

Report on Master Thesis

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

Student:	Bc. Bořivoj Vlk
Advisor:	PhDr. Ing. Jiří Skuhrovec, PhD.
Title of the thesis:	Reinforcement learning in Agent-based macroeconomic model

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

Contribution

This thesis is very innovative. Agent-based models with various forms of learning mechanisms are at the frontier of research. The work brings some interesting results regarding the possibility of sharp endogenous economic cycles related purely to the departures from rational expectations. At the same time, it is apparent that there are still many ad hoc assumptions in those models that raise questions (see below the suggested list of topics for discussion at the defence) and reduce practical applicability of such modelling approaches at the moment.

Methods

The thesis uses a standard RBC model and replaces rational expectations with a version of learning. As there are neither nominal rigidities nor exogenous shocks in the model, any business cycles that arise in it must be associated purely with the departures from rational expectations. The author had to code and numerically simulate the model in Matlab R2018a. From the technical point of view, the research work is thus very advanced.

I have some doubts about the simplifying assumptions used in the research. To make the model tractable, the author needed to restrict the optimal choice of households and firms to several discrete options. While using natural numbers may be in line with the reality, the actual choice of the economic agents is much more granular than assumed (e.g. a household can in principle consume any fraction of its budget, not just 50% or 100%). At the same time, the prices and wages set by the divine auctioneer are restricted to several discrete options. The problem is that sometimes the allowed set of options does not include the market-clearing equilibrium. In many cases, the very volatile outcomes of the model may be a result of this issue rather than of the learning process. In my opinion, the author should thus pay more attention to explaining his selection of the allowed options.

Literature

The literature review is not extremely long. But it is clear from it that the author had to combine knowledge from many different areas (micro- and macroeconomics, dynamic programming, game theory, machine learning). There is one non-standard issue in the list of references: the names of some co-authors in many references are abbreviated to their initials only, which is not in line with the common practice.

Manuscript form

The structure of the thesis is clear (except that I would personally put sections 7.2 and 7.4 together). The introductory chapters are a nice summary for someone, who is only vaguely familiar with this stream of literature (including myself). Chapter 8 provides the model simulation outcomes in a condensed way. The thesis is written in decent English, but there are numerous typos and omitted/redundant words, which makes reading a bit difficult in some places.

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Summary and suggested questions for the discussion during the defence

Overall, the thesis is very innovative and brings interesting findings. I appreciate courage of the student to explore such a topic with a lot of technically demanding work on the one hand, and rather uncertain outcomes on the other hand.

At the defence, I suggest concentrating on (some of) the following issues:

- 1) In several places, the author calls the employed model "monetary". Why is that? My impression is that this is a purely real, non-monetary model.
- 2) The allowed values of wages presented on page 32 are different from what is used later on. Why is that?
- 3) On page 33, the impression is that the author is going to use a linear production function. Later on, a different production function is presented on page 37, without explaining motivation for the choice. Why was the exponential production function chosen, and not e.g. a Cobb-Douglas form?
- 4) For simplicity, the bond market was dropped from the model. Could the author explain how can the households save or dis-save in such an environment? This was not fully clear to me.
- 5) Why are the firms not allowed to have one employee, or more than five? This restriction is not explained in thesis, and looks too restrictive for me.
- 6) Why is the consumer choice restricted to two values only?
- 7) Why is the maximum real wage level sometimes by assumption restricted to values that may in some periods be less than the market-clearing equilibrium (e.g. in a growing economy, the level of 11 becomes too small sooner or later)? In principle, the maximum wage level should be linked to productivity.
- 8) The unemployment rates on page 39, 42 and 44 seem implausibly large in many periods. Could the author explain this at the defence?

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

CATEGORY	POINTS
Contribution (max. 30 points)	30
Methods (max. 30 points)	28
Literature (max. 20 points)	17
Manuscript Form (max. 20 points)	17
TOTAL POINTS (max. 100 points)	92
GRADE (A – B – C – D – E – F)	A

NAME OF THE REFEREE: Tomáš Holub

DATE OF EVALUATION: 10 September 2018



Referee Signature