Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Computational Finance and Financial Engineering: The R/Rmetrics Software Environment

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useR! 2008

What is Rmetrics ?

… Open Source Software Development for Statistical and Financial Computing

Rmetrics
is a system of R packages for computational finance and financial engineering.
It is based on the R language and the R run-time environment.

Rmetrics
is designed as an

Open Source Environment and as a

Rapid Model Prototyping System for

Teaching "Computational Finance and Financial Engineering".

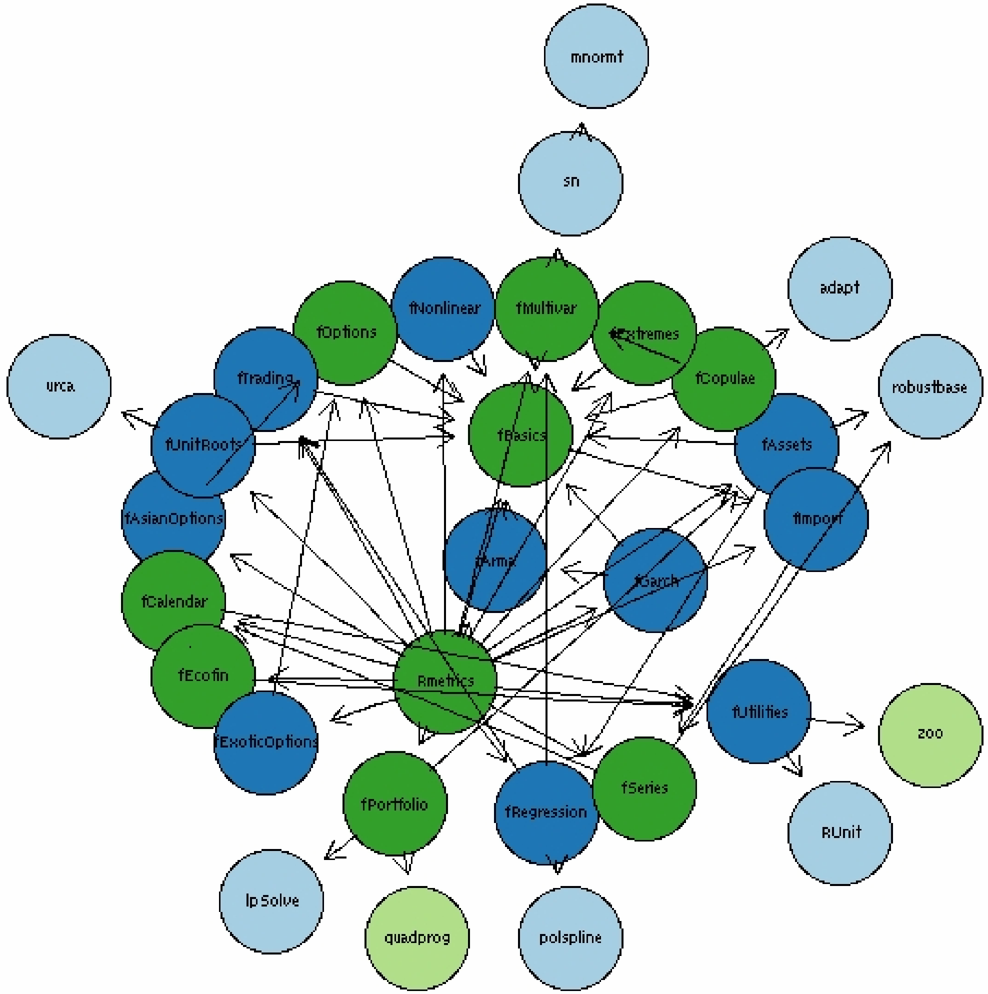
Which Packages are Coming with Rmetrics ?

… 20 R Packages, 1’600 R Functions, 80’000 lines of R Code

Rmetrics
- fUtilities
- fEcofin
- fCalendar / timeDate
- fSeries / timeSeries
- fImport
- fBasics
- fArma
- fGarch
- fNonlinear
- fUnitRoots
- fTrading
- fMultivar
- fRegression
- fExtremes
- fCopulae
- fOptions
- fExoticOptions
- fAsianOptions
- fAssets
- fPortfolio

Rmetrics Package Graph by Dirk Eddelbuettel

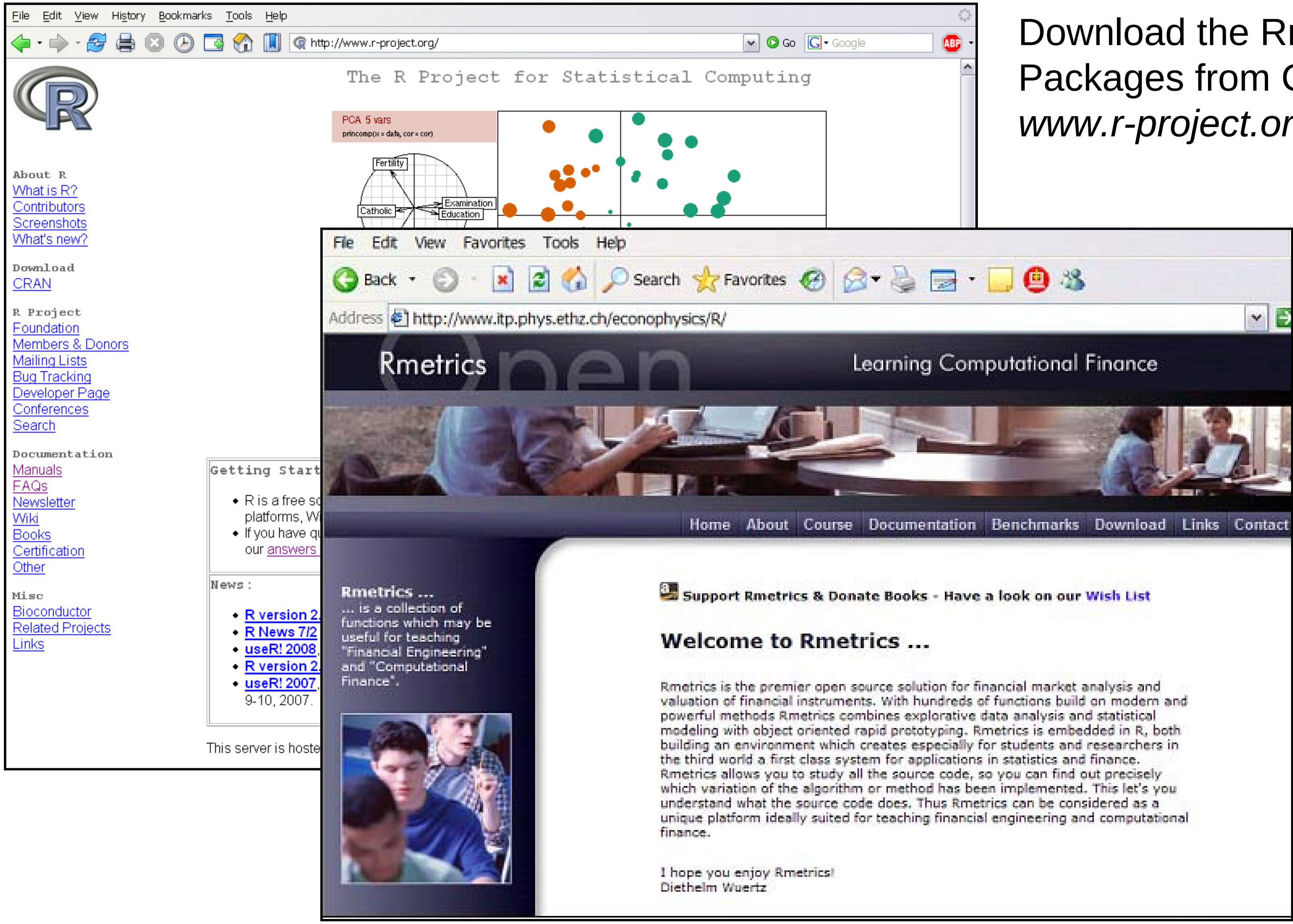
Rmetrics Package Graph as of release 260.72



New packages are shown in green, and existing packages in blue. The corresponding non-Rmetrics packages are shown in a lighter tone

From where I can get Information on R / Rmetrics ?

… visit the CRAN and Rmetrics Servers

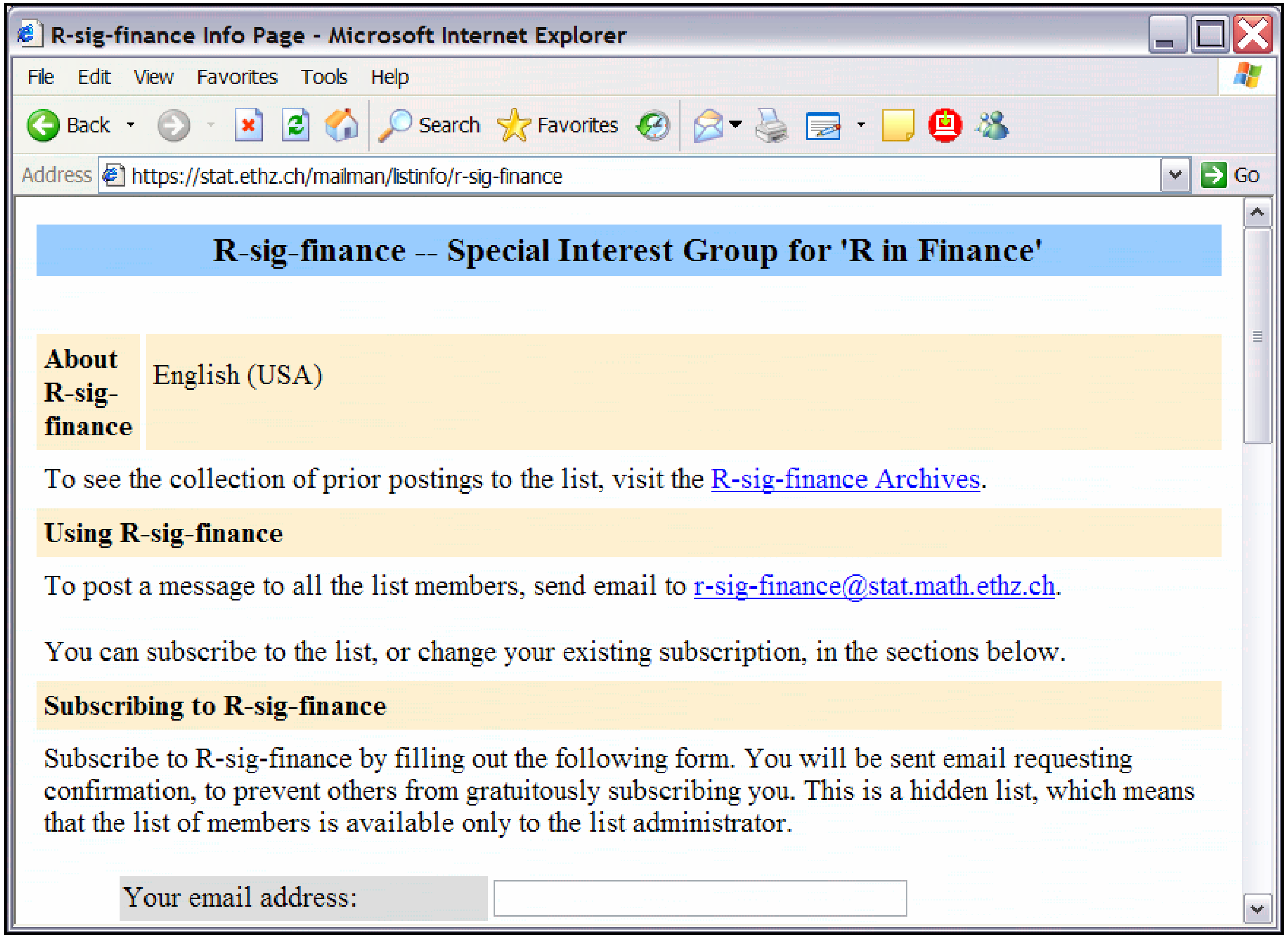


Download the Rmetrics Packages from CERAN
www.r-project.org

Visit the home of **Rmetrics**:
www.rmetrics.org

Where I can get help for R/Rmetrics' Financial Applications ?

… join the R-sig-finance – Special Interest Group for 'R in Finance'



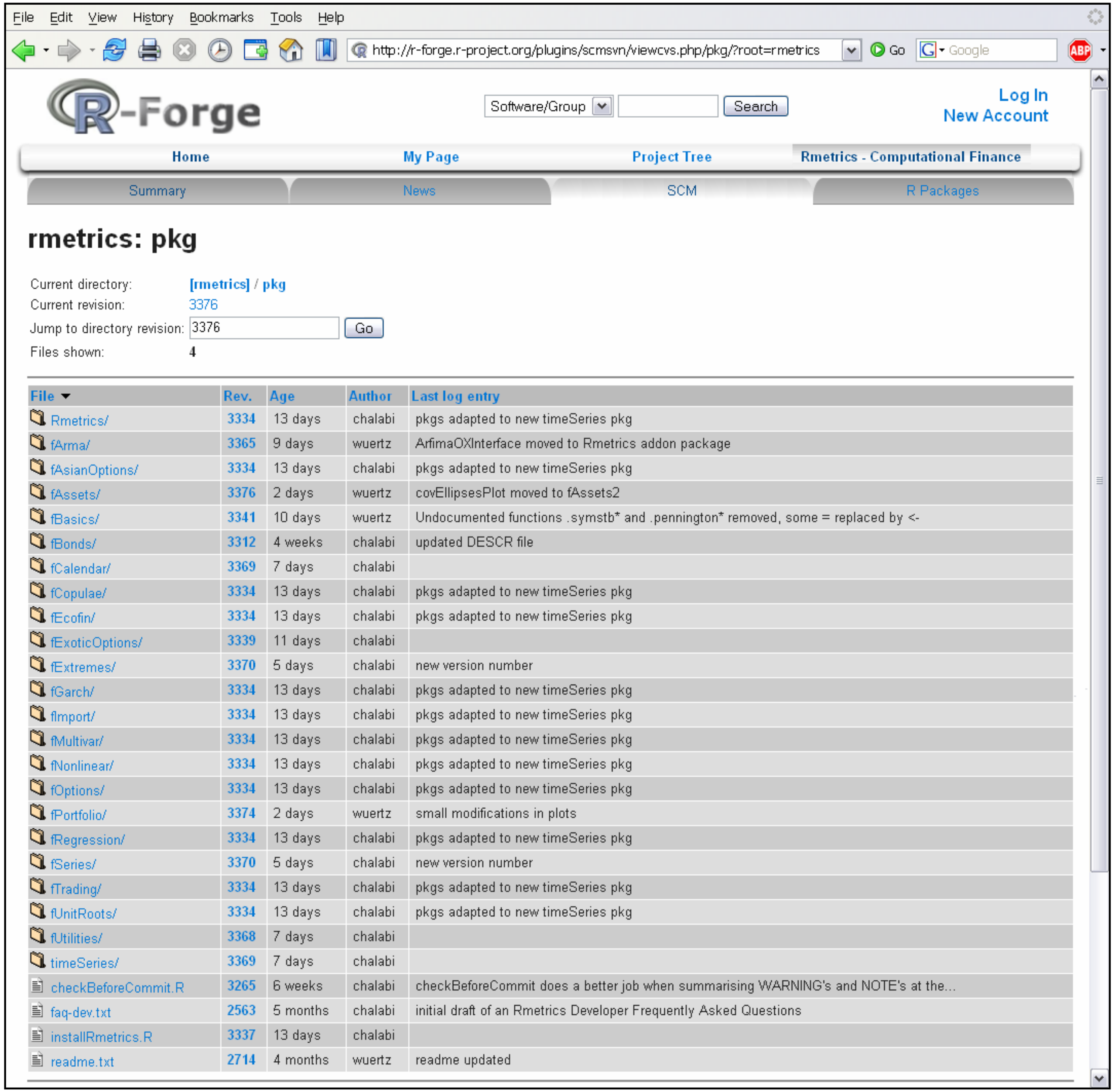
Where to discuss and find help on **R/Rmetrics** ?

https://stat.ethz.ch/mailman/listinfo/r-sig-finance

Thanks to Martin Mächler

The most recent Rmetrics ?

… get it from the R-forge Server



File Edit View History Bookmarks Tools Help

http://r-forge.r-project.org/plugins/scmsvn/viewcvs.php/pkg/?root=rmetrics

R-Forge

Software/Group Search

Log In
New Account

Home | My Page | Project Tree | Rmetrics - Computational Finance

Summary | News | SCM | R Packages

rmetrics: pkg

Current directory: [rmetrics] / pkg
Current revision: 3376
Jump to directory revision: 3376 Go
Files shown: 4

File	Rev.	Age	Author	Last log entry
Rmetrics/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fArma/	3365	9 days	wuertz	ArfimaOXInterface moved to Rmetrics addon package
fAsianOptions/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fAssets/	3376	2 days	wuertz	covEllipsesPlot moved to fAssets2
fBasics/	3341	10 days	wuertz	Undocumented functions .symstb* and .pennington* removed, some = replaced by <-
fBonds/	3312	4 weeks	chalabi	updated DESCR file
fCalendar/	3369	7 days	chalabi	
fCopulae/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fEcofin/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fExoticOptions/	3339	11 days	chalabi	
fExtremes/	3370	5 days	chalabi	new version number
fGarch/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fImport/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fMultivar/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fNonlinear/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fOptions/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fPortfolio/	3374	2 days	wuertz	small modifications in plots
fRegression/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fSeries/	3370	5 days	chalabi	new version number
fTrading/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fUnitRoots/	3334	13 days	chalabi	pkgs adapted to new timeSeries pkg
fUtilities/	3368	7 days	chalabi	
timeSeries/	3369	7 days	chalabi	
checkBeforeCommit.R	3265	6 weeks	chalabi	checkBeforeCommit does a better job when summarising WARNING's and NOTE's at the...
faq-dev.txt	2563	5 months	chalabi	initial draft of an Rmetrics Developer Frequently Asked Questions
installRmetrics.R	3337	13 days	chalabi	
readme.txt	2714	4 months	wuertz	readme updated

Where to get the most recent versions of the **Rmetrics** Packages?

Goto to the SVN repository of **Rmetrics**, part of

https://r-forge.r-project.org

Thanks to Kurt Hornik,Stefan Theussl for R-forge, and Martin Mächler and Yohan Chalabi for the move to R-forge

Next Workshop
June 28th – July 2nd 2009

Organization:
Swiss Rmetrics Foundation
Co-Organizers:
Swiss Federal Institute of Technology, Zurich, University of Economics and Business Administration, Vienna, University of Auckland

Conference Chairs:
Diethelm Würtz, ETH Zurich
Kurt Hornik, University of Vienna
David J. Scott, University of Auckland

Topics:
Econometrics, Finance and Insurance
Financial Time Series, Volatility Forecasts
Trading and Decision Making Systems
Portfolio Selection and Optimization
Valuation of Financial Derivatives
Extreme Value Theory and Copulae
FX High Frequency, Time&Sales Data
Monte Carlo Simulation and Pricing
Robust Statistics in Finance

Important Dates:
Registration starts on February 1st, 2008
Paper Submission ends on May 31st 2008

www.rmetrics.org
The workshop is limited to 60 participants


View from Meielisalp on Lake Thune

Second R/Rmetrics User and Developer Workshop
June 29th – July 3rd, 2008, Meielisalp, Lake Thune, Switzerland

The workshop focuses on ...

* using R/Rmetrics as the premier open source solution for financial market analysis, valuation of financial instruments, and insurance tasks,
* providing a platform for R/Rmetrics users to discuss and exchange ideas how R and Rmetrics can be used to do computations, data analysis, and visualization in finance and insurance,
* giving an overview of the new features of the rapidly evolving R/Rmetrics project.

The program consists of ...

* presentations of new R/Rmetrics directions and developments through keynote lectures,
* user-contributed presentations reflecting the wide range of fields in which R and Rmetrics are used in finance and insurance to analyze and model data,
* bringing together developers, practitioners, and users from finance and insurance providing a platform for common discussions and exchange of ideas.

Example 1: ARMA-GARCH Modeling

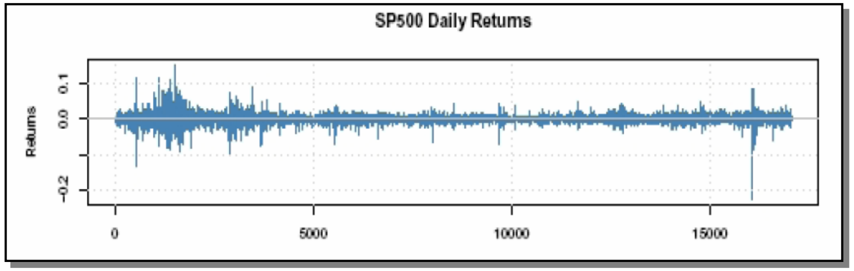
Modeling and Forecasting Volatility

fGARCH

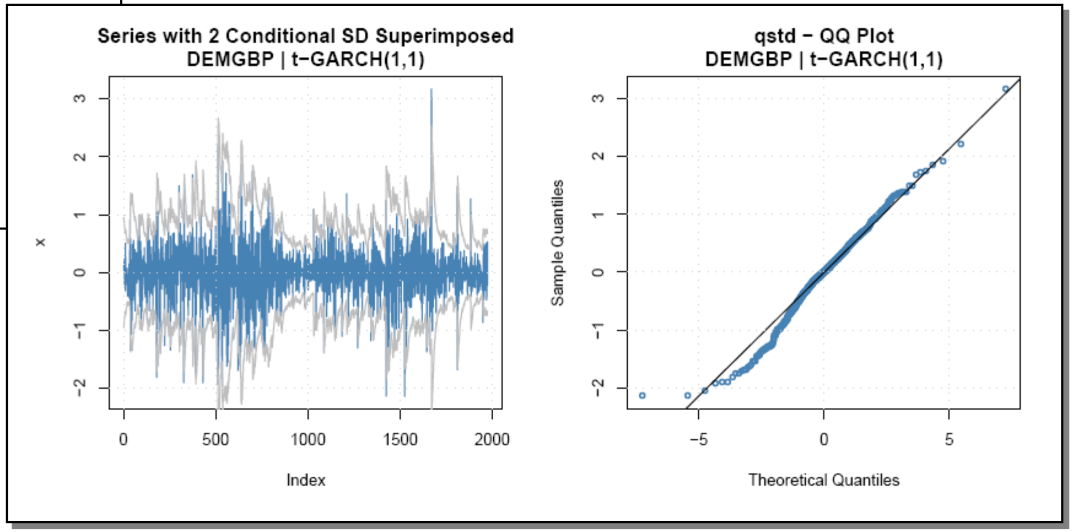
```
# DGE MA(1)-GARCH(1,1) Model Parameter Estimation:
> data(sp500dge)
# Percentual returns result in better scaling and faster convergence ...
> x = 100*sp500dge[, 1]

# R/Rmetrics:
> garchFit(~arma(0,1), ~aparch(1,1))
          Estimate   Std. Error    t value   Pr(>|t|)
mu        0.020646    0.006346      3.253    0.00114 **
ma1       0.144745    0.008357     17.319    < 2e-16 ***
omega     0.009988    0.001085      9.203    < 2e-16 ***
alpha1    0.083803    0.004471     18.742    < 2e-16 ***
gamma1    0.373092    0.027995     13.327    < 2e-16 ***
beta1     0.919401    0.004093    224.622    < 2e-16 ***
delta     1.435124    0.067200     21.356    < 2e-16 ***
```

SP500 ARMA -APARCH Modeling



Diagnostic Analysis:



Residual Tests, ARCH Tests, IC Statistics, 11 Diagnostic Plots

Volatility Forecasts:

	R/Rmetrics		Splus/Finmetrics		Ox/G@RCH	
Steps:	**Mean**	**StDev**	**Mean**	**StDev**	**Mean**	**StDev**
1	-0.006190	0.3834	-0.006053	0.3838	-0.006183	0.3834
2	-0.006190	0.3895	-0.006053	0.3900	-0.006183	0.3895
3	-0.006190	0.3953	-0.006053	0.3959	-0.006183	0.3953
4	-0.006190	0.4008	-0.006053	0.4014	-0.006183	0.4007
5	-0.006190	0.4060	-0.006053	0.4067	-0.006183	0.4060

Example 2: Extreme Value Theory

Robust Estimation of VaR and Expected Shortfall

fExtremes

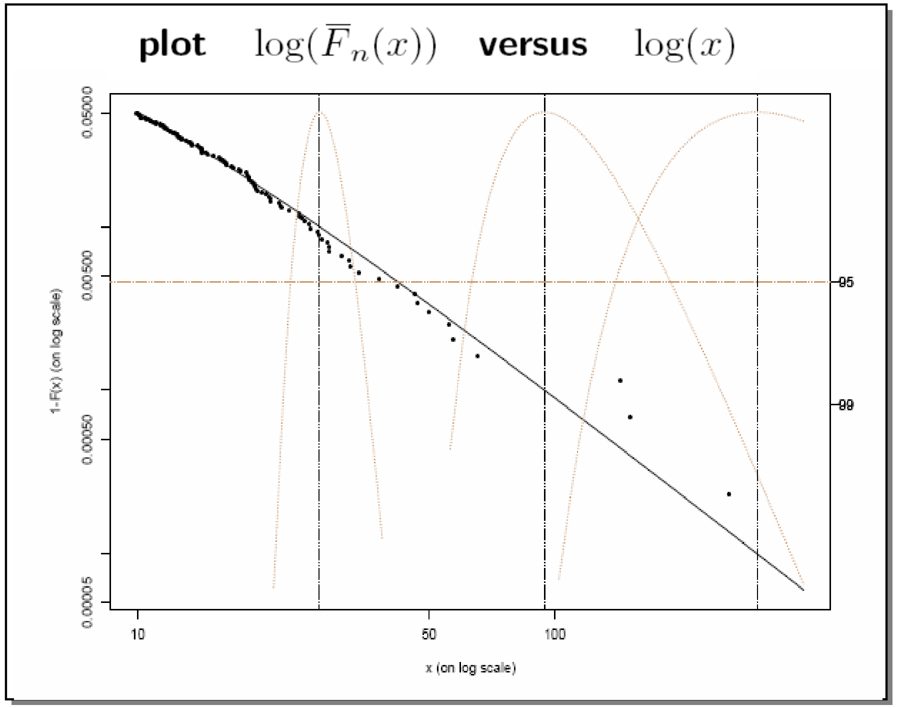
Extreme Value Theory: Value-at-Risk and Expected Shortfall are estimated from the GPD

$$\widehat{\mathrm{VaR}}_q = u + \frac{\hat\beta}{\hat\xi}\left(\left(\frac{n}{N_u}(1-q)\right)^{-\hat\xi} - 1\right).$$

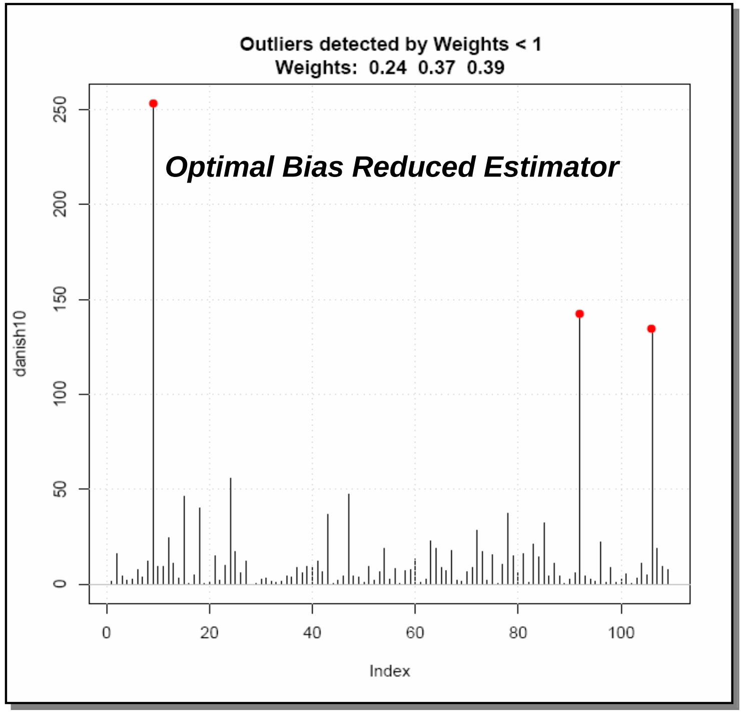
$$\widehat{\mathrm{ES}}_q = \frac{\widehat{\mathrm{VaR}}_q}{1-\hat\xi} + \frac{\hat\beta - \hat\xi u}{1-\hat\xi}.$$

Danish Fire Losses

GPD



OBRE



Example 3: Bivariate Copulae

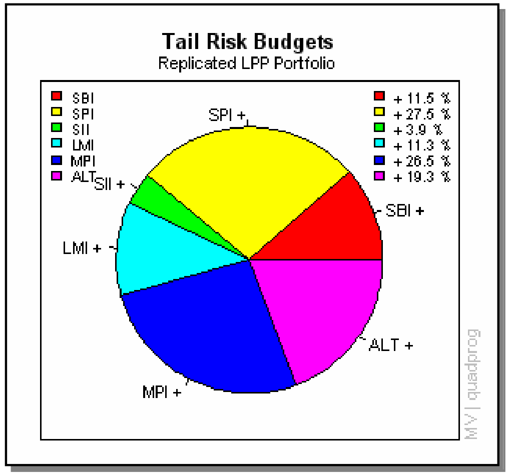
fCopulae

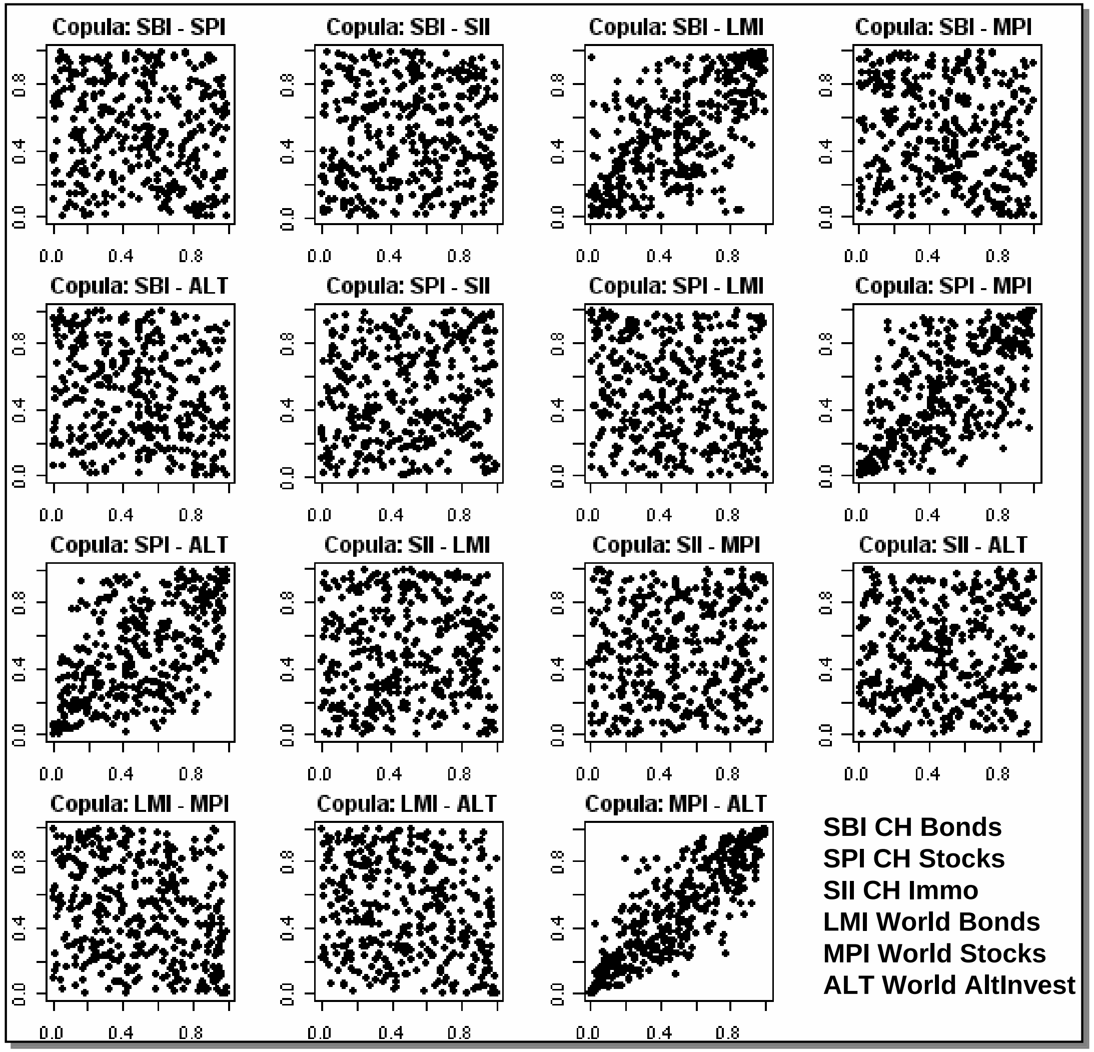
Estimating Pairwise Lower Tail Dependence

Pictet Swiss Pension Fund Portfolio

Tail Dependence:

	Lower	Upper
SBI SPI	0	0
SBI SII	0.055	0
SBI LMI	0.064	0.069
SBI MPI	0	0
SBI ALT	0	0
SPI SII	0	0.064
SPI LMI	0	0.072
SPI MPI	0.352	0.214
SPI ALT	0.273	0.048
SII LMI	0.075	0
SII MPI	0	0.164
LMI MPI	0	0
LMI ALT	0	0
MPI ALT	0.124	0.012



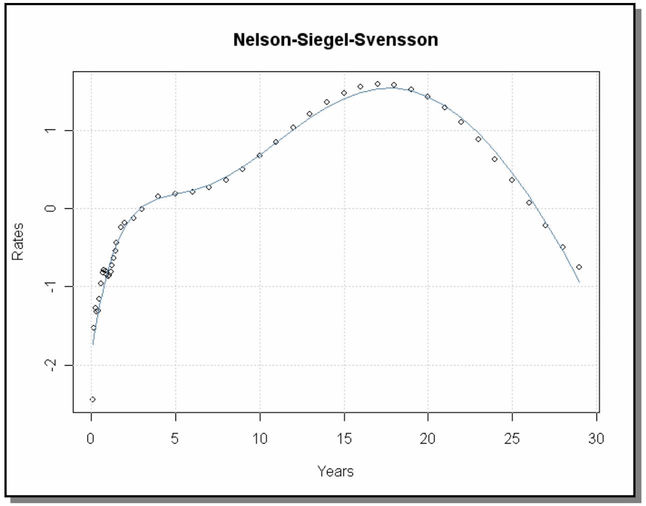


Example 4: Term Structure Modeling

fBonds

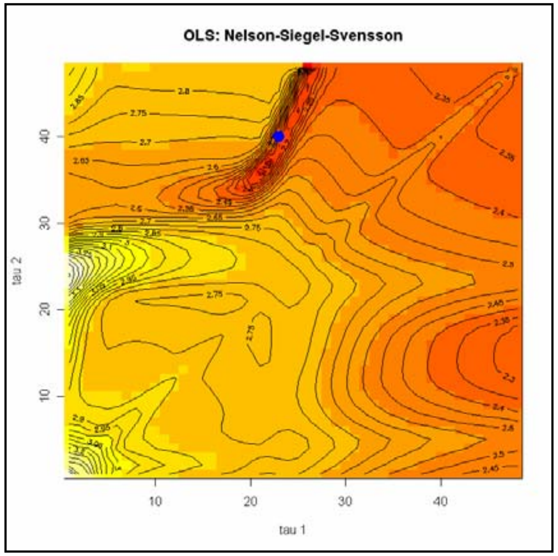
… Nelsen-Siegel-Svenson Estimation for the Zero Rates

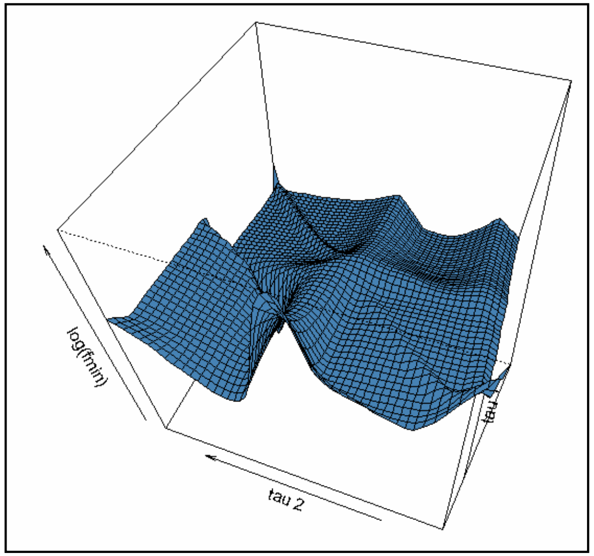
$$y(m) = \beta_0 + \beta_1 \frac{1-e^{-m/\tau_1}}{m/\tau_1} + \beta_2 \left[\frac{1-e^{-m/\tau_1}}{m/\tau_1} - e^{-m/\tau_1}\right] + \beta_3 \left[\frac{1-e^{-m/\tau_2}}{m/\tau_2} - e^{-m/\tau_2}\right].$$



Objective Function: non-convex!

Search for the Global Minimum





Calibration

- Find for all maturities $\tau_{1,2}$ the best solution for the coefficients β
- Take this value as starting point for the nonlinear (least square) solver.

Example 5: Vontobel German Sector Rotation Index

ISIN CH0026834058

fPortfolio

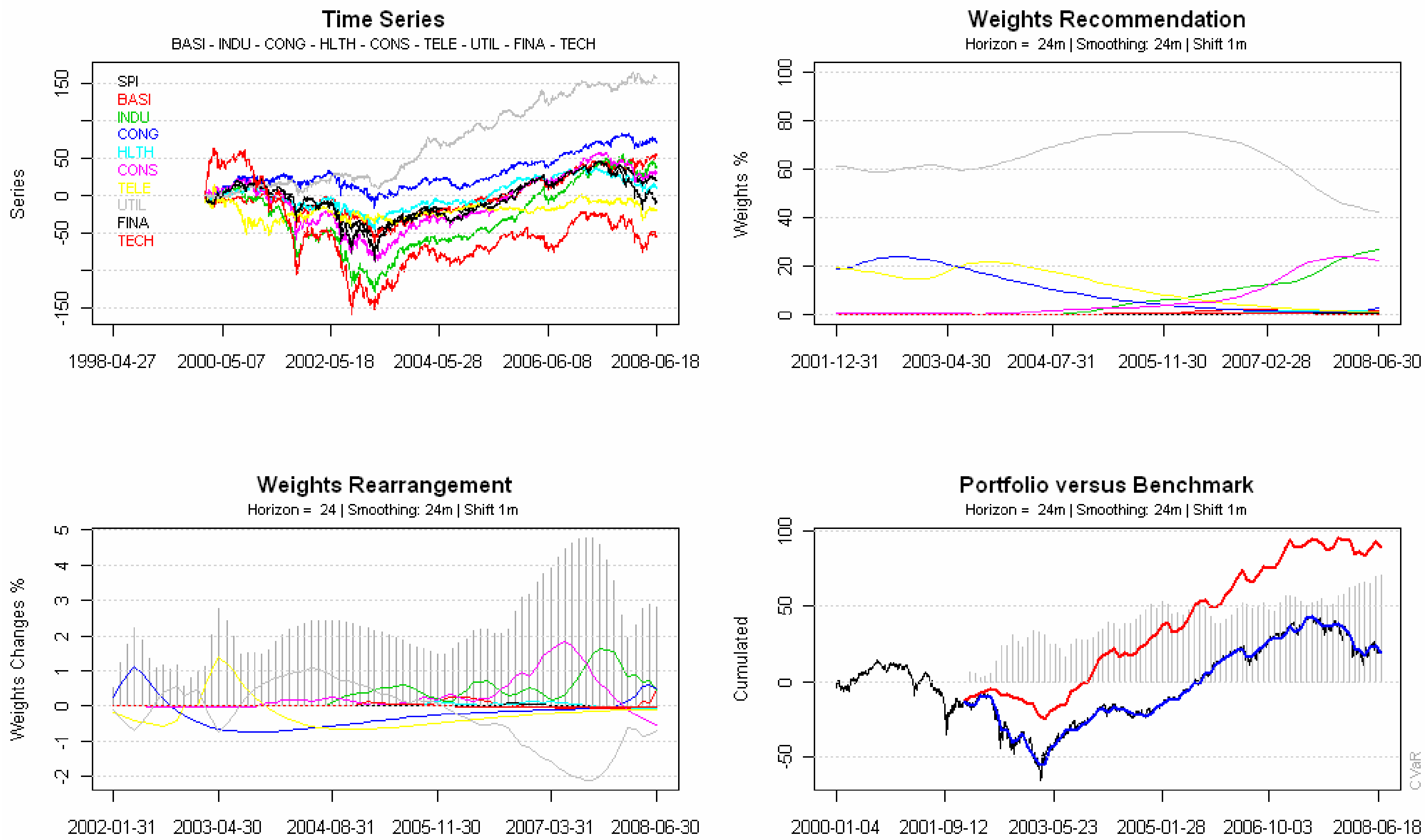
Sectors: Auto, Banks, Chemicals, Basic Resources, Food & Beverage, Insurance, Transport & Logistics, Industrial, Construction Performance, Pharmacy & Healthcare Utilities

Rebalancing: Quarterly

Build a Portfolio on the SPI Universe:

SWX SWISS EXCHANGE

ISIN	Security
CH0022635152	SWX ID ENERGY TR
CH0022635194	SWX ID BASICMAT TR
CH0022635210	SWX ID INDUSTRY TR
CH0022635301	SWX ID CONGOODS TR
CH0022647017	SWX ID HLTHCARE TR
CH0022647256	SWX ID CONSERV TR
CH0022647405	SWX ID TELECOM TR
CH0022647835	SWX ID UTILITIES TR
CH0022647934	SWX ID FINANCE TR
CH0022652785	SWX ID TECH TR

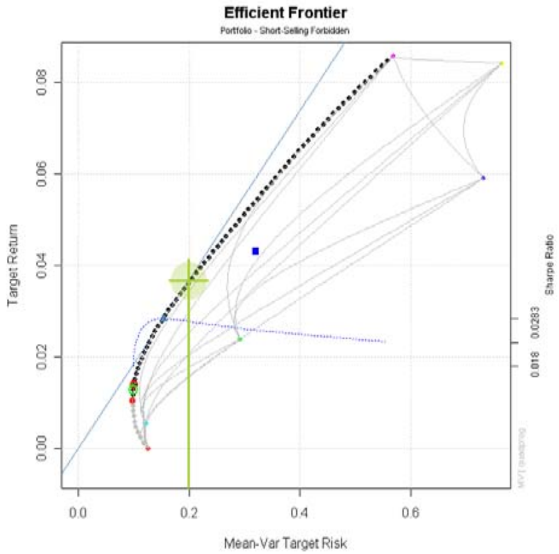


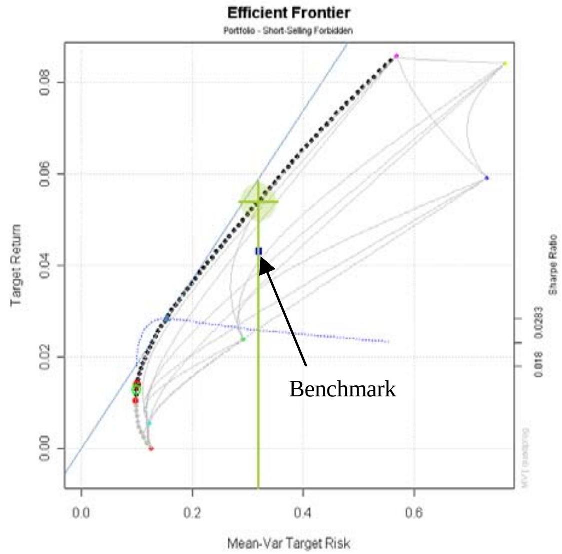
dynAAx
dynamic Asset Allocation index

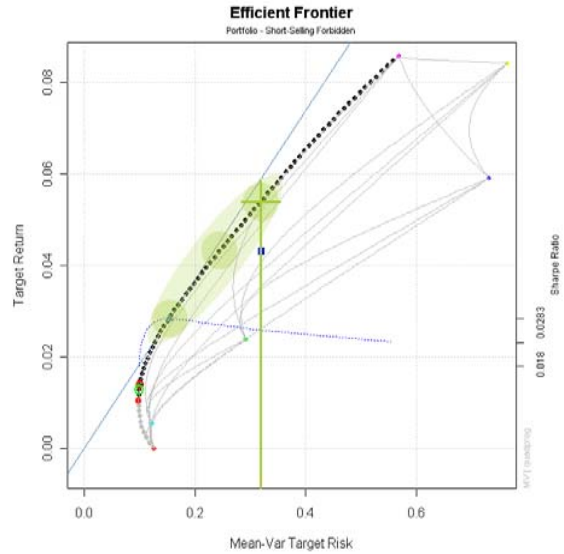
Theta Fund Managment, Zürich

Dominik Locher

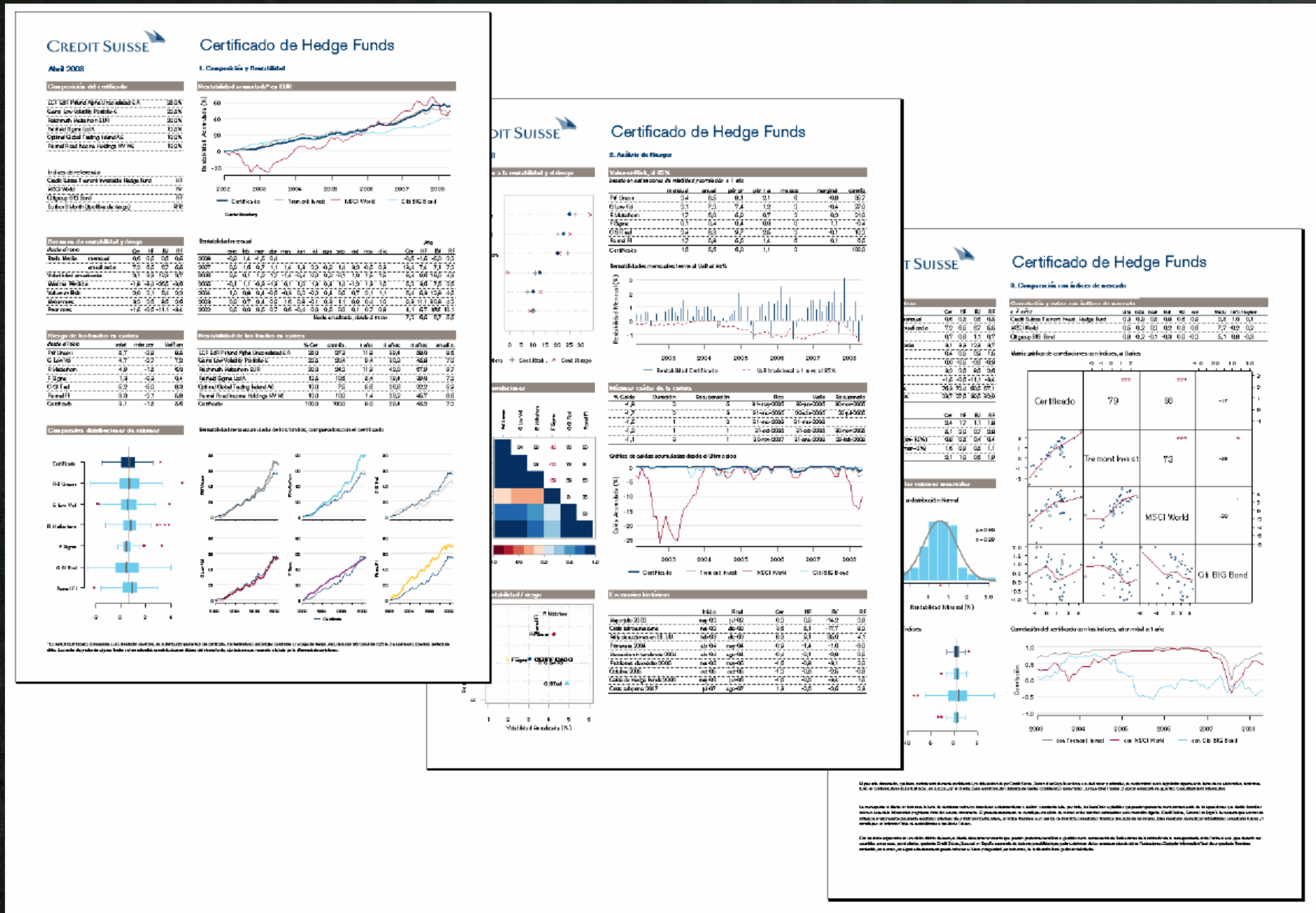
dynAAx FIX	dynAAx TRACKER	dynAAx FLEX
▪ Constant risk Index	▪ Tracking the risk or return of a known benchmark	▪ An Index following an investment strategy …







Advisory Services



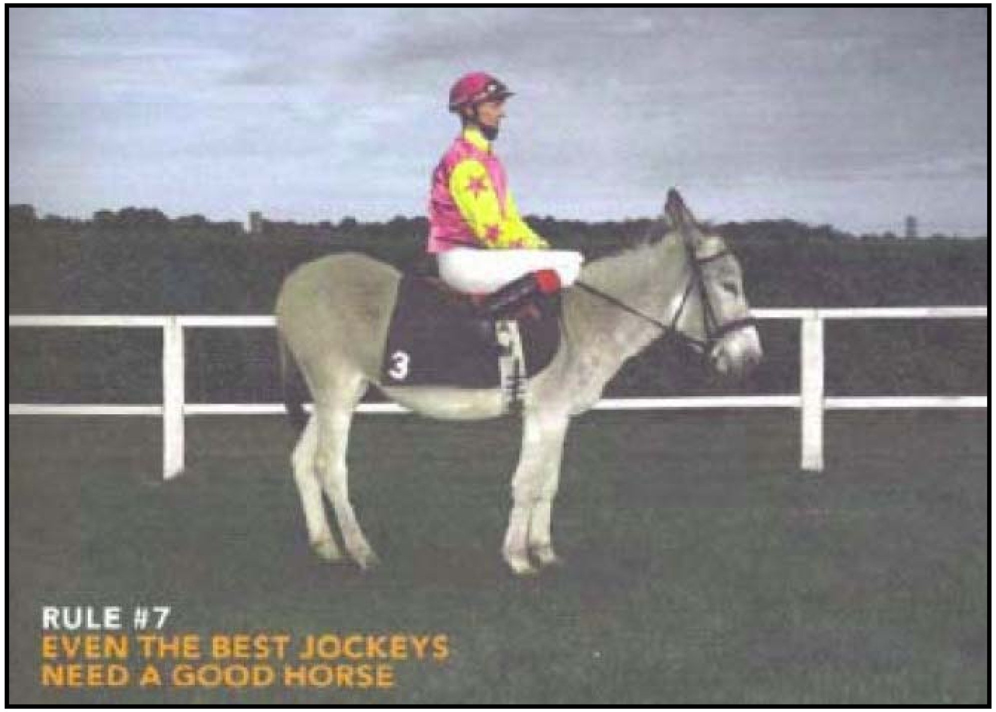
Delivering Private Banking Advisory Services with R

Enrique Bengoechea
enrique.bengoechea@credit-suisse.com
Credit Suisse Madrid

2nd R/Rmetrics Summer Workshop
3rd July 2008

Summary

Consider **R/Rmetrics** as a competitive and unique rapid model prototyping environment in education and even for business applications



Thank You

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