Computing Returns

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download resources

- PETR4.SA.csv file
- index.Rmd source file

loading time series into data.frame

```
petr4.df = read.csv(file = "data/PETR4.SA.csv", header = TRUE, stringsAsFactors = FALSE)
class(petr4.df)
```

```
## [1] "data.frame"
```

```
str(petr4.df)
```

```
## 'data.frame':    142 obs. of  7 variables:
##  $ Date     : chr  "2001-01-03" "2001-02-01" "2001-03-01" "2001-04-02" ...
##  $ Open     : num  5.89 6.81 6.87 5.62 6.75 7.47 6.74 6.78 6.84 6.35 ...
##  $ High     : num  7.04 7.35 7.22 6.82 7.56 7.86 6.85 7.12 7.38 6.91 ...
##  $ Low      : num  5.82 6.62 5.7 5.57 6.62 6.49 6.25 6.43 6 6.01 ...
##  $ Close    : num  6.81 6.86 5.87 6.68 7.47 6.75 6.78 6.88 6.41 6.49 ...
##  $ Volume   : int  41736900 30358200 37962600 34395000 27670200 30358800 38772600 28004400 40997500
##  $ Adj.Close: num  0.69 0.69 0.59 0.67 0.75 0.68 0.68 0.69 0.65 0.66 ...
```

data.frame head

```
head(petr4.df)
```

```
##         Date Open High  Low Close   Volume Adj.Close
## 1 2001-01-03 5.89 7.04 5.82  6.81 41736900      0.69
## 2 2001-02-01 6.81 7.35 6.62  6.86 30358200      0.69
## 3 2001-03-01 6.87 7.22 5.70  5.87 37962600      0.59
## 4 2001-04-02 5.62 6.82 5.57  6.68 34395000      0.67
## 5 2001-05-03 6.75 7.56 6.62  7.47 27670200      0.75
## 6 2001-06-01 7.47 7.86 6.49  6.75 30358800      0.68
```

data.frame `tail`

```
tail(petr4.df)
```

```
##           Date  Open  High   Low Close   Volume Adj.Close
## 137 2012-05-02 21.26 22.25 18.08 19.13 27983000     19.13
## 138 2012-06-01 18.53 20.15 17.42 18.25 30203300     18.25
## 139 2012-07-02 18.10 20.31 17.97 19.50 26911600     19.50
## 140 2012-08-01 19.50 21.88 18.83 20.75 25709700     20.75
## 141 2012-09-03 20.77 23.84 20.28 22.37 23399800     22.37
## 142 2012-10-01 22.33 23.10 22.02 22.25 21491800     22.25
```

data.frame properties

```
colnames(petr4.df)
```

```
## [1] "Date"      "Open"      "High"      "Low"       "Close"     "Volume"
## [7] "Adj.Close"
```

```
class(petr4.df$Date)
```

```
## [1] "character"
```

```
class(petr4.df$Adj.Close)
```

```
## [1] "numeric"
```

indexing data.frame - always returns a vector

```
petr4.df[1:5, "Adj.Close"]  # using column name
```

```
## [1] 0.69 0.69 0.59 0.67 0.75
```

```
petr4.df[1:5, 7]  # using column index
```

```
## [1] 0.69 0.69 0.59 0.67 0.75
```

```
petr4.df$Adj.Close[1:5]  # using attribite reffering to column
```

```
## [1] 0.69 0.69 0.59 0.67 0.75
```

`drop=FALSE` keeps data.frame structure

```
petr4.df[1:5, "Adj.Close", drop = FALSE]
```

```
##   Adj.Close
## 1      0.69
## 2      0.69
## 3      0.59
## 4      0.67
## 5      0.75
```

extracting data.frame subsets isn't easy

```
c(which(petr4.df$Date == "2010-01-04"), which(petr4.df == "2010-07-01"))
```

```
## [1] 109 115
```

```
petr4.df[which(petr4.df == "2010-01-04"):which(petr4.df == "2010-07-01"), ]
```

```
##           Date  Open  High   Low Close   Volume Adj.Close
## 109 2010-01-04 36.95 37.50 33.51 34.17 19068700     33.45
## 110 2010-02-01 34.29 34.89 30.72 34.61 19589300     33.88
## 111 2010-03-01 34.82 37.48 34.12 35.39 21152500     34.64
## 112 2010-04-01 35.66 36.41 31.90 32.80 20999100     32.11
## 113 2010-05-03 32.55 32.63 26.00 29.60 23845800     29.16
## 114 2010-06-01 29.00 30.38 26.71 26.86 17958000     26.46
## 115 2010-07-01 27.11 28.28 26.31 27.85 12439600     27.43
```

defining rownames

```
petr4Prices.df = petr4.df[, "Adj.Close", drop = FALSE]
rownames(petr4Prices.df) = petr4.df$Date
head(petr4Prices.df)
```

```
##            Adj.Close
## 2001-01-03      0.69
## 2001-02-01      0.69
## 2001-03-01      0.59
## 2001-04-02      0.67
## 2001-05-03      0.75
## 2001-06-01      0.68
```

indexing by rownames

```
petr4Prices.df["2010-01-04", 1]
```

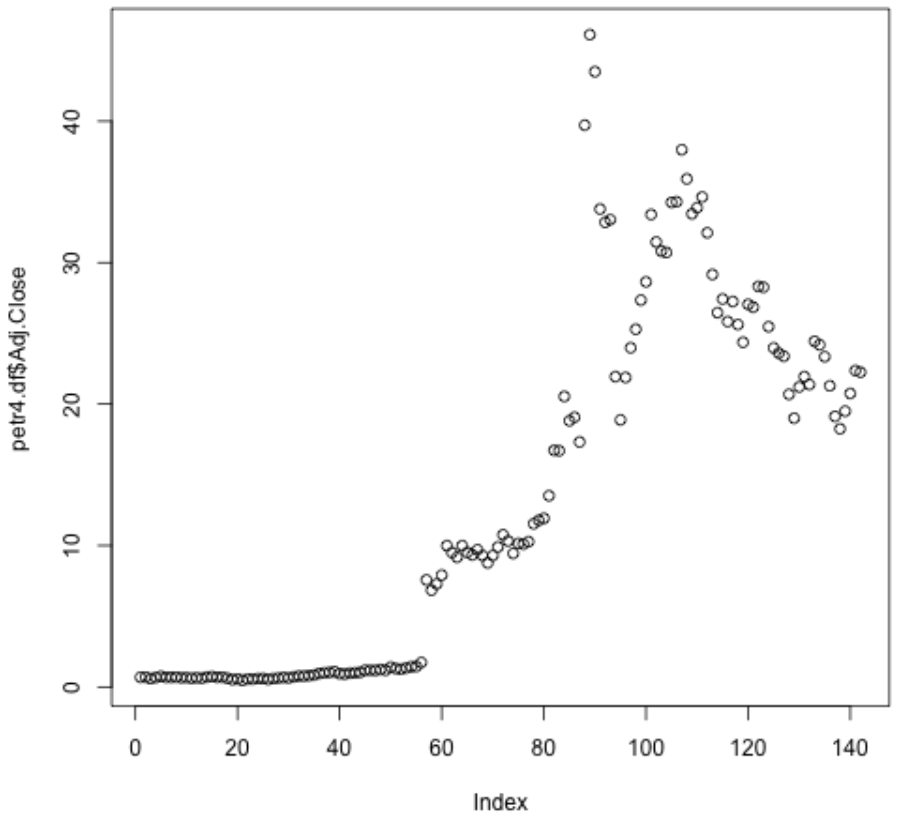
```
## [1] 33.45
```

```
petr4Prices.df["2010-01-04", 1, drop = FALSE]
```

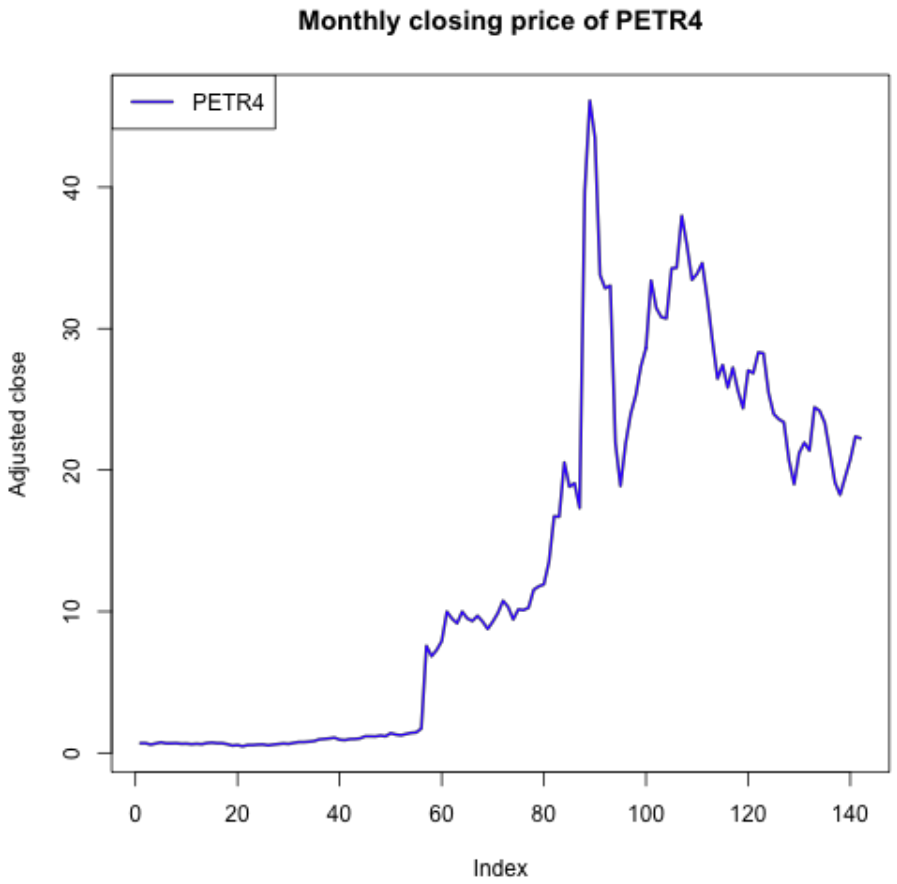
```
##            Adj.Close
## 2010-01-04     33.45
```

plotting data

```
plot(petr4.df$Adj.Close)
```



```
plot(petr4.df$Adj.Close, type = "l", col = "blue", lwd = 2, ylab = "Adjusted close",
    main = "Monthly closing price of PETR4")
legend(x = "topleft", legend = "PETR4", lty = 1, lwd = 2, col = "blue")
```



simple returns

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

```
n = nrow(petr4Prices.df)  # number of rows
petr4.ret = (petr4Prices.df[2:n, 1] - petr4Prices.df[1:(n - 1), 1])/petr4Prices.df[1:(n -
    1), 1]
head(petr4.ret)
```

```
## [1]  0.00000 -0.14493  0.13559  0.11940 -0.09333  0.00000
```

`petr4.ret` is not a data.frame object

```
class(petr4.ret)
```

```
## [1] "numeric"
```

```
names(petr4.ret) = rownames(petr4Prices.df)[2:n]  # adding names to a vector
head(petr4.ret)
```

```
## 2001-02-01 2001-03-01 2001-04-02 2001-05-03 2001-06-01 2001-07-02
##    0.00000   -0.14493    0.13559    0.11940   -0.09333    0.00000
```

simple returns as data.frame objects - use `drop=FALSE`

```
petr4.ret.df = (petr4Prices.df[2:n, 1, drop = FALSE] - petr4Prices.df[1:(n - 1),
    1, drop = FALSE])/petr4Prices.df[1:(n - 1), 1, drop = FALSE]
head(petr4.ret.df)
```

```
##            Adj.Close
## 2001-02-01   0.00000
## 2001-03-01  -0.14493
## 2001-04-02   0.13559
## 2001-05-03   0.11940
## 2001-06-01  -0.09333
## 2001-07-02   0.00000
```

continuously compounded returns

$$r_t = \log(1 + R_t) = \log\left(\frac{P_t}{P_{t-1}}\right)$$

easy way

```
petr4.ccret = log(1 + petr4.ret)
head(petr4.ccret)
```

```
## 2001-02-01 2001-03-01 2001-04-02 2001-05-03 2001-06-01 2001-07-02
##    0.00000   -0.15657    0.12716    0.11280   -0.09798    0.00000
```

alternatively

```
petr4.ccret = log(petr4Prices.df[2:n, 1]) - log(petr4Prices.df[1:(n - 1), 1])
names(petr4.ccret) = rownames(petr4Prices.df)[2:n]
head(petr4.ccret)
```

```
## 2001-02-01 2001-03-01 2001-04-02 2001-05-03 2001-06-01 2001-07-02
##    0.00000   -0.15657    0.12716    0.11280   -0.09798    0.00000
```

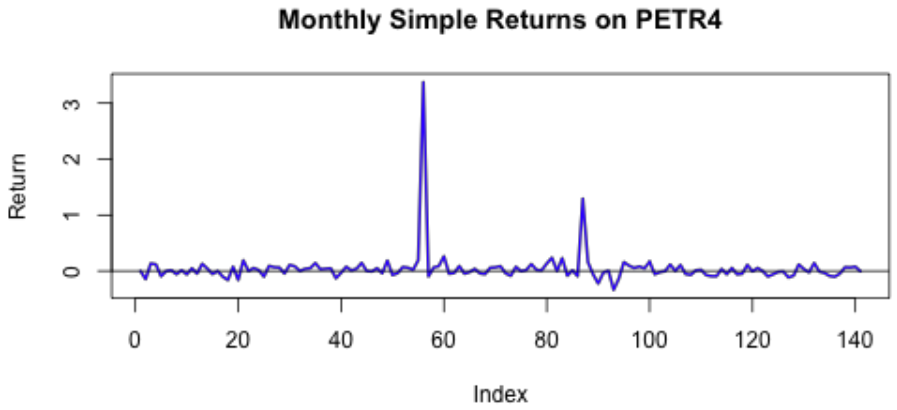
comparing returns

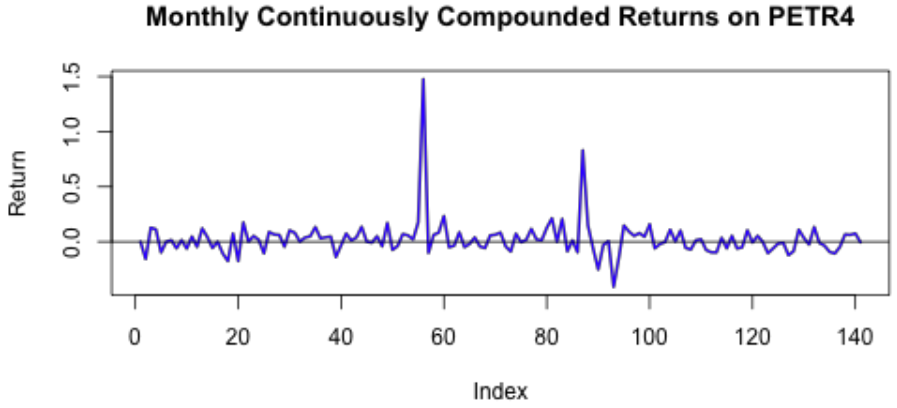
```
head(cbind(petr4.ret, petr4.ccret))
```

```
##            petr4.ret petr4.ccret
## 2001-02-01   0.00000     0.00000
## 2001-03-01  -0.14493    -0.15657
## 2001-04-02   0.13559     0.12716
## 2001-05-03   0.11940     0.11280
## 2001-06-01  -0.09333    -0.09798
## 2001-07-02   0.00000     0.00000
```

plotting simple and continuous returns

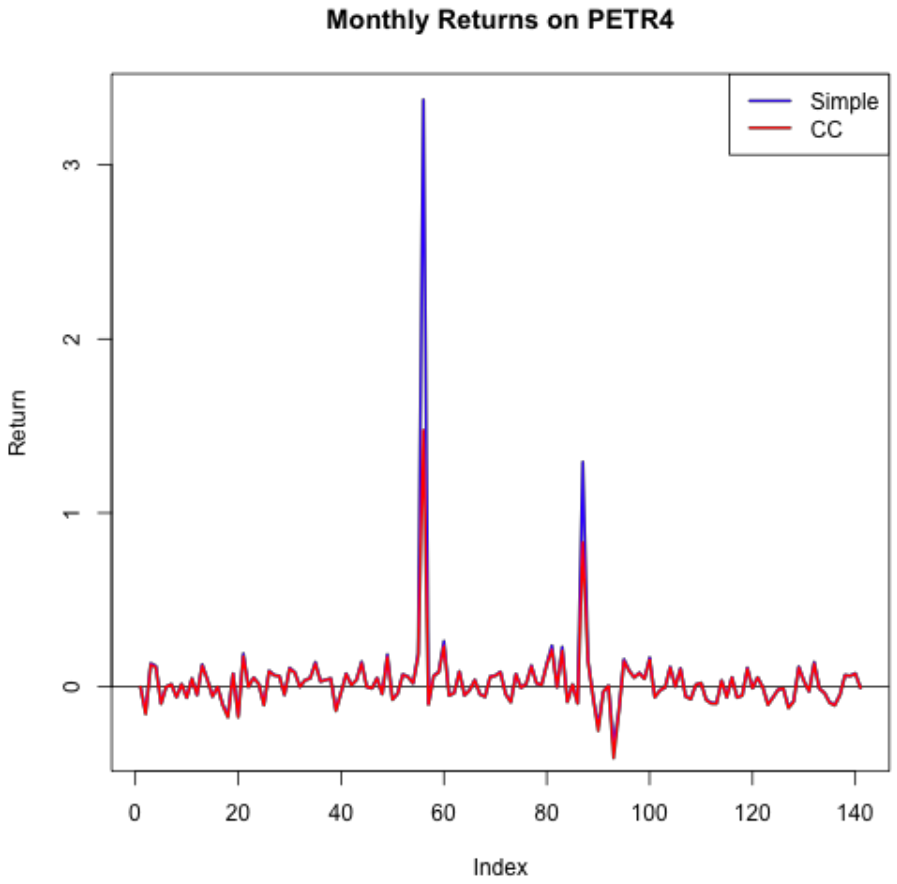
```
par(mfrow = c(2, 1))  # split screen into 2 rows and 1 column
plot(petr4.ret, main = "Monthly Simple Returns on PETR4", ylab = "Return", type = "l",
    col = "blue", lwd = 2)
abline(h = 0)
plot(petr4.ccret, main = "Monthly Continuously Compounded Returns on PETR4", ylab = "Return",
    type = "l", col = "blue", lwd = 2)
abline(h = 0)
par(mfrow = c(1, 1))  # reset the screen to 1 row and 1 column
```


Monthly Simple Returns on PETR4
Return
0
1
2
3
0
20
40
60
80
100
120
140
Index

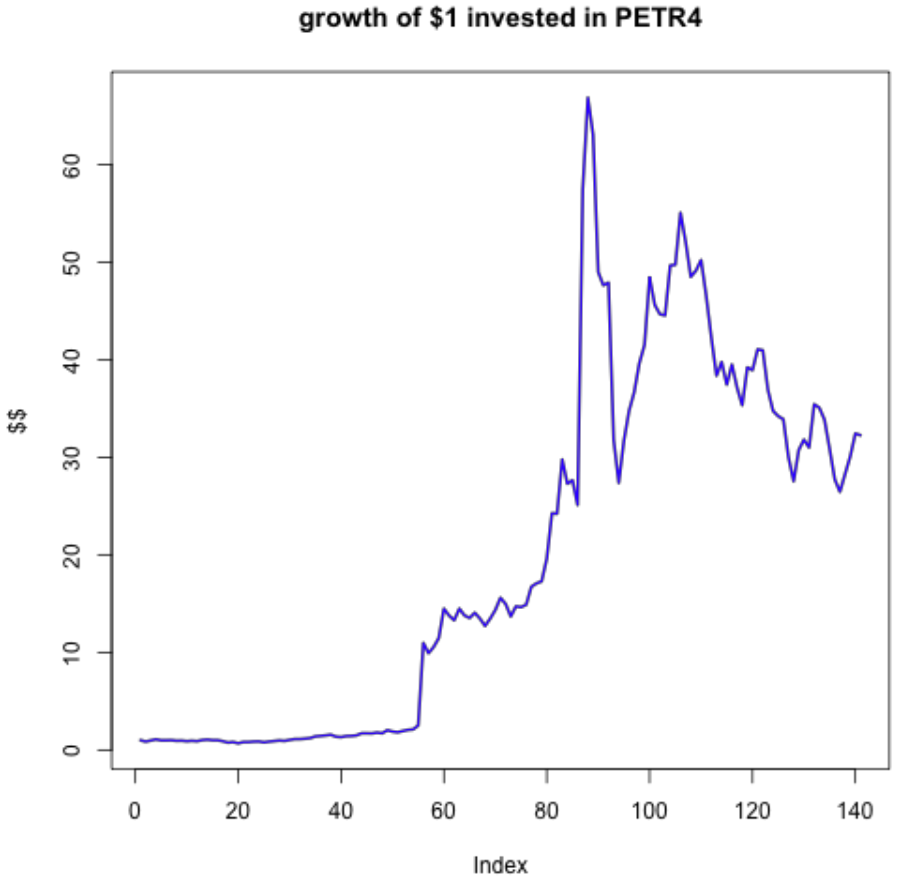

Monthly Continuously Compounded Returns on PETR4
Return
0.0
0.5
1.0
1.5
0
20
40
60
80
100
120
140
Index

on the same graph

```
plot(petr4.ret, main = "Monthly Returns on PETR4", ylab = "Return", type = "l", col = "blue",
    lwd = 2)
abline(h = 0)
lines(petr4.ccret, col = "red", lwd = 2)
legend(x = "topright", legend = c("Simple", "CC"), lty = 1, lwd = 2, col = c("blue",
    "red"))
```


Monthly Returns on PETR4
Simple
CC
Return
Index
0
1
2
3
0
20
40
60
80
100
120
140

```
petr4.gret = 1 + petr4.ret  # compute gross returns
petr4.fv = cumprod(petr4.gret)  # compute future values
plot(petr4.fv, type = "l", col = "blue", lwd = 2, ylab = "$$", main = "growth of $1 invested in PETR4")
```



could life be easier?

R has a large number of packages that make life easier.

- PerformanceAnalytics: Econometric tools for performance and risk analysis
- quantmod: functions for quantitative modelling in finance
- zoo: Z's ordered observations
- xts: Extensible time series
- tseries: Time series analysis and computational finance
- fPortfolio: Portfolio Selection and Optimization
- mvtnorm: Multivariate normal and multivariate t distribution

CRAN

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Download and Install R

Precompiled binary distributions of the base system and contributed packages, **Windows and Mac** users most likely want one of these versions of R:

- Download R for Linux
- Download R for MacOS X
- Download R for Windows

R is part of many Linux distributions, you should check with your Linux package management system in addition to the link above.

Source Code for all Platforms

Windows and Mac users most likely want to download the precompiled binaries listed in the upper box, not the source code. The sources have to be compiled before you can use them. If you do not know what this means, you probably do not want to do it!

- The latest release (2012-10-26, Trick or Treat): R-2.15.2.tar.gz, read what's new in the latest version.
- Sources of R alpha and beta releases (daily snapshots, created only in time periods before a planned release).
- Daily snapshots of current patched and development versions are available here. Please read about new features and bug fixes before filing corresponding feature requests or bug reports.
- Source code of older versions of R is available here

CRAN Task Views

CRAN Task Views

Bayesian	Bayesian Inference
ChemPhys	Chemometrics and Computational Physics
ClinicalTrials	Clinical Trial Design, Monitoring, and Analysis
Cluster	Cluster Analysis & Finite Mixture Models
DifferentialEquations	Differential Equations
Distributions	Probability Distributions
Econometrics	Computational Econometrics
Environmetrics	Analysis of Ecological and Environmental Data
ExperimentalDesign	Design of Experiments (DoE) & Analysis of Experimental Data
Finance	Empirical Finance
Genetics	Statistical Genetics
Graphics	Graphic Displays & Dynamic Graphics & Graphic Devices & Visualization
HighPerformanceComputing	High-Performance and Parallel Computing with R
MachineLearning	Machine Learning & Statistical Learning
MedicalImaging	Medical Image Analysis
Multivariate	Multivariate Statistics
NaturalLanguageProcessing	Natural Language Processing
OfficialStatistics	Official Statistics & Survey Methodology
Optimization	Optimization and Mathematical Programming
Pharmacokinetics	Analysis of Pharmacokinetic Data
Phylogenetics	Phylogenetics, Especially Comparative Methods
Psychometrics	Psychometric Models and Methods

Finance Task View

CRAN Task View: Empirical Finance

Maintainer: Dirk Eddelbuettel
Contact: Dirk.Eddelbuettel at R-project.org
Version: 2012-12-15

This CRAN Task View contains a list of packages useful for empirical work in Finance, grouped by topic.

Besides these packages, a very wide variety of functions suitable for empirical work in Finance is provided by both the basic R system (and its set of recommended core packages), and a number of other packages on the Comprehensive R Archive Network (CRAN). Consequently, several of the other CRAN Task Views may contain suitable packages, in particular the Econometrics, Multivariate, Optimization, Robust, SocialSciences and TimeSeries Task Views.

Please send suggestions for additions and extensions for this task view to the task view maintainer .

Standard regression models

- A detailed overview of the available regression methodologies is provided by the Econometrics task view. This is complemented by the Robust which focuses on more robust and resistant methods.
- Linear models such as ordinary least squares (OLS) can be estimated by `lm()` (from by the stats package contained in the basic R distribution). Maximum Likelihood (ML) estimation can be undertaken with the standard `optim()` function. Many other suitable methods are listed in the Optimization view. Non-linear least squares can be estimated with the `nls()` function, as well as with `nlme()` from the nlme package.
- For the linear model, a variety of regression diagnostic tests are provided by the car, lmtest, strucchange, urca, and sandwich packages. The Rcmdr and Zelig packages provide user interfaces that may be of interest as well.

Time series

- A detailed overview of tools for time series analysis can be found in the TimeSeries task view. Below a brief overview of the most important methods in finance is given.

PerformanceAnalytics package

```
library(PerformanceAnalytics)
```

```
## Loading required package: zoo
```

```
## Attaching package: 'zoo'
```

```
## The following object(s) are masked from 'package:base':
##
## as.Date, as.Date.numeric
```

```
## Loading required package: xts
```

```
## Attaching package: 'PerformanceAnalytics'
```

```
## The following object(s) are masked from 'package:graphics':
```

```
dates.petr4 = as.yearmon(petr4.df$Date, format = "%Y-%m-%d")  # convert to month-year
head(dates.petr4)
```

```
## [1] "Jan 2001" "Feb 2001" "Mar 2001" "Apr 2001" "May 2001" "Jun 2001"
```

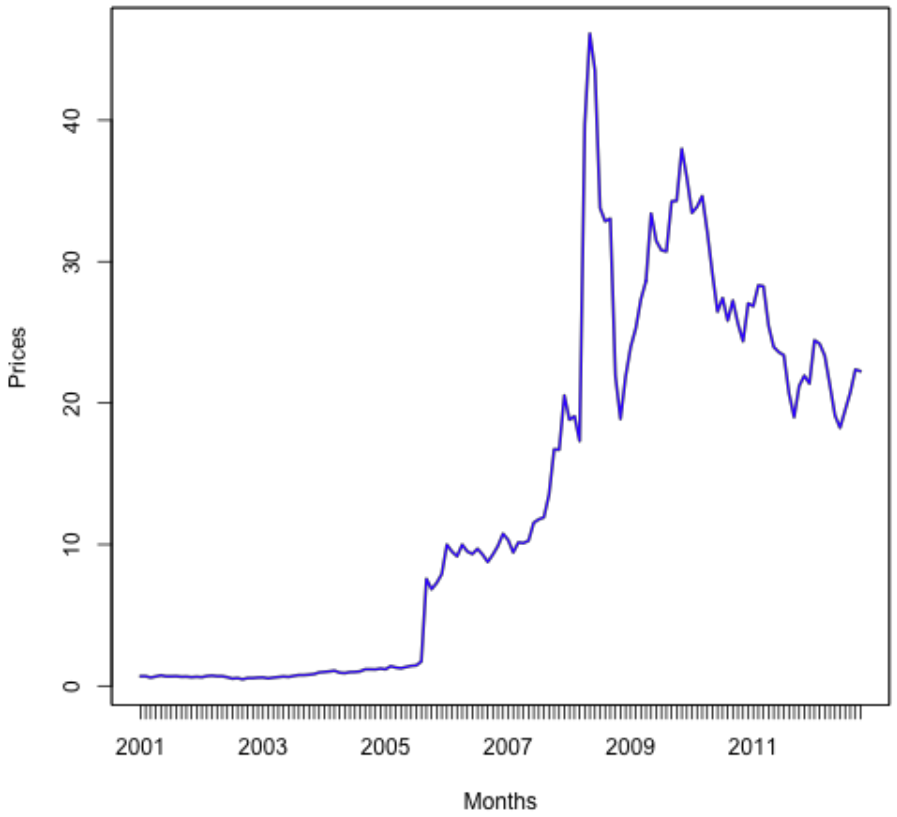
```
petr4.z = zoo(x = petr4.df$Adj.Close, order.by = dates.petr4)  # create zoo object
class(petr4.z)
```

```
## [1] "zoo"
```

```
head(petr4.z)
```

```
## Jan 2001 Feb 2001 Mar 2001 Apr 2001 May 2001 Jun 2001
##     0.69     0.69     0.59     0.67     0.75     0.68
```

```
plot(petr4.z, lwd = 2, col = "blue", ylab = "Prices", xlab = "Months")
```



subsetting zoo objects

```
petr4.z[as.yearmon(c("Jan 2010", "Jan 2011"))]
```

```
## Jan 2010 Jan 2011
##    33.45    26.85
```

```
window(petr4.z, start = as.yearmon("Jan 2010"), end = as.yearmon("Jan 2011"))
```

```
## Jan 2010 Feb 2010 Mar 2010 Apr 2010 May 2010 Jun 2010 Jul 2010 Aug 2010
##    33.45    33.88    34.64    32.11    29.16    26.46    27.43    25.83
## Sep 2010 Oct 2010 Nov 2010 Dec 2010 Jan 2011
##    27.25    25.62    24.37    27.05    26.85
```

computing returns made simple

core (no-package dependency)

```
petr4Ret.z = diff(petr4.z)/lag(petr4.z, k = -1)
petr4Retcc.z = diff(log(petr4.z))
head(merge(petr4Ret.z, petr4Retcc.z))
```

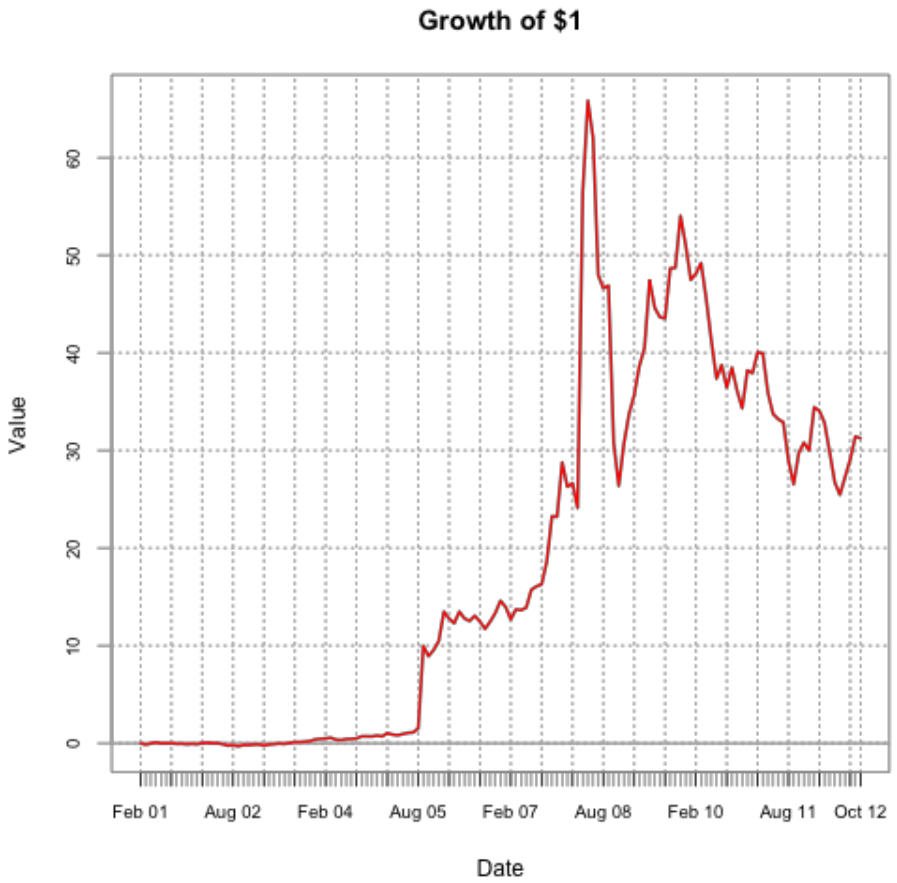
```
##          petr4Ret.z petr4Retcc.z
## Feb 2001    0.00000      0.00000
## Mar 2001   -0.14493     -0.15657
## Apr 2001    0.13559      0.12716
## May 2001    0.11940      0.11280
## Jun 2001   -0.09333     -0.09798
## Jul 2001    0.00000      0.00000
```

with PerformanceAnalytics functions

```
petr4Ret.z = CalculateReturns(petr4.z, method = "simple")
petr4Retcc.z = CalculateReturns(petr4.z, method = "compound")
head(merge(petr4Ret.z, petr4Retcc.z))
```

```
##          e1 petr4Retcc.z
## Jan 2001  0           NA
## Feb 2001  0      0.00000
## Mar 2001  0     -0.15657
## Apr 2001  0      0.12716
## May 2001  0      0.11280
## Jun 2001  0     -0.09798
```

```
chart.CumReturns(petr4Ret.z, lwd = 2, col = "red", main = "Growth of $1")
```



quantmod package

```
library(quantmod)
```

```
## Loading required package: Defaults
```

```
## Loading required package: TTR
```

```
## Loading required package: methods
```

```
getSymbols("YHOO")  # fetching time series as xts object
```

```
## [1] "YHOO"
```

```
class(YHOO)
```

```
## [1] "xts" "zoo"
```

```
colnames(YHOO)
```

```
## [1] "YHOO.Open"     "YHOO.High"     "YHOO.Low"      "YHOO.Close"
## [5] "YHOO.Volume"   "YHOO.Adjusted"
```

```
start(YHOO)  # first date
```

```
## [1] "2007-01-03"
```

```
end(YHOO)  # last date
```

```
## [1] "2012-12-20"
```

```
head(YHOO)
```

```
##            YHOO.Open YHOO.High YHOO.Low YHOO.Close YHOO.Volume YHOO.Adjusted
## 2007-01-03     25.85     26.26    25.26      25.61    26352700         25.61
## 2007-01-04     25.64     26.92    25.52      26.85    32512200         26.85
## 2007-01-05     26.70     27.87    26.66      27.74    64264600         27.74
## 2007-01-08     27.70     28.04    27.43      27.92    25713700         27.92
## 2007-01-09     28.00     28.05    27.41      27.58    25621500         27.58
## 2007-01-10     27.48     28.92    27.44      28.70    40240000         28.70
```

```
chartSeries(YHOO, theme = chartTheme("white"))
```

Computing Returns

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