

# Report on Master Thesis

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

<b>Student:</b>	<b>Bc. Tomáš Kvasnička</b>
<b>Advisor:</b>	<b>PhDr. Ladislav Krištofuk, Ph.D.</b>
<b>Title of the thesis:</b>	<b>Wavelet portfolio optimization: Investment horizons, stability in time and rebalancing</b>

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

The thesis "Wavelet portfolio optimisation: Investment horizons, stability in time and rebalancing" presents an extensive quantitative research and several original (although sometimes a bit ambiguous to me, see below, please) results on application of the wavelet covariance estimation within the framework of the classical Markowitz (1952) optimal portfolio selection. Moreover, taking the advantage of the interpretation of the wavelet energy decomposition of signals in financial time series as signs of activities of groups of traders with different investment horizons, it tries to answer two recent hypotheses of the financial market design and functioning, namely the Fractal Market Hypothesis (FMH) and the Heterogeneous Market Hypothesis (HMH).

I am pleased to mention at the very beginning that Tomas has produced a very quality work and therefore **I can honestly suggest the highest grade (1)**.

The thesis is dominated by a technical quantitative finance approach and when considering related computational demandingness (not only the computational time, but also a human labor to prepare all the codes and evaluate all the settings), I feel a bit of regret that finally some more interesting (or as authors state: "revolutionary") results were not "distilled". To my mind, the most important result from the practical point of view is that the so called "1-day scale portfolios" consistently exhibit significantly higher cumulative returns but at the cost of higher risk compared to the MV portfolio. Moreover, the higher returns are further offset by higher turnover that in practice requires higher rebalancing costs. Therefore the main contribution of the work lies in the original application and robust examination of the methodology together with conclusions supporting HMH and going against FMH.

Within the entire thesis, Tomas demonstrates broad theoretical knowledge of financial economics and portfolio risk management complemented by very strong quantitative and programming skills without which the technical part of the work could not have been completed. The literature review is well elaborated when the relative width of the combination of several topics is taken into account. The theoretical part guides the reader well through all theoretical concepts of wavelet transform and portfolio optimisation. The extent of the "Results" chapter comes from the fact that the entire analysis is included in here. To my mind, not every figure is a real "result", so division into two chapters would perhaps help the logic of the thesis content. A possibly biggest drawback of the thesis is that compared to the greatly elaborated technical side of the thesis, the economics explanation or reasoning of some (mainly "surprising and counterintuitive") results does not go into details and thus might not seem credible (examples below).

I have to stress here that I am neither specialised in wavelets nor in the portfolio optimisation. Maybe therefore some part of the thesis raised questions which I believe need to be more explained or are candidates to be answered during the thesis defense:

1. Pg. 2: I hope you do not only believe that your approach is original but that you also did your best to verify this using accessible sources.
2. Pg. 32 (data): Why do you require the data to be included in a single market index? Does not this go directly against the idea of portfolio optimisation?
3. Pg 33: Cont (2001) lists at least 11 stylised facts and analyses some more than just three stated in the thesis. Thus the related statement in the thesis seems at least very vague. How did you e.g. check for heavy tails? Negative skewness holds for 18/28 stocks only which is only 2/3 of your data...
4. Pg. 38: LA8 + scale 32 days returns definitely need more rationale than only saying that it seems "arbitrary". Here you simply resign to make a step out of purely computational results and provide any meaningful (even technical) explanation. Can really several outliers be

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responsible for such a big jumps over entire dataset? Can you identify them? Why they did not influenced other filters?

5. Pg. 38: Additionally to the suggested question below, the suspicious result of higher returns with higher rebalancing period invalidates a bit the credibility of your results in general. It would be therefore very beneficial to discuss more the technical effect of the rolling window length.
6. Pg. 38: "Interestingly" is not enough, some attempt on explanation needed.
7. Pg. 46: What goals do long-term traders have? Moreover, if the "market consists predominantly of short-term traders who are able to beat the overall market" consistently, at expenses of whom do they so in the long run?
8. Pg. 46: Redefining the EMH based solely on those results (daily data treatment) does not seem as a good idea to me...
9. Pgs. 52 and 56: What the "pure" information related to the first scale wavelet covariance really is?
10. Personal note to the Acknowledgement: I believe that the part about "managing to waking up the interest" was mentioned in a different way than it in fact sounds...

Nonetheless, the aim, structure, working hypotheses, and conclusion are clearly stated and carefully elaborated. The approach as well the format of the work is more than legitimate for a student of the master lever program, meets very high academic standards and originally contributes to recent financial literature.

Detected typos:

Pg. 2: Pecival&Wladen (2000); pg. 3: Fractional MH; pg. 9: marked participant :-); pg. 18: defines, express; pg. 18: MODTW; pg. 29: express; pg. 38: is needed; pg 56: does not.

## Suggested questions for the defense are:

1. Significantly higher cumulative returns of the "1-day scale portfolios" are offset by both higher risk and higher turnover implying higher costs for rebalancing. What is then your opinion on the practical application of suggested methodology? Considering higher risk, higher rebalancing costs and higher computational demandingness, does it make some sense to use the "1-day scale portfolios" as a real investment tool?
2. Pg. 38: I do not understand how "the first level WC filters out noise traders". Is their behaviour not part of the price signal you are interested in? What is the precise signal then made of? Maybe, who are the noise traders in your interpretation/understanding? Is not this interpretation at odds with the overall conclusions of the thesis?

## Summary:

All in all, **I do find this thesis exceeding academic standards for master theses at IES**. Personally considered, the original application of the wavelet covariance estimation within the portfolio optimisation framework together with very strong quantitative and computational analysis are the most distinctive qualities of the thesis.

I am very pleased **I can strongly recommend the thesis of Tomas Kvasnicka to defense at the IES FSV UK. With no doubts, I suggest the grade "1". i.e. "excellent".**

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

CATEGORY	POINTS
Literature (max. 20 points)	19
Methods (max. 30 points)	30
Contribution (max. 30 points)	25
Manuscript Form (max. 20 points)	19
<b>TOTAL POINTS</b> (max. 100 points)	<b>93</b>
<b>GRADE</b> (1 – 2 – 3 – 4)	<b>1</b>

**NAME OF THE REFEREE:** Jiří Kukačka

**DATE OF EVALUATION:** 18. 9. 2015

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Referee

Signature

**EXPLANATION OF CATEGORIES AND SCALE:**

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

Strong                  Average                  Weak  
20                          10                          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.*

Strong                  Average                  Weak  
30                          15                          0

**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.*

Strong                  Average                  Weak  
30                          15                          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.*

Strong                  Average                  Weak  
20                          10                          0

**Overall grading:**

TOTAL POINTS	GRADE		
81 – 100	<b>1</b>	= excellent	= výborně
61 – 80	<b>2</b>	= good	= velmi dobře
41 – 60	<b>3</b>	= satisfactory	= dobře
0 – 40	<b>4</b>	= fail	= nedoporučuji k obhajobě