Report on **Bachelor Thesis**

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

Student:	**Miroslav Fil**
Advisor:	**doc. PhDr. Ladislav Krištoufek Ph.D.**
Title of the thesis:	**Pairs Trading in Cryptocurrency Markets**

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

Contribution

Author tests pairs trading on the universe of cryptocurrencies from the largest exchange Binance. He applies two standard practices to identify candidate pairs of assets; they are based on the distance and cointegration. Further, given the limited time frame of the data used, only one year, the author works with high-frequency data up to the 1-minute resolution, extending the literature on the added value of high-frequency trading. Regarding the results, it is shown that the distance approach works better than the cointegration method when selecting pairs. Further, the author discovers similar issues with the application of pairs trading strategies as documented in the case of more conventional assets. In general, it is clear, that there is a lot of work behind the thesis and I see the main contribution in the advancement of the author's skills even though the achieved results are not optimistic.

Methods

A pairs trading strategy consists of two parts, pairs formation and trading period. To form pairs, assets that tend to move together, the author uses a distance method and cointegration methods. Next, based on the calculated spread, more precisely its distance from the equilibrium, market neutral positions are opened, and backtest is conducted.
To evaluate the performance of portfolios he uses standard portfolio evaluation metrics, e.g. Sharpe ratio, VaR, etc. Transaction costs, rather straightforward in case of cryptocurrencies, are also taken into account.
Methods used are appropriate, and by their complexity, they seem to be at the level usual for Bachelor theses at our institute or perhaps slightly higher. Further, all methods are described nicely and more importantly motivated clearly.
Nevertheless, there are some fundamental problems with the approach, specifically with the issue of multiple hypothesis testing. Author himself is aware of the problem, as he mentions it on pages 18 and 19. He works with 23 assets, so there are 253 pairs, and at the 5% significance level, one can expect approximately 13 pairs to be spuriously cointegrated. Please, see suggested question #1 in the end.

Literature

The literature review covers both key areas of the thesis, pairs trading and cryptocurrencies quite well. The part regarding the pairs trading is very extensive and also contains a chronological review offering a valuable historical perspective of the research. With respect to the cryptocurrencies literature I disagree with the author's statement "Studies applying trading strategies (...) on cryptocurrency markets are very limited in general.", given the widespread interest in the topic during the last two years.

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Manuscript form

The thesis is very well structured, with only a couple of problems. There are some inconsistencies in labelling equations, where some equations have numbers associated with them, and some do not. Graph and table captions should be more self-contained, they contain just the title with no additional details like time-period, what was the procedure behind the chart, etc. There are also minor typos scattered over the thesis but nothing extensive.

Summary and suggested questions for the discussion during the defense

I suggest the following questions for the defense:

- If the multiple hypothesis testing problem is not addressed, how can you know, you are not trading just spuriously cointegrated pairs? Not looking at your results, what performance would you expect if you were trading based on the spurious relationships? What would it be after transaction costs?
- In section 4.3., descriptive statistics on your portfolio returns are provided. How does your portfolios performance satisfy restrictive assumptions mentioned in Lo 2003 (ref. on p.26). Is it valid to use the Sharpe ratio then? Further, if the distributions of returns are so leptokurtic, why are the performance statistics so correlated, when they are supposed to control for different types of risks, e.g. Sharpe vs. Sortino ratio.

Overall, I think there is a lot of work behind this thesis and I believe that the author has learned a lot and arrived at some interesting results. Therefore, in case of successful defense, I recommend grade A (with a total of 91 points).

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

CATEGORY		POINTS
Contribution	*(max. 30 points)*	26
Methods	*(max. 30 points)*	26
Literature	*(max. 20 points)*	20
Manuscript Form	*(max. 20 points)*	19
TOTAL POINTS	*(max. 100 points)*	**91**
GRADE	**(A – B – C – D – E – F)**	**A**

NAME OF THE REFEREE: Martin Hronec

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DATE OF EVALUATION: 28.8.2019

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Referee Signature

<u>*EXPLANATION OF CATEGORIES AND SCALE:*</u>

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*

<u>*Overall grading:*</u>

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