

VOLATILITY ESTIMATION AND PRICE PREDICTION
USING A HIDDEN MARKOV MODEL
WITH EMPIRICAL STUDY

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ABSTRACT

This work provides a solid development of a hidden Markov model(HMM) from the economic insight to the mathematic formulation. In this model, we assume both drift and volatility of the security return process are driven by certain underlying economic forces which evolve together as a finite-state, time-invariant Markov chain. Unfortunately, this chain is unobservable.

Through stochastic filtering techniques and EM algorithm with modified iteration steps, we estimate the state space and transition matrix of the Markov chain, as well as the state spaces of the drift and volatility. With these estimates we can smooth and predict the drift and volatility processes and apply them to the security price prediction.

On an empirical level, we first use Monte Carlo simulation to show the robustness of our estimates, and then implement HMM on various data sets of historical prices including: major indices, bonds, mutual funds, common stocks, and ETFs to back test the predicability of the model. Moreover, we compare the applicability of HMM with the well established GARCH(1,1) model, as far as the prediction performance is concerned, our results indicate HMM outperforms GARCH(1,1).