

# Report on Bachelor / Master Thesis

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

<b>Student:</b>	<b>Bc. Jan Cvrček</b>
<b>Advisor:</b>	<b>doc. PhDr. Jozef Baruník, Ph.D.</b>
<b>Title of the thesis:</b>	<b>Can Image-Based Convolutional Neural Networks Forecast Volatility?</b>

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

## Short summary

The thesis focuses on the possibility of predicting financial market volatility using image-based convolutional neural networks (CNN). This method converts the graph of price and volumes to pictures and the network then performs the forecast based on this graphical representation. Forecasts are made one day ahead. The data used is the E-Mini S&P 500 from 2010 to 2019. The CNN was trained on the last week, month and quarter's price and volume to capture the (possible) non-linear relationship with price volatility. The best performance of volatility forecasting was achieved with a month data as an input. The results of CNN were compared with standard models used for volatility forecasting, but the performance of CNN forecasts was inferior to the classical models.

## Contribution

The contribution of the thesis lies in demonstrating the possibility of forecasting the volatility with the image-based CNN. The results are not superior to the classical models used for volatility forecasting but it does not mean that the thesis is not contributive.

## Methods

The methods used in the thesis are spot on for the research question. They're used perfectly and the interpretation of the results is spot on too. The image-based convolutional neural network is a modern method that could be really beneficial for financial modelling. The methodology is a connection of image processing and neural networks, so it's a pretty complex methodology that's not an easy task to implement. Jan has done a very good job here.

## Literature

The literature review is on a good standard level. Jan quotes relevant and current literature in a proper way.

## Manuscript form

The manuscript as a whole is very well formatted, logically structured, easy to navigate and properly referenced.

## Overall evaluation and suggested questions for the discussion during the defense

Overall, the Master's thesis is a very good piece of work. Jan shows that he can use modern advanced and standard methods correctly and he interprets the results appropriately. In my opinion, the thesis fulfils the requirements for a bachelor thesis at IES, Faculty of Social Sciences, Charles University, I recommend it for defence and suggest a grade of A. The results of the Turnitin analysis do not indicate significant text similarity with other available sources.

- Q1: How would you interpret the result that the 20 days as an input for the network generate the highest performance of the CNN.
- Q2: Could you elaborate on your comment that one of the reasons the standard models may be better at modelling volatility is because of the "autoregressive feature"? Can the CNN also exploit autocorrelation?

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

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

**NAME OF THE REFEREE:** Lukáš Vácha

**DATE OF EVALUATION:** 8.9.2024

**Digitálně podepsáno (8.9.2024)**  
**Lukáš Vácha**

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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.*

**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	<b>A</b>
81 - 90	<b>B</b>
71 - 80	<b>C</b>
61 – 70	<b>D</b>
51 – 60	<b>E</b>
0 – 50	<b>F</b>