An Optimal Band for Prediction of Buy and Sell Signals and Forecasting of States:
Optimal Band for Buy and Sell Signals

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ABSTRACT

A trading band, based on historical movements of a security price, suggests buy or sell pattern. Bollinger band is one of the most famous bands based on moving average and volatility of the security. The authors define a new trading band, namely Optimal Band, to forecast the buy or sell signals. This optimal band uses a linear function of local and absolute extrema of a given financial time series. The parameters of this linear function are then estimated by simple linear optimization technique. The authors then define different states using various upper and lower values of Bollinger band and the optimal band. The approach of Markov and Hidden Markov Models are used to forecast the future states of given time series. The authors apply all the techniques on the closing price of Bombay stock exchange and intra-day price series of crude oil and Nifty stock exchange.

Keywords: Bollinger Band, Hidden Markov Model, Markov Model, Time Series, Trading Band

1. INTRODUCTION

Prediction of movements of a stock or the whole market has always been a challenging task. It is mainly due to complexity, high volatility and non-linearity in the data. The rate of variation of financial time series depends on several factors, such as, fluctuation, interest rate, volume of transaction, etc. Several statistical and machine learning techniques have been developed to forecast the movement.

Here, we first discuss the trading band approach to predict the buy or sell pattern of a particular stock. These bands suggest buy or sell signal based on the historical movements. Originally developed by J.H Hurst, these bands became more popular when a trading band was defined by using Moving Average (MA). The most popular trading band is Bollinger band, developed by

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John Bollinger in 1989. These are volatility bands placed below and above moving average of the given financial time series. If the price hits the upper band it generates a sell signal, whereas hitting the lower band at any time tick is a signal of buy. Gap between the bands increase when volatility increases and decrease when volatility is low. This dynamic nature means that they can be used for different securities with the standard settings. We discuss the theoretical development of Bollinger band in the next section. We, then, define a new trading band which is based on absolute extrema (maxima and minima) and local extrema. The optimal band uses a linear function, of these extreme values which is optimized by using Solver in MS Excel. Based on the outcomes of these bands, we define different states.

We discuss forecasting of states for a given financial time series by using Markov and Hidden Markov Model [Hassan 2009]. These models use state transition probability matrix. These states are defined by using the lower, middle and upper bands. We use both the Bollinger band and optimal band to forecast states and compare the values.

The structure of the paper is as follows. In Section 2, the Bollinger band is discussed with application to BSE (Bombay Stock Exchange) monthly data, Crude oil intra-day and Nifty intra-day data. The new trading band, namely optimal band, is discussed in Section 3. A brief introduction of Markov and Hidden Markov Model (HMM) is given in Section 4. In Section 5, forecasting of states for BSE, Crude oil and Nifty data is discussed based on Markov and HMM.

2. BOLLINGER BAND

Traders attempt to profit on short terms price fluctuations. An active trader normally holds an asset for a very short period of time, sometimes minutes and sometimes even seconds. The decision of a trader is based upon technical analysis. There are several technical indicators which predict the trends of movements. Some of them are based on moving average, some are based on volatility. There are some indicators which are free of statistical parameters, for example, PVO (Percentage Volume Oscillator). One of the most reliable and useful technical indicator is Bollinger Band. These bands are plotted at standard deviation levels above or below moving averages. The bands are volatility adjusting bands, that is, during more volatile market widening can be observed. A Bollinger band consists of:

1. An N'-period moving average (MA);
2. An upper band at K times the N'-period standard deviation above the moving average (MA +Kσ);
3. A lower band at K times the N'-period standard deviation below the moving average (MA - Kσ);
4. A middle band consists of values between (MA +Kσ) and (MA -Kσ).

The values of K and N’ are considered to be K= ± 1.5 and N’ = 20 (for details, see, Bollinger 2002).

We construct Bollinger bands for BSE monthly data (April 2007 - October 2013), Crude oil intra-day data of 22 Mar 2007 and Nifty intra-day 03-05 Jan 2011 data. Also, we assume N’=20 and K =0.75 and 1.5. These bands are given in Figure 2, 3 and 4 in Appendix.

Some facts about graphs in Figures 2, 3 and 4:

1. For a given value of K, higher prices are represented by the upper band (MA + K σ) and lower prices by the lower band (MA - K σ). The middle band acts as simple moving average between the bands;
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