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Evaluation report for the habilitation thesis "Adaptive learning in monetary models" by Sergey Slobodyan, Univerzita Karlova, CERGE 2018

Introductory remarks

This thesis presents original research results in the area of macroeconomics with adaptive learning. This research area has recently become a popular approach in various topics in macroeconomics. It provides an alternative to the currently most prevalent approach that relies on the assumption of rational expectations (RE). The latter is based on very strong assumption about the knowledge and information that economic agents are assumed to have. In contrast adaptive learning assumes that knowledge of economic agents is imperfect.

These knowledge imperfections can take various forms. A common formulation is that while agents know their own preference and technology characteristics, they operate in relatively anonymous markets and, in particular, they do not have accurate knowledge of the dynamics of market aggregates like market prices. Agents must then forecast these dynamics in order to make current decisions because their decision problem in each period has intertemporal linkages in utility and/or profit and also in budget or other similar constraints. Given the forecasts agents' decisions in any period determine the actual outcomes in the market and the new data in turn influences expectations for the subsequent periods. To make forecasts agents rely on learning algorithms which describe the updating of the parameters in agents' forecasting.

Sergey Slobodyan's habilitation thesis considers the dynamics of learning, expectations and temporary equilibria in a few different settings. He considers settings in which economic agents perceive that the economic environment is non-stationary because of frequent changes. In such situations adaptive learning relies on an algorithm that is appropriate for perpetual learning.[1] Usually, it is assumed that the algorithm is based a constant gain which implies that in parameter updating the weight on older data decays exponentially.

The thesis consists of three chapters which have been published in top or very good refereed journals. I will next discuss these chapters one by one.

Chapter 1

Chapter 1, titled "Escape Dynamics : A Continuous-Time approximation" was published in Journal of Economic Dynamics and Control in 2014 (with co-authors D. Kolyuzhov and A Bogomolova). JEDC is among the best journals for publishing technically advanced research in economic dynamics. This paper makes a very useful contribution to the study of what is known as `escape dynamics' in economic models with constant gain learning. Escape dynamics are occasional big deviations from a neighborhood of a steady state that is locally stable under decreasing gain learning. Constant-gain learning paths spend most of their time in the neighborhood of the locally stable steady state but they do not precisely converge and occasionally these paths deviate far away from the steady state.

[1] Much of the literature has instead focused on situation where agents perceive the environment to be constant.

The chapter studies and uses in great detail a continuous-time approximation to the escape dynamics in a well-known economic model. The model, so-called Phelps model, describes a government trying to control inflation when it has misspecified perceptions of the Phillips curve. Earlier literature, in particular Sargent (1999) and Cho, Williams and Sargent (2002), studied the nature and possibility of escape dynamics by employing discrete-time theory of large deviations in the analysis of the learning algorithm.[2] An alternative approach adopted in this chapter is to employ a continuous-time approximation to the algorithm and apply techniques from continuous-time theory of large deviations.

The latter approach provides new tools for assessing escape dynamics. An economically appropriate value of the constant gain parameter is an important issue for learning models as speed of learning is an important consideration in economic applications. The chapter argues that the initial discrete-time approach does not yield good approximations for escape paths when the value of the gain parameter takes values that are typical for economic applications. The paper then applies the continuous-time approach to study the escape and related phenomena in the model. It is shown that the latter approach can be usefully applied for accurate results when the gain parameter has a numerical value used in the Phelps model. The chapter concludes that the proposed technique should also work well for other economic models.

Chapter 2

Chapter 2, titled "Learning in an Estimated Medium-Scale DSGE Model" (with coauthor Raf Wouters), was also published in Journal of Economic Dynamics and Control in 2012 (with coauthor Raf Wouters). It is a very useful contribution as so far empirical analysis of models with learning have been limited to small-scale models. This chapter estimates a well-known medium-scale DSGE model when agents are assumed use a constant-gain learning mechanism in expectations formation in place of RE. (The original model is usually called the Smets-Wouters (S-W) model was based on the RE hypothesis, see Smets and Wouters 2003, 2007). Before looking at learning the paper compares the RE version SW model and a DSGE VAR model, where the latter is a VAR that employs restrictions for the DSGE model as prior in estimation to account for some misspecification issues of the RE model.

If a learning framework is empirically applied, it is important to consider the starting point of learning carefully as it can influence the dynamics a great deal. The general learning setup for SW model first focuses on studying so-called minimal state variable (MSV) reduced form under different specifications of initial beliefs: model consistent initial beliefs, optimized initial beliefs, MSV beliefs with pre-sample model initialization and MSV beliefs with pre-sample regression initialization. In the MSV cases agents know the correct specification of the model but not its parameter values. The idea is to look at some alternatives for specification of initial beliefs. The formulation of optimized initial beliefs seems to performs best but there are some computation issues.

A second approach to learning is to assume that agents do not know the equilibrium structure and instead estimate reduced forms that are VARs. Again the role of different formulations of initial beliefs are studied. The framework with VAR learning and optimized initial beliefs seems to be best performing specification and it substantially outperforms the RE model with marginal likelihood coming close to the best-fitting DGSE VAR model. The results are both interesting and somewhat puzzling. The best learning formulations for the SW model outperform the RE version of the model but the initial conditions play a big role relative to learning adjustment. This result may, however, be due to the formulation of the learning process itself as one could also consider alternatives here.

Chapter 3

[2] See the thesis for the details on the references.

Chapter 3, titled "Learning in a Medium-Scale DSGE Model with Expectations Based on Small Forecasting Models" (with coauthor Raf Wouters), was published in American Economic Journal: Macroeconomics in 2012. Like chapter 2, this paper considers learning in medium-size DSGE models. The new aspects are (i) the forecasting models of agents are small models and (ii) the parameter updating is based the Kalman filter. The small forecasting models are in general underparameterized relative to the RE solution which raises to the analyst the issue of choice of the forecasting models and of the information sets. This could be a limitation but can allow avoiding parameter uncertainty and instabilities in complex estimations. It is shown that introducing learning with best small forecasting models can match the best-fitting DGSE VAR models and thus is a significant improvement over a corresponding RE model.

The S-W model is employed as the analytical framework. Interestingly, the limited information forecasting models are indeed simple, as the information sets contain a constant and AR(1) form of the variable under investigation. Perceived parameter updating of the forecasting models follows a diagonal VAR and the actual updating is done using a Kalman filter. The Bayesian estimation leads to marginal likelihoods and posterior estimates which shows that the learning model noticeably improves upon the RE version of the model. This result seems to come from the time-wise flexibility in parameter updating.

It also turns out that expectations mechanism in learning and internal decision rules are the central propagation mechanism for markup shocks. This is in marked contrast to the corresponding RE model where propagation comes mostly from persistence in the exogenous shocks. This is a major achievement in modelling. The learning version also improves out-of-sample forecasting with the model relative to the RE version and comparisons of the model forecasts to actual forecasts in surveys of professional forecasts show a good fit. The authors have also run a number of robustness check and the learning model seems to perform robustly well.

This is a very important paper and the analysis provides very useful results. It should provide inspiration for further research to using learning as a starting hypothesis about expectations in macro modelling. The publication outlet AEJ:Macro is a relatively new journal (it was established ten years ago) but currently it is probably becoming the most important field journal in macroeconomics.

Concluding assessment

I regard this habilitation thesis to be a fine piece research as should be evident from my descriptions of and comments on the individual chapters. Each chapter makes a useful and original contribution to its area of research and all chapters have been published in very good journals. In particular, I want to highlight chapter 3. It has elegant results and has provided a good starting point for further development of applied models than those based on the usual RE paradigm.

I recommend that Sergey Slobodyan's thesis is accepted as habilitation thesis in your university.

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