

USING R FOR ANALYZING FINANCIAL MARKETS

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Abstract

Financial markets are hard to analyse and almost impossible to predict. The progress in computer technology means also the improvement of the available tools for the analysts to observe the evolution of financial markets. The R software, besides different statistical analysis, offers also the tools to process and analyse the data from these markets, in a free and accessible manner.

Keywords: *financial markets, R, software, financial data, technical indicator.*

1. Introduction

1.1. Introduction

There is a lot of interest in analysing the financial markets. We are not stressing here the advantages of such an analysis. There are a lot of studies that present the importance of anticipating the evolution on these markets. Of course, predicting the evolution is not the easiest type of forecast. For example, when the government of the country where the market is located, announces a new policy measure aimed at deregulating a particularly stifling part of an industry segment, it may have a positive impact on the financial market). Financial market analysts cannot anticipate such factors and therefore the impact of these factors do not come under the main purview of financial market analysis. However, most analysts do set aside some space for the impact of extraneous factors on the market and they do so in equal measure for both positive as well as negative factors.

Financial market analysis has become a highly specialized activity confined to select groups of experts known as technical analysts. In most cases they are professionally trained in financial analysis and are reasonably familiar with the tools used to analyze a particular market. In certain other cases they are economists or veteran investors with a special interest in financial market analysis and market economics. The number of factors that directly or indirectly impact the financial markets are increasing rapidly with more analysts digging deeper into the circumstances that influence financial market behavior. On the other hand, the integration of information technology in market analysis is increasingly meeting the challenge posed by the complexities of financial market analysis.

We start from the need for rigorous analysis of capital markets, individual investors and institutional traders, brokers and other market

participants seek to maximize profits earned from their investments. Obviously, these participants will want to find a way how best to reduce the risk of losing money and improve their chance of getting a return as high. The question of identifying timing to buy or sell a share, to trade a futures contract etc.

These market players will use graphical and analytical tools to identify such moments that changes in supply and demand for financial instruments traded will help in forecasting price and formulate trading strategies.

There are a lot of tools for analysing the financial markets, but in this article we are focusing on the solution offered by the R environment. The advantages of using a free solution are detailed in a former article (Jula N.-M., ECONOMETRIC SOFTWARE - FREE VS. PAID SOLUTIONS, CKS 2014).

2. Using R for Analysing Financial Markets

2.1. Why using R?

Out opinion is that you should use the method that gives you the best result, including the cost/outcome ratio. Why we suggest using R and not other solutions? There are a lot of arguments, regarding the costs, the flexibility, the on-going support. And there are big names that trust this solution, like Microsoft, Google, Twitter, Bank of America, Facebook, just to name a few. (Source: <http://www.revolutionanalytics.com/companies-using-r>).

2.2. R solution

We start with the conclusion: there is not a single solution. There are many ways to import and manipulate financial data. We are presenting here just one of the many possibilities offered by the R environment.

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From the financial analysis packages, we will present the Quantitative Financial Modelling Framework, or *quantmod* package. This is not installed by default in R, and one should install prior to use it (`> install.packages(quantmod)`). As the package creator stipulates, “the *quantmod* package for R is designed to assist the quantitative trader in the development, testing, and deployment of statistically based trading models.” (Jeffrey A. Ryan, <http://www.quantmod.com/>).

To use the functions included in this package, one should import the data first. The software is very versatile, allowing a plethora of sources to be selected for data importing, like Google or Yahoo Finance or even Bloomberg):

- Yahoo! Finance (OHLC data)
 - Federal Reserve Bank of St. Louis FRED® (11,000 economic series)
 - Google Finance (OHLC data)
 - Oanda, The Currency Site (FX and Metals)
 - MySQL databases (Your local data)
 - R binary formats (.RData and .rda)
 - Comma Separated Value files (.csv)
- (source:
<http://www.quantmod.com/examples/intro/>)

For faster and better display and manipulation of the data, we should import the data in some local variables. For importing, the *getSymbols* function should be used:

```
>getSymbols("MSF",src="yahoo")
```

We imported the Microsoft values from Yahoo Finance.

There are a lot of options for displaying the imported data. For example, we can create a bar chart using the following function:

```
> barChart(MSF)
```

And the result is:

Figure 1



Source: Author’s calculations in R, Microsoft value, Yahoo Finance data source.

Other options to display the results are:

```
>candleChart(MSF,multi.col=TRUE,theme="white")
```

Figure 2



Source: Author’s calculations in R, Microsoft value, Yahoo Finance data source.

Capital market analysts use a variety of indicators to confirm or strengthen trading strategies that they have settled on the graphs or based on fundamental analysis. Currently, there are a variety of indicators, having from simple to complex mathematical formulas. We must specify that various indicators may be better suited to different types of MBI. A successful trading strategy should use a combination of indicators, not just an isolated indicator. The evolution of computer techniques has allowed the development of composite indices, with the possibility of using them in real time, with access and power to process large volumes of data.

A technical indicator is a series of data that is obtained by applying a formula (equations) on the price action (currency or other traded goods).

When calculating the index values may be used for any opening, closing, minimum or maximum volume.

Usually indicators are using values from several trading days (usually the number of days is introduced as a parameter). Based on numerical analysis, the used historical data series should be as long as possible for a correct interpretation of the result provided by that indicator.

As a mode of representation, some indicators overlaid the chart displayed price, while others are displayed in a separate chart.

For technical analysis, the TTR package should be loaded. This package allows the access to a wide list of technical indicators, like MACD, Bollinger Bands and so on.

Moving average convergence divergence (MACD) is a 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. (Source: <http://www.investopedia.com/terms/m/macd.asp>)

As an example, we use the Microsoft data for the last 4 months, no volume and white template. On this graph, we add the MACD indicator:

```
>chartSeries(MSF, subset='last 4 months',
TA=NULL, theme="white")
>addMACD()
```

Figure 3



Source: Author's calculations in R, Microsoft value, Yahoo Finance data source.

Other intense used indicator is represented by the Bollinger Bands. Bollinger Bands were created by John Bollinger and combine two indicators, a simple moving average and a standard deviation.

The indicator consists of three lines, a simple moving average (usually 20 periods are used) and two lines obtained by subtracting or adding a number of standard deviations (usually 2) to the simple moving average. Bollinger statistically determined that 85% -95% in the evolution of the quotations analyzed is framed by the two bands.

The use of this indicator:

- narrowing Bollinger bands placed interval occurs due to the decline of the standard deviation. This narrowing (squeeze) precedes a sharp increase in volatility, buying signal being generated when the price breaks the upper band (bullish breakout), while sale signal is when the price strips down the lower line (bearish breakout).

- Bollinger Bands can also be used as a trend indicator, signal being generated, as in the previous case, when the price breaks up the upper band or the lower down. Momentum indicators are used alongside standard Bollinger bands to confirm the generated signals.

- Also, Bollinger Bands indicator can be used as an indicator of reversal, breaking up the top band followed by closure between the strip generates a sell signal, and breaking down the strip below followed by the return within the strip generates a buy signal. Oscillators are used to detect moments suitable for this strategy. Divergences on the oscillators may confirm a reversal scenario.

The indicator for Microsoft share price for the last 12 months is:

```
>chartSeries(MSF, subset='last 12 months',
TA=NULL,theme="white")
>addBBands()
```

Figure 4



Source: Author's calculations in R, Microsoft value, Yahoo Finance data source.

Awesome Oscillator (AO) indicator was created by Bill Williams and is an indicator of momentum, plotted as histograms.

The oscillator is created using the difference between a moving average of 34 periods and a 5 period moving average. Moving averages are calculated using the middle value of a period $(\text{maximum} + \text{minimum}) / 2$.

Each line in the histogram which is taller than the previous one is colored in green. Histogram lines that reach a value lower than the previous line shall be colored in red.

The use of this indicator:

- intersections with the midline: AO generates a trading signal when the zero line is cut. A buy signal is generated when the line is cut from the bottom up. A sell signal occurs when the line is cut from top to bottom.

- a buy signal is generated when the oscillator is above the zero line and two lines of red histogram are followed by one green.

- a sell signal is generated when the oscillator is below the zero line and two green histogram lines are followed by a red line.

- a buy signal occurs when the histogram is located below zero line of the indicator and the last minimum is located at a higher value than the previous one. The histogram must remain below zero between these two requirements. When a minimum at a higher value of the indicator is followed by a green line, a buy signal is generated.

- sell signal occurs when the histogram is located above zero line of the indicator and the last maximum is located at a lower value than the previous maximum. The histogram must remain above zero between these maxims. When the maximum set at a lower value is followed by a red line, it generates a sell signal.

There are some analysts that suggest instead of AO, one should use Ultimate Oscillator, developed by Larry Williams in 1979.

In R, we can call this indicator:

```
>ultimateOscillator(MSF, n = c(7, 14, 28), wts = c(4, 2, 1)),
```

Where :

HLC - Object that is coercible to xts or matrix and contains High-Low-Close prices.

N - a vector of the number of periods to use for each average calculation.

Wts - the weights applied to each average.

Money flow index (MFI)

MFI indicator is a "momentum" indicators that measure the strength of money that "enter" or "exit". It is calculated as the product of volume traded and the typical price for the analyzed period, the price typically defined as the simple median of the high, low and closing price for that interval.

Interpretation:

- Searching for divergence between price developments and the MFI: if prices are in an uptrend when MFI values into a downward, it is possible the trend of prices to change;

- There are two reference levels: values of 20 and 80. If the value exceeds 80, the prices reach new highs, otherwise (drops below 20), the prices are touching new lows.

```
>ultimateOscillator(MSF, n = c(7, 14, 28), wts = c(4, 2, 1))
>addMFI()
```

Figure 5



Source: Author's calculations in R, Microsoft value, Yahoo Finance data source.

Another indicator is Momentum. Momentum indicator is a simple indicator that provides an overview of the movement and it was intensely used for a period of time.

Usage:

- as a trend indicator: buy signal is generated

when the Momentum stops declining and begins to grow. Sell signal is generated when the Momentum stops growing and begins to decline. It is advisable to use an average short-term indicator for these signals. It is also indicated awaiting confirmation of trend change and price movement.

- as a predictive indicator: this approach assumes that a minimum or maximum values are preceded by a strong acceleration in price developments. When the market reaches a peak, indicator will grow stronger and will begin to decline after the divergence to quote that will continue to grow or will stay in a neutral trend.

Calculation method:

It is calculated as the ratio between current price and the price in the previous period N:

$$\text{MOMENTUM} = \frac{\text{CLOSE}(i)}{\text{CLOSE}(i-N)} * 100$$

where

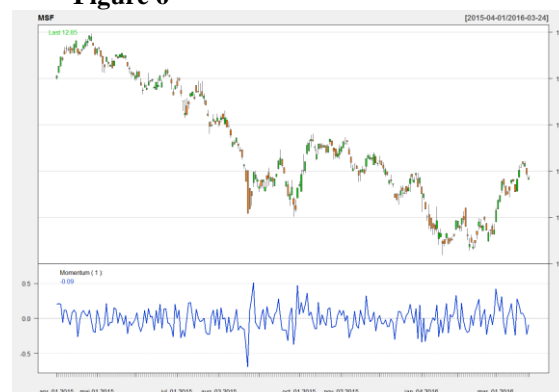
CLOSE (i) - current closing price;

CLOSE (i-N) - the closing price during the previous N.

In R, using quantmod and TTR packages:

```
>addMomentum()
```

Figure 6



Source: Author's calculations in R, Microsoft value, Yahoo Finance data source.

4. Conclusions

There are a lot of software packages to import and analyse financial data. We recommended the R solution as being a totally free and multi-platform option. You can even access R through web interface and there are developers who create PHP support (Ciucu Ș. C., 2014). The on-growing support and the big companies which are using R packages for different data analysis are another proof that the environment is trustworthy and the provided solutions are not only easily accessible, but they may represent the tomorrow's approach in data analysis.

References:

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Annex

R source code for importing and analysing the financial data:

```
#installing Quantitative Financial Modelling Framework package
install.packages(quantmod)
require(quantmod)

#importing Microsoft data from Yahoo! Finance
getSymbols("MSF",src="yahoo")

#displaying last 6 entries
tail(MSF)

#candlestick chart
candleChart(MSF,multi.col=TRUE,theme="white")
chartSeries(MSF ,multi.col=TRUE,theme="white")

#requiring Technical Trading Rules package for technical indicators
require(TTR)

#chart with Microsoft data, last 12 months
chartSeries(MSF, subset='last 12 months', TA=NULL,theme="white")

#MACD
addMACD()

#Bollinger Bands
addBBands()

#Ultimate Oscillator
ultimateOscillator(MSF, n = c(7, 14, 28), wts = c(4, 2, 1))

#Money Flow Index
addMFI()

#Momentum
addMomentum()

Other indicators that can be found in TTR package:

TTR-package      Functions to create Technical Trading Rules (TTR)
%D               Stochastic Oscillator / Stochastic Momentum Index
%K               Stochastic Oscillator / Stochastic Momentum Index
adjRatios        Split and dividend adjustment ratios
adjust           Split and dividend adjustment ratios
```

ADX	Welles Wilder's Directional Movement Index
ALMA	Moving Averages
aroon	Aroon
ATR	True Range / Average True Range
BBands	Bollinger Bands
bollingerBands	Bollinger Bands
CCI	Commodity Channel Index
chaikinAD	Chaikin Accumulation / Distribution
chaikinVolatility	Chaikin Volatility
changes	Rate of Change / Momentum
CLV	Close Location Value
CMF	Chaikin Money Flow
CMO	Chande Momentum Oscillator
DEMA	Moving Averages
DI	Welles Wilder's Directional Movement Index
Donchian	Donchian Channel
DonchianChannel	Donchian Channel
DPO	De-Trended Price Oscillator
DVI	DV Intermediate Oscillator
DX	Welles Wilder's Directional Movement Index
EMA	Moving Averages
EMV	Arms' Ease of Movement Value
EVWMA	Moving Averages
garman.klass	Volatility
GD	Moving Averages
getYahooData	Fetch Internet Data
gk.yz	Volatility
GMMA	Guppy Multiple Moving Averages
growth	Miscellaneous Tools
Guppy	Guppy Multiple Moving Averages
guppy	Guppy Multiple Moving Averages
HMA	Moving Averages
KST	Know Sure Thing
lags	Miscellaneous Tools
MA	Moving Averages
MACD	MACD Oscillator
MFI	Money Flow Index
momentum	Rate of Change / Momentum
moneyFlow	Money Flow Index
MovingAverages	Moving Averages
naCheck	Miscellaneous Tools
OBV	On Balance Volume (OBV)
parkinson	Volatility
PBands	Construct (optionally further smoothed and centered) volatility bands around prices
PercentRank	Percent Rank over a Moving Window
percentRank	Percent Rank over a Moving Window
priceBands	Construct (optionally further smoothed and centered) volatility bands around prices
ROC	Rate of Change / Momentum
rogers.satchell	Volatility
rollFun	Analysis of Running/Rolling/Moving Windows
rollSFM	Analysis of Running/Rolling/Moving Windows
RSI	Relative Strength Index
runCor	Analysis of Running/Rolling/Moving Windows
runCov	Analysis of Running/Rolling/Moving Windows
runFun	Analysis of Running/Rolling/Moving Windows
runMAD	Analysis of Running/Rolling/Moving Windows
runMax	Analysis of Running/Rolling/Moving Windows
runMean	Analysis of Running/Rolling/Moving Windows
runMedian	Analysis of Running/Rolling/Moving Windows
runMin	Analysis of Running/Rolling/Moving Windows
runPercentRank	Percent Rank over a Moving Window
runSD	Analysis of Running/Rolling/Moving Windows
runSum	Analysis of Running/Rolling/Moving Windows
runVar	Analysis of Running/Rolling/Moving Windows
SAR	Parabolic Stop-and-Reverse
SMA	Moving Averages

<i>SMI</i>	<i>Stochastic Oscillator / Stochastic Momentum Index</i>
<i>stoch</i>	<i>Stochastic Oscillator / Stochastic Momentum Index</i>
<i>stochastic</i>	<i>Stochastic Oscillator / Stochastic Momentum Index</i>
<i>stochastics</i>	<i>Stochastic Oscillator / Stochastic Momentum Index</i>
<i>stockSymbols</i>	<i>Fetch Internet Data</i>
<i>T3</i>	<i>Moving Averages</i>
<i>TDI</i>	<i>Trend Detection Index</i>
<i>TR</i>	<i>True Range / Average True Range</i>
<i>TRIX</i>	<i>Triple Smoothed Exponential Oscillator</i>
<i>TTR</i>	<i>Functions to create Technical Trading Rules (TTR)</i>
<i>ttrc</i>	<i>Technical Trading Rule Composite data</i>
<i>ultimateOscillator</i>	<i>The Ultimate Oscillator</i>
<i>VHF</i>	<i>Vertical Horizontal Filter</i>
<i>VMA</i>	<i>Moving Averages</i>
<i>volatility</i>	<i>Volatility</i>
<i>VWAP</i>	<i>Moving Averages</i>
<i>VWMA</i>	<i>Moving Averages</i>
<i>WebData</i>	<i>Fetch Internet Data</i>
<i>wilderSum</i>	<i>Analysis of Running/Rolling/Moving Windows</i>
<i>williamsAD</i>	<i>Williams Accumulation / Distribution</i>
<i>WMA</i>	<i>Moving Averages</i>
<i>WPR</i>	<i>William's %R</i>
<i>yang.zhang</i>	<i>Volatility</i>
<i>ZigZag</i>	<i>Zig Zag</i>
<i>zigzag</i>	<i>Zig Zag</i>
<i>ZLEMA</i>	<i>Moving Averages</i>