

Report on Master Thesis

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

Student:	Martin Nedvěd
Advisor:	doc. PhDr. Jozef Baruník, Ph.D.
Title of the thesis:	Predictability of financial returns across horizons using Deep Learning

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

Short summary

This thesis explores the potential of deep learning in predicting financial returns. While the topic of return predictability is widely explored in the literature and machine learning algorithms have been applied in various ways, this thesis provides a fresh look through the lens of predictability at different horizons, starting from hourly returns to monthly returns. The literature is also inconclusive on the use of deep learning algorithms in time series forecasting, as most of the algorithms have been developed for independent data. Martin uses LSTM networks to address these issues and finds that it is a useful strategy, especially for short-term forecasts, including hourly and daily returns.

Contribution

Financial stock returns are generally very difficult to predict due to several issues, including an extremely low signal-to-noise ratio, which makes this problem attractive. In his thesis, Martin contributes to the broad literature by exploring the potential of deep learning techniques to improve the predictability of returns at different horizons, including high frequency. He also contributes with the idea of using fractionally-differenced returns as features, which is novel and potentially interesting since we can hypothesise that different horizons (or different aggregates) contain different amounts of noise and therefore deep learning coupled with such transformed returns could have potential to improve predictability at some horizons. To this end, Martin uses appropriate machine learning techniques that are computationally expensive but have the potential to explore the dependencies. At the same time, the thesis offers a novel empirical perspective that improves learning by using high-frequency data as well as additional features that are informative for predictions.

Methods

The thesis uses appropriate advanced statistical methods for analysis, the coupling of deep learning with memory components appropriately used with fractionally differentiated inputs (returns) is novel and potentially useful. I must emphasise that Martin had to deal with a number of non-trivial problems, which he dealt with in a professional manner.

Literature

The author uses all relevant literature correctly, introduces the literature well and discusses all relevant sources in sufficient detail.

Manuscript form

The thesis is very well and clearly motivated, the writing is logical and the results are well linked to the literature. The introduction and motivation are clear and the reader can see that the authors have put a lot of care into the text. Martin has worked consistently on the results over a long period of time and we have discussed the results and the text regularly. The only part that could be improved a bit are details in the description of results, tables, figures, which are sometimes not very clear and require the attention of the reader, but this does not affect the high quality of the work itself.

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Overall evaluation and suggested questions for the discussion during the defense

In conclusion, I believe that Martin has shown himself to be an independent researcher who has produced interesting results that are relevant to both the academic literature and practitioners. He has mastered advanced methods and acquired skills to produce a sound and economically relevant work. Martin has worked consistently with me and I must highlight the hard work he has put into the analysis to answer his question of whether deep learning helps to improve the predictability of financial returns across horizons.

Two general areas to discuss during the defence could be

1/ As it is a novel feature not commonly used in the literature and at the same time a somewhat technical concept, try to explain to a general interest economist why a fractional differentiation of prices should help in the forecasting task.

2/ How would you relate your results to the literature that finds improved predictive power with increasing horizon, in line with the idea that with aggregated series to weekly or monthly data we have less noise and more signal to extract? Is this a small sample problem for deep learning, or is it related to fractional differencing?

The thesis deserves to be defended without reservation. If Martin is confident in presenting the details of the work, I suggest awarding it an A.

Finally, the results of the documentary analysis do not indicate any significant similarity of the text to other available sources.

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

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

NAME OF THE REFEREE: Jozef Baruník

DATE OF EVALUATION: 15.8.2024

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.*

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.*

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

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.*

Overall grading:

TOTAL	GRADE
91 – 100	A
81 - 90	B
71 - 80	C
61 – 70	D
51 – 60	E
0 – 50	F