

# Report on Master Thesis

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

<b>Student:</b>	<b>Bc. Adam Nedvěd</b>
<b>Advisor:</b>	<b>doc. PhDr. Jozef Baruník, Ph.D.</b>
<b>Title of the thesis:</b>	<b>Analysis of Term Structure in High Frequencies</b>

The thesis contributes to the study of the multivariable dependence structure in the term structure of interest rates based on up to date techniques of analyzing the frequency domain of the high-frequency time series of US Treasury futures.

## Contribution

The author masterfully manages to presents all relevant theoretical concepts which comprise of nearly half of the text, which tends to be a bit technical and heavy to read on occasions, see my more detailed comment on this in the section Manuscript form. The author's brilliance shines in sections 4 and 5 where he presents enormous amount of original results about on various aspects of dependency analysis of the term structure of the analyzed futures. The thesis is complemented with an extensive amount of graphs and figures to support his interpretation of the empirical results.

## Methods

The methods used are very modern and advanced. As far as I know, most of the techniques are not covered in any of the master level courses at IES so the author showed a great skill to learn advanced techniques on his own. The achieved results surely will be of interest in the corresponding scientific community as I consider this thesis to be original research that deserves to be published in a suitable international journal.

## Literature

The author presents a very nicely balanced of a historical overview on the topic and recent new results published in the scientific papers and monographs on the studies topic. I find no shortcomings regarding referencing and cross-referencing papers of other authors and nor with the form of the list of references.

## Manuscript form

The first part of the thesis is very reader-friendly and introduces the studied phenomena and logically guides the reader through the history of the studied problem. The author is very clear on why the used techniques were not accessible few decades ago and justifies his results to be very timely and relevant for the community. The middle part comprises of the overview of the theoretical concepts relevant for the numerical part. On some occasions, this part tends to be a bit sketchy and heavy on terminology and I find it hard to get in touch with concepts which may not familiar to the reader prior reading this thesis. Perhaps some illuminating examples and more frequent references to basic monographs would be helpful to ease this part. I understand that in the scientific paper it would be superfluous to do so but in the form of a master thesis, the author should at least attempt to present a standalone text.

On the other hand, regardless of the amount of theory presented there, the author makes a very clear use of mathematical symbols and his good command of mathematics and presentation of written mathematical expressions deserves a positive comment. The only two exceptions from the last comment is the use of  $f'$  below the expression on page 15, invoking a derivative of  $f$  which was not the intention; and footnote number 2 on page 34 – footnotes to mathematical expressions are tricky as they invoke powers of the expression rather than footnote related to it. The last part of the thesis is complemented with a high number of tables, graphs and figures, which however are difficult to read without a thorough explanation of the phenomena depicted. On many occasions I was not able to confirm the authors conclusions derived from it as I did not have proper instructions how to do so. This could have been done by a short note in the captions to the tables/graphs/figures. On the other hand, I

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really enjoyed the concluding section which gave a very nice global overview of the results from the previous parts and it finally made sense after reading the concluding part.

The author has near flawless English which also contributes to the good readability of the manuscript.

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

As this thesis is truly remarkable on new original results of high relevance, I am very happy to suggest grade A.

I would like to suggest the following for a discussion during the defense:

- 1) Do the results contradict in some way the previously derived results (which did not use the spectral form of the time series) on the same topic
- 2) Regarding section 3.5.1, is the considered spectral form of the time series the result of either forward or backward Fourier transform? Could you use results from mathematica analysis regarding Fourier transforms to state some qualitative results about the studied time series? Further, the decomposition of  $F$  into three parts (page 23) invokes representation of any random variable as a sum of three basic types or random variables - discrete, (absolutely) continuous and singular (continuous) – is that the same idea here? Why is the third (singular) component not relevant in economic applications?
- 3) Would it make sense to extend the quantile cross-spectral analysis for a counterpart of conditional dependence and study a conditional dependence of the term structure of futures in the spectral domain, where the condition would be the macroeconomic or other factors which may influence the interest rates?
- 4) On page 31 you explain that CF stands for the conversion factor with reference basis of 6 % yield-to-maturity? Why is it 6 % and not some other level?
- 5) As you describe several techniques of synchronisation of high-frequency tick-by-tick data, which result in selecting a representative/approximation/estimate of the value for the corresponding time frame, how sensitive are your results to various types of the synchronisation techniques? Would it be possible to draw different, contradictory results of another technique was used?

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

CATEGORY	POINTS
<i>Contribution (max. 30 points)</i>	30
<i>Methods (max. 30 points)</i>	30
<i>Literature (max. 20 points)</i>	20
<i>Manuscript Form (max. 20 points)</i>	16
<b>TOTAL POINTS (max. 100 points)</b>	<b>96</b>
<b>GRADE (A – B – C – D – E – F)</b>	<b>A</b>

**NAME OF THE REFEREE: RNDr. Michal Červinka, Ph.D.**

**DATE OF EVALUATION: August 13, 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