

# Report on Bachelor / Master Thesis

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

<b>Student:</b>	<b>Rastislav Kisel'</b>
<b>Advisor:</b>	<b>Doc. Jozef Baruník</b>
<b>Title of the thesis:</b>	<b>Quoting behaviour of a market-maker under different exchange fee structures</b>

## **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.*

The thesis targets specific micro-structure feature and proposes a Hawkes process-based model to capture statistical differences arising from different fee regimes on the market. Based on the results of the deep reinforcement learning some policy implications are suggested. The thesis is ballanced in terms of the subject's introduction, review of the literature, methods, as well as the applied analysis. It is quite technical piece of work. The empirical work itself is presented with a lot of details. The language of the thesis is easy to understand. The subject of the thesis is clearly defined.

### Contribution

The thesis analyzes specific micro-structure and contributes to the knowledge on the quoting behaviour of a market-maker under different exchange fee structures. The thesis brings a detailed application of the deep reinforcement learning techniques to the domain of the market-making. The thesis represents a comprehensive treatment of the subject.

### Methods

The methodology employed builds on the Hawkes processes and suggests a Hawkes process-based model for the limit order arrival from maker-taker and taker-maker exchanges and market order arrivals. The process is simulated with successive optimization and it is shown that the maximum likelihood optimization techniques perform well even in multidimensional case. The source of the data and their adjustments needed for the modelling are described in detail along with presentation of the Hawkes process'optimization results. Finally, deep reinforcement learning methods are applied. Overall the methodology approach is fine, innovative, well motivated and skillfully executed.

### Literature

The literature section summarizes the current state of research in the domains of make-take fees, Hawkes process, limit order book modelling and finally optimal market-making and deep reinforcement Learning. The literature is reviewed in a detail and covers all relevant papers. There is probably nothing much in terms of related papers that could be added at this point.

### Manuscript form

The manuscript conforms to formal requirements for the master thesis. It reads well and contains only some minor typos. Introduction is clear and motivates well the researched topic. Data are fully described. Hypotheses are clearly stated. Tables and figures are presented in an organized and legible manner. Their scope is extensive and detailed.

In case of the successful defense, I recommend the grade A.

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

<b>CATEGORY</b>	<b>POINTS</b>
<i>Contribution</i> (max. 30 points)	27
<i>Methods</i> (max. 30 points)	28
<i>Literature</i> (max. 20 points)	30
<i>Manuscript Form</i> (max. 20 points)	30
<b>TOTAL POINTS</b> (max. 100 points)	<b>95</b>
<b>GRADE</b> (A – B – C – D – E – F)	<b>A</b>

**NAME OF THE REFEREE:** *Evžen Kočenda*

**DATE OF EVALUATION:** *Jan. 23, 2017*



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**Referee Signature**