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Dear Professor Jurajda

I am writing with regards to whether the submission by Dr Sergey Slobodyan meets the standards for award of the docent title.

The thesis is divided into a theoretical (first chapter) and empirical part (second and third chapters) both related to adaptive learning models in macroeconomics. This branch of work is related to relaxing the (strong) assumption of rational expectations (RE) in expectations formation in economic models. Even though RE does serve as a useful benchmark, it is often recognized that the assumption is very demanding since it assumes complete knowledge of the systematic aspects of the economy. This can be restrictive since, in reality, economic decisions are made under incomplete knowledge. For instance, the RE assumption is particularly strained when considering the effect of policy changes (or large structural shifts). Agents, in this case, need complete understanding of the underlying economic structure including model parameters, both before and after the policy change, and be able to incorporate this rationally in their decision making.

Since the 1990s, an alternative approach has developed which assumes that economic agents (consumers, firms, and policy makers alike), in situations of incomplete understanding, try improving their knowledge by using methods of scientific inference. This more realistic approach to expectations formation assumes that agents act like statisticians when making forecasts relevant to their economic decisions. They do this by running regressions on actual time series data on economic variables. This assumption that agents engage in learning behaviour has been incorporated into macroeconomic theory (eg. Sargent (1993) and Evans and Honkapohja (2001)). The initial literature on adaptive learning provided support for RE by showing how, in many cases, boundedly rational agents using least-squares and related learning rules can converge to a rational expectations equilibrium (REE) in the long run. The learning viewpoint has particularly met with huge success in analysing macroeconomic policy design: eg. Bullard and Mitra (2002, 2007) and Evans and Honkapohja (2003, 2006) for monetary policy. Indeed researchers in both academia and central banks have come to accept the importance of learning in assessing policy design as evidenced by the number of scientific papers published in top journals and conferences devoted to the topic.

The first chapter is primarily theoretical in nature. The chapter extends a continuous-time approximation approach to the analysis of escape dynamics in economic models with constant gain adaptive learning. Analysis of escape dynamics allows analytical characterization of diverse economic phenomena such as currency crises, inflation



episodes, and business cycles of economic activity. Escape dynamics is characterized by analytically deriving the most probable escape point and mean escape time. The approximation is tested on the Phelps problem of a government controlling inflation while adaptively learning a misspecified Phillips curve, studied previously by Sargent (1999) and Cho et al (2002) among others. This approach approximates simulations relatively well for very low values of the constant gain and importantly suggests improvements over the earlier approach based on large deviations theory. This is a solid contribution to the theoretical adaptive learning literature which enhances our understanding of escape dynamics.

The learning approach has also seen a shift towards the empirical implementation of these ideas in fully specified dynamic stochastic general equilibrium models. One of the major problems in explaining macroeconomic data based on micro-founded models with rational expectations (RE) is the persistence of inflation and output evident in the data. Typically, researchers have added mechanical sources of persistence like habit persistence and price indexation to get the type of persistence seen in the data whilst maintaining the assumption of RE. However, Milani (Journal of Monetary Economics 2007), for instance has found that adaptive learning can be an independent source of persistence in the data. Milani uses Bayesian estimation techniques in a system involving only a small number of macro variables.

The second chapter, among other things, considers whether similar results like Milani's would emerge from larger and more realistic medium-scale quantitative models of the type, eg., those estimated by Smets and Wouters (2003, 2007) within the framework of rational expectations. This is precisely what the second chapter does. They find that learning models fit the data equally well or even better than the RE model. This is particularly striking since the learning approach makes much fewer demands on the information requirements of economic agents. It is also found that restricting the set of variables used in the forecasting equations to a limited list of observed macro-variables generates learning models that explain the data better than models with beliefs that use the complete set of observed and unobserved state variables implied by the REE.

The third chapter continues to examine the empirical performance of learning models in the context of a medium-scale DSGE model when agents form expectations using small forecasting models updated by Kalman filter. The adaptive learning model fits the data better than the RE model. Beliefs about the inflation persistence explain the observed decline in the mean and the volatility of inflation in the data. Learning about inflation results in lower estimates for the persistence of the exogenous shocks that drive price and wage dynamics in the RE version of the model. Most importantly, the chapter shows that expectations based on small forecasting models are closely related to the survey evidence on inflation expectations.

I view particularly the second and third chapters as being highly influential and widely cited in the literature internationally. These papers have helped to shape the adaptive learning literature and to it being taken much more seriously by people who swear by rational expectations! These are excellent pieces of work and I myself have benefitted and used these in my own work. Incidentally, I was the discussant of



"Estimating a medium-scale DSGE model with expectations based on small forecasting models" when Sergey presented this in a workshop in Cambridge several years ago! Sergey impressed me with the presentation of his material and sounded very confident and knowledgeable. In my subsequent interactions with him, I have always found him to be a deep thinker with incisive comments on people's work.

Sergey is well known internationally through his own work and discussions of other people's work. He is widely respected and is a frequent presence in international conferences.

All in all I have no hesitation at all in saying that this submission easily meets the standards for award of the docent title.

Please let me know if I can be of any further use.

Thanking you,

Yours sincerely,

Kaushik

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