

Hierarchical Markov Normal Mixture Models with Applications to Financial Asset Returns

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Abstract:

Motivated by the common problem of constructing predictive distributions for daily asset returns over horizons of one to several trading days, this paper introduces a new model for time series. This model is a generalization of the Markov normal mixture model in which the mixture components are themselves normal mixtures, and it is a specific case of a neural network model with two hidden layers. The paper characterizes the implications of the model for time series in two ways. First, it derives the restrictions placed on the autocovariance function and linear representation of integer powers of the time series in terms of the number of components in the mixture and the roots of the Markov process. Second, it uses the prior predictive distribution of the model to study the implications of the model for widely studied interesting functions of asset returns. The paper uses the model to construct predictive distributions of daily S&P 500 returns 1971-2005, US dollar/UK pound returns 1972-1998, and one- and ten-year maturity bonds 1987-2006. It compares the performance of the model for these returns with ARCH and stochastic volatility models using the predictive likelihood function. The model's performance is about the same as its competitors for the bond returns, better than its competitors for the S&P 500 returns, and much better than its competitors for the dollar/pound returns. Out-of-sample validation exercises using inverse predictive cumulative distribution functions and in-sample validation exercises using posterior predictive distributions identify some remaining deficiencies in the model and suggest potential improvements. The paper concludes by using the model to form predictive distributions of one- to ten-day returns during very volatile episodes for the S&P 500, dollar/pound and bond return series.

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