

# Opponent's Report on Dissertation Thesis

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Title of the Thesis:	Essays on Data-driven, Non-parametric Modelling of Time-Series
Type of Defense:	<b>DEFENSE</b>
Date of Pre-Defense	January 10, 2024
Opponent:	Prof. Jiří Witzany (VŠE)

Address the following questions in your report, please:

- Can you recognize an original contribution of the author?
- Is the thesis based on relevant references?
- Is the thesis defensible at your home institution or another respected institution where you gave lectures?
- Do the results of the thesis allow their publication in a respected economic journal?
- Are there any additional major comments on what should be improved?
- What is your overall assessment of the thesis? (a) I recommend the thesis for defense without substantial changes, (b) the thesis can be defended after revision indicated in my comments, (c) not-defensible in this form.

*(Note: The report should be at least 2 pages long.)*

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The thesis comprises of four papers which can be split into two topics. The first two papers apply frequency domain analysis methods to model macroeconomic data, namely synchronization of business cycles of EU countries, and effects of monetary shocks on selected US macroeconomic variables. The second two papers focus on machine learning applications for distributional predictions of macroeconomic and financial variables. All the papers are well motivated and deal with relevant policy-oriented or financial topics. The applied techniques are methodologically and computational on very high level. The questions stated above can be answered positively, that is:

- Yes, there are significant original contributions of the author.
- The thesis is based on an extensive set of relevant references that are used throughout the text.
- The thesis would be definitely defensible at my home institution (FFA VSE).
- The technical complexity of the papers might be related to the fact that only two out of the four papers are reported to be published in a respected journal. The first paper is reported to be published in the Empirical Economics journal (2020, JCR Q3 in F5.2). The second paper has been published in the IES WP series (not submitted to a respected journal yet?), a part of the third paper has been published in Finance Research Letters (2024, JCR Q2 in F5.2), and the fourth paper has been submitted to a non-disclosed journal and is still under review. The two not-yet-published papers, in my opinion, allow their publication in a respected economic journal.

- e) The presentation of methodologies and results might need some minor improvements in terms of clarification and readability. Overall, I do not have any major comments or recommendations for revisions of the thesis final version.
- f) The conclusion of my pre-defense review is to **recommend the thesis for defense without substantial changes.**

More detailed comments to the four papers are as follows:

**The first paper** analyses the growth cycle synchronization of the four Visegrad countries with respect to synchronization of the other EU countries. The co-movement between two specific countries is decomposed into time and frequency dimensions using the wavelet transform methodology. The multivariate relationship is characterized by a weighted average of the wavelet cohesion measures of the individual pairs. The pair-based and multivariate cohesion analysis provides interesting results that might have important policy implications discussed in the text. The author has resolved or explained most of the minor comments and question raised in the pre-defense review report. The questions that are briefly answered in the concluding part of the Thesis (Part A. Response to opponents) but can be also discussed during the final defense are the following:

- Why is the nominal rather than real GDP used? There might be an undesirable effect of exchange rate fluctuations on the nominal GDP of the Visegrad countries.
- I assume that Figure 2.4 shows the multivariate cohesion of the set of all V4 and EU countries. Did you consider a multivariate measure where the pairs would be selected so that one country is in the first set (V4) and the other country in the second set (EU core)?

**The second paper** aims to analyze the effects a monetary policy shock on the US GDP, inflation, and interest rate. The employed methodology includes the TVP-VAR model, time-frequency decomposition, and the impulse response analysis. The main results are presented in figures 3.3-3.8. The author has improved readability of these figures in final version of the thesis. Figures 3.4-3.6 show responses and their confidence intervals of the three variables over the short, medium, and long-term horizons. My recommendation to unify the scale and indicate the zero level by a horizontal line to make the visual comparison of the effects over different horizons easier has been partially accepted. Besides the formal issues I have no further comments. It is a high quality and interesting paper.

**The third paper** proposes a machine learning approach to probabilistic (distributional) forecasting of macroeconomic and financial-time series. The key idea is to train a neural network with the target being a vector of probabilities estimating the cumulative distribution function on a grid of values. This can be viewed as an analogy to the classical ordinal regression model. The input would characterize the information at time  $t$  (including the history in the LSTM framework), and the output should estimate the distribution of a variable at time  $t + h$ . The empirical results based on a dataset containing 216 quarterly US macroeconomic and financial variables demonstrate superiority of the ML approach compared to selected benchmark approaches such as BVAR. My pre-defense technical comments have been resolved or explained in the final version of the thesis. The only general and rather philosophical question that is briefly answered in the Response to opponents and could be still discussed during the defense is the following:

- The introduction to machine learning (4.2.1) includes, in my opinion, a few over-optimistic statements such as “... *machine learning seeks to choose the most preferable model from an unknown pool of models using innovative optimization*”

*techniques. As opposed to traditional measures of fit, machine learning focuses on the out-of-sample forecasting performance and understanding the bias-variance trade-off; as well as using data driven techniques that concentrate on finding structures in large datasets. Further, if one dismisses the “black-box” view of machine learning as a misconception ...”* I think that all of those statements could be opposed. For example, what is the most preferable model selected from a pool of models? Can we really dismiss the “black-box” view?

**The fourth paper** applies basically that same ML methodology as the previous paper, but in this case applied to electricity prices with the goal to forecast distributions of day ahead hourly electricity prices. The empirical results are in this case compared to a naïve estimation, quantile regression averaging, or quantile regression committee machine models again demonstrating superiority of the ML approach. On the other hand, the computational time analysis indicates a high computational cost which is a limitation of the ML approach. I miss a more detailed discussion related to practical motivation and applicability of the presented results.

- Could the forecasting ML model be used for profitable electricity trading or does it have any policy implications?

To conclude, I can just reiterate that **I do recommend the thesis for defense without substantial changes.**

Date:	27. 2. 2024
Opponent's Signature:	
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