

Public Abstract

First Name:Pei

Middle Name:

Last Name:Yin

Adviser's First Name:Allanus H.

Adviser's Last Name:Tsoi

Co-Adviser's First Name:

Co-Adviser's Last Name:

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Title:Volatility Estimation and Price Prediction Using a Hidden Markov Model with Empirical Study

This work starts with summarizing and comparing all the popular models for financial market return process on both a theoretic level and an empirical level. It ranges from the ancient Geometric Brownian Motion model to the cutting edge stochastic models, along with the implied volatility and the “model free” realized volatility. It provides a solid development of a hidden Markov model(HMM), from the economic insight of the hypothesis to the mathematic formulation of the estimation and prediction.

In addition, enormous empirical work is done with HMM on our cautiously selected datasets including: major Indices; ETFs; government bonds; mutualfunds; commonstocks. The results can be incorporated with the phenomena observed from the real financial market. Moreover, we compare the applicability of our model with the well established GARCH(1,1) model. As far as the prediction performance is concerned, our results indicate that HMM outperforms GARCH(1,1).

Originalities of this work include:

- (1) In our EM iteration, not only the parameters but also the observation get updated in each pass. The idea is to seek quality rather than quantity of the information, as the recent data are more relevant in terms of predicting the near future.
- (2) While judging the prediction performance, we employ the concepts of “relative alpha” and “relative standard error” as modification to the three criteria for a good model proposed by Fama and Gibbons(1984). This modification has been proved to be more appropriate.
- (3) As far as the under lying Markov process is concerned, previous work intended to explain it as a specific economic process. We suggest that it is a combination of all the forces that can move the stock price, including the information about market sentiment, the psychology of market participants; fundamental factors such as earning base, evaluation multiple; and technical factors such as inflation, economic strength of market and peers, substitutions, incidental transactions, demographics, trends, liquidity. Our discovery is that we don't need a clean equation to describe them, which is impossible anyway, and it is sufficient to estimate their overall impact on any price process, i.e. to estimate the hidden Markov chain.
- (4) It is interesting to consider how the behaviors of drift and volatility are related across states. However, most of the models force the drift to be constant for analytic reasons. We suggest a technique to model them together as a pair of random variables. Our results indicate that except for a few securities the drift does have different states. In addition, we find very little evidence of leverage effect.