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1 Summary

This paper shows how to calculate various objects of interest for Markov switching VAR or linear state space models. Such models have become popular in recent years in both empirical studies and in more theoretical work looking at the implications of switches in fiscal and monetary policy. This paper shows how to calculate the conditional expectations of the state variables, and hence how to forecast the future evolution of the states taking into account the possibility of switches in regimes. In addition, the paper shows how calculate second moments of the state variables, and hence how to depict the evolution of volatility or uncertainty which captures the ongoing additive shocks as well as the occasional switches in regime. The author then applies these methods in three different settings, a variant of a standard New Keynesian model with switches in the volatility of the exogenous shocks and the monetary policy rule, a Markov switching VAR which shows how uncertainty can affect the levels of variables, and a Campbell-Shiller type model of return decompositions. The New Keynesian model is analyzed in some detail, while the others are shorter illustrations.

2 Comments

Overall, this paper provides methods which ar potentially useful for researchers interested in working with Markov switching models, and illustrates the type of issues which such studies may want to focus on. However the innovations relative to the existing literature do not seem sufficient to warrant publication in a top general interest journal like the *Top Journal*. My standard for such a journal is that a paper of this type must make either substantive theoretical contributions or apply theory to bring out substantive insights into economic applications. Neither the theoretical innovations nor the applications in this paper meet these criteria. The paper is explicitly a "tools and methods" paper, with the applications serving more of a means of illustrating the types of issues which could be addressed with the tools. While there is some interest in the results of the monetary policy model, these issues seem to have been addressed in more detail by the author in separate work. Thus the real contribution of the paper is in the methods, but these are not sufficiently novel to warrant publication in the *Top Journal*. However I certainly think the paper, perhaps with some revision, should be publishable in a more specialized outlet.

In terms of the theoretical contribution, the main results in the paper are Propositions 1 and 2 which show how to compute the conditional means and second moments of the state variables. The later results on variances and covariances largely follow from these results. While these results in Proposition 1 and 2 are useful, they seem to be largely an issue of setting up the matrices and the linear algebra in the right way and then carrying out the appropriate calculations. Perhaps I was missing something, but there did not seem to be anything novel or surprising that such calculations could be done or anything particularly difficult about the derivations.

The main trick in the analysis is the construction of the vector q_t which gives the conditional expectation of the state at horizon t, conditioned on being in a particular regime at that date. Then the conditional means are linear combinations of q_t. The matrix Q_t plays a similar role in the computation of the second moments. This is a clever trick, and one which allows the computations to be reduced to rather straightforward matrix multiplications, however it is not new to the paper. In order to check the results on mean-square stability that the author provides, I looked at the Costa, Fragoso, and Marques (2004) book that the author cites. They also use this trick and construction of q_t and Q_t. In addition, they derive the evolution of q_t and Q_t, albeit in what appears to be a somewhat different form than is provided here. That is, I do not think that the paper simply reproduces calculations which are available elsewhere. However the methods and tricks have been used previously, and the results seem similar to those that exist in the literature. Thus while the results are certainly useful, they are not very novel.

In terms of the applications, the New Keynesian application in the paper is studied in some depth and has some interest. However it seems that the author has considered similar issues in more detail in other papers. In addition, most of the results in the application are explicitly stated as illustrations. That is, the author says things like, "a researcher may be interested in characterizing the historical evolution of expectations and uncertainty...," and "if an economist were interested in studying...," and similar phrases, rather than explicitly arguing why we should be interested in such characterizations or results in this case. Of course this is fine when the application is viewed as an illustration of the methods, but it limits the inherent interest in the results of the application themselves.

In particular, I did not find anything very surprising or insightful about results, perhaps with the exception of the evolutions of uncertainty. There the author shows that, unlike in most settings, uncertainty as measured by the conditional standard deviations of variables may decline over time. This is initially surprising, but the author clearly explains how this can happen if the economy is currently in a high volatility regime. Conditional on staying in that regime, there is more uncertainty about the variables at longer horizons as is typically the case. However at longer horizons there is also a greater chance that the economy will have transited out of the high volatility regime into one with lower volatility, and so there would be an expectation of smaller shocks going forward. This is nicely explained in the paper.

The final two applications in Section 5 added little to the paper, other than again

as illustrations of how to apply the methods. But the applications were short and relatively sketchy, and so served more as an indication of how one would go about studying such models than actually doing it. I would advise cutting these.