Bayesian inference in multivariate nonlinear state-space models

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Chapter 6

Valorisation

"It is our responsibility as scientists, knowing the great progress and great value of a satisfactory philosophy of ignorance, the great progress that is the fruit of freedom of thought, to proclaim the value of this freedom, to teach how doubt is not to be feared but welcomed and discussed, and to demand this freedom as our duty to all coming generations."

-Richard Feynman

In the following addendum, I will discuss the value of this dissertation for society through two prisms. First, through the research questions that I have been investigating. Second, through a personal reflection on the training, I have received from the academic community.

This thesis contributes to the utilization of a specific class of nonlinear state-space models. First, I would like to remind the reader why these models can be useful. In the real world, it often happens that there exist latent or unobservable variable that affects the system we are interested in. This latent variable can be either some aspect of the real world that potentially could be measured but was not for some practical reasons, or an abstract concept, like volatility on the financial markets in our case, that cannot be measured directly at all. State-space models often are chosen to deal with the problem of modeling latent variables. Moreover, the state-space approach can model various types of linear and non-linear relationships in observations through latent variables. These models can have a wide range of applications in different scientific fields. It is still commonly accepted that non-linear state-space models are hard to estimate. It already happens in the univariate case when a single observation process depends on a single latent process. The challenges of estimation become more severe in multivariate models. However, if one manages to build an efficient estimation procedure, these models can serve well in various scientific fields, including economics, finance, biology, physics, engineering.

As non-linear state-space models are hard to estimate, Chapter 2 of this thesis is particularly concerned with bringing together scientific fields (statistics, machine learning, and econometrics) and comparing methods that can be used for the estimation of models of our interest, namely stochastic volatility models. Having an overview of existing methods from these fields can be helpful in efficiently solving the problem. Non-linear state-space models are quite flexible and the estimation method has to be chosen based on the particular specification of the model. Thus, this chapter can be used as a guideline for choosing a strategy to estimate the model of a particular specification. In our case we use it as a guideline for estimation of the multivariate stochastic volatility models where the latent variables are modeled with Vector Autoregressive process and the dependence between latent variables and observations is non-linear.

Chapter 3 develops a new method for measuring spillover effects on financial markets. This method can be used by portfolio managers and policymakers for taking more effective decisions. Knowing the dependencies between financial markets, portfolio managers can make a better decision regarding portfolio diversification and policymakers can be more effective in making a decision regarding bailout funds. The volatility spillover effects in this framework are defined in a very transparent and intuitive way. Bayesian inference allows us to report the uncertainty in the parameters and spillover measures themselves. Overall, this approach to measuring volatility spillovers can make the decision process more informed. Imagine, that financial markets of country A and country B are interconnected. Moreover, it is known that there is Granger-causal relationship from country A to country B, i.e. there is a spillover effect from country A to country B. If policymakers of country B know how strong this relationship is, it would help them to create sufficient fund to support their economy in case crisis happens in country A and in case it transmits to their own economy. Thus, the whole society would benefit from it since the consequences of a crisis would be reduced. Finally, in this chapter we also discuss current limitations in estimation of non-linear state-space models and propose directions for future research.

Chapter 4 is concerned with the application of non-linear state-space models in a different scenario: in modeling multivariate count data. These data appear in many scientific fields and has its specific problems. We compare the state-space approach with its most relevant competitor in terms of forecasting performance and conclude that the state-space approach is usually favorable. This conclusion and method can be useful for practitioners who work with count data. The applications we have considered are forecasting of a number of transactions on financial markets, forecasting the number of car crashes and forecasting number of bank failures. However, there are much more different problems that could benefit from modeling with the state-space approach.

Academic research in its many different variations has different societal impacts. Likewise, Ph.D. training has its own specific value to society. Young scientists form their scientific values during this time, which in turn shapes the science of the future. We learn how to conduct scientific investigation, we learn how to teach, how to assimilate and expand knowledge. We learn to pose interesting questions and try to answer them. Moreover, we learn how to deal with the uncertainty, how to live with the fact that many questions have not yet been answered. These are unique skills that take time to be developed and can be important in universities, research institutes, public organizations, and companies. One of the responsibilities I have had was teaching on undergraduate level at the university. Lecturers and tutors and the universities can have profound impact on the students who will, later on, find their careers in academia, public organizations and companies. I believe that we are capable of not only teaching students the material but also change their attitude towards knowledge. There is room for the development of critical thinking, creativity and accepting that perhaps not all questions can be answered straight away, which does not mean we should not try. I think that I, like many academics before and after me, have the power to show students the importance and impact of science.