TECHNICAL ANALYSIS OF FTSE 100 INDEX USING QUANTMOD PACKAGE

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Abstract: The goal of this article is to present the functionality of quantmod package to provide complex technical analysis for any financial time series (shares, indices, forex pairs, bonds, commodities, etc). Using quantmod, a special package created for quantitative analysis in R programming language, we can create trading/investing strategies, algorithmic trading or Risk Management plans on short or long term. I selected 5 technical indicators for this analysis and I used daily prices for FTSE 100 from March 2012 to January 2015.

JEL Classification Codes: C13, C32, C52, G15.
Key words: Technical Analysis, R, FTSE, quantmod, financial markets, volatility , algorithmic trading

1.INTRODUCTION

In last decade the complexity of financial markets became incredible high and the difficulty of generating constant profit during all crises and geopolitical conflicts became a very tough goal. Always short or medium term trading was more difficult than long term investment. The "game rules" are made by super computers or the biggest investment banks or funds. To be successful in these markets you have to develop a competitive and complex analysis and be up to date with all news related to your trading products.

In every second in all markets are probably hundreds of thousands of algorithms created by brilliant minds which use complex technical analysis and mathematical models.

In this paper I will present the utility of quantmod package for creating a technical analysis using FTSE 100 daily prices.

2.LITERATURE REVIEW

Technical analysis represent a set of methodologies and methods for forecasting the direction of prices through the study of past market data, primary price and volume.[1]

In finance applications, technical analysis is a widely used methodology which represent a combination of applied mathematical models and methods used for forecasting the direction of prices through the study of past market data, primarily price and volume.

The principles of technical analysis are derived from hundreds of years of financial market data. First technical analysis elements began to appear in Joseph de la Vega's accounts of the Dutch markets in the 17th century. In Asia, technical analysis

[1] http://en.wikipedia.org/wiki/Technical_analysis#cite_note-Kirk-1

is said to be a method developed by Homma Munehisa during early 18th century which evolved into the use of candlestick techniques, and is today a technical analysis charting tool.[2]

The origin of modern technical analysis is dating from 1920s. Richard Schabacker is considering the father of technical analysis. He was a successful trader, investment advisor, and author whose approach was based on classifying many variations of patterns. His books include variation after variation on continuation patterns, trend change patterns, consolidation patterns, etc.[3] He wrote three large books prior to his death at the young age of 36. These were: Stock Market Theory and Practice (1930); Technical Analysis and Stock Market Profits: A Course in Forecasting (1932); Stock Market Profits (1934).

In 1948 Robert Edwards and John Magge wrote the most important book for technical analysis, Technical Analysis of Stock Trends. Few people know that Richard Schabacker was Robert Edward's uncle.

Today most serious technical analysts own a copy of Technical Analysis of Stock Trends (first published in 1948). Robert Edwards and John Magee wrote this classic. Few realize that Richard Schabacker was Robert Edwards's uncle.

More recent, a bible of technical analysis is consider the book of Murphy, John J. Technical Analysis of the Financial Markets. New York Institute of Finance, 1999;

Another good reference is Kahn, Michael N.(2006). Technical Analysis Plain and Simple: Charting the Markets in Your Language, Financial Times Press, Upper Saddle River, New Jersey which present a practical approach of technical analysis.

In 2011, Andrew W. Lo; Jasmina Hasanhodzic published -The Evolution of Technical Analysis: Financial Prediction from Babylonian Tablets to Bloomberg Terminals. In this book he offer a detail history of technical analysis evolution.

3.METHODOLOGY

The quantmod package for R was created by Jeffrey A. Ryan in 2008 and is designed to assist the quantitative trader in the development, testing, and deployment of statistically based trading models.

As methodology I used 3 category of indicators: Trend indicators (SMA, EMA and MACD), volatility (Bollinger Bands) and momentum (RSI).

3.1 Bollinger Bands

Bollinger Bands is a technical analysis tool invented by John Bollinger in the 1980s as well as a term trademarked by him in 2011.[4] Bollinger Bands consist of:
an *N*-period moving average (MA); an upper band at *K* times an *N*-period standard deviation above the moving average (MA+$K\sigma$); a lower band at *K* times an *N*-period standard deviation below the moving average (MA−$K\sigma$);

The purpose of Bollinger Bands is to offer a relative definition of high and low. By definition, prices are high at the upper band and low at the lower band.

[2] http://en.wikipedia.org/wiki/Technical_analysis#cite_note-8
[3] http://www.smbtraining.com/blog/technical-analysis-a-little-background-and-history
[4] "Bollinger Bands – Trademark Details". Justia.com. 2011-12-20.

The Bollinger Bands Indicator can be used also in micro-economy applications. In a paper published in 2006 by the Society of Photo-Optical Engineers, "Novel method for patterned fabric inspection using Bollinger bands", Henry Y. T. Ngan and Grantham K. H. Pang present a method of using Bollinger bands to detect defects (anomalies) in patterned fabrics.[5]

The International Civil Aviation Organization is using Bollinger bands to measure the accident rate as a safety indicator to measure efficiency of global safety initiatives.[6]

3.2 Simple moving Average - SMA

A moving average is commonly used with time series data to eliminate short-term fluctuations and highlight longer-term trends directions. It is also used in economics to examine gross domestic product, employment or other macroeconomic time series.[7]

In financial applications a simple moving average (SMA) is the un-weighted mean of the previous *n* data. An example of a simple equally weighted running mean for an n-day sample of closing price is the mean of the previous *n* days' closing prices. If those prices are $p_m, p_{m-1}, ..., p_{m-(n-1)}$ then the formula is :

$$SMA = \frac{p_m + p_{m-1} + ... + p_{m-(n-1)}}{n} \quad (1)$$

When calculating successive values, a new value comes into the sum and an old value drops out,

$$SMA_{today} = SMA_{yesterday} - \frac{p_{m-n}}{n} + \frac{p_m}{n} \quad (2)$$

One characteristic of the SMA is that if the data have a periodic fluctuation, then applying an SMA of that period will eliminate that.

3.3 Exponential moving average - EMA

A type of moving average that is similar to a simple moving average, except that more weight is given to the latest data. The exponential moving average is also known as "exponentially weighted moving average". [8]

The EMA for a series *Y* may be calculated recursively:

For $S_1 = Y_1$ then $t > 1, S_t = \alpha \cdot Y_t + (1-\alpha) \cdot S_{t-1}$; (3)

where: α - represents the degree of weighting decrease, a constant factor between 0 and 1. A higher α discounts older observations faster.

Y_t - is the value at a time period *t*.

S_t is the value of the EMA at any time period *t*.

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[5] Optical Engineering, Volume 45, Issue 8

[6] CAO Methodology for Accident Rate Calculation and Trending on SKYbary

[7] http://en.wikipedia.org/wiki/Moving_average#Simple_moving_averageb

[8] http://lorien.ncl.ac.uk/ming/filter/filewma.htm

S_1 is undefined. S_1 may be initialized in a number of different ways, most commonly by setting equal to Y_1,. The importance of the S_1 initializations effect on the resultant moving average depends on α; smaller α values make the choice of S_1 relatively more important than larger α values, since a higher α discounts older observations faster.

In technical analysis terms the above formula can also be expressed as follows, showing how the EMA steps towards the latest datum point, but only by a proportion of the difference:

$$EMA_{today} = EMA_{yesterday} + \alpha \times (price_{today} - EMA_{yesterday})$$

(4)

Expanding out $EMA_{yesterday}$ each time results in the following power series, showing how the weighting factor on each datum point p_1, p_2, etc., decreases exponentially:

$$EMA_{today} = \alpha \times (p_1 + (1-\alpha)p_2 + (1-\alpha)^2 p_3 + (1-\alpha)^3 p_4 + ...)$$

(5)

Where p_1 is $price_{today}$; p_2 is $price_{yesterday}$; and so on.

This type of moving average reacts faster to recent price changes than a simple moving average. The most popular EMAs are 12 and 26-day for short-term averages, and they are used to create indicators like the moving average convergence divergence (MACD)

For long-term, the 50 and 200 days are the most used EMAs. Also 200 days id consider the limitation from a bull and bear market.

3.4 Moving average convergence/divergence - MACD

MACD, short for moving average convergence/divergence, was created by Gerald Appel in the late 1970s. It is supposed to reveal changes in the strength, direction, momentum, and duration of a trend in a stock's price.

The MACD indicator is a collection of three time series calculated from historical price data, most often the closing price but not obligatory . These three series are: the MACD series proper, the "signal" ("average") series, and the "divergence" series which is the difference between the two. The MACD series is actually the difference between a short period) exponential moving average (EMA), and a "slow" (longer period) EMA of the price series. The average series is an EMA of the MACD series itself.

Trend-following momentum indicator that shows the relationship between two moving averages of prices. The MACD is calculated by subtracting the 26-day exponential moving average (EMA) from the 12-day EMA. A nine-day EMA of the MACD, called the "signal line", is then plotted on top of the MACD, functioning as a trigger for buy and sell signals.

3.5 Relative Strength Index

The relative strength index was developed by J. Welles Wilder in 1978 and published in , *New Concepts in Technical Trading Systems*, and in Commodities magazine (now Futures magazine) in the June 1978 issue. Now is one of the most popular and used oscillator indices. RSI is a technical momentum indicator that

compares the magnitude of recent gains to recent losses in an attempt to determine overbought and oversold conditions of an asset. It is calculated using the following formula:

$$RSI = 100 - 100/(1 + RS) \quad (6)$$

*Where RS = Average of x days' up closes / Average of x days' down closes.

The RSI is classified as a momentum oscillator, measuring the velocity and magnitude of directional price movements. Momentum is the rate of the rise or fall in price. The RSI is most typically used on a 14 day timeframe, measured on a scale from 0 to 100, with high and low levels marked at 70 and 30, respectively.

4.DATA ANALYSIS

For this analysis I used daily FTSE 100 prices from 2012 to January 2015 for the main part of the application and American Treasury Bonds from 2001 to January 2015 for the 3d representation.

The date was downloaded from Yahoo Finance And Federal Reserve databases and contains open and close prices, high and low prices and daily volume.

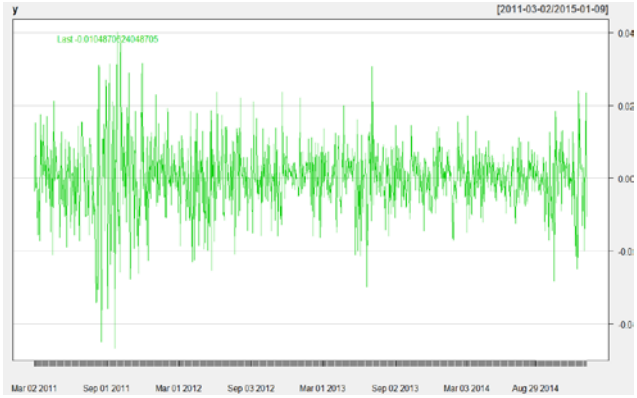
A usefully function for data extraction is *getSymbols.*

Below is presented a daily chart for FTSE 100 prices created using *chartSeries:*

Chart 1: FTSE daily prices
Source: Yahoo Finance

Also using quantmod package can be created weekly , monthly or yearly time series using function *to.weekly/monthly/yearly***.** For creation daily return we can use *dailyReturn* function.

Chart 2: Daily returns



Analyzing daily returns chart we can observe a very common financial market feature: *volatility clustering*: after a high volatility period we will have another volatile period.

For FTSE 100 time series we can create also a descriptive statistics table using a widely used R function *summary()*.

Table 1: Descriptive statistics

Descriptive Statistics	Value
Min	5260
1st Quintile	5869
Median	6443
3rd Quintile	6665
Max	6878

In the fallowing chapter I presented a technical analysis using the most used indicators: Bollinger Bands for volatility analysis; Simple Moving Average (SMA), Exponential Moving Average (EMA) and MACD for trend; Relative strength index (RSI) for Momentum.

More than that, I created a new indicator using 10 moving averages and a 3D analysis of American Treasuries Bonds.

5. RESULTS

The goal of this analysis is to demonstrate the ability of quantmod package to provide high level technical analysis. I provided for every combination of indicators the technical and economic interpretation and the most used trading strategies.

The first set of indicators I used is the trend indicators. In every analysis this is the first step, you must figure out what is the big picture of market. For a better visual representation I created a weekly chart using candlestick type of chart:

Chart 3: Trend indicators
Source: Yahoo Finance

In Chart 3 are presented : a fast SMA of 30 prices (red line), two slow EMA of 50 and 100 periods (green and blue line) and the MACD indicator (below volumes bars).

In order to check if the market is on an uptrend, downtrend or the market is in sideways – i used three moving averages - one on short term, one on medium term and one on long term. The market is in a complete uptrend if the short term moving average is above the medium term moving average and the medium term moving average is above the long term moving average

From 2012 to July 2014 the 50 periods' EMA acted as a support for our uptrend but in last weeks we have an intersection of the moving averages which can indicate an possible trend inversion.

The Moving Average Convergence Divergence (MACD) indicator gives us a good timing in a trend market. For example if we have an uptrend, we are expecting to buy on a MACD intersection in the positive territory. In our case we have an intersection in a negative territory which means that here it is a possible trend change.

For this representation I used chartSeries(), addSMA() and add EMA() functions.

The second chart presents the indicators: Bollinger Bands and RSI (volatility and momentum indicators)

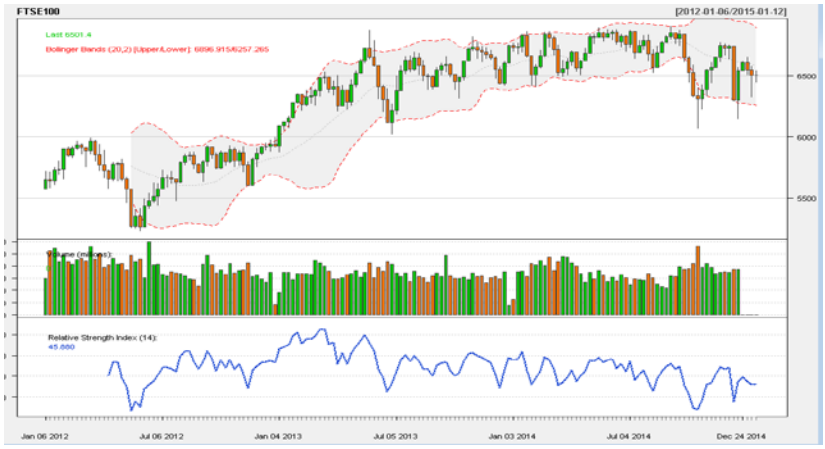


Chart 4: Volatility and momentum indicators
Source: Yahoo Finance

Bollinger Bands and RSI indicators can be added simple using addBBands and addRSI functions. Bollinger Bands are being used for a sideways market – when the prices are moving in ranges. This indicator is using a 20-day moving average and LowerBollinger and UpperBollinger, which represents the second standard deviation. When the asset is trading in range, investors usually prefer to buy in LowerBollinger and to sell in UpperBollinger. The second indicator is Relative Strength Index (RSI) – which is also used in sideways-trading. It has two zones – above 70, which is called overbought zone and below 30, which is called oversold zone. Investors will trade using this indicator by buying in the oversold area and selling in the overbought area.

The above two chart presented standard functionality of this quantmod package. For advanced traders, quantmod offer the possibility to create new indicators, 3d graphics or trading strategies and high frequency algorithms. Below I presented a custom indicator and a 3d graphic. For the fallowing indicators I randomly selected 4

fast EMA(3,8,10,15) and 4 slow EMA(30,50,100,200) and used function addTA to create it. The graphic representation is presented below:

Chart 5: Custom indicator
Source: Yahoo Finance

The last chart is a 3D representation of American Treasury Bonds with 1m, 3m, 6m, 1y ,2y, 3y, 5y, 7y, 10y, 20y and 30 years maturity.

For this, first I create a new database downloading daily quotations for American Bonds from Federal Reserve official site and using merge() function. After I used an special created program for 3d charts named chartSeries3d0.

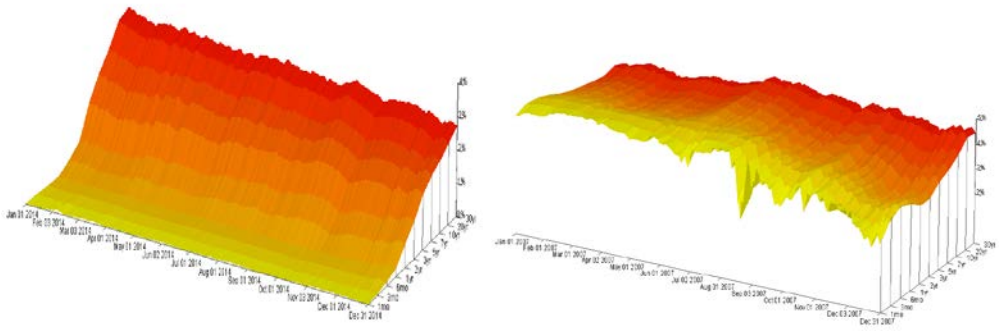


Chart 6: Comparative 3D Graphic: 2014 vs 2007 American Bonds yields
Source: Federal Reserve databases

As it can be seen in the second chart – 2007 year – we had a big *spike* in September, because of the collapse of Lehman Brothers. This was the "zero-point" for the Financial Crisis – when everything started. As you can see the distribution of the yields aren't a normal one, because the small maturity yield - like 1m, 3m, 6m or 1yr – are almost the same as the long maturity yield like 10yr, 20yr or 30yr. In 2014 for example we have a normal distribution in the yield curve, which is totally normal.

6. CONCLUSIONS

Analyzing the above charts I can confirm that quantmod package offer the possibility to create very useful technical analysis with a wide applicability in trading strategies or long-term investment.

It is relatively easy to create or add the most used indicators and any person with minimal skills of programing and financial modeling can use this free package. Because R is free modeling software it can be used anywhere.

About economic interpretation of the charts, my opinion is that the indicators suggest us a big risk for buying positions and a possible good future selling opportunity for short to medium term. The 3d chart confirms that the SUA economy and majority of world economies are coming back and the risk of a new crisis is relatively low.

This article will be continue with a integration of quantmod package with TTR package, creating and simulating of a trading strategies or Risk Management signals system. Also can be implemented a neuronal network or Big Data algorithm for a more accurate prediction of financial markets.

References

1. Andrew, W. Lo; Hasanhodzic, J The Evolution of Technical Analysis: Financial Prediction from Babylonian Tablets to Bloomberg Terminals., 2011
2. Kahn, M. Technical Analysis Plain and Simple: Charting the Markets in Your Language, Financial Times Press, 2006
3. Murphy, J Technical Analysis of the Financial Markets. New York Institute of Finance, 1999
4. Edwards, R. ; Magge, J Technical Analysis of Stock Trends, 1948
5. Schabacker , R. Stock Market Theory and Practice, 1930
6. Schabacker, R. Technical Analysis and Stock Market Profits:
7. A Course in Forecasting, 1932
8. Schabacker, R. Stock Market Profits, 1934
9. *** http://en.wikipedia.org/wiki/Technical_analysis#cite_note-Kirk-1
10. *** http://en.wikipedia.org/wiki/Technical_analysis#cite_note-8
11. *** http://www.smbtraining.com/blog/technical-analysis-a-little-background-and- history
12. *** "Bollinger Bands – Trademark Details". Justia.com. 2011-12-20.
13. *** Optical Engineering, Volume 45, Issue 8
14. *** http://en.wikipedia.org/wiki/Moving_average#Simple_moving_averageb
15. *** http://lorien.ncl.ac.uk/ming/filter/filewma.htm