(2.66e-03)	(1.60e-03)	(5.11e-03)	(2.03e-03)***	(1.34e-03)	(2.15e-03)***	(3.16e-03)
jan	1.49e-04	1.99e-03	6.13e-03	-4.16e-03	2.39e-03	3.46e-03	7.60e-04	2.26e-04	3.15e-03	2.47e-03	5.52e-04	3.94e-03	2.34e-04
	(1.74e-03)	(2.43e-03)	(2.51e-03)**	(3.28e-03)	(3.78e-03)	(4.23e-03)	(2.61e-03)	(1.43e-03)	(4.74e-03)	(2.13e-03)	(1.38e-03)	(2.44e-03)	(3.24e-03)
Constant	5.96e-04	-3.73e-04	-3.48e-03	2.49e-03	-1.51e-03	-1.09e-03	-5.70e-04	2.86e-04	6.25e-03	5.28e-03	1.44e-03	6.79e-04	-8.63e-03
	(1.08e-03)	(2.31e-03)	(2.06e-03)*	(2.25e-03)	(1.61e-03)	(3.00e-03)	(1.84e-03)	(4.39e-03)	(2.55e-02)	(4.23e-03)	(4.60e-03)	(4.28e-03)	(1.20e-02)
Observations	1560	1850	832	1044	239	836	971	873	679	829	824	808	345
R-squared	0.01	0.00	0.04	0.02	0.07	0.02	0.02	0.01	0.02	0.03	0.02	0.03	0.02

*Notes: * significant at 10%; ** significant at 5%; *** significant at 1%*
Robust standard errors in parentheses
Standard errors in parentheses

Table 4. GARCH results.

	Dependent Variables, IndexRet, %											
	SAX	**BET**	**BUX**	**PFTS**	**RTS**	**PX**	**RIGSE**	**SOFIX**	**TALSE**	**VILSE**	**WIG**	**CROBEX**
wind_up	-2.77e-05	-2.00e-04	-3.89e-04	4.41e-04	-8.66e-04	1.39e-04	-7.40e-05	-5.49e-04	-4.21e-06	-1.57e-04	1.54e-05	5.74e-04
	(1.53e-04)	(1.75e-04)	(3.46e-04)	(3.56e-04)	(5.57e-04)	(2.20e-04)	(3.62e-04)	(5.23e-04)	(1.77e-04)	(1.91e-04)	(1.81e-04)	(5.79e-04)
wind_down	5.09e-04	-2.53e-04		1.01e-03	-6.31e-04	-8.38e-04	-4.63e-04	-4.67e-04	-1.25e-03	2.39e-05	7.90e-05	
	(1.59e-03)	(4.99e-04)		(8.44e-04)	(9.59e-04)	(5.43e-04)	(3.33e-04)	(6.05e-04)	(7.85e-04)	(2.14e-04)	(3.63e-04)	
cloud_up	-1.55e-07		-5.73e-07			1.97e-07	-4.06e-07	-4.75e-07	-3.30e-07	5.58e-07	-7.02e-07	4.55e-07
	(3.89e-07)		(6.36e-07)			(6.25e-07)	(6.33e-07)	(7.97e-07)	(5.51e-07)	(4.10e-07)	(5.37e-07)	(7.90e-07)
cloud_down	-3.12e-06	4.46e-07	-1.41e-06	4.95e-07	-7.62e-07	1.87e-06	-3.19e-06	-3.41e-06	4.95e-06	2.42e-08	1.62e-07	4.92e-06
	(3.91e-06)	(7.38e-07)	(1.25e-06)	(9.50e-07)	(1.13e-06)	(7.66e-06)	(6.22e-05)	(4.44e-06)	(7.64e-06)	(6.59e-06)	(1.18e-06)	(9.21e-06)
pressure_down	-3.20e-06	9.95e-07	4.07e-06		4.53e-06	3.79e-06	-9.87e-07	-7.30e-07	-8.78e-06	-2.27e-06	-2.40e-06	
	(2.34e-06)	(2.53e-06)	(3.99e-06)		(3.18e-06)	(4.44e-06)	(3.53e-06)	(3.32e-05)	(5.13e-06)*	(3.43e-06)	(6.90e-06)	
precipit_up	-7.73e-05	-1.10e-04	5.09e-04	1.30e-05	-5.33e-04	7.30e-04	-1.32e-04	-4.53e-04	2.37e-04	3.42e-05	5.95e-05	3.84e-04
	(1.51e-04)	(3.52e-04)	(2.20e-04)**	(2.71e-04)	(3.23e-04)*	(7.60e-04)	(2.03e-04)	(5.11e-04)	(1.85e-04)	(1.63e-04)	(1.90e-04)	(3.17e-04)
humidity_up	2.94e-05	-9.39e-06	-4.08e-05	3.35e-05	4.82e-05	-4.55e-05	-1.81e-05	-8.00e-05	-5.29e-05	3.53e-05	2.43e-05	-1.11e-04
	(2.31e-05)	(2.36e-05)	(3.97e-05)	(4.50e-05)	(4.79e-05)	(3.67e-05)	(3.76e-05)	(8.66e-05)	(3.67e-05)	(2.44e-05)	(4.37e-05)	(4.03e-05)***
humidity_down	5.07e-05	-1.06e-06	-4.93e-05	5.87e-05	2.56e-05		1.34e-05	-1.78e-04	-7.55e-06	3.36e-05	8.94e-05	-1.96e-04
	(3.22e-05)	(2.79e-05)	(1.19e-04)	(7.45e-05)	(6.01e-05)		(4.30e-05)	(7.93e-05)**	(8.02e-05)	(2.45e-05)	(6.40e-05)	(5.48e-05)***
temp_up	-4.91e-05	-8.65e-05	-1.08e-05	1.64e-04	-2.97e-05	3.71e-05	-4.47e-05	-3.82e-04	-1.74e-04	-3.80e-05	-1.26e-04	1.01e-04
	(5.40e-05)	(7.08e-05)	(9.30e-05)	(1.03e-04)	(1.02e-04)	(8.78e-05)	(1.04e-04)	(1.24e-04)***	(9.02e-05)*	(6.45e-05)	(8.35e-05)	(1.30e-04)
temp_down	3.24e-05	-2.67e-04	-6.27e-05	2.14e-03	-2.14e-04	3.07e-05	2.78e-04	-2.67e-04	-1.82e-04	-1.71e-05	-9.73e-06	-8.29e-04
	(1.09e-04)	(2.30e-04)	(8.66e-05)	(6.06e-04)***	(1.91e-04)	(9.79e-05)	(3.83e-04)	(1.60e-04)*	(2.10e-04)	(2.27e-04)	(1.22e-04)	(6.72e-04)
visibility_up	9.26e-05	6.29e-05	2.23e-04		-4.97e-06	-4.69e-05	-5.72e-05	7.06e-05	6.31e-05	-5.06e-05	1.33e-04	4.85e-05
	(4.12e-05)**	(1.26e-04)	(8.57e-05)***		(3.36e-04)	(7.10e-05)	(1.54e-04)	(2.04e-04)	(6.86e-05)	(1.07e-04)	(8.69e-05)	(9.30e-05)
visibility_down	-2.10e-05	-7.37e-05	3.13e-04	-2.58e-04	-8.87e-05	-1.59e-05	1.67e-03	1.29e-03	-1.72e-04	3.02e-04	9.46e-05	-3.19e-04
	(6.41e-05)	(1.61e-04)	(6.14e-04)	(1.54e-04)*	(6.18e-04)	(7.89e-05)	(6.15e-03)	(5.61e-04)**	(1.81e-04)	(2.53e-04)	(2.30e-04)	(3.90e-04)
winter	-1.95e-04	-1.20e-03	-1.81e-03	6.71e-03	-1.02e-03	1.69e-03	9.35e-04	-1.35e-02	-3.61e-03	1.22e-03	-4.11e-03	2.27e-03
	(1.64e-03)	(2.09e-03)	(2.98e-03)	(3.42e-03)**	(4.01e-03)	(2.34e-03)	(4.31e-03)	(2.81e-03)***	(2.64e-03)	(1.96e-03)	(2.92e-03)	(4.45e-03)
spring	6.64e-05	-1.07e-03	2.67e-03	4.96e-03	4.09e-04	2.29e-03	4.27e-04	-7.01e-03	-1.11e-03	1.07e-03	-1.38e-05	1.05e-03
	(1.03e-03)	(1.41e-03)	(1.66e-03)	(1.88e-03)***	(2.14e-03)	(1.55e-03)	(1.88e-03)	(2.41e-03)***	(1.63e-03)	(1.03e-03)	(1.75e-03)	(2.40e-03)
autumn	7.54e-04	-9.92e-04	2.01e-03	1.34e-03	-4.87e-03	2.94e-03	2.93e-04	-6.89e-03	-6.64e-04	6.35e-04	-2.10e-04	2.14e-03
	(1.10e-03)	(1.42e-03)	(1.72e-03)	(2.09e-03)	(2.36e-03)**	(1.70e-03)*	(1.43e-03)	(2.50e-03)***	(1.60e-03)	(1.10e-03)	(1.91e-03)	(2.26e-03)
dec	6.40e-04	1.48e-03	6.46e-03	6.53e-03	-7.14e-04	3.49e-03	1.10e-03	7.17e-03	5.41e-03	5.11e-04	6.14e-03	5.92e-03
	(1.87e-03)	(2.11e-03)	(3.16e-03)**	(2.79e-03)**	(4.06e-03)	(2.47e-03)	(4.59e-03)	(2.95e-03)**	(2.60e-03)**	(2.14e-03)	(3.14e-03)*	(4.91e-03)
jan	-1.92e-04	6.23e-04	6.58e-03	-4.64e-03	2.53e-03	1.25e-03	1.97e-04	2.16e-03	2.28e-03	7.01e-04	3.53e-03	-2.88e-03
	(1.58e-03)	(1.65e-03)	(3.04e-03)**	(3.56e-03)	(4.42e-03)	(2.44e-03)	(4.43e-03)	(3.17e-03)	(2.42e-03)	(2.01e-03)	(2.74e-03)	(3.95e-03)
Constant	1.07e-03	2.72e-03	-3.58e-03	5.22e-04	-3.68e-04	-2.03e-03	4.29e-03	2.28e-02	1.56e-02	-2.78e-03	3.03e-04	2.47e-03
	(9.70e-04)	(2.40e-03)	(1.99e-03)*	(2.53e-03)	(2.77e-03)	(1.42e-03)	(5.10e-03)	(3.20e-02)	(6.12e-03)**	(2.85e-03)	(7.58e-03)	(1.31e-01)
Observations	1560	1850	832	1044	836	970	873	679	829	824	808	345

*Notes: * significant at 10%; ** significant at 5%; *** significant at 1%*
Robust standard errors in parentheses
Standard errors in parentheses

A "Holidays effect" is found in Hungary, Estonia, Poland (OLS, GARCH), Ukraine and Bulgaria (GARCH).

Next step in the analysis is to include S&P 500 index and New-York city weather variables into the model to account for the impact of the rest of the world on stock returns of the countries under consideration (results are in Appendix I). First, New-York weather only is included to check if American investors (through their mood) influence market movements in CEE and CIS states. Results show that inclusion of the mentioned above variables improve R-squared of the regressions. NY weather variables are not more often significant than local weather variables. Then S&P 500 Index returns are added. Coefficient on S&P 500 index, however, is not significant for a number of countries (Ukraine, Romania, Croatia, Slovenia, Estonia, Bulgaria and Lithuania). Results for both models with and without S&P 500 Index returns do not differ much.

Weather variables correlation statistics can be found in Appendix G. As it can be seen from the results, only *humidity* and *pressure* variables seem to be strongly correlated (with correlation of around 70-80% for some countries). All other correlation coefficients are relatively low and, hence, results of the regression analysis performed can be trusted, that is multicollinearity is not too much of an issue.

A final thing to note is that R-squared value in the regressions is not very high. Naturally, variation in weather variables can not encompass all variation in stock returns. The analysis does not make a stab at explaining all factors that affect stock prices movements; it rather tries to reveal whether investors behave in accord with rational expectations hypothesis or deficient market hypothesis.

Due to a big number of companies for which regression analysis of the impact of weather variables on individual stocks' returns, spreads and trading volumes is performed, all regression results (i. e. tables etc) are available upon request. Overall, the results of the analysis show that weather does not explain variation in returns, volumes and spreads of individual stocks to a large extent, though there are cases of significant weather variables which are going to be discussed below.

INDIVIDUAL STOCK RETURNS RESULTS

CIS countries (Ukraine and Russia):

Among the 19 most liquid Ukrainian stocks that are being analysed, only 5 companies are found to be affected by some weather variables:

- returns on UNAF (Ukranafta) decrease by $1.26e^{-03}$ as *wind* level above the threshold increases by 1 point (in a threshold model with NY weather and S&P 500 Index returns);
- KIEN (Kyivenergo) returns decrease by $2.10e^{-04}$ and KVBZ (Kryukiv Wagon) returns fall by $3.36e^{-04}$ if *humidity* higher than a threshold rises by 1 point (in a threshold model with NY weather and S&P 500 Index returns);
- returns on STIR (Stirol) decrease by $9.09e^{-05}$ as *pressure* above the threshold falls by 1 ^{o}C; though returns on this stock increase by $9.27e^{-04}$ if *humidity* upper than a threshold rises by 1 point (in a threshold model);
- MZVM (Mariupol Tyazhmash) returns decrease by $4.18e^{-03}$ as *wind* below a threshold falls (in a threshold model).

Interestingly, these are industrial companies and there are no obvious reasons for their stock returns to be affected by the weather as might be the case with companies from agricultural sector. Inclusion of NY weather variables and S&P 500 Index returns do not bring many changes to the regression results.

Coefficient on S&P 500 Index returns is not significant for most of the companies.

The same story can be found for Russian data. The model that includes NY weather and S&P 500 Index returns do not have higher R-squared than other models for most of Russian companies. The Index is not significant for most companies. The only weather variable that is being significant in both no threshold and threshold models is *pressure.* According to the regression results, it affects most stock returns of Russian companies positively.

Central European companies (Poland, Czech Republic, Slovakia and Hungary):
No effect of weather variables on individual stock returns is found in Slovakia. *Humidity* (negatively) and *cloud* cover (negatively) influence Polish stock returns; stock returns of Hungarian companies increase with *visibility* above the threshold; and returns of Czech companies rise as *temperature* rises to the value of the threshold (20 ^{o}C).

Threshold model and a model with NY S&P 500 Index returns give almost the same results concerning significance and signs of the coefficients on weather variables.

Baltic region companies (Estonia, Latvia and Lithuania):
Temperature higher than corresponding threshold values (3-4 ^{o}C) is significant in all three countries' regressions. It affects companies' returns negatively – the hotter it becomes, the lower returns companies face. This sign of the coefficients can be explained in the following way: an average yearly temperature in Baltic States is 7-8 ^{o}C; hence, it can be assumed that as temperature increases way above the threshold, people try to take advantage of the warm weather period and prefer spending time on the beach than in the office. Hence, "lazy" mood of

traders/investors affect stock returns negatively. *Precipitation* also affects stock markets of Latvia and Lithuania negatively. The higher the precipitation levels, the lower the returns of individual stocks in these countries.

Southern European States (Bulgaria, Slovenia and Romania):

Again, as in the case of Baltic countries Southern European States are not significantly affected by the American market. Probably, stock returns of these countries are more sensitive to the impact of their EU counterparts. As for the weather variables influence, the higher the *visibility* in Bucharest, the higher the returns on individual stocks are. Slovenian stock market is affected negatively by the *temperature*. It is significant for some companies even at 1% level. However, no effect of weather on stock returns or very small one (for some companies *pressure* is marginally significant) is found in Bulgaria.

INDIVIDUAL STOCK SPREADS RESULTS

CIS countries (Ukraine and Russia):

According to regression results, spreads are more sensitive to weather than returns. Almost all Ukrainian companies under consideration are affected by certain weather variables as evident from the no threshold model estimation. Threshold model, however, gives a bit different results: MZVM has the most weather sensitive spread (it is affected negatively by *pressure* and *humidity*, and positively by *temperature*); and *temperature* influences spreads of 7 out of 19 companies being analyzed. As temperature increases by 1 ^{o}C, spreads of the following stocks increase: DNEN (Dniproenergo) by 1.36e^{-03}; PGOK (Poltava Ore Mining and Processing Plant) by 1.24e^{-03}; USCB (Ukrsotsbank) by 3.99e^{-02}; and ZAEN (Zahidenergo) by 5.39e^{-04}. As t*emperature* below the threshold falls by 1 ^{o}C, spread of MZVM decreases by 2.22e^{-03}; AVDK (Avdiivka Cokery Plant) by

$2.76e^{-01}$; and SMASH (Sumy Frunze Machine Building Plant) by $8.38e^{-01}$. A 1 °C increase in temperature level above the threshold causes spread of PGOK to rise by $1.10e^{-03}$. The largest effect is found for SMASH, AVDK and USCB.

"Holidays effect" has also been detected – dummies on *January* and *December* are significant for the majority of companies in all three models. As in the case with individual stock returns, S&P 500 Index returns are not significant in case of spreads regressions. However, NY weather variables impact Ukrainian stock spreads significantly: *temperature* and *visibility* – positively, while *pressure* and *humidity* – negatively.

Russian stock spreads are mostly affected by *cloud* cover (positively). S&P 500 Index returns are not significant if included while NY weather variables are: *ny_temperature* affects Russian companies' spreads positively and *ny_preassure* – negatively. There is a strong evidence of "holidays effect" as well.

Central European companies (Poland, Czech Republic, Slovakia and Hungary):
Hungarian stock spreads are mostly affected negatively by *temperature* lower than the threshold being 27 °C. *Precipitation* impacts spreads of Czech and Slovak companies positively – the higher the precipitation level, the less liquid companies become as signalled by the increasing spreads. *Visibility* affects spreads of Polish companies negatively.

Baltic region companies (Estonia, Latvia and Lithuania):
Spreads of Estonian companies are affected negatively by *visibility* in all three models. New-York weather variables are highly significant: *temperature* and *humidity* both below and above the threshold are significant at 1% level and impact Baltic

stock spreads. Baltic States have the same result concerning the "holidays effect" and S&P 500 Index returns as Central European countries.

Southern European States (Bulgaria, Slovenia, and Romania):

Spreads of Slovenian companies are positively affected by *temperature* and *visibility*. The higher the w*ind*, the lower the spread levels of Romanian companies. "Holidays effect" has been detected in Romania only. S&P 500 Index returns are not significant if included.

INDIVIDUAL STOCK TRADING VOLUMES RESULTS

CIS countries (Ukraine and Russia):

In general, results for individual stock trading volumes are very close to those for returns and spreads. Most weather sensitive Ukrainian companies are MZVM, STIR, UTEL. *Temperature* above the threshold affect trading volumes of Ukrainian companies positively according to the threshold model: trading volumes of MMKI (Ilyich Iron and Steel Works) rise by $4.87e^{+03}$ with a 1 ^{o}C increase in *temperature* above the threshold, and of USCB by $4.45e^{+03}$ (model with a threshold estimation). *Cloud* cover below the threshold impacts trading volumes of Ukrainian stocks negatively according to the model with NY and S&P 500 Index returns; and *wind* – negatively based on the results of no threshold model.

As for the trading volumes of Russian companies, they are affected negatively by *humidity*. Also there is a positive impact of New-York city *visibility* on Russian trading volumes.

Central European companies (Poland, Czech Republic, Slovakia and Hungary):

There is a very small effect of weather on trading volumes of Polish and Slovak companies, no general trend is detected. Both *precipitation* and *cloud* cover impact trading volumes of Czech companies negatively; while *temperature* has a positive influence on Hungarian trading volumes.

Baltic region companies (Estonia, Latvia and Lithuania):

Trading volumes of Latvian companies seem to be not affected by the weather. However, in Estonia and Lithuania *visibility* impacts trading volumes of local stocks greatly: the better the *visibility*, the higher the trading volumes.

Southern European States (Bulgaria, Slovenia, and Romania):

It seems to be that trading volumes of Slovenian companies are the most weather sensitive among other Southern European countries. *Precipitation* impacts them negatively while *visibility* – positively. "Holidays effect" is present as well. In Romania, trading volumes are affected negatively by both *wind* and *precipitation*. Trading volumes of Bulgarian companies are influenced by the weather slightly and no general trend can be distinguished.

Chapter 6

CONCLUSIONS

This paper tests the relationship between stock market variables (indices returns, individual stocks' returns, spreads and trading volumes) and the weather in transition countries of Central and Eastern Europe and CIS. Weather is considered to be a proxy for the mood factors that affect decisions of investors and traders. It is hypothesized that they tend to be more optimistic about the market prospects if the weather is warm and sunny and are more pessimistic if it is rainy and cloudy. Hence, market players are more predisposed to buy stocks when the weather if fine and sell them when the weather is bad.

Three models are implemented to test the relationship under consideration: a threshold model where there are two values for each weather variable included into the regression – one contains values of a given variable above the threshold and the other one includes all values that are below the threshold; no threshold model; and a threshold model that includes New-York weather variables and S&P 500 Index returns to test the impact of the rest of the world on stock markets of transition countries. All three models are estimated using OLS, OLS with robust option and GARCH techniques.

No effect of weather variables on indices returns is found for Romania, Latvia, Lithuania (OLS, GARCH); Slovenia, Bulgaria and Croatia (OLS); Czech Republic and Poland (GARCH). According to OLS estimation, Estonia has the most weather sensitive stock market; while it is Bulgaria based on GARCH results. Ukraine, on the contrary, seems to be a weather proof country: only *temperature* lower than a threshold influences PFTS returns if estimated by GARCH. The size of this effect is very small: as *temperature* below the threshold falls by 1 ^{o}C, PFTS returns decrease by $2.14e^{-03}$.

Results for individual stocks' returns, spreads and trading volumes are very similar. UNAF (Ukranafta), STIR (Stirol), and MZVM (Mariupol Tyazhmash) are the most weather sensitive stocks in Ukraine. *Temperature* positively affects not only PFTS Index returns but also spreads and trading volumes of individual stocks. The largest effects among those estimated for spreads of Ukrainian companies are found for AVDK (coefficient on *temperature* below the threshold is $2.76e^{-01}$) and SMASH (coefficient on *temperature* below the threshold is $8.38e^{-01}$). As *temperature* above the threshold increases by 1 ^{o}C, trading volumes of MMKI rise by $4.87e^{+03}$ and of USCB by $4.45e^{+03}$. The difference in the sizes of the effects for spreads and trading volumes comes from the sizes of dependent variables themselves: average trading volume of MMKI, for example, is USD 430 567, while AVDK average spread is equal to 0.2.

Temperature affects returns of Czech (positively), Latvian, Lithuanian and Estonian, and Slovenian (negatively) companies; spreads of Hungarian (negatively) companies. *Cloud* cover impacts negatively returns of Polish companies, spreads of Russian stocks, and trading volumes of Czech firms. *Visibility* has a positive influence on stock returns in Hungary and Romania, on spreads in Ukraine, Poland, Estonia and Slovenia, and on trading volumes in Estonia, Lithuania and Slovenia. The higher the *precipitation*, the lower the returns in Latvia and Lithuania, spreads in Czech Republic and Slovakia, trading volumes in Czech Republic and Romania. *Wind* also has a negative effect on returns and spreads of Ukrainian companies, spreads and trading volumes of Romanian stocks. Trading volumes of Russian firms as well as returns and spreads of Ukrainian companies are impacted negatively by the increase in *humidity* levels.

To summarize, while we find some significant effects, the overall impression our results give is that there is little evidence of a systematic effect of weather on stock markets in Eastern Europe, and hence, that it is unlikely one could make money on the stock market from accurate weather forecasts.

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APPENDICES

APPENDIX A. Indices Description.

Index	Country	Description
PFTS	Ukraine	It is a capital-weighted price index of the 20 major and most liquid Ukrainian equities traded at the PFTS Stock Exchange
WIG	Poland	It is a total return index which includes all companies listed on the main market, excluding foreign companies and investment funds
RTS	Russia	An index of 50 Russian stocks that trade on the RTS Stock Exchange in Moscow
BUX	Hungary	An official index of blue-chip shares listed on the Budapest Stock Exchange Ltd.
PX	Czech Republic	Price index of blue chip issues that trade on the Prague Stock Exchange
BET	Romania	Reflects the evolution of the most liquid 10 stocks (except Investment Funds) and is the most followed index of the Bucharest Stock exchange
CROBEX	Croatia	An official share index of the Zagreb Stock Exchange and it includes stocks of 24 companies and is calculated continuously using latest stock prices
SBITOP	Svolenia	It comprises only the most liquid shares of the Slovene securities market
SOFIX	Bulgaria	The official Bulgarian Stock Exchange index
SAX	Slovakia	It is the official share index of the Bratislava Stock Exchange
TALSE	Estonia	Reflects changes in the prices of shares listed in the Main and Investor lists of the Estonian Stock Exchange
VILSE	Lithuania	It is capitalization-weighted chain-linked total return indexes
RIGSE	Latvia	An all-share index consisting of all the shares listed on theMain & Secondary lists on the Riga Stock Exchange

APPENDIX B. Weather Variables Description.

Table B1. Bratislava weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3113	3.836171	2.798529	0	21
cloud	3113	1340.138	972.8576	0	3000
pressure	3113	865.3205	342.3349	0	1026.5
precipit	1560	1.072436	2.346071	0	30
humidity	3113	50.29168	26.38738	0	100
temp	3113	12.12601	10.44307	-26	36.5
visibility	3113	13.632	9.54966	1.1	38.7

Table B2. Bucharest weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3582	2.656337	1.802907	0	30
cloud	3582	1574.497	1124.241	0	3000
pressure	3582	950.9727	226.4854	0	1029.3
precipit	3582	.1683417	.9291413	0	15
humidity	3582	48.91346	24.06641	0	100
temp	3582	14.96399	11.13967	-13	41
visibility	3582	7.99665	3.730594	0	24

Table B3. Budapest weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3538	2.923686	1.774812	0	11
cloud	3538	1515.397	932.3073	0	3000
pressure	3538	946.568	225.6542	0	1026.1
precipit	1560	.9544872	2.502054	0	33
humidity	3538	53.31458	23.0898	0	100
temp	3538	13.69135	10.23773	-8	36
visibility	3538	13.4121	8.865903	1	30

Table B4. Kyiv weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3535	2.882603	1.678477	0	49
cloud	3535	1467.341	1077.831	0	3000
pressure	3535	938.1076	233.5393	0	1023.4
precipit	1565	.833099	2.786149	0	35
humidity	3535	58.70636	24.91394	0	100
temp	3535	10.8454	10.80884	-23	35
visibility	3535	21.98523	17.08322	0	50

Table B5. Ljubljana weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3113	1.624478	1.269326	0	7
cloud	3113	1236.629	860.3705	0	3000
pressure	3113	844.8015	333.8449	0	1000
precipit	1562	2.071703	5.076101	0	43
humidity	3113	52.09765	27.23691	0	99
temp	3113	12.75586	10.04349	-8	37
visibility	3113	17.55284	12.83099	0	60

Table B6. Moscow weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3294	1.667274	1.286635	0	22
cloud	3294	1229.159	977.7684	0	3000
pressure	3294	935.4551	236.8121	0	1036
precipit	1570	.8923567	2.638974	0	35
humidity	3294	63.28658	23.42237	0	100
temp	3294	8.08986	11.26935	-27	32
visibility	3294	7.505161	3.424577	0	19

Table B7. Prague weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	1821	3.044481	2.488147	0	17
cloud	1821	920.3734	926.7267	0	3000
pressure	1821	745.0857	413.2885	0	1008
precipit	1821	.2740253	.7472519	0	10
humidity	1821	53.15596	32.99797	0	99
temp	1821	7.415706	9.229977	-10	34
visibility	1821	14.42614	11.68025	0	39

Table B8. Riga weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	1958	3.840654	1.775937	0	13
cloud	1958	1255.733	1060.368	0	3000
pressure	1958	1009.232	61.44126	0	1047
precipit	1513	1.699934	3.218228	0	40
humidity	1958	67.38815	20.53345	0	100
temp	1958	10.04801	9.910831	-18	33
visibility	1958	6.685904	3.471162	0	40

Table B9. Sofia weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3411	1.914395	1.953942	0	33
cloud	3411	1436.544	614.005	0	3000
pressure	3411	943.9559	34.71078	0	965
precipit	1512	1.172619	2.797601	0	27
humidity	3411	56.92114	18.69042	0	100
temp	3411	13.8971	10.02312	-16	38
visibility	3411	10.41425	7.175097	0	30

Table B10. Tallinn weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3461	3.818261	1.756136	0	10
cloud	3461	919.0118	874.5272	0	3000
pressure	3461	996.7012	104.2356	0	1046.4
precipit	1513	1.542631	2.824625	0	31
humidity	3461	70.0026	20.97073	0	100
temp	3461	8.467639	9.306857	-22	30
visibility	3461	15.72147	13.7622	0	50

Table B11. Vilnius weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	1933	3.926022	1.781609	0	13
cloud	1933	1273.163	1001.215	0	3000
pressure	1933	988.1387	81.92484	0	1024.29
precipit	1513	.9378057	2.479826	0	37
humidity	1933	64.5732	22.51718	0	100
temp	1933	9.685773	10.27784	-21.8	33
visibility	1933	5.500776	2.293122	0	23

Table B12. Warsaw weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	3491	4.636494	2.293239	0	18
cloud	3491	1337.009	898.3684	0	3000
pressure	3491	1000.448	48.79482	0	1036
precipit	1513	.8167217	2.577239	0	33
humidity	3491	65.06302	20.41292	0	100
temp	3491	11.94512	9.722129	-19	34.4
visibility	3491	11.29407	7.699122	0	30

Table B13. Zagreb weather variables descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
wind	1493	2.118553	1.265127	0	8
cloud	1493	1684.645	854.0566	0	3000
pressure	1493	987.7502	53.34407	0	1022
precipit	1493	.9626926	3.074326	0	31
humidity	1493	58.02076	18.00883	22	100
temp	1493	15.3858	9.492334	-7	37
visibility	1493	18.76289	11.48172	0	40

APPENDIX C. Time Series of indices Returns.

Figure C1. Time series of WIG stock returns.

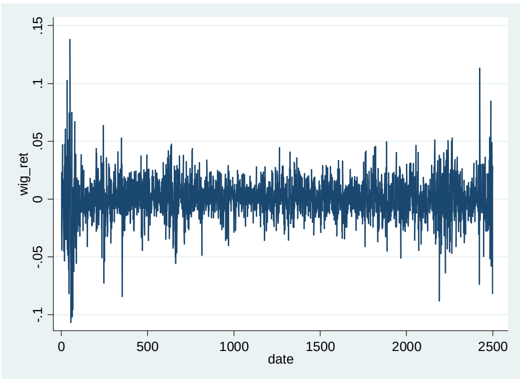


Figure C2. Time series of RTS stock returns.

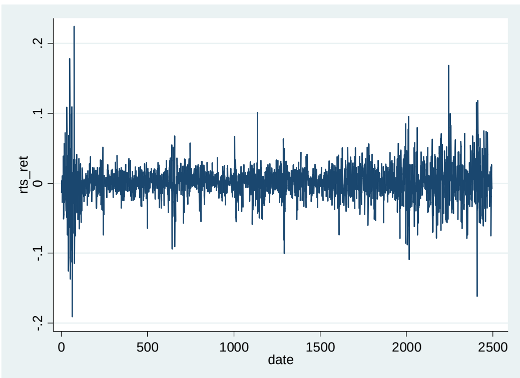


Figure C3. Time series of BUX stock returns.

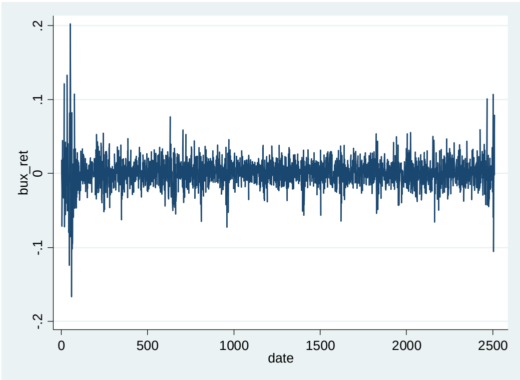


Figure C4. Time series of PX stock returns.

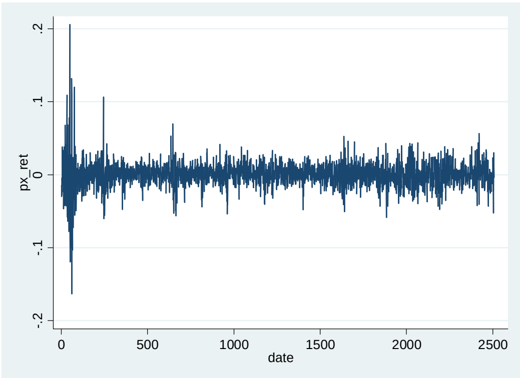


Figure C5. Time series of BET stock returns.

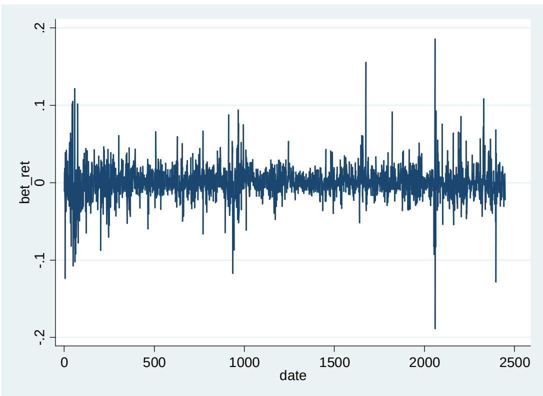


Figure C6. Time series of SBITOP stock returns.

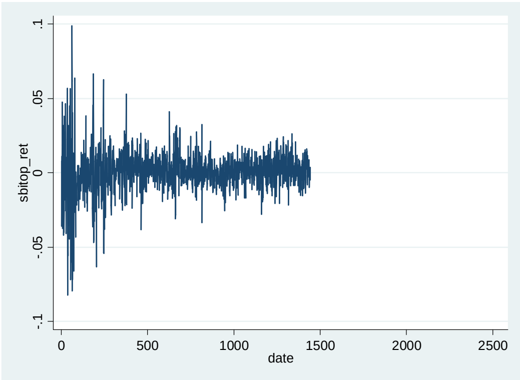


Figure C7. Time series of CROBEX stock returns.

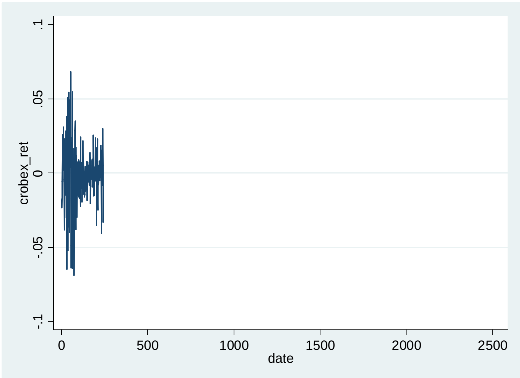


Figure C8. Time series of SOFIX stock returns.

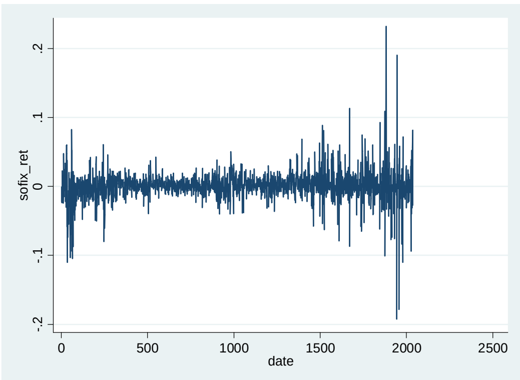


Figure C9. Time series of SAX stock returns.

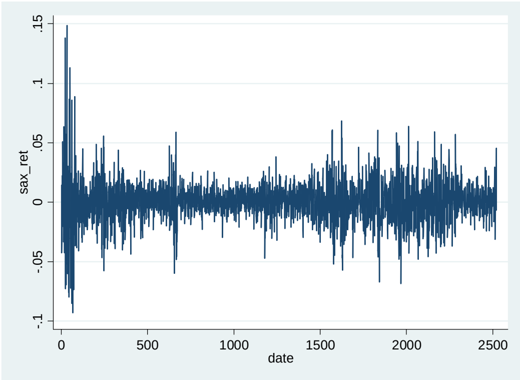


Figure C10. Time series of TALSE stock returns.

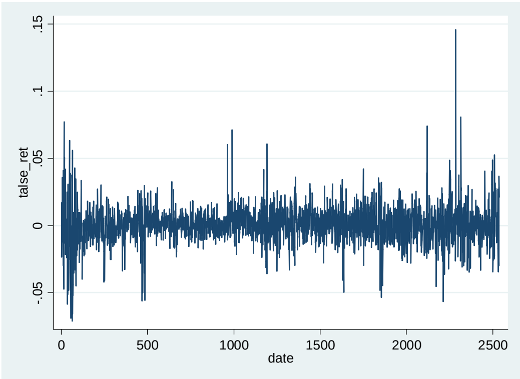


Figure C11. Time series of RIGSE stock returns.

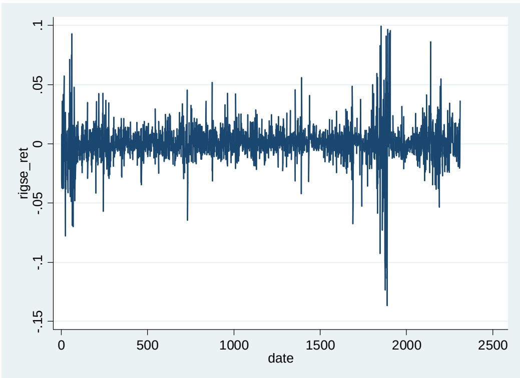
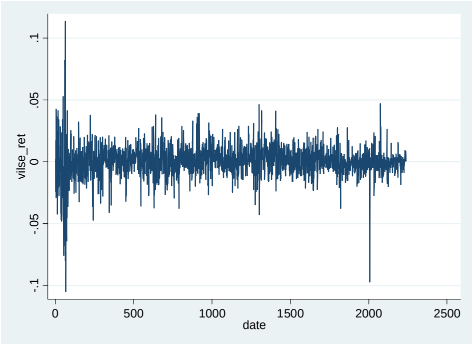


Figure C12. Time series of VILSE stock returns.



APPENDIX D. Test for Heteroscedasticity Results.

Note: Ho - Constant variance

Country	Index	Hettest p values
Ukraine	PFTS	0.00
Poland	WIG	0.47
Russia	RTS	0.28
Hungary	BUX	0.09
Czech Republic	PX	0.00
Romania	BET	0.00
Croatia	CROBEX	0.00
Slovenia	SBITOP	0.19
Bulgaria	SOFIX	0.37
Slovakia	SAX	0.18
Estonia	TALSE	0.09
Latvia	RIGSE	0.00
Lithuania	VILSE	0.01

Bratislava

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
bsl_ret	0,00	bsl_spread	0,00	bsl_vol	0,00
ses_ret	0,01	ses_spread	0,00	ses_vol	0,00
vub_ret	0,72	vub_spread	0,00	vub_vol	0,00

Bucharest

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
alr_ret	0,00	alr_spread	0,00	alr_vol	0,00
azo_ret	0,00	azo_spread	0,00	azo_vol	0,00
bcc_ret	0,00	bcc_spread	0,00	bcc_vol	0,00
bio_ret	0,00	bio_spread	0,13	bio_vol	0,00
brd_ret	0,00	brd_spread	0,17	brd_vol	0,00
brk_ret	0,00	brk_spread	0,00	brk_vol	0,00
imp_ret	0,00	imp_spread	0,00	imp_vol	0,00
oil_ret	0,00	oil_spread	0,00	oil_vol	0,00
olt_ret	0,00	olt_spread	0,00	olt_vol	0,00
sif1_ret	0,00	sif1_spread	0,00	sif1_vol	0,00

Budapest

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
egis_ret	0.79	egis_spread	0.00	egis_vol	0.00
fhb_ret	0.02	fhb_spread	0.00	fhb_vol	0.00
fotex_ret	0.00	fotex_spread	0.00	fotex_vol	0.00
mol_ret	0.00	mol_spread	0.00	mol_vol	0.00
mtelekom_ret	0.16	mtelekom_sprea	0.00	mtelekom_vol	0.00
otp_ret	0.29	otp_spread	0.00	otp_vol	0.00
pannergy_ret	0.02	pannergy_spread	0.00	pannergy_vol	0.00
phylaxia_ret	0.00	phylaxia_spread	0.00	phylaxia_vol	0.00
raba_ret	0.50	raba_spread	0.00	raba_vol	0.00
richter_ret	0.01	richter_spread	0.00	richter_vol	0.00
synergon_ret	0.00	synergon_spread	0.00	synergon_vol	0.00
tvk_ret	0.01	tvk_spread	0.00	tvk_vol	0.00

Kyiv

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
almk_ret	0,00	almk_spread	0,00	almk_vol	0,00
avdk_ret	0,00	avdk_spread	-	avdk_vol	-
azst_ret	0,00	azst_spread	0,00	azst_vol	0,05
bavl_ret	0,00	bavl_spread	0,59	bavl_vol	0,00
ceen_ret	0,00	ceen_spread	0,00	ceen_vol	0,00
dnen_ret	0,90	dnen_spread	0,00	dnen_vol	0,00
enmz_ret	0,00	enmz_spread	0,01	enmz_vol	0,00
kien_ret	0,00	kien_spread	0,00	kien_vol	0,00
kvbz_ret	0,00	kvbz_spread	0,00	kvbz_vol	0,01
mmki_ret	0,00	mmki_spread	0,05	mmki_vol	0,00
msich_ret	0,00	msich_spread	0,00	msich_vol	0,00
mzvm_ret	0,00	mzvm_spread	0,00	mzvm_vol	0,00
nitr_ret	0,00	nitr_spread	0,05	nitr_vol	0,00
pgok_ret	0,75	pgok_spread	0,00	pgok_vol	0,67
smash_ret	0,00	smash_spread	0,00	smash_vol	-
stir_ret	0,53	stir_spread	0,00	stir_vol	0,00
unaf_ret	0,08	unaf_spread	0,00	unaf_vol	0,00
uscb_ret	0,00	uscb_spread	0,00	uscb_vol	0,00
utel_ret	0,00	utel_spread	0,00	utel_vol	0,00
zaen_ret	0,62	zaen_spread	0,00	zaen_vol	0,00

Ljubljana

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
grvg_ret	0,10	grvg_spread	0,00	grvg_vol	0,00
ieks_ret	0,16	ieks_spread	0,00	ieks_vol	0,00
krkg_ret	0,05	krkg_spread	0,00	krkg_vol	0,00
lkpg_ret	0,81	lkpg_spread	0,00	lkpg_vol	0,00
melr_ret	0,62	melr_spread	0,00	melr_vol	0,00
petg_ret	0,95	petg_spread	0,00	petg_vol	0,00
tlsg_ret	0,53	tlsg_spread	0,00	tlsg_vol	0,00

Moscow

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
agamit_ret	0.02	agamit_spread	0.00	agamit_vol	0.00
ogke_ret	0.54	ogke_spread	0.00	ogke_vol	0.00
rbci_ret	0.54	rbci_spread	0.00	rbci_vol	0.00
rtkm_ret	0.20	rtkm_spread	0.09	rtkm_vol	0.00
sber_ret	0.07	sber_spread	0.00	sber_vol	0.00
tatn_ret	0.08	tatn_spread	0.00	tatn_vol	0.00
ursi_ret	0.00	ursi_spread	0.00	ursi_vol	0.00
usamci_ret	0.13	usamci_spread	0.00	usamci_vol	0.00

Prague

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
cetv_ret	0.93	cetv_spread	0.17	cetv_vol	0.00
cez_ret	0.00	cez_spread	0.03	cez_vol	0.00
komb_ret	0.58	komb_spread	0.00	komb_vol	0.00
nwr_ret	0.38	nwr_spread	0.12	nwr_vol	0.00
orco_ret	0.53	orco_spread	0.00	orco_vol	0.01
pegas_ret	0.14	pegas_spread	0.00	pegas_vol	0.00
rbag_ret	0.93	rbag_spread	0.40	rbag_vol	0.00
tabak_ret	0.02	tabak_spread	0.00	tabak_vol	0.00
unip_ret	0.34	unip_spread	0.00	unip_vol	0.00
vig_ret	0.15	vig_spread	0.85	vig_vol	0.00
zen_ret	0.84	zen_spread	0.04	zen_vol	0.00

Riga

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
grd1r_ret	0.38	grd1r_spread	0.00	grd1r_vol	0.00
lsc1r_ret	0.00	lsc1r_spread	0.00	lsc1r_vol	0.00
olf1r_ret	0.84	olf1r_spread	0.00	olf1r_vol	0.00
vnf1r_ret	0.02	vnf1r_spread	0.00	vnf1r_vol	0.00

Sofia

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
id_ret	0.00	id_spread		id_vol	0.00
alb_ret	0.00	alb_spread		alb_vol	0.00
sr_ret	0.00	sr_spread	0.95	sr_vol	0.00
s7_ret	0.00	s7_spread		s7_vol	0.00

Tallinn

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
arc1t_ret	0.02	arc1t_spread	0.00	arc1t_vol	0.00
blt1t_ret	0.24	blt1t_spread	0.00	blt1t_vol	0.00
eeg1t_ret	0.01	eeg1t_spread	0.00	eeg1t_vol	0.00
eeh1t_ret	0.19	eeh1t_spread	0.00	eeh1t_vol	0.00
etlat_ret	0.10	etlat_spread	0.00	etlat_vol	0.00
hae1t_ret	0.29	hae1t_spread	0.00	hae1t_vol	0.00
klv1t_ret	0.79	klv1t_spread	0.00	klv1t_vol	0.00
nrm1t_ret	0.00	nrm1t_spread	0.00	nrm1t_vol	0.00
oeg1t_ret	0.46	oeg1t_spread	0.00	oeg1t_vol	0.00
sfgat_ret	0.72	sfgat_spread	0.00	sfgat_vol	0.00
tal1t_ret	0.62	tal1t_spread	0.00	tal1t_vol	0.00
tkm1t_ret	0.30	tkm1t_spread	0.00	tkm1t_vol	0.00
tpd1t_ret	0.00	tpd1t_spread	0.00	tpd1t_vol	0.00
tveat_ret	0.09	tveat_spread	0.00	tveat_vol	0.00
vsn1t_ret	0.59	vsn1t_spread	0.00	vsn1t_vol	0.00

Vilnius

Ticker	Hettest p values	Ticker	Hettest p values
apg1l_ret	0.00	apg1l_vol	0.00
ivl1l_ret	0.00	ivl1l_vol	0.00
ldj1l_ret	0.00	ldj1l_vol	0.00
ptr1l_ret	0.00	ptr1l_vol	0.00
pzv1l_ret	0.00	pzv1l_vol	0.00
rst1l_ret	0.19	rst1l_vol	0.00
rsu1l_ret	0.00	rsu1l_vol	0.00
sab1l_ret	0.04	sab1l_vol	0.00
san1l_ret	0.15	san1l_vol	0.00
sng1l_ret	0.00	sng1l_vol	0.00
teo1l_ret	0.26	teo1l_vol	0.00
ukb1l_ret	0.44	ukb1l_vol	0.00
utr1l_ret	0.00	utr1l_vol	0.00
vbl1l_ret	0.00	vbl1l_vol	0.00

Warsaw

Ticker	Hettest p values	Ticker	Hettest p values	Ticker	Hettest p values
bre_ret	0.29	bre_spread	0.00	bre_vol	0.00
cez_ret	0.24	cez_spread	0.00	cez_vol	0.00
gtc_ret	0.05	gtc_spread	0.02	gtc_vol	0.00
pbg_ret	0.01	pbg_spread	0.00	pbg_vol	0.00
tvn_ret	0.56	tvn_spread	0.00	tvn_vol	0.00

APPENDIX E. Threshold Values of Weather Variables.

Country	Index	Weather variable						
		Wind	Cloud	Pressure	Precipit	Humidity	Temperature	Visibility
Ukraine	PFTS	3	3 000	0	1	50	5	50
Poland	WIG	5	1 750	1 003	0	62	16	7
Russia	RTS	3	3 000	994	2	72	13	10
Hungary	BUX	1	2 250	1 005	0	30	27	6
Czech Republic	PX	4	450	952	0	0	20	30
Romania	BET	3	3 000	998	0	90	8	10
Croatia	CROBEX	1	800	967	0	56	5	10
Slovenia	SBITOP	1	0	975	10	28	21	40
Bulgaria	SOFIX	5	1 250	948	1	88	22	6
Slovakia	SAX	2	800	1 011	0	71	15	25
Estonia	TALSE	3	450	999	0	41	4	21
Latvia	RIGSE	7	150	1 009	0	81	3	2
Lithuania	VILSE	6	450	985	0	91	-1	6

Country	Index	New York weather variable					
		Wind	Cloud	Pressure	Humidity	Temperature	Visibility
Ukraine	PFTS	3	2250	1017	74	22	6
Poland	WIG	5	450	1016	82	9	11
Russia	RTS	0	3000	1004	85	22	16
Hungary	BUX	0	1750	1032	69	27	9
Czech Repul	PX	3	1250	1017	86	23	7
Romania	BET	3	1250	1023	81	-5	16
Croatia	CROBEX	4	3000	987	78	15	12
Slovenia	SBITOP	3	1750	1008	84	1	16
Bulgaria	SOFIX	3	1750	1008	75	9	16
Slovakia	SAX	4	250	1012	76	11	15
Estonia	TALSE	7	1250	1020	73	26	11
Latvia	RIGSE	10	1250	1024	70	5	15
Lithuania	VILSE	3	1750	1015	75	1	12

APPENDIX F. Portfolio Investment from USA.

Country	Portfolio Investment from USA, USD mln									
	2003	% of total	**2004**	% of total	**2005**	% of total	**2006**	% of total	**2007**	% of total
Ukraine	17	24%	25	13%	50	19%	235	39%	643	28%
Poland	1 671	31%	3 072	31%	4 562	29%	7 384	33%	9 078	30%
Russia	13 259	47%	10 775	37%	18 631	37%	40 291	34%	74 386	41%
Hungary	2 412	36%	4 503	35%	4 880	31%	7 619	37%	7 309	38%
Czech Republic	1 249	33%	1 843	30%	1 727	25%	3 045	34%	5 155	42%
Romania	24	14%	120	22%	249	30%	372	27%	612	19%
Croatia	270	42%	234	31%	189	25%	74	8%	164	14%
Slovenia	13	5%	1	0.2%	48	32%	116	20%	318	35%
Bulgaria	5	20%	6	6%	78	24%	95	13%	387	27%
Slovakia	14	5%	-	-	1	0.4%	-	-	-	-
Estonia	138	15%	304	21%	62	6%	63	4%	135	6%
Latvia	-	-	4	3%	10	5%	13	4%	18	7%
Lithuania	3	2%	3	1%	20	3%	9	1%	29	3%

Source: IMF. Portfolio Investment: Coordinated Portfolio Investment Survey (CPIS) Data. Available from: http://www.imf.org/external/np/sta/pi/geo.htm

APPENDIX G. Correlation Between Weather Variables.

Bratislava

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,47	1,00					
pressure	0,69	0,74	1,00				
precipit	0,07	-0,10	0,02	1,00			
humidity	0,55	0,57	0,85	0,08	1,00		
temp	0,41	0,44	0,61	-0,02	0,28	1,00	
visibility	0,46	0,48	0,63	0,00	0,39	0,59	1,00

Bucharest

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,11	1,00					
pressure	0,34	0,33	1,00				
precipit	0,00	-0,08	-0,09	1,00			
humidity	0,15	0,00	0,44	0,06	1,00		
temp	-0,01	0,05	0,28	-0,07	-0,41	1,00	
visibility	0,26	0,21	0,51	-0,07	-0,14	0,42	1,00

Budapest

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,23	1,00					
pressure	0,54	0,56	1,00				
precipit	0,10	-0,10	0,03	1,00			
humidity	0,26	0,28	0,68	0,11	1,00		
temp	0,26	0,20	0,44	-0,02	-0,08	1,00	
visibility	0,33	0,31	0,49	0,03	0,14	0,47	1,00

Kyiv

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,36	1,00					
pressure	0,63	0,53	1,00				
precipit	0,02	-0,11	-0,01	1,00			
humidity	0,38	0,22	0,71	0,08	1,00		
temp	0,17	0,12	0,35	-0,01	-0,09	1,00	
visibility	0,53	0,48	0,71	-0,01	0,18	0,50	1,00

Ljubljana

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,42	1,00					
pressure	0,64	0,71	1,00				
precipit	-0,04	-0,08	-0,02	1,00			
humidity	0,40	0,51	0,83	0,05	1,00		
temp	0,55	0,42	0,63	-0,05	0,27	1,00	
visibility	0,58	0,55	0,69	-0,03	0,32	0,68	1,00

Moscow

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,17	1,00					
pressure	0,39	0,46	1,00				
precipit	-0,02	-0,13	0,02	1,00			
humidity	0,21	0,14	0,74	0,19	1,00		
temp	0,07	0,05	0,25	0,07	-0,12	1,00	
visibility	0,38	0,42	0,67	-0,14	0,25	0,40	1,00

Prague

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,35	1,00					
pressure	0,67	0,55	1,00				
precipit	0,05	-0,14	-0,02	1,00			
humidity	0,60	0,36	0,88	0,04	1,00		
temp	0,19	0,30	0,44	-0,05	0,14	1,00	
visibility	0,56	0,42	0,68	0,00	0,39	0,59	1,00

Riga

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,03	1,00					
pressure	-0,03	0,10	1,00				
precipit	0,00	-0,22	-0,06	1,00			
humidity	-0,10	-0,54	0,09	0,34	1,00		
temp	-0,07	0,24	0,04	-0,06	-0,54	1,00	
visibility	0,08	0,18	0,06	-0,11	-0,42	0,21	1,00

Tallinn

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,04	1,00					
pressure	0,06	0,11	1,00				
precipit	0,00	-0,26	-0,04	1,00			
humidity	-0,12	-0,51	0,03	0,39	1,00		
temp	0,03	0,14	0,06	-0,10	-0,46	1,00	
visibility	0,07	0,21	0,05	-0,14	-0,28	0,13	1,00

Vilnius

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	0,02	1,00					
pressure	0,07	0,08	1,00				
precipit	0,00	-0,20	-0,04	1,00			
humidity	-0,08	-0,49	0,18	0,27	1,00		
temp	0,03	0,12	-0,02	0,04	-0,54	1,00	
visibility	0,08	0,31	0,08	-0,18	-0,50	0,31	1,00

Warsaw

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	-0,02	1,00					
pressure	0,08	0,12	1,00				
precipit	-0,01	-0,19	-0,02	1,00			
humidity	-0,01	-0,66	0,04	0,23	1,00		
temp	-0,03	0,33	0,03	0,07	-0,56	1,00	
visibility	0,11	0,23	0,10	-0,08	-0,41	0,26	1,00

Zagreb

	wind	cloud	pressure	precipit	humidity	temp	visibi~ y
wind	1,00						
cloud	-0,07	1,00					
pressure	0,09	0,12	1,00				
precipit	0,00	-0,22	-0,01	1,00			
humidity	-0,22	-0,31	-0,04	0,36	1,00		
temp	0,06	0,11	0,02	-0,06	-0,60	1,00	
visibility	0,24	0,09	0,04	-0,20	-0,63	0,45	1,00

APPENDIX H. No Threshold Model Estimation Results.

Table H1. OLS Results

	SAX	**BET**	**BUX**	**PFTS**	**SBITOP**	**RTS**	**PX**	**RIGSE**	**SOFIX**	**TALSE**	**VILSE**	**WIG**	**CROBEX**
wind	-1.06e-04	-2.55e-04	-4.00e-04	7.38e-04	-5.28e-04	-3.75e-04	7.31e-04	-1.93e-04	-8.66e-04	3.79e-05	-9.68e-05	-1.60e-04	-1.64e-04
	(1.85e-04)	(2.59e-04)	(3.54e-04)	(5.63e-04)	(5.75e-04)	(6.25e-04)	(2.90e-04)**	(3.59e-04)	(4.66e-04)*	(2.49e-04)	(1.95e-04)	(2.12e-04)	(6.84e-04)
cloud	-4.24e-07	-6.10e-07	-2.81e-07	-1.02e-06	-5.90e-07	1.48e-06	2.66e-07	-1.46e-07	-4.51e-07	-3.85e-07	4.90e-07	-8.22e-07	-7.45e-07
	(5.21e-07)	(4.52e-07)	(6.46e-07)	(7.45e-07)	(8.71e-07)	(9.81e-07)	(6.76e-07)	(7.29e-07)	(1.71e-06)	(5.80e-07)	(4.34e-07)	(7.60e-07)	(1.03e-06)
pressure	-4.43e-07	2.73e-06	5.89e-06	-3.47e-06	1.15e-05	-4.96e-06	2.71e-06	-1.49e-06	4.72e-06	-9.84e-07	-9.58e-07	5.00e-07	7.00e-06
	(3.16e-06)	(3.54e-06)	(4.32e-06)	(6.42e-06)	(6.18e-06)*	(6.71e-06)	(5.00e-06)	(1.10e-05)	(2.57e-05)	(7.30e-06)	(3.65e-06)	(6.65e-06)	(1.47e-05)
precipit	1.31e-05	1.72e-04	5.02e-04	-1.25e-04	-2.46e-05	-4.02e-04	6.94e-04	-2.70e-04	-1.08e-04	1.75e-04	-1.03e-04	3.31e-05	3.45e-04
	(1.62e-04)	(4.77e-04)	(2.13e-04)**	(2.39e-04)	(1.23e-04)	(3.04e-04)	(6.81e-04)	(2.20e-04)	(4.19e-04)	(1.69e-04)	(1.67e-04)	(1.94e-04)	(3.25e-04)
humidity	1.18e-05	-1.59e-05	-5.97e-05	-7.26e-07	-8.15e-05	8.83e-05	-4.76e-05	2.71e-05	-1.22e-04	-6.10e-05	4.39e-06	-4.02e-05	-1.08e-04
	(3.01e-05)	(3.00e-05)	(3.98e-05)	(5.24e-05)	(5.77e-05)	(6.24e-05)	(4.74e-05)	(5.26e-05)	(8.52e-05)	(3.23e-05)*	(2.68e-05)	(4.45e-05)	(7.68e-05)
temp	-6.97e-05	-3.84e-05	-1.63e-04	4.32e-05	6.21e-06	-1.48e-05	1.02e-04	-1.17e-05	-3.44e-04	-1.63e-04	-2.94e-05	-1.71e-04	-6.43e-05
	(6.63e-05)	(8.06e-05)	(9.88e-05)*	(1.12e-04)	(1.09e-04)	(1.22e-04)	(8.80e-05)	(1.19e-04)	(2.09e-04)	(7.92e-05)**	(6.22e-05)	(9.22e-05)*	(1.59e-04)
visibility	7.75e-05	1.04e-04	2.31e-04	-9.40e-05	-1.58e-04	5.27e-05	-1.22e-04	6.94e-05	6.42e-06	3.09e-05	-2.78e-04	1.32e-04	6.07e-05
	(5.31e-05)	(1.53e-04)	(7.67e-05)***	(1.54e-04)	(9.69e-05)	(3.23e-04)	(7.72e-05)	(1.99e-04)	(2.83e-04)	(7.45e-05)	(1.84e-04)	(1.33e-04)	(1.01e-04)
winter	-7.54e-04	6.23e-04	0.00e+00	5.80e-03	6.49e-04				-1.15e-02		8.27e-04	-5.50e-03	
	(1.82e-03)	(2.35e-03)	(0.00e+00)	(3.48e-03)*	(3.01e-03)				(5.32e-03)**		(1.92e-03)	(2.70e-03)**	
spring	2.61e-05	1.65e-04	4.52e-03	4.04e-03	1.69e-03	1.06e-03	1.28e-04	5.42e-04	-6.69e-03	2.05e-03	6.84e-04	-2.61e-04	4.04e-04
	(1.10e-03)	(1.50e-03)	(2.36e-03)*	(2.06e-03)**	(1.72e-03)	(3.55e-03)	(1.96e-03)	(2.98e-03)	(3.56e-03)*	(2.00e-03)	(1.13e-03)	(1.65e-03)	(3.61e-03)
autumn	5.75e-04	6.68e-04	4.06e-03	1.08e-03	5.21e-03	-4.00e-03	1.05e-03	2.91e-04	-4.73e-03	2.78e-03	2.05e-04	-5.05e-04	3.07e-04
	(1.18e-03)	(1.49e-03)	(2.40e-03)*	(2.17e-03)	(1.97e-03)***	(3.51e-03)	(2.01e-03)	(2.94e-03)	(3.38e-03)	(1.98e-03)	(1.22e-03)	(1.74e-03)	(3.62e-03)
dec	9.62e-04	2.87e-03	6.93e-03	7.56e-04	4.01e-03	-1.15e-03	3.26e-03	1.35e-03	6.02e-03	5.38e-03	6.61e-04	5.94e-03	4.66e-03
	(1.93e-03)	(2.50e-03)	(2.87e-03)**	(3.44e-03)	(3.29e-03)	(4.10e-03)	(2.52e-03)	(3.31e-03)	(5.02e-03)	(2.28e-03)**	(1.81e-03)	(2.65e-03)**	(3.97e-03)
jan	5.25e-04	1.87e-03	5.93e-03	-3.68e-03	2.19e-03	4.13e-03	9.75e-04	-6.86e-04	2.06e-03	2.52e-03	7.42e-04	3.66e-03	1.73e-03
	(1.92e-03)	(2.18e-03)	(2.75e-03)**	(3.57e-03)	(3.27e-03)	(4.20e-03)	(2.38e-03)	(3.26e-03)	(4.70e-03)	(2.22e-03)	(1.77e-03)	(2.55e-03)	(3.79e-03)
Constant	2.18e-04	-3.30e-04	-5.82e-03	2.46e-03	-1.94e-03	-3.39e-04	-7.78e-04	1.38e-03	1.79e-02	4.70e-03	3.17e-03	5.96e-03	2.83e-04
	(1.07e-03)	(2.31e-03)	(2.56e-03)**	(2.41e-03)	(1.80e-03)	(3.78e-03)	(2.00e-03)	(1.13e-02)	(2.61e-02)	(7.25e-03)	(3.65e-03)	(7.12e-03)	(1.61e-02)
Observations	1560	1850	832	1044	239	836	971	873	679	829	824	808	345
R-squared	0.00	0.00	0.03	0.02	0.06	0.02	0.02	0.00	0.01	0.02	0.01	0.02	0.02

Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table H2. OLS with Robust Standard Errors Results

	SAX	BET	BUX	PFTS	SBITOP	RTS	PX	RIGSE	SOFIX	TALSE	VILSE	WIG	CROBEX
wind	-1.06e-04	-2.55e-04	-4.00e-04	7.38e-04	-5.28e-04	-3.75e-04	7.31e-04	-1.93e-04	-8.66e-04	3.79e-05	-9.68e-05	-1.60e-04	-1.64e-04
	(1.94e-04)	(3.07e-04)	(3.33e-04)	(5.88e-04)	(6.06e-04)	(6.31e-04)	(3.01e-04)**	(3.68e-04)	(5.28e-04)	(2.65e-04)	(1.90e-04)	(2.11e-04)	(7.83e-04)
cloud	-4.24e-07	-6.10e-07	-2.81e-07	-1.02e-06	-5.90e-07	1.48e-06	2.66e-07	-1.46e-07	-4.51e-07	-3.85e-07	4.90e-07	-8.22e-07	-7.45e-07
	(5.23e-07)	(4.63e-07)	(6.13e-07)	(7.79e-07)	(9.51e-07)	(1.04e-06)	(7.04e-07)	(6.72e-07)	(1.51e-06)	(6.37e-07)	(4.02e-07)	(7.72e-07)	(1.16e-06)
pressure	-4.43e-07	2.73e-06	5.89e-06	-3.47e-06	1.15e-05	-4.96e-06	2.71e-06	-1.49e-06	4.72e-06	-9.84e-07	-9.58e-07	5.00e-07	7.00e-06
	(3.13e-06)	(3.16e-06)	(3.77e-06)	(7.42e-06)	(6.64e-06)*	(6.00e-06)	(4.70e-06)	(3.24e-06)	(1.30e-05)	(3.72e-06)	(4.70e-06)	(6.14e-06)	(4.44e-06)
precipit	1.31e-05	1.72e-04	5.02e-04	-1.25e-04	-2.46e-05	-4.02e-04	6.94e-04	-2.70e-04	-1.08e-04	1.75e-04	-1.03e-04	3.31e-05	3.45e-04
	(1.64e-04)	(3.63e-04)	(2.06e-04)**	(2.23e-04)	(9.03e-05)	(2.55e-04)	(6.16e-04)	(1.70e-04)	(2.65e-04)	(1.53e-04)	(1.60e-04)	(1.74e-04)	(3.36e-04)
humidity	1.18e-05	-1.59e-05	-5.97e-05	-7.26e-07	-8.15e-05	8.83e-05	-4.76e-05	2.71e-05	-1.22e-04	-6.10e-05	4.39e-06	-4.02e-05	-1.08e-04
	(3.02e-05)	(2.61e-05)	(3.58e-05)*	(5.61e-05)	(6.12e-05)	(5.84e-05)	(4.52e-05)	(4.82e-05)	(8.17e-05)	(3.27e-05)*	(2.59e-05)	(4.47e-05)	(8.28e-05)
temp	-6.97e-05	-3.84e-05	-1.63e-04	4.32e-05	6.21e-06	-1.48e-05	1.02e-04	-1.17e-05	-3.44e-04	-1.63e-04	-2.94e-05	-1.71e-04	-6.43e-05
	(6.88e-05)	(8.14e-05)	(8.48e-05)*	(1.32e-04)	(1.07e-04)	(1.14e-04)	(8.42e-05)	(1.21e-04)	(2.02e-04)*	(7.77e-05)**	(5.83e-05)	(9.00e-05)*	(1.86e-04)
visibility	7.75e-05	1.04e-04	2.31e-04	-9.40e-05	-1.58e-04	5.27e-05	-1.22e-04	6.94e-05	6.42e-06	3.09e-05	-2.78e-04	1.32e-04	6.07e-05
	(5.29e-05)	(1.47e-04)	(7.66e-05)***	(1.51e-04)	(1.07e-04)	(2.88e-04)	(7.10e-05)*	(1.22e-04)	(2.47e-04)	(8.49e-05)	(1.71e-04)	(1.48e-04)	(9.02e-05)
winter	-7.54e-04	6.23e-04	0.00e+00	5.80e-03	6.49e-04				-1.15e-02	0.00e+00	8.27e-04	-5.50e-03	
	(1.66e-03)	(2.39e-03)	(0.00e+00)	(3.77e-03)	(2.97e-03)				(5.16e-03)**	(0.00e+00)	(1.75e-03)	(2.37e-03)**	
spring	2.61e-05	1.65e-04	4.52e-03	4.04e-03	1.69e-03	1.06e-03	1.28e-04	5.42e-04	-6.69e-03	2.05e-03	6.84e-04	-2.61e-04	4.04e-04
	(1.10e-03)	(1.49e-03)	(1.87e-03)**	(2.09e-03)*	(1.62e-03)	(3.23e-03)	(1.88e-03)	(1.49e-03)	(3.95e-03)*	(1.99e-03)	(1.11e-03)	(1.62e-03)	(3.03e-03)
autumn	5.75e-04	6.68e-04	4.06e-03	1.08e-03	5.21e-03	-4.00e-03	1.05e-03	2.91e-04	-4.73e-03	2.78e-03	2.05e-04	-5.05e-04	3.07e-04
	(1.24e-03)	(1.39e-03)	(1.92e-03)**	(2.16e-03)	(1.92e-03)***	(3.35e-03)	(1.89e-03)	(1.67e-03)	(3.51e-03)	(1.92e-03)	(1.35e-03)	(1.76e-03)	(2.87e-03)
dec	9.62e-04	2.87e-03	6.93e-03	7.56e-04	4.01e-03	-1.15e-03	3.26e-03	1.35e-03	6.02e-03	5.38e-03	6.61e-04	5.94e-03	4.66e-03
	(1.50e-03)	(2.32e-03)	(2.69e-03)**	(4.19e-03)	(3.27e-03)	(4.31e-03)	(2.68e-03)	(1.54e-03)	(4.84e-03)	(1.99e-03)***	(1.31e-03)	(2.14e-03)***	(2.70e-03)*
jan	5.25e-04	1.87e-03	5.93e-03	-3.68e-03	2.19e-03	4.13e-03	9.75e-04	-6.86e-04	2.06e-03	2.52e-03	7.42e-04	3.66e-03	1.73e-03
	(1.72e-03)	(2.36e-03)	(2.47e-03)**	(3.27e-03)	(3.90e-03)	(3.72e-03)	(2.55e-03)	(1.31e-03)	(4.36e-03)	(2.12e-03)	(1.38e-03)	(2.43e-03)	(2.96e-03)
Constant	2.18e-04	-3.30e-04	-5.82e-03	2.46e-03	-1.94e-03	-3.39e-04	-7.78e-04	1.38e-03	1.79e-02	4.70e-03	3.17e-03	5.96e-03	2.83e-04
	(1.05e-03)	(2.43e-03)	(2.14e-03)***	(2.25e-03)	(1.65e-03)	(3.31e-03)	(1.85e-03)	(2.88e-03)	(1.51e-02)	(3.33e-03)	(4.79e-03)	(6.62e-03)	(7.04e-03)
Observations	1560	1850	832	1044	239	836	971	873	679	829	824	808	345
R-squared	0.00	0.00	0.03	0.02	0.06	0.02	0.02	0.00	0.01	0.02	0.01	0.02	0.02

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table H3. GARCH Results

	SAX	**BET**	**BUX**	**PFTS**	**SBITOP**	**RTS**	**PX**	**RIGSE**	**SOFIX**	**TALSE**	**VILSE**	**WIG**	**CROBEX**
wind	-8.71e-05	-3.17e-04	-4.18e-04	-3.23e-04	-4.23e-04	-7.57e-04	6.53e-04	-3.76e-04	-4.25e-04	1.28e-04	-1.32e-04	-1.61e-04	5.93e-04
	(1.66e-04)	(2.13e-04)	(3.76e-04)	(5.38e-04)	(6.05e-04)	(5.34e-04)	(2.73e-04)**	(3.00e-04)	(3.89e-04)	(2.37e-04)	(1.87e-04)	(2.09e-04)	(7.62e-04)
cloud	-3.05e-07	-1.67e-07	-4.56e-07	9.13e-08	-6.29e-07	1.91e-06	4.92e-08	-2.45e-07	3.42e-08	-6.00e-07	5.91e-07	-1.04e-06	2.03e-07
	(4.31e-07)	(3.97e-07)	(7.09e-07)	(7.41e-07)	(8.48e-07)	(7.39e-07)***	(6.42e-07)	(6.34e-07)	(1.34e-06)	(5.81e-07)	(4.44e-07)	(7.36e-07)	(1.05e-06)
pressure	-7.18e-08	2.20e-06	5.95e-06	6.29e-06	1.18e-05	-4.18e-06	5.31e-06	-9.29e-08	-3.00e-06	5.44e-08	3.38e-06	1.31e-06	1.98e-06
	(2.84e-06)	(3.31e-06)	(4.79e-06)	(5.83e-06)	(6.38e-06)*	(5.08e-06)	(4.86e-06)	(5.40e-05)	(5.00e-05)	(2.60e-05)	(2.85e-06)	(6.60e-06)	(1.11e-04)
precipit	-5.07e-05	-6.46e-05	4.84e-04	2.69e-05	-3.01e-05	-3.61e-04	7.63e-04	-1.63e-04	-2.59e-04	2.07e-04	-3.33e-05	3.47e-05	3.61e-04
	(1.46e-04)	(3.49e-04)	(2.22e-04)**	(2.76e-04)	(1.86e-04)	(3.13e-04)	(7.50e-04)	(2.08e-04)	(4.94e-04)	(1.88e-04)	(1.67e-04)	(1.98e-04)	(2.97e-04)
humidity	-3.46e-06	-1.53e-05	-5.85e-05	-7.84e-05	-8.99e-05	1.06e-04	-7.76e-05	-2.39e-06	-1.32e-04	-6.88e-05	1.66e-05	-3.73e-05	-7.28e-05
	(2.78e-05)	(2.88e-05)	(4.24e-05)	(4.36e-05)*	(5.88e-05)	(4.85e-05)**	(4.62e-05)*	(4.64e-05)	(6.44e-05)**	(3.41e-05)**	(2.57e-05)	(4.34e-05)	(6.26e-05)
temp	-6.47e-05	-7.21e-05	-1.40e-04	-8.71e-05	1.03e-05	-9.75e-05	5.27e-05	1.78e-05	-3.21e-04	-1.73e-04	-4.51e-05	-1.43e-04	4.23e-05
	(6.03e-05)	(7.39e-05)	(1.15e-04)	(1.16e-04)	(1.19e-04)	(1.06e-04)	(8.50e-05)	(1.05e-04)	(1.46e-04)**	(8.26e-05)**	(6.05e-05)	(9.46e-05)	(1.33e-04)
visibility	6.46e-05	1.38e-05	2.30e-04	-2.20e-04	-1.53e-04	-9.80e-05	-1.22e-04	2.09e-05	-2.12e-04	7.70e-05	-2.65e-04	1.21e-04	7.96e-05
	(4.42e-05)	(1.31e-04)	(7.29e-05)***	(1.55e-04)	(9.92e-05)	(2.97e-04)	(8.11e-05)	(1.53e-04)	(2.74e-04)	(6.32e-05)	(1.77e-04)	(1.15e-04)	(1.02e-04)
winter	-2.94e-04	-6.31e-04	-3.00e-03	6.11e-03	1.00e-03	-2.54e-03	1.46e-03	1.14e-03	-1.46e-02	-3.06e-03	6.99e-04	-5.10e-03	1.61e-03
	(1.62e-03)	(2.07e-03)	(3.45e-03)	(3.00e-03)**	(3.18e-03)	(3.86e-03)	(2.33e-03)	(4.41e-03)	(3.42e-03)***	(2.58e-03)	(1.97e-03)	(3.04e-03)*	(4.48e-03)
spring	1.07e-04	-9.14e-04	1.58e-03	3.39e-03	2.05e-03	-9.64e-04	2.12e-03	8.29e-04	-6.65e-03	-8.12e-04	8.57e-04	1.82e-04	7.86e-04
	(1.01e-03)	(1.44e-03)	(1.82e-03)	(1.80e-03)*	(1.96e-03)	(2.06e-03)	(1.51e-03)	(1.84e-03)	(2.41e-03)***	(1.55e-03)	(9.90e-04)	(1.67e-03)	(2.40e-03)
autumn	9.80e-04	-7.72e-04	1.17e-03	6.29e-04	5.03e-03	-7.28e-03	3.02e-03	6.58e-04	-5.96e-03	-4.88e-04	5.90e-04	-2.80e-04	2.43e-03
	(1.07e-03)	(1.43e-03)	(1.83e-03)	(2.24e-03)	(2.14e-03)**	(2.06e-03)***	(1.64e-03)*	(1.48e-03)	(2.48e-03)**	(1.55e-03)	(1.07e-03)	(1.77e-03)	(2.14e-03)
dec	9.02e-04	1.23e-03	6.34e-03	-7.95e-03	3.93e-03	-9.52e-04	3.79e-03	8.34e-04	7.76e-03	5.17e-03	7.48e-04	5.71e-03	5.33e-03
	(1.86e-03)	(2.07e-03)	(3.17e-03)**	(3.48e-03)**	(3.47e-03)	(3.81e-03)	(2.39e-03)	(4.70e-03)	(2.71e-03)***	(2.64e-03)**	(2.23e-03)	(3.11e-03)*	(4.87e-03)
jan	3.65e-05	5.63e-04	6.10e-03	-6.04e-03	1.40e-03	2.42e-03	1.46e-03	-4.21e-04	2.43e-03	2.31e-03	6.09e-04	3.30e-03	-6.90e-04
	(1.56e-03)	(1.62e-03)	(3.01e-03)**	(3.38e-03)*	(2.83e-03)	(4.35e-03)	(2.39e-03)	(4.40e-03)	(3.00e-03)	(2.33e-03)	(2.00e-03)	(2.76e-03)	(4.09e-03)
Constant	7.99e-04	2.52e-03	-2.75e-03	3.27e-03	-2.09e-03	2.05e-03	-2.04e-03	2.03e-03	2.61e-02	6.84e-03	-2.32e-03	4.90e-03	-2.96e-03
	(9.50e-04)	(2.40e-03)	(2.00e-03)	(2.58e-03)	(2.06e-03)	(2.80e-03)	(1.39e-03)	(5.60e-02)	(4.89e-02)	(2.66e-02)	(2.46e-03)	(7.09e-03)	(1.13e-01)
Observations	1560	1850	832	1044	239	836	970	873	679	829	824	808	345

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

APPENDIX I. Model with NYC Weather and S&P 500 Index

Table I1. OLS Results.

	SAX	BET	BUX	PFTS	SBITOP	RTS	PX	RIGSE	SOFIX	TALSE	VILSE	WIG	CROBEX
wind_up	-4.61e-05	6.66e-05	-2.81e-04	4.95e-04	-5.95e-04	-4.48e-04	8.60e-05	3.06e-04	-8.88e-04	-1.06e-04	-5.99e-05	6.35e-05	2.27e-04
	(2.33e-04)	(2.49e-04)	(3.35e-04)	(3.96e-04)	(4.63e-04)	(6.16e-04)	(2.29e-04)	(3.92e-04)	(5.20e-04)*	(1.85e-04)	(1.88e-04)	(1.78e-04)	(5.67e-04)
wind_down	5.55e-04	1.27e-04	0.00e+00	3.19e-04	0.00e+00	-3.52e-06	-1.08e-03	-4.49e-04	2.08e-04	-1.20e-03	1.21e-04	2.93e-04	0.00e+00
	(2.26e-03)	(6.43e-04)	(0.00e+00)	(9.45e-04)	(0.00e+00)	(1.09e-03)	(5.55e-04)*	(4.42e-04)	(8.14e-04)	(7.19e-04)*	(2.41e-04)	(3.53e-04)	(0.00e+00)
cloud_up	1.21e-07	0.00e+00	-3.05e-07	0.00e+00	-4.35e-07	0.00e+00	2.79e-07	-7.13e-07	-9.36e-07	-6.40e-08	4.75e-07	-6.72e-07	-3.18e-07
	(6.15e-07)	(0.00e+00)	(6.28e-07)	(0.00e+00)	(8.53e-07)	(0.00e+00)	(6.32e-07)	(7.10e-07)	(1.06e-06)	(5.44e-07)	(4.01e-07)	(5.30e-07)	(9.63e-07)
cloud_down	-8.35e-06	5.95e-07	-1.02e-06	1.27e-06	0.00e+00	-4.26e-07	4.63e-06	-4.55e-05	-7.91e-06	3.50e-06	-1.72e-06	-4.68e-07	1.19e-06
	(6.35e-06)	(8.94e-07)	(1.28e-06)	(1.01e-06)	(0.00e+00)	(1.23e-06)	(8.98e-06)	(6.69e-05)	(4.62e-06)*	(7.31e-06)	(6.11e-06)	(1.20e-06)	(8.73e-06)
pressure_up	0.00e+00	0.00e+00	3.92e-06	-7.92e-06	2.60e-06	4.29e-06	1.73e-06	-1.15e-06	4.19e-06	-3.31e-07	-3.74e-06	3.66e-07	-1.14e-05
	(0.00e+00)	(0.00e+00)	(3.98e-06)	(6.28e-06)	(3.05e-06)	(3.27e-06)	(3.67e-06)	(3.40e-06)	(2.79e-05)	(6.42e-06)	(3.62e-06)	(5.18e-06)	(1.74e-05)
pressure_down	-6.83e-06	-1.58e-07	2.80e-06	0.00e+00	1.19e-06	4.33e-06	1.99e-06	-2.30e-06	2.84e-06	-1.94e-06	-6.32e-06	-8.14e-07	0.00e+00
	(3.86e-06)*	(3.00e-06)	(4.20e-06)	(0.00e+00)	(3.75e-06)	(3.59e-06)	(4.90e-06)	(3.51e-06)	(2.81e-05)	(6.64e-06)	(3.79e-06)*	(5.27e-06)	(0.00e+00)
precipit_up	-2.51e-05	1.12e-04	6.02e-04	-7.01e-05	7.75e-05	-4.57e-04	9.04e-04	-2.30e-04	-3.26e-04	2.52e-04	-5.64e-05	7.08e-06	5.69e-05
	(2.10e-04)	(4.70e-04)	(2.26e-04)***	(2.44e-04)	(1.52e-04)	(3.00e-04)	(7.14e-04)	(2.27e-04)	(4.46e-04)	(1.74e-04)	(1.69e-04)	(1.96e-04)	(3.35e-04)
precipit_down	0.00e+00	0.00e+00	0.00e+00	0.00e+00	-4.61e-04	-2.96e-03	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00
	(0.00e+00)	(0.00e+00)	(0.00e+00)	(0.00e+00)	(3.74e-04)	(3.95e-03)	(0.00e+00)	(0.00e+00)	(0.00e+00)	(0.00e+00)	(0.00e+00)	(0.00e+00)	(0.00e+00)
humidity_up	5.83e-05	1.51e-05	-1.74e-05	2.79e-05	2.72e-05	4.14e-06	-6.85e-06	2.80e-05	-1.18e-05	-6.60e-05	3.94e-05	2.63e-05	4.64e-05
	(3.71e-05)	(2.97e-05)	(4.03e-05)	(5.33e-05)	(3.57e-05)	(5.03e-05)	(3.74e-05)	(4.42e-05)	(9.52e-05)	(3.59e-05)*	(2.29e-05)*	(3.72e-05)	(6.52e-05)
humidity_down	6.60e-05	4.91e-05	-9.11e-05	3.31e-05	2.28e-04	-2.91e-05	0.00e+00	7.57e-05	-1.35e-04	-7.10e-05	3.09e-05	9.46e-05	7.93e-05
	(5.15e-05)	(3.55e-05)	(1.20e-04)	(8.74e-05)	(2.66e-04)	(6.19e-05)	(0.00e+00)	(5.15e-05)	(9.01e-05)	(7.67e-05)	(2.41e-05)	(5.42e-05)*	(8.88e-05)
temp_up	-2.51e-05	-5.95e-05	2.86e-06	1.13e-04	1.00e-04	4.96e-05	9.82e-05	6.79e-05	-2.24e-04	-2.01e-04	1.66e-05	-9.75e-05	1.54e-04
	(8.47e-05)	(8.82e-05)	(9.41e-05)	(1.25e-04)	(1.01e-04)	(1.28e-04)	(9.05e-05)	(1.45e-04)	(1.90e-04)	(9.90e-05)**	(8.08e-05)	(8.94e-05)	(1.75e-04)
temp_down	1.54e-04	1.05e-05	-8.96e-05	4.77e-04	1.89e-05	-6.05e-05	8.97e-05	1.55e-04	-4.60e-05	-1.33e-04	-1.14e-04	9.05e-06	-6.58e-04
	(1.58e-04)	(2.99e-04)	(8.95e-05)	(6.30e-04)	(1.43e-04)	(2.06e-04)	(1.00e-04)	(3.79e-04)	(2.15e-04)	(1.93e-04)	(1.87e-04)	(1.23e-04)	(7.63e-04)
visibility_up	1.39e-04	-1.16e-05	2.24e-04	0.00e+00	0.00e+00	1.58e-04	-1.45e-05	3.70e-05	-1.18e-05	-2.54e-05	-1.08e-04	1.34e-04	9.37e-05
	(6.68e-05)**	(1.36e-04)	(8.84e-05)**	(0.00e+00)	(0.00e+00)	(3.30e-04)	(6.77e-05)	(2.00e-04)	(2.23e-04)	(7.58e-05)	(1.14e-04)	(9.53e-05)	(1.00e-04)
visibility_down	3.99e-05	-3.60e-04	-3.25e-06	-1.15e-04	-7.82e-05	-3.84e-04	1.27e-05	4.84e-03	5.76e-04	-3.45e-04	2.86e-04	1.85e-04	-1.43e-05
	(9.97e-05)	(2.63e-04)	(5.81e-04)	(1.69e-04)	(8.79e-05)	(7.02e-04)	(8.22e-05)	(6.39e-03)	(7.07e-04)	(1.78e-04)*	(2.64e-04)	(2.34e-04)	(4.36e-04)
dec	3.24e-04	2.53e-03	6.54e-03	-6.86e-05	3.16e-03	-7.82e-04	3.31e-03	1.86e-03	6.73e-03	5.98e-03	4.70e-04	5.66e-03	3.46e-03
	(2.64e-03)	(2.67e-03)	(2.89e-03)**	(3.61e-03)	(3.51e-03)	(4.14e-03)	(2.56e-03)	(3.34e-03)	(5.21e-03)	(2.30e-03)***	(1.82e-03)	(2.67e-03)**	(4.08e-03)
jan	-1.31e-03	7.40e-04	5.96e-03	-4.76e-03	7.60e-03	3.45e-03	6.05e-04	-1.62e-04	2.11e-03	2.44e-03	7.02e-04	4.72e-03	1.50e-03
	(2.67e-03)	(2.44e-03)	(2.81e-03)**	(3.82e-03)	(4.42e-03)*	(4.28e-03)	(2.45e-03)	(3.41e-03)	(4.87e-03)	(2.26e-03)	(1.86e-03)	(2.59e-03)*	(4.09e-03)
spx_ret	5.23e-01	1.96e-02	2.08e-01	-6.38e-02	-1.05e-01	3.78e-01	2.32e-01	7.71e-02	-3.51e-02	-6.29e-03	-4.83e-02	2.44e-01	5.03e-02
	(3.79e-02)***	(4.16e-02)	(4.17e-02)***	(5.16e-02)	(8.28e-02)	(5.99e-02)***	(3.85e-02)***	(4.91e-02)	(7.75e-02)	(3.31e-02)	(2.66e-02)*	(3.83e-02)***	(6.50e-02)
wind_ny_wup	3.52e-05	5.39e-05	-2.98e-04	2.28e-04	1.38e-04	-7.08e-04	1.15e-05	1.69e-04	-5.39e-04	-1.82e-04	9.48e-05	9.16e-05	9.25e-05
	(2.24e-04)	(1.86e-04)	(3.00e-04)	(3.11e-04)	(2.82e-04)	(4.40e-04)	(2.06e-04)	(1.22e-03)	(4.38e-04)	(2.66e-04)	(1.55e-04)	(2.34e-04)	(3.57e-04)
wind_ny_wdown	-7.98e-05	1.84e-04	0.00e+00	7.49e-04	-1.93e-04	0.00e+00	2.78e-04	-2.12e-04	7.99e-05	2.92e-04	-7.44e-04	3.91e-04	2.47e-06
	(4.97e-04)	(7.37e-04)	(0.00e+00)	(1.03e-03)	(9.62e-04)	(0.00e+00)	(7.46e-04)	(3.67e-04)	(1.52e-03)	(2.85e-04)	(5.19e-04)	(3.99e-04)	(8.33e-04)
cloud_ny_wdown	2.89e-05	2.32e-07	-1.75e-06	1.34e-06	1.41e-06	1.08e-06	1.24e-06	4.86e-06	6.36e-07	-8.37e-07	-1.45e-07	5.64e-06	1.10e-06
	(2.63e-05)	(2.25e-06)	(1.48e-06)	(1.14e-06)	(1.77e-06)	(9.47e-07)	(2.52e-06)	(3.39e-06)	(2.77e-06)	(2.29e-06)	(9.30e-07)	(1.23e-05)	(9.62e-07)
cloud_ny_wup	7.08e-07	1.50e-07	4.50e-07	-1.64e-07	-2.14e-07	0.00e+00	7.62e-07	1.47e-06	-1.16e-06	6.90e-07	-1.19e-07	1.22e-06	0.00e+00
	(7.13e-07)	(5.01e-07)	(5.34e-07)	(6.68e-07)	(6.11e-07)	(0.00e+00)	(5.57e-07)	(7.34e-07)**	(9.72e-07)	(5.03e-07)	(3.42e-07)	(7.09e-07)*	(0.00e+00)
pressure_ny_wup	4.18e-06	-1.11e-05	-4.26e-07	-1.54e-05	-6.64e-06	-3.11e-06	-1.67e-06	5.52e-06	5.59e-06	1.14e-06	2.60e-06	-4.35e-06	1.13e-05
	(5.47e-06)	(5.45e-06)**	(6.97e-06)	(7.80e-06)**	(6.84e-06)	(7.23e-06)	(5.38e-06)	(6.51e-06)	(1.17e-05)	(4.69e-06)	(3.52e-06)	(5.43e-06)	(1.02e-05)
pressure_ny_wdown	4.95e-06	-1.16e-05	-2.85e-06	-1.53e-05	-8.49e-06	-9.30e-06	-4.30e-07	6.82e-06	8.86e-06	2.37e-06	2.21e-06	-5.05e-06	5.76e-07
	(5.57e-06)	(5.45e-06)**	(5.76e-06)	(7.81e-06)**	(7.20e-06)	(8.35e-06)	(5.43e-06)	(6.42e-06)	(1.23e-05)	(4.72e-06)	(3.58e-06)	(5.46e-06)	(1.93e-05)
humidity_ny_wup	-5.46e-05	2.20e-05	-4.41e-05	3.12e-05	-6.01e-05	-5.37e-05	-5.79e-05	3.06e-05	-2.42e-05	-2.55e-05	-2.89e-05	4.00e-05	6.15e-05
	(3.43e-05)	(3.00e-05)	(4.44e-05)	(5.20e-05)	(5.22e-05)	(5.33e-05)	(2.90e-05)**	(4.66e-05)	(7.57e-05)	(3.13e-05)	(2.77e-05)	(3.13e-05)	(6.78e-05)
humidity_ny_wdown	-4.58e-05	3.84e-05	-5.00e-05	5.97e-05	-1.04e-04	-4.41e-05	-7.74e-05	4.50e-05	3.06e-05	-4.57e-05	-3.45e-05	3.85e-05	3.26e-05
	(4.15e-05)	(3.64e-05)	(5.71e-05)	(6.42e-05)	(6.17e-05)*	(6.54e-05)	(3.16e-05)**	(5.96e-05)	(9.59e-05)	(3.88e-05)	(3.44e-05)	(3.54e-05)	(8.12e-05)
temp_ny_wup	7.79e-05	5.97e-05	2.04e-04	-5.12e-05	-9.24e-05	1.30e-04	1.29e-04	-1.70e-04	-6.25e-05	5.32e-05	-2.52e-05	-9.02e-06	-2.65e-04
	(1.05e-04)	(1.10e-04)	(2.43e-04)	(1.58e-04)	(1.43e-04)	(1.77e-04)	(1.24e-04)	(1.55e-04)	(2.06e-04)	(1.50e-04)	(9.28e-05)	(1.09e-04)	(1.76e-04)
temp_ny_wdown	1.57e-04	-5.70e-05	1.85e-04	-4.94e-05	9.77e-04	-1.29e-04	5.96e-06	-1.42e-04	-2.33e-04	5.98e-05	1.61e-04	2.81e-04	-7.72e-05
	(1.54e-04)	(2.59e-04)	(1.10e-04)*	(1.49e-04)	(4.54e-04)**	(1.67e-04)	(1.01e-04)	(2.76e-04)	(3.27e-04)	(9.90e-05)	(1.91e-04)	(1.69e-04)*	(2.18e-04)
visibility_ny_wup	-1.65e-04	-5.61e-05	1.10e-04	2.01e-04	-2.29e-04	-6.68e-05	2.72e-06	-2.43e-04	-6.24e-04	-1.34e-04	-1.15e-04	-1.46e-04	9.08e-05
	(1.61e-04)	(1.66e-04)	(2.41e-04)	(2.90e-04)	(2.05e-04)	(2.01e-04)	(2.19e-04)	(1.96e-04)	(2.65e-04)**	(1.92e-04)	(1.30e-04)	(2.35e-04)	(3.28e-04)
visibility_ny_wdown	-1.36e-04	1.87e-06	4.54e-04	-2.54e-04	-2.75e-04	-2.50e-05	2.87e-04	-1.52e-04	-5.86e-05	1.96e-05	2.34e-05	-2.78e-04	-9.07e-05
	(1.92e-04)	(8.83e-05)	(5.48e-04)	(9.59e-04)	(1.08e-04)**	(1.36e-04)	(5.76e-04)	(2.38e-04)	(1.75e-04)	(3.46e-04)	(2.20e-04)	(4.16e-04)	(5.67e-04)
R-squared	0.18	0.01	0.08	0.03	0.17	0.08	0.07	0.03	0.04	0.05	0.04	0.09	0.05

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table I2. GARCH Results with NYC Weather and S&P 500 Index.

	SAX	BET	BUX	RTS	PX	RIGSE	SOFIX	TALSE	VILSE	WIG
wind_up	-2.23e-05	-1.51e-04	-3.78e-04	-5.72e-04	1.53e-04	2.38e-04	-4.17e-04	1.95e-05	-1.09e-04	3.41e-05
	(2.07e-04)	(2.02e-04)	(3.58e-04)	(6.17e-04)	(2.20e-04)	(2.96e-04)	(5.62e-04)	(1.86e-04)	(1.97e-04)	(1.83e-04)
wind_down	1.97e-03	-8.46e-05		2.60e-05	-6.98e-04	-2.16e-04	1.20e-04	-1.03e-03	9.79e-05	2.38e-04
	(2.24e-03)	(5.08e-04)		(1.05e-03)	(5.41e-04)	(3.03e-04)	(5.74e-04)	(8.20e-04)	(2.27e-04)	(3.58e-04)
cloud_up	1.34e-07		-2.31e-07		-2.87e-08	-4.41e-07	-2.76e-07	-1.19e-07	5.00e-07	-7.61e-07
	(5.41e-07)		(6.80e-07)		(6.33e-07)	(5.61e-07)	(7.83e-07)	(5.99e-07)	(4.31e-07)	(5.41e-07)
cloud_down	-4.01e-06	4.28e-07	-7.24e-07	-3.21e-07	3.57e-06	-1.26e-05	-7.54e-06	6.05e-06	-8.44e-07	-2.86e-07
	(5.42e-06)	(7.58e-07)	(1.32e-06)	(1.21e-06)	(8.07e-06)	(6.53e-05)	(4.04e-06)*	(7.73e-06)	(6.85e-06)	(1.16e-06)
pressure_down	-6.50e-06	5.84e-07	3.29e-06	3.90e-06	2.13e-06	-4.74e-06	-1.23e-05	-3.92e-06	-2.70e-06	-4.49e-07
	(3.25e-06)**	(2.55e-06)	(4.31e-06)	(3.38e-06)	(4.54e-06)	(2.70e-06)*	(5.61e-05)	(1.46e-05)	(3.64e-06)	(7.12e-06)
precipit_up	-2.03e-05	1.10e-05	5.87e-04	-3.90e-04	8.03e-04	1.24e-05	-3.33e-04	2.51e-04	3.79e-05	3.04e-05
	(1.61e-04)	(3.50e-04)	(2.35e-04)**	(3.11e-04)	(7.79e-04)	(1.61e-04)	(3.74e-04)	(1.97e-04)	(1.65e-04)	(1.75e-04)
humidity_up	3.86e-05	-1.16e-06	-2.52e-05	-4.13e-06	-2.96e-05	-6.45e-05	-2.85e-05	-5.33e-05	4.22e-05	2.81e-05
	(3.11e-05)	(2.49e-05)	(4.23e-05)	(5.30e-05)	(3.70e-05)	(3.45e-05)*	(8.10e-05)	(3.71e-05)	(2.61e-05)	(4.31e-05)
humidity_down	4.93e-05	1.22e-05	-1.09e-04	-1.70e-05		-3.85e-05	-1.65e-04	-4.45e-06	3.73e-05	9.50e-05
	(4.24e-05)	(3.13e-05)	(1.26e-04)	(6.25e-05)		(3.90e-05)	(6.89e-05)**	(7.85e-05)	(2.62e-05)	(6.29e-05)
temp_up	-3.33e-05	-7.79e-05	8.55e-06	7.45e-05	6.83e-05	-1.54e-04	-3.22e-04	-2.04e-04	-1.34e-05	-6.67e-05
	(8.04e-05)	(7.96e-05)	(9.95e-05)	(1.24e-04)	(8.86e-05)	(1.05e-04)	(1.20e-04)***	(1.06e-04)*	(7.29e-05)	(8.82e-05)
temp_down	1.58e-04	1.57e-04	-9.41e-05	-1.80e-04	4.20e-05	1.71e-04	-2.59e-04	-1.44e-04	-6.03e-05	2.70e-05
	(1.53e-04)	(2.61e-04)	(9.46e-05)	(2.23e-04)	(1.00e-04)	(2.93e-04)	(1.48e-04)*	(2.14e-04)	(2.25e-04)	(1.21e-04)
visibility_up	1.66e-04	3.73e-05	2.64e-04	2.31e-04	-3.09e-05	-3.46e-04	-1.23e-04	2.81e-05	-6.53e-05	1.36e-04
	(6.24e-05)***	(1.44e-04)	(9.18e-05)***	(3.31e-04)	(6.93e-05)	(8.54e-05)***	(2.04e-04)	(7.30e-05)	(1.10e-04)	(9.15e-05)
visibility_down	5.16e-05	-2.96e-04	1.58e-04	1.20e-04	1.63e-05	1.95e-03	3.74e-04	-3.04e-04	3.13e-04	1.93e-04
	(9.50e-05)	(2.19e-04)	(6.42e-04)	(7.24e-04)	(8.24e-05)	(5.82e-03)	(5.41e-04)	(1.98e-04)	(2.67e-04)	(2.31e-04)
dec	1.66e-03	6.16e-04	5.76e-03	-5.06e-05	3.60e-03	2.13e-03	9.01e-03	5.74e-03	7.70e-04	5.47e-03
	(2.78e-03)	(2.00e-03)	(3.13e-03)*	(4.38e-03)	(2.60e-03)	(3.07e-03)	(3.35e-03)***	(2.62e-03)**	(2.10e-03)	(3.14e-03)*
jan	-1.19e-03	-1.47e-03	5.27e-03	3.30e-03	3.45e-04	-7.13e-04	4.35e-03	2.53e-03	7.59e-04	4.32e-03
	(2.39e-03)	(1.92e-03)	(3.10e-03)*	(4.66e-03)	(2.55e-03)	(3.06e-03)	(2.98e-03)	(2.61e-03)	(2.14e-03)	(2.73e-03)
spx_ret	5.50e-01	1.32e-02	2.16e-01	3.35e-01	2.24e-01	4.17e-02	-8.83e-03	-7.43e-03	-4.43e-02	2.31e-01
	(2.90e-02)***	(2.92e-02)	(3.78e-02)***	(4.96e-02)***	(3.36e-02)***	(3.34e-02)	(5.87e-02)	(3.68e-02)	(2.58e-02)*	(3.44e-02)***
wind_ny_wup	7.12e-05	1.47e-04	-2.57e-04	-7.39e-04	1.36e-04	6.92e-05	-1.42e-04	-1.60e-04	2.38e-04	1.29e-04
	(2.12e-04)	(1.53e-04)	(2.79e-04)	(4.41e-04)*	(1.99e-04)	(2.22e-03)	(3.43e-04)	(2.96e-04)	(1.47e-04)	(2.29e-04)
wind_ny_wdown	6.08e-05	-8.12e-05			4.44e-04	-1.74e-04	7.63e-04	2.46e-04	-5.47e-04	4.12e-04
	(4.52e-04)	(6.08e-04)			(7.38e-04)	(2.48e-04)	(1.03e-03)	(2.99e-04)	(4.99e-04)	(4.01e-04)
cloud_ny_wdown	3.69e-05	9.57e-08	-2.25e-06	8.32e-07	-2.96e-07	4.02e-06	-3.53e-06	-5.83e-07	-9.16e-07	9.25e-06
	(3.54e-05)	(1.74e-06)	(1.49e-06)	(8.96e-07)	(2.60e-06)	(1.91e-06)**	(2.23e-06)	(2.47e-06)	(9.23e-07)	(1.11e-05)
cloud_ny_wup	8.80e-08	-3.97e-07	4.40e-07		7.52e-07	1.65e-06	-1.19e-06	9.20e-07	-1.43e-08	1.27e-06
	(6.78e-07)	(3.90e-07)	(5.59e-07)		(5.92e-07)	(4.50e-07)***	(8.02e-07)	(5.56e-07)*	(3.34e-07)	(7.25e-07)*
pressure_ny_wup	7.90e-06	-1.58e-05	-3.77e-07	-2.21e-06	-5.53e-07	3.75e-06	7.01e-06	-5.40e-07	5.50e-07	-4.18e-06
	(4.49e-06)*	(2.46e-06)***	(5.87e-06)	(4.53e-06)	(5.14e-06)	(3.82e-06)	(5.75e-06)	(6.04e-06)	(3.75e-06)	(7.16e-06)
pressure_ny_wdown	8.42e-06	-1.76e-05	-2.64e-06	-6.27e-06	1.69e-07	8.00e-06	6.66e-06	4.83e-07	-4.73e-08	-4.82e-06
	(4.62e-06)*	(2.28e-06)***	(3.96e-06)	(5.91e-06)	(5.12e-06)	(3.69e-06)**	(6.64e-06)	(6.06e-06)	(3.81e-06)	(7.21e-06)
humidity_ny_wup	-6.12e-05	2.02e-05	-5.78e-05	-8.56e-06	-5.83e-05	-3.72e-05	4.61e-05	-1.62e-05	-2.18e-05	3.64e-05
	(3.17e-05)*	(3.16e-05)	(4.73e-05)	(5.30e-05)	(2.47e-05)**	(2.99e-05)	(7.92e-05)	(3.58e-05)	(2.56e-05)	(3.40e-05)
humidity_ny_wdown	-4.66e-05	3.64e-05	-6.91e-05	2.03e-06	-6.95e-05	-4.85e-05	8.53e-05	-4.58e-05	-2.53e-05	3.64e-05
	(3.85e-05)	(3.90e-05)	(6.12e-05)	(6.53e-05)	(2.84e-05)**	(3.77e-05)	(9.89e-05)	(4.47e-05)	(3.20e-05)	(3.85e-05)
temp_ny_wup	7.03e-05	-1.94e-05	1.86e-04	1.29e-04	3.05e-05	-1.09e-04	-2.45e-05	2.38e-04	-4.76e-05	-3.12e-05
	(9.49e-05)	(9.05e-05)	(6.70e-04)	(1.83e-04)	(1.10e-04)	(1.19e-04)	(1.80e-04)	(1.38e-04)*	(8.37e-05)	(1.08e-04)
temp_ny_wdown	1.11e-04	3.70e-04	1.96e-04	-1.58e-04	-1.69e-06	-2.83e-04	1.43e-04	6.33e-05	1.81e-04	3.08e-04
	(1.29e-04)	(2.34e-04)	(1.14e-04)*	(1.72e-04)	(9.89e-05)	(2.38e-04)	(2.37e-04)	(1.07e-04)	(2.16e-04)	(1.72e-04)*
visibility_ny_wup	-1.70e-04	2.37e-05	3.88e-05	-7.25e-05	-9.17e-05	-5.60e-04	3.52e-04	-7.42e-05	-1.11e-04	-1.77e-04
	(1.62e-04)	(1.54e-04)	(2.24e-04)	(2.01e-04)	(2.01e-04)	(1.25e-04)***	(1.69e-04)**	(2.25e-04)	(1.29e-04)	(2.29e-04)
visibility_ny_wdown	-1.92e-04	4.55e-05	2.39e-04	-6.26e-05	2.61e-04	-4.07e-04	4.01e-05	1.16e-05	5.13e-05	-2.98e-04
	(1.97e-04)	(7.77e-05)	(4.94e-04)	(1.39e-04)	(4.93e-04)	(1.59e-04)**	(1.37e-04)	(4.20e-04)	(2.38e-04)	(4.13e-04)
pressure_up			3.79e-06	3.15e-06	3.10e-06	-4.10e-06	-1.13e-05	-2.71e-06	1.55e-07	4.30e-07
			(4.05e-06)	(3.01e-06)	(3.56e-06)	(2.75e-06)	(5.54e-05)	(1.42e-05)	(3.33e-06)	(7.00e-06)

Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%