

# Report on Bachelor / Master Thesis

Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague

<b>Student:</b>	<b>Patrik Černý</b>
<b>Advisor:</b>	<b>Jiří Kukačka</b>
<b>Title of the thesis:</b>	<b>The weather and stock returns</b>

## **OVERALL ASSESSMENT** (provided in English, Czech, or Slovak):

*Please provide your assessment of each of the following four categories, summary and suggested questions for the discussion. The minimum length of the report is 300 words.*

### **Contribution**

The bachelor thesis of Patrik Cerny „The weather and stock returns“ analyses one of rather controversial topics from the field of Behavioral Finance: a potential influence of weather-related phenomena (sunshine, precipitation, humidity, temperature, or e.g. a lack of daylight) on the efficiency and potential predictability of stock markets. The topic became famous after the publication of a highly cited paper by Saunders (1993) in the American Economic Review where the authors conclude that „the discovery that the weather in New City has a long history of significant correlation with major stock indexes supports the view that investor psychology influences asset prices“. Since that time, many researches focused on the various whether effects in various markets/different countries with inconclusive results. The contribution of the work is then the following: 1) with and aim to bring some concluding results, it expands the research on the weather effects to a large number of markets, thus covering a larger number of countries analyzed with a consistent methodology; 2) it focuses on potential differences between developed and emerging markets; 3) it focuses on both the effect on returns as well as on volatility of stock market indices; 4) it confidently presents almost solely „negative results“.

On the other hand, I need to mention here that from the point of view of a supervisor, the cooperation on the elaboration of the thesis was insufficient from the Patrik's side and I am thus not sure about correctness of implementation of the selected methods and the presented results. The second part of the thesis was being written in a rush during December: at the end of November, not even the Methodology chapter was finished and only some very first preliminary and rather unsatisfactory results were presented, the first preliminary working version of the thesis was not ready before December 18th (which was the last version I commented on), which effectively precluded any potential improvements, suggestions, or changes in some questionable implementations of the methods. But I respected the decision of Patrik to deliver the thesis for the January defense term. Actually, I was a bit surprised (both in positive as well as in negative sense) with some parts emerging in the final version of the thesis after it was uploaded to the SIS.

### **Methods**

The thesis covers a range of standard methods from both the bachelor (OLS & related tests of assumptions) as well as master level IES curriculum. Moreover, Patrik aimed at implementing methods of time-series analysis from the master level subject Applied Econometrics (GARCH extended by other explanatory variables, model selection using AIC) which he in fact did not study. What was relatively challenging was the preparation of the data for which Patrik combined the TR Eikon database with the U.S. National Oceanic and Atmospheric Administration database of weather-related data, where issues such as missing data or different frequencies of observations play important role, and managed to merged those into one consistent dataset. On the other hand, although the methodology section seems relatively complete for the first glance, after reading it one can recognize it has been completed in a rush, just briefly summarising the important concepts, not signalling a deeper understanding of the methods or their proper utilisation.

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Some specific problematic or questionable parts are:

- The Sky cover data mapping to  $\langle 0,1 \rangle$  is confusing and does not make sense to me (pg. 17).
- In Eq. 4.1, time index is missing for *Temp* and *Prec*.
- AIC does not use any AIC estimator, it can itself be understood as an estimator.
- I do not like the argumentation: „*In order to make the effects strong (!), some of the variables were transform ed into dummy variables (!)*“ without any other explanation. It means that the explanatory variables in the OLS and GARCH models are used inconsistently. Also not the same set of explanatory variables is used in OLS regression compared to GARCH without additional explanation.
- Results: „*To deal with heteroskedasticity in order not to have biased OLS estimators...*“ (pg. 27) suggests the author does not understand either the issue of heteroskedasticity or the issue of the OLS unbiasedness (or both)!
- I do not find optimal to use an automated model selection using AIC for the linear model 4.1 with many explanatory variables. It is a great tool for a time-series analysis where a theory to decide how many AR or MA lags should be used is largely missing, but in this case other selection criteria (theory/intuition,  $R^2$ , t-test, F-test, omitted variable bias) should have been preferred.
- OLS part of the analysis is disconnected from the GARCH part (it starts again from the very beginning with the ARIMA analysis, but the GARCH model is then augmented with the weather-related variables), although these are the two sides of the coin. I would like to have these two approaches interconnected.
- The results of the GARCH analysis are suspect: no ARCH effect found in Brazil, Hungary, Russia, UAE, China, South Korea, Germany, Japan; moreover, the overall GARCH part results contradict the recent literature without providing convincing evidence.

## Literature

Definitely the best part of the thesis. The literature section not only covers a majority of important papers but provides a nice overview of the topic for even an uninformed reader. It also provides not only description and the most important results of the topical papers on weather effects, but it also clusters and critically summarises the literature in several important directions: it discusses the details of included weather-related variables; it compares the practical issues with the data; it contrasts the parts of the literature with positive and the negative results; it presents the most important points of criticism of this research topic; and it briefly summarizes the methodologies used in the literature.

All in all, I see a substantive difference in the quality of the Literature review chapter to which enough attention was devoted compared to other parts of the thesis.

## Manuscript form

The thesis is written in a decent English and typeset in LaTeX, which I need to appreciate at the level of a bachelor thesis. I found several typos, incomplete sentences, and formatting/typesetting imperfections but nothing serious. In fact, I was a bit surprised how the final version looks like compared to the version before Christmas. The only issue I find serious is that tables are not „self-contained“, i.e. abbreviations in or the logic of the table is not explained below („notes“) and the reader thus needs to search in the text to understand the information depicted. This is especially problematic for the „cumulative tables“ which can hardly be understood without a proper explanation which is even not sufficiently provided in the text.

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## Summary and suggested questions for the discussion during the defense

To conclude, the thesis could have reached a much better quality if some additional time was devoted and I am a bit unhappy that it was delivered in this version after more than a year of our cooperation. If properly finished, it could have been a very nice thesis contradicting a large amount of ad-hoc results in the literature and providing econometric evidence and arguments in favour of stock market efficiency increasing in time.

However, I find the thesis defensible and suggest the grade D.

Two questions suggested for the defense:

- Can you summarize and explain in detail (econometrically) the main points of the criticisms of the statistically significant results in the literature (mostly discussed in Kim, 2017)?
- Can you defend the utilisation of the AIC-based model selection?

## **SUMMARY OF POINTS AWARDED** (for details, see below):

<b>CATEGORY</b>	<b>POINTS</b>
<i>Contribution</i> (max. 30 points)	20
<i>Methods</i> (max. 30 points)	15
<i>Literature</i> (max. 20 points)	19
<i>Manuscript Form</i> (max. 20 points)	16
<b>TOTAL POINTS</b> (max. 100 points)	<b>70</b>
<b>GRADE</b> (A – B – C – D – E – F)	<b>D</b>

**NAME OF THE REFEREE:** Jiří Kukačka

**DATE OF EVALUATION:** 24. 1. 2018

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**Referee Signature**

**EXPLANATION OF CATEGORIES AND SCALE:**

**CONTRIBUTION:** *The author presents original ideas on the topic demonstrating critical thinking and ability to draw conclusions based on the knowledge of relevant theory and empirics. There is a distinct value added of the thesis.*

<i>Strong</i>	<i>Average</i>	<i>Weak</i>
30	15	0

**METHODS:** *The tools used are relevant to the research question being investigated, and adequate to the author's level of studies. The thesis topic is comprehensively analyzed.*

<i>Strong</i>	<i>Average</i>	<i>Weak</i>
30	15	0

**LITERATURE REVIEW:** *The thesis demonstrates author's full understanding and command of recent literature. The author quotes relevant literature in a proper way.*

<i>Strong</i>	<i>Average</i>	<i>Weak</i>
20	10	0

**MANUSCRIPT FORM:** *The thesis is well structured. The student uses appropriate language and style, including academic format for graphs and tables. The text effectively refers to graphs and tables and disposes with a complete bibliography.*

<i>Strong</i>	<i>Average</i>	<i>Weak</i>
20	10	0

**Overall grading:**

TOTAL	GRADE
91 – 100	A
81 - 90	B
71 - 80	C
61 – 70	D
51 – 60	E
0 – 50	F