Report on **Bachelor / Master Thesis**

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

Student:	**Tomáš Kovařík**
Advisor:	**Ing. Vilém Semerák, M.A., Ph.D.**
Title of the thesis:	**Machine learning-based approaches to forecasting international trade**

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 thesis has an original and timely topic as ML methods increase its importance for many data driven tasks. Its usefulness of ML methods for forecasting is undoubtable and thus it is important to study its implementation in the International Trade forecasts.

Methods
The author uses fairly standard setting of both the gravity models (PPML and OLS) and also the ML methods he investigates. The choice of ML classes (SVM, RF and NN) is thus appropriate to the selected topic.

I also appreciate that the student get his own data using Comtrade API. This might have been the hard part.

However the thesis suffer from vague description of both the methodology and the results.

I strongly miss the detailed description of the data collection and the available data. I have to assume that the authors use data for total trade and there is no sector differentiation. I recommend adding information about API request sent to the Comtrade database as well as the process of its collection (for what countries in what years are the data collected?).

There is no information about quality of panel – whether it is balanced or not and how the missing data are perhaps distributed – that is important for dealing with zeros. How is it distributed between developed and developing countries? Between large and small countries?

There is no description of the split between training set, validation set and a test set.

There is no visual representation of the forecast (!!!). The visual check of the meaningfulness of the forecast is a key first step to evaluate its quality. There is no intituitive interpretation of the thesis results. I suggest adding a Figure with the time series for countries in the Figure 8, where it is clear on the path of the true and the forecast.

There is no description of what data are exactly trained and predicted (each country separately? All together? If the second, how 200 countries at once predicted?)

No information about connection between forecast and the original data (are forecasted changes? Or levels?)

No information about confidence intervals

All these problems makes it virutally impossible to evaluate the adequacy of the methodology.

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Literature
As the author focus on rather unexplored topic (perhaps surpisingly) his choice of literature is logical and appropriate.

Manuscript form
As this is strongly data-driven thesis I would recommend adding a source code as an attachment (ideally as a jupyter notebook).

1) The data collection notebook containing the information on exact data collection process
2) The core forecast notebook with the separate function for each forecasting method (OLS, PPML, NN, SVM and RF) that would accept appropriate parameters and the plotting functions of the resutls.

That would strongly improve the replicablity and also the credibility of the results. It would also allow reviewers to check what is not written in the thesis.

Authors sometimes do not explain meaning of abbreviations (i.e. RMSE or MAPE).

Summary and suggested questions for the discussion during the defense
All in all the thesis has an interesting topic, it is relatively well written and understandable. I would strongly recommend the author to continue with such research.

Similar approach would be most useful when broken-down sectorally – then a unified ML framework for forecasting would gain even more sense. But this require more data, large emphasis on the structure and dealing with missing data etc.

However the manuscript requires further editations that would shed more light into the forecast. As it is submitted there is not enough information about the adequacy of the approach.

The evaluation of thesis is thus decreased accordingly. If the author demonstrates the adequacy of used methodology with the forecast chart and detailed description of the dataset collection and forecast then I recommend increasing number of points in *Methods* section to 25.

More detailed elaboration on the purpose of such forecasts would also beneficial – who should use it and why? The author acknowledges the „black-boxiness“ of ML methods in general. But this can hinder the forecasting itself as often it is necessary to include structural changes in the forecast (i.e. sanctions on Russia) that is not in the past data, but wil certainly affect the development of international trade between countries

Suggested questions (**bold** are especially important) :

1) How did you split the training set, validation set and test test?
2) **How exactly did you collect data?**
3) **How exactly did you perform forecasts?**
4) **Is your forecast connected to the last value in the dataset? Can you visualize the forecast?**
5) Can you differentatiate between missing observation and 0?
6) How would you add structural changes into model?

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

CATEGORY		**POINTS**
Contribution	*(max. 30 points)*	30
Methods	*(max. 30 points)*	15
Literature	*(max. 20 points)*	20
Manuscript Form	*(max. 20 points)*	15
TOTAL POINTS	*(max. 100 points)*	**80**
GRADE	**(A – B – C – D – E – F)**	**C**

NAME OF THE REFEREE: Vít Macháček

DATE OF EVALUATION: January 19th 2019

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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.*

Strong	*Average*	*Weak*
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.*

Strong	*Average*	*Weak*
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.*

Strong	*Average*	*Weak*
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.*

Strong	*Average*	*Weak*
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**