Opponent's Report on Dissertation Thesis

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Title of the Thesis:	Essays on Data-driven, Non-parametric Modelling of Time-Series
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Opponent:	Dr. Michael Ellington BA MSc PhD (University of Liverpool Management School)

Address the following questions in your report, please:

a) Can you recognize an original contribution of the author?
b) Is the thesis based on relevant references?
c) Is the thesis defendable at your home institution or another respected institution where you gave lectures?
d) Do the results of the thesis allow their publication in a respected economic journal?
e) Are there any additional major comments on what should be improved?
f) 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-defendable in this form.

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

Please see attached pdf file.

Date:	25/01/2024
Opponent's Signature:	
Opponent's Affiliation:	Dr. Michael Ellington BA MSc PhD (University of Liverpool Management School)

Opponent Report for the PhD Dissertation of Mgr. Luboš Hanus:
Essays on Data-driven, Non-parametric Modelling of Time-Series

Michael Ellington

1 Synopsis of the thesis

This thesis contains four stand alone empirical chapters that contribute to the literature modelling time-series. The theme connecting these chapters are non-parametric and data-driven approaches to modelling economic and financial data. The first two chapters focus on frequency domain methods to analyse macroeconomic data. Meanwhile, the focal point of the latter two chapters utilizes contemporary Machine Learning (M-L) methods to generate predictive probability distributions for forecasting purposes.

The thesis is well presented and is structured in a coherent manner. Tables and Figures are all self-contained and are readable. Following the recommendations of the three opponents, and the amendments made by Luboš, each chapter's contribution is clear, contains high quality writing, and properly motivates the topic.

Overall, I can confirm that there are original contributions from the author that are relevant to the literature from each of the four chapters. The candidate utilizes contemporary methods and justifies their approach to each paper within the thesis using pertinent references. I am extremely confident that this thesis would pass a defence at my home institution, and indeed any other respected international institution. The results, some of which are already published in journals with impact factor, are publishable in select general interest and/or many top field journals.

Therefore, I recommend the thesis for defence as is.

1.1 Minor editorial comments

Thank you for addressing the minor editorial comments.

2 Growth cycle synchronization of the Visegrad Four and the European Union

This paper is already published in *Empirical Economics.* I have no comments or suggestions for this chapter since it has already been through the peer review process. I enjoyed reading the paper and like the execution of the empirical analysis. On the whole, I like that the paper uses coherence and cohesion to assess growth cycle synchronization of the Visegrad Four. I think that the findings that cohesion is strong after 2005 is unsurprising due to the turbulence in the 90s. It is also reassuring, for policymakers, that cohesion is strong at business cycle frequencies. The paper suggests that with higher cohesion, the more efficient policies may be. I am pleased with, and agree with the minor editorial comments by the other referees.

3 Identification persistence in macroeconomic responses

This paper proposes a frequency domain approach to analysing impulse response functions of variables within a vector autoregression (VAR). The focus is on the monetary policy transmission mechanism and the paper uses popular time-varying parameter VAR (TVP VAR) models (see e.g. Primiceri, 2005). The results of the paper reveal that using US data, low frequency cycles of output are prevalent and have positive cycles. However, the paper documents a price puzzle that many others show when analyzing how monetary policy shocks affect inflation.

I had many comments and suggestions for this chapter, and Luboš addresses them all properly. I am very happy with the introduction for this chapter now as the contributions are clear and appear at the start of the introduction. I am glad to see that the comments regarding the empirical analysis are well taken. Given the focus of the work, I think fully expect a revision to land in a high-level general interest, or top field journal.

4 Taming data-driven probability distributions

This paper introduces a deep learning approach to generate predictive distributions for macroeconomic and financial time-series. The approach rests on a deep learning recurrent neural network which alleviates the need to specify a single model to generate predictive distributions. The main problem that underpins the idea is that practitioners care about uncertainty shrouding their forecast. I agree with this notion and believe this is an impor-

tant contribution; particularly to the finance literature where there is a habit of focusing on measures of central tendency (i.e. Root Mean Squared Errors etc.).

The paper offers two empirical applications. The first is a data rich environment using a quarterly version of the FRED-MD database in McCracken and Ng (2016). The first application benchmarks against a Bayesian VAR. The second is an application using daily data. The main results use the ordered logit model of Anatolyev and Baruník (2019). In both cases there is evidence that the approaches within are at least as good as benchmark models.

Overall, I like the paper and enjoyed reading it. It is well written and easy to follow. Luboš addresses all reviewer's comments well.

5 Learning probability distributions of day-ahead electricity prices

This paper presents distribution forecasts of electricity prices using contemporary M-L methods. This is a non-parametric approach to selecting the best predictive distribution from all possible distributions that the machine learns from the data. A multiple output neural network with a monotonicity adjusting penalty is able to learn complex patterns in electricity prices and outperforms a variety of M-L benchmarks and a naive forecasting model.

I learned a lot from this paper since electricity prices/markets is not my area of expertise. Overall, I like the paper and can see a clear contribution to existing knowledge. Below I list my comments, some comments are suggestions to help the candidate and are specified as not necessary to address for defence of the thesis. I note that this paper is under review at a reputable journal and am happy that my minor comments help improve the exposition of the paper; I look forward to reading the work when published.

References

Anatolyev, S., Baruník, J., 2019. Forecasting dynamic return distributions based on ordered binary choice. International Journal of Forecasting 35, 823–835.

McCracken, M.W., Ng, S., 2016. FRED-MD: A monthly database for macroeconomic research. Journal of Business & Economic Statistics 34, 574–589.

Primiceri, G.E., 2005. Time varying structural vector autoregressions and monetary policy. Review of Economic Studies 72, 821–852.