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RiskDemo software for demonstrating actuarial and financial risks

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RiskDemo is a free-to-use R software tool designed to illustrate insurance business risks from a probabilistic and statistical perspective. The R commander can be used to illustrate risks through a variety of graphical representations, tables, and risk figures. It includes valuation of bonds and stocks, portfolio optimization, classical ruin theory, demography and epidemic. Risk can be illustrated with a variety of graphs, tables, and figures.

Keywords: Demography; Graphic; Investments; Pandemia; R software environment

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1 Description

RiskDemo works in the R environment, which is open source software specifically designed for statistical modeling and graphics (R Core Team, 2017). R with its source code, binaries and documentation, as well as an extensive collection of additional packages is available on the CRAN network (Comprehensive R Archive Network). RiskDemo is implemented as an add-on to R Commander (Fox & Bouchet-Valat 2017; Fox 2017 ja 2005). RiskDemon resembles R-package TeachingDemos, which can be used to illustrate the basic concepts of statistics and probability (Snow, 2016). The Demographics part of RiskDemon is essentially based on the R-package Demography programmed by Rob Hyndman (2017).

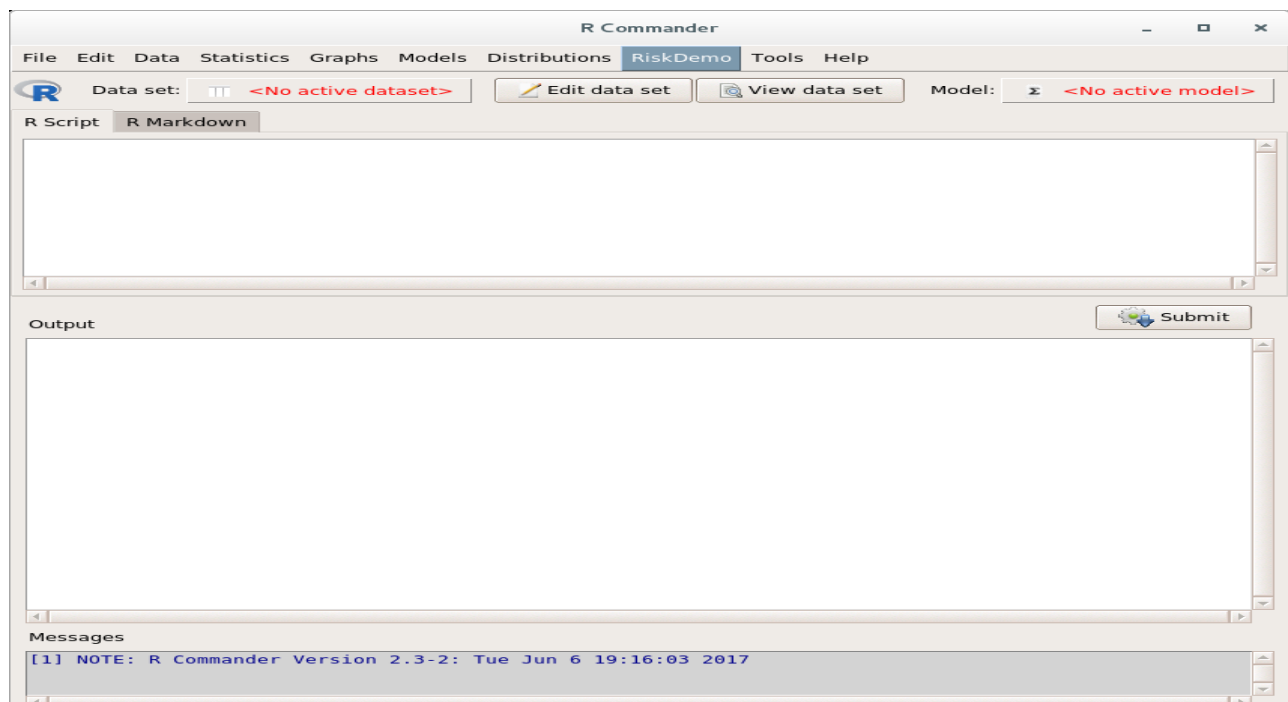


Figure 1. R Commander Window.

RcmdrPlugin.RiskDemo: R Commander Plug-in

Version: 3.0
Depends: R ($\geq 3.5.0$)
Imports: stats, [Rcmdr](#), [demography](#), [forecast](#), [ftsa](#), [ggplot2](#), [dplyr](#), [scales](#), [zoo](#),
[data.table](#)
Suggests: [tkrplot](#), [rgl](#)
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Author: Arto Luoma
Maintainer: Arto Luoma <arto.luoma at wippies.com>
License: [GPL-2](#)
NeedsCompilation: no

on:

Materials: [ChangeLog](#)
CRAN checks: [RcmdrPlugin.RiskDemo results](#)

Downloads:

Reference manual: [RcmdrPlugin.RiskDemo.pdf](#)
Package source: [RcmdrPlugin.RiskDemo_3.0.tar.gz](#)
Windows binaries: r-devel: [RcmdrPlugin.RiskDemo_3.0.zip](#), r-release: [RcmdrPlugin.RiskDemo_3.0.zip](#), r-oldrel: [RcmdrPlugin.RiskDemo_3.0.zip](#)
macOS binaries: r-release (arm64): [RcmdrPlugin.RiskDemo_3.0.tgz](#), r-release (x86_64): [RcmdrPlugin.RiskDemo_3.0.tgz](#), r-oldrel: [RcmdrPlugin.RiskDemo_3.0.tgz](#)
Old sources: [RcmdrPlugin.RiskDemo archive](#)

Linking: The canonical form

<https://CRAN.R-project.org/package=RcmdrPlugin.RiskDemo>

Rtopics documented:

RcmdrPlugin.RiskDemo-package, bondCurve, bondFigure, bondPrice, computeRuin, computeRuinFinite, countries.mort, covidSmooth, dataCovid, dataCovidFin, drawBars, drawBarsFin, drawFigure, drawIncidence, drawIncidenceFin, drawPositiveRate, drawRuin, drawTests, fin, fin.fcast, fin.lca, loglikCovid, params, plotForecast, plotR, pop.pred, popRegionsFin, portfOptim, returns, solveLund, solveYield, stock.price, stockData.

2. Risk demonstration tools

2.1. Bonds-menu

This tool draws forward and yields curves, for AAA-rated central government bonds and/or all central government bonds. There are two options. “Determine bond price” ja “Draw yield curves”. Theoretical background can be found e.g. in Bodien, Kanen and Marcusin (2014).

The dialog box is titled "Calculating bond yield or price". It contains two date selection sections: "Settlement date" and "Maturity date". Each section has three dropdown menus for Year, Month, and Day. Below these are input fields for "Annual coupon rate (%)" (set to 3), "Coupon payments per year" (set to 2), and a choice between "Yield to maturity (%)" (set to 5) and "Flat price (% of par)". At the bottom are buttons for Help, Reset, Apply, Cancel, and OK.

Settlement date		
Year	Month	Day
2000	Jan	1
2001	Feb	2
2002	Mar	3
2003	Apr	4
2004	May	5
2005	Jun	6

Maturity date		
Year	Month	Day
2000	Jan	26
2001	Feb	27
2002	Mar	28
2003	Apr	29
2004	May	30
2005	Jun	31

Annual coupon rate (%)
Coupon payments per year
Fill either yield to maturity or flat price
Yield to maturity (%)
Flat price (% of par)

Buttons: Help, Reset, Apply, Cancel, OK

Figure 2. Bond Calculator.

The dialog box is titled "Drawing a yield curve". It contains two date selection sections: "First date" and "Second date (optional)". Each section has three dropdown menus for Year, Month, and Day. Below these are checkboxes for "Yield curve?", "Forward curve?", "AAA bonds?", and "All bonds?". At the bottom are buttons for Help, Reset, Apply, Cancel, and OK.

First date		
Year	Month	Day
None	Jul	1
2004	Aug	2
2005	Sep	3
2006	Oct	4
2007	Nov	5
2008	Dec	6

Second date (optional)		
Year	Month	Day
2012	Jan	26
2013	Feb	27
2014	Mar	28
2015	Apr	29
2016	May	30
2017	Jun	31

☒ Yield curve ?
☒ Forward curve ?
☒ AAA bonds ?
☒ All bonds ?

Buttons: Help, Reset, Apply, Cancel, OK

Figure 3. Drawing bond yields.

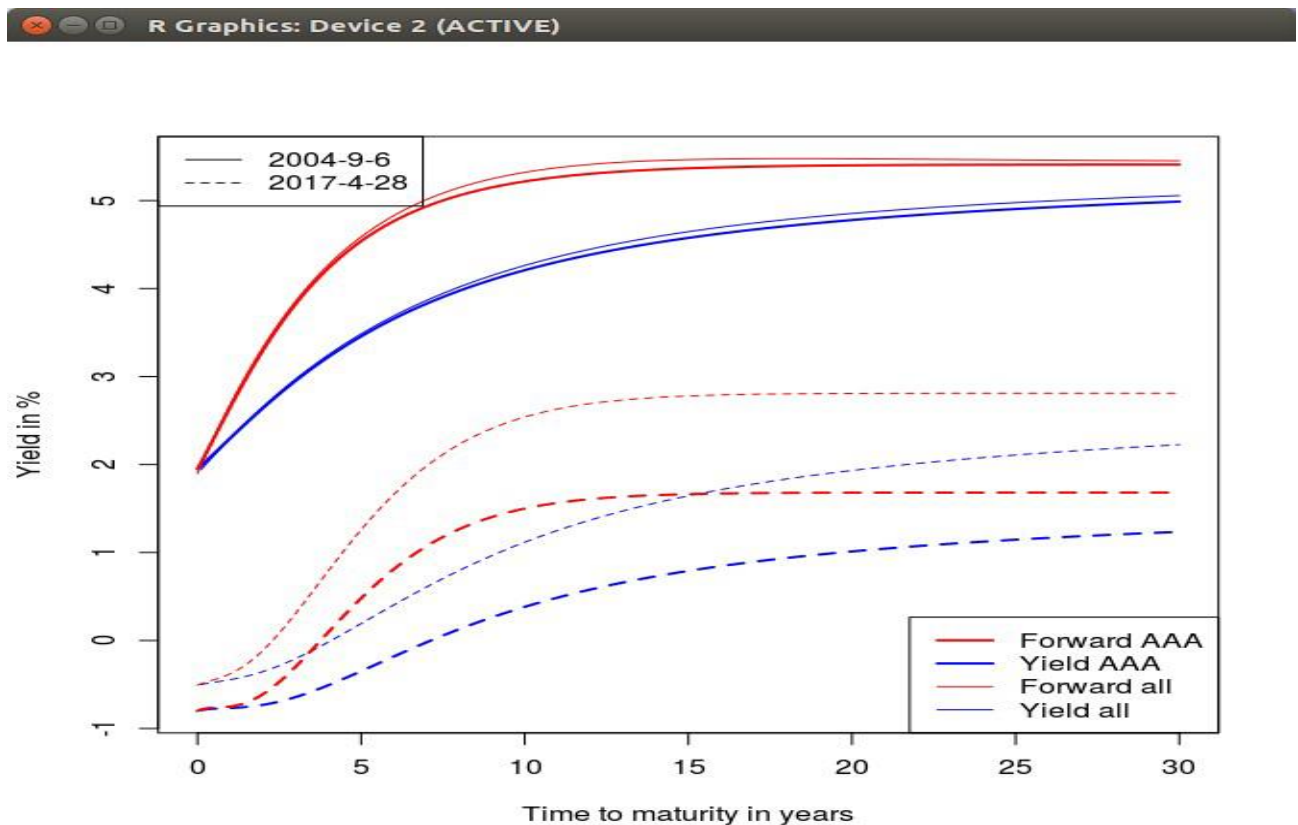


Figure 4. Bond yield and term structure.

2.2. Demography menu

Demography tools makes it possible to draw demographic graphs and make demographic predictions. In addition, it includes mortality data downloaded from the Human Mortality Database (HMD) for 38 different countries. Main window includes options "Plot demographic data", "Choose demographic data", "Compute lifetable", "Estimate demographic model", "Forecast demographic data", "Forecast population data". Theoretical background can be found e.g. in Alho and Spencer (2005).

Figure 5. Demographic window.

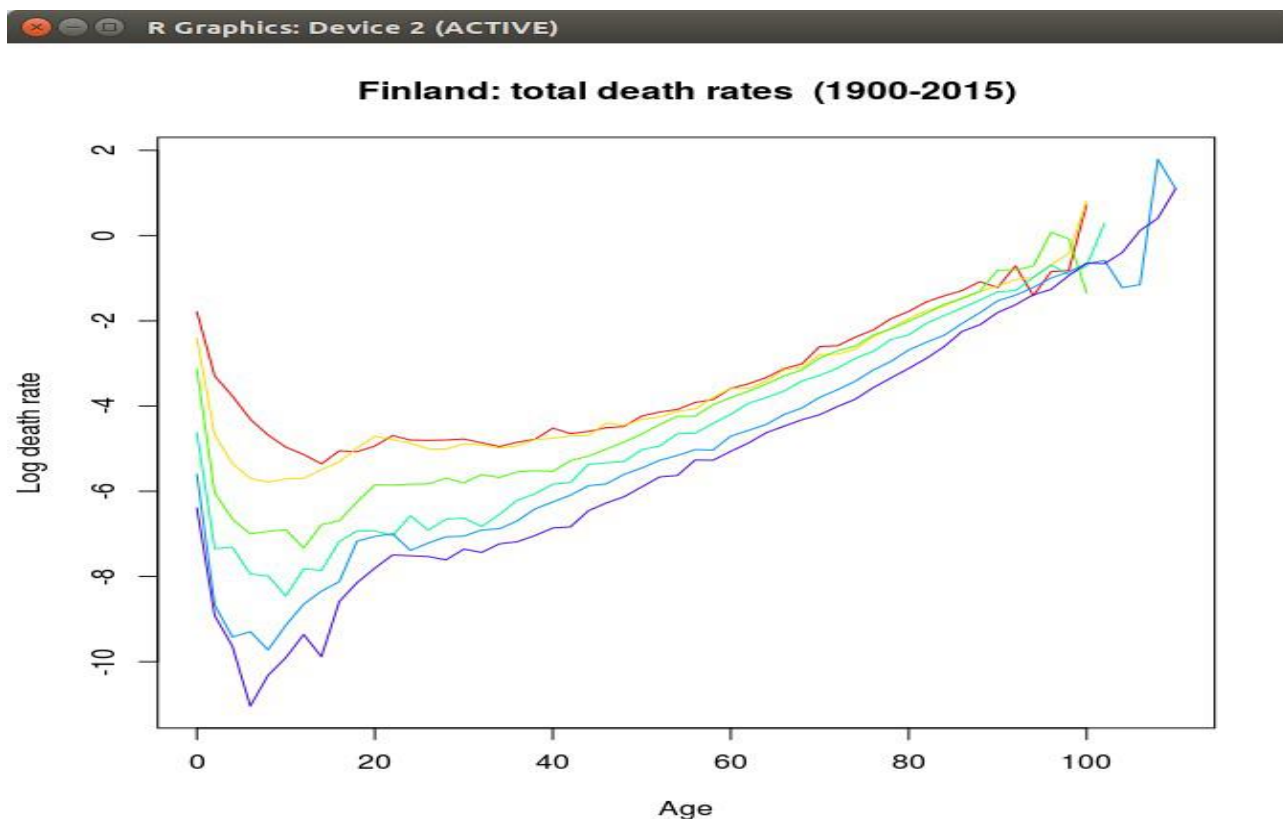


Figure 6. Mortality between 1900 and 2015 in Finland.

fin: Finland total rate

	row.names	1878	1879	1880	1881	1882	1883
1	0	0.201289	0.154785	0.184604	0.206265	0.191259	0.171650
2	1	0.082972	0.052944	0.068387	0.079438	0.073939	0.053752
3	2	0.045015	0.032662	0.042385	0.045003	0.042757	0.036228
4	3	0.028611	0.022491	0.028371	0.033389	0.029953	0.028299
5	4	0.020423	0.016773	0.021245	0.026800	0.023473	0.021520
6	5	0.015087	0.010805	0.016259	0.021063	0.017891	0.017545
7	6	0.012510	0.007491	0.011225	0.016632	0.014518	0.013727
8	7	0.009705	0.007178	0.009738	0.011719	0.012259	0.010582
9	8	0.008268	0.005691	0.008374	0.009062	0.008752	0.008571
10	9	0.005923	0.005296	0.007552	0.008580	0.006410	0.006059
11	10	0.006561	0.004066	0.007742	0.007458	0.006133	0.004510
12	11	0.005391	0.004151	0.005497	0.007978	0.005087	0.004763

Figure 7. Life table.

From the “Estimating demographic model” window you can select which model will be fitted to the demographic (mortality or fertility) data.

✖

Estimating a demographic model

Input object

Name:

Output object

Name:

Method

☒ Lee Carter (standard)
☐ Lee Carter (BMS methodology)
☐ Functional model

Series

☒ Total
☐ Female
☐ Male

Subset

Ages:
Years:

☒ Plot residuals?
☒ Plot model (Lee Carter)?
☐ Print summary (functional model)?

🛟 Help

↺ Reset

➡ Apply

✖ Cancel

✔ OK

Figure 8. Demographic model window.

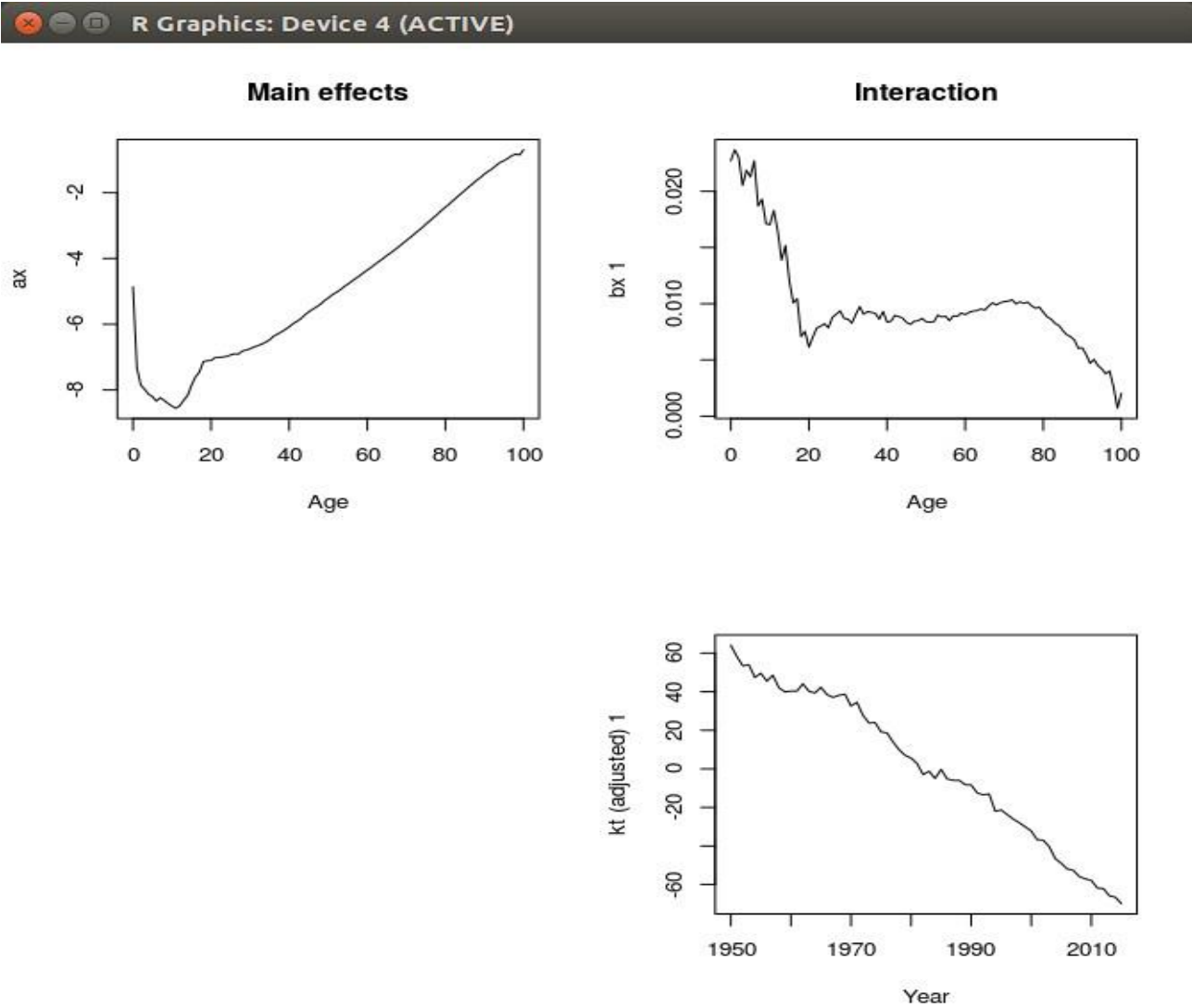


Figure 9. Estimated Lee Carter mortality model.

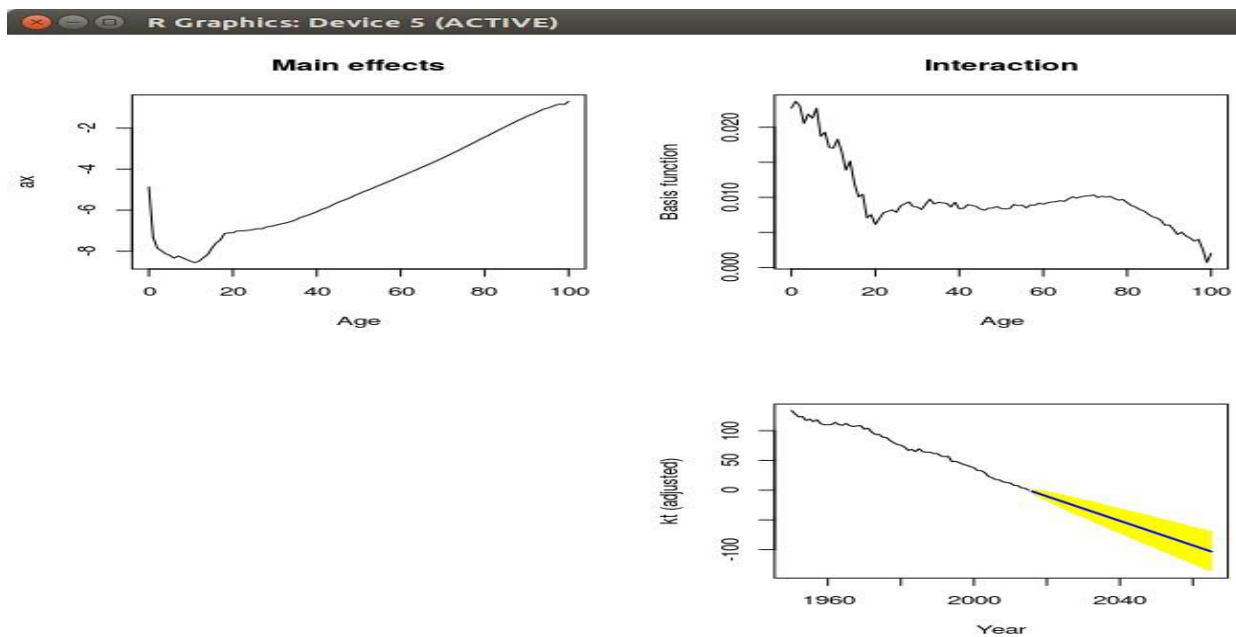


Figure 10. Demographic predictions by Lee Carter model.

2.3. Risk Theory Menu

This tool illustrates ruin theory. This tool uses classical ruin theory to compute either ruin probability, safety loading or initial capital, given two of them. The time horizon is infinite. Gamma distribution is used to model claim sizes. Theoretical background can be found e.g. in Kaas, Goovaerts, Dhaenens and Denuit (2008).

×

Illustrating classical ruin theory

Model parameters for compound Poisson distribution

Claim intensity (λ)

100

Time horizon

Time horizon (years)

10

Fill two of the following:

Initial capital (€)

1000

Safety loading (%)

1.25

Ruin probability (%)

Claim sizes are assumed to be gamma-distributed

Shape (α)

1

Rate (β)

0.1

Figure parameters

Number of simulation paths

10

Time horizon (years)

10

Help

Reset

Apply

Cancel

OK

Figure 11. Parameter Window for Risk Models.

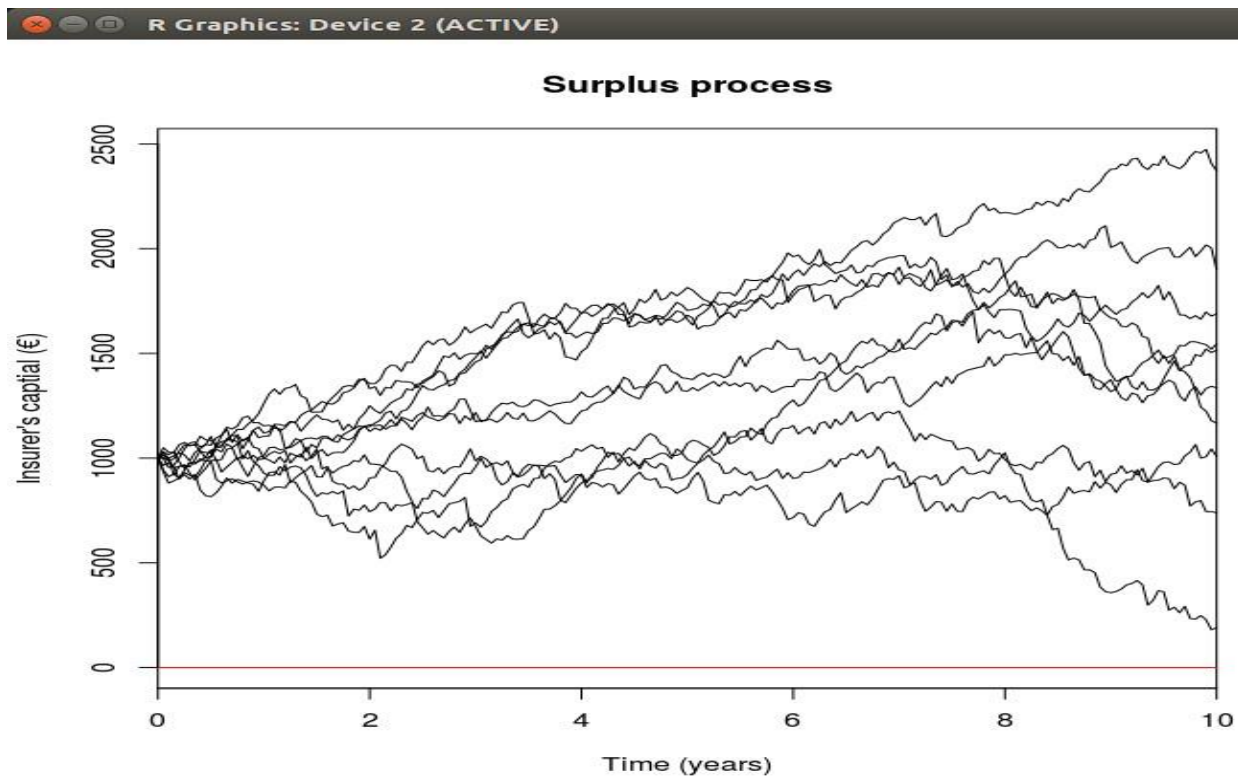


Figure 12. Simulated surplus process.

2.4. Stocks menu

The Stocks tool makes it possible to illustrate the calculations and risks associated with equity investing. The menu contains items "Load stock data", "Optimize portfolio" and "Determine stock price". Theoretical background can be found e.g. in Bodie, Kane and Marcus (2014).

Expected yield variable(%)	Volatility variable (%)	Beta variable (%)
beta	beta	beta
div	div	div
divYield	divYield	divYield
quote	quote	quote
vol	vol	vol

Portfolio index volatility (%)
☒ Include risk-free investment ?

Rebalancing interval (months)
☒ Allow borrowing ?

Number of risky investments
 Risk-free interest rate (%)

Total investment (€)
 Risk aversion coefficient

Figure 13. Optimization window.

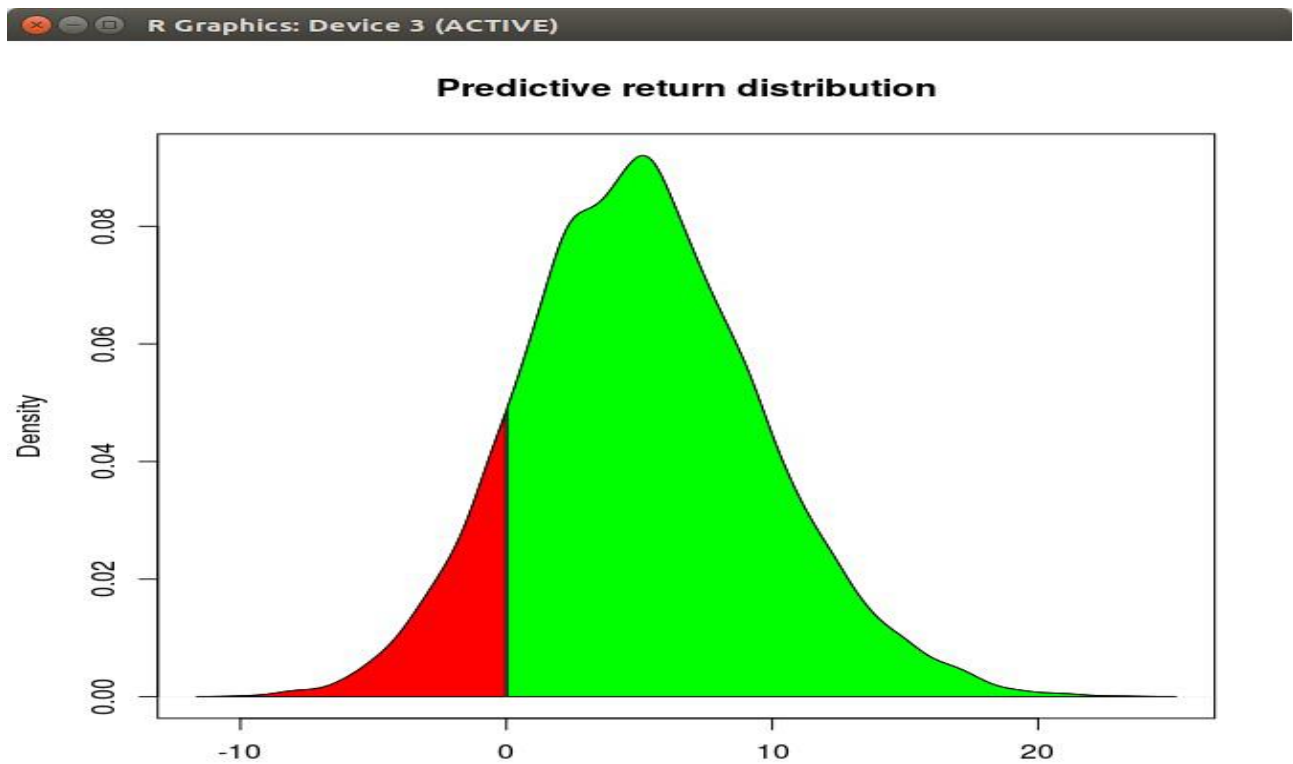


Figure 14. Predictive return distribution.

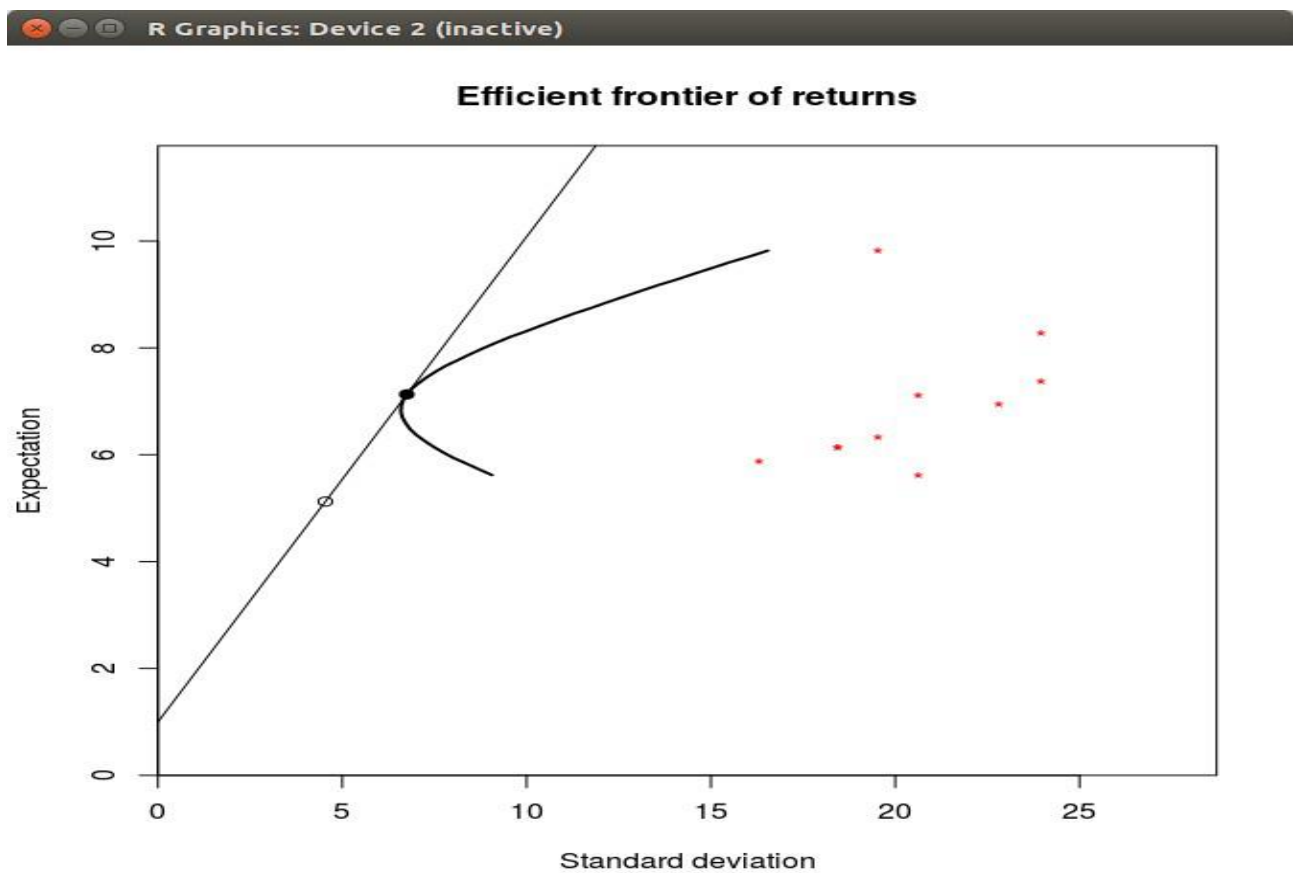
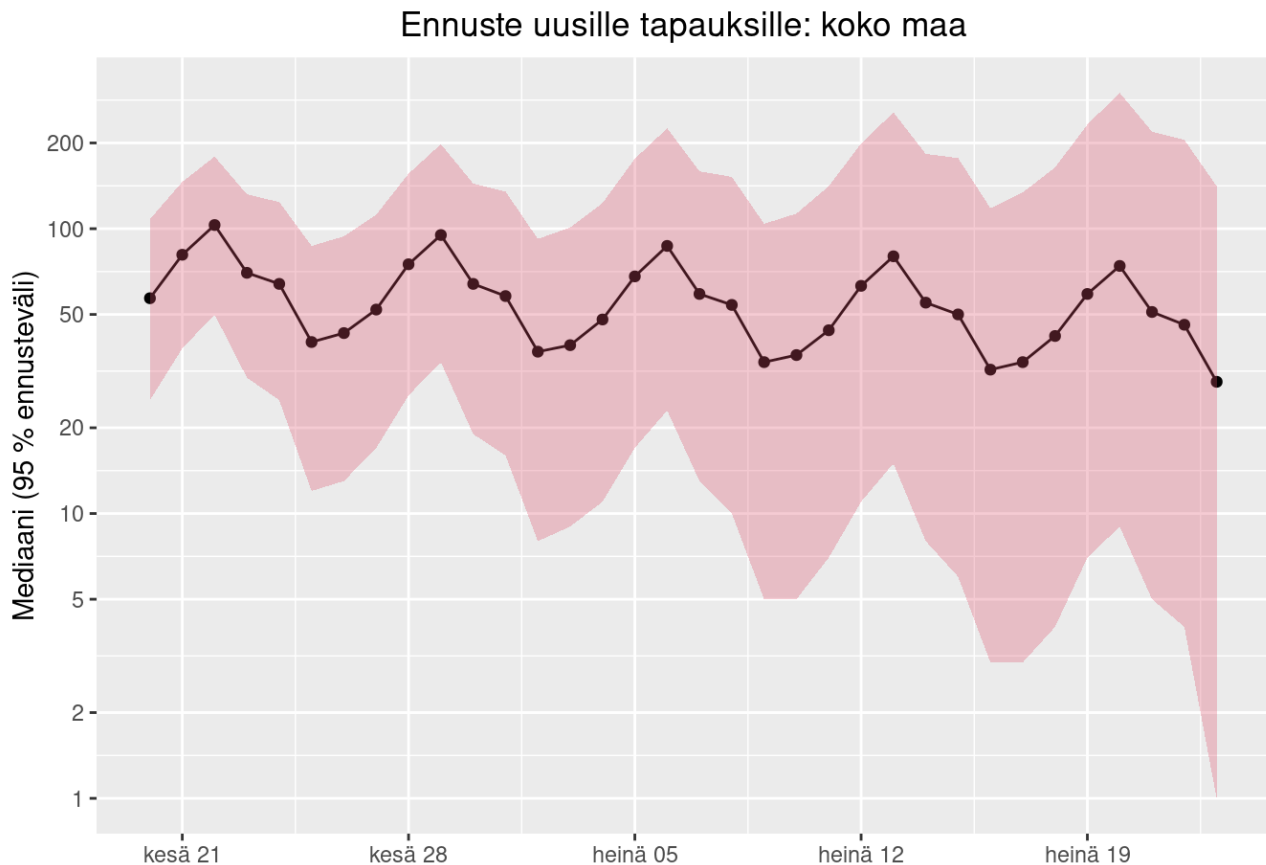


Figure 15. Efficient frontier window.

2.5. Corona pandemic Menu

Kalman smoothing of the SIER model is used to predict new COVID-19 cases. Data set consists of several statistics about the COVID-19 pandemic in 45 countries. Tool plots a time series of either the positive rate of COVID-19 tests or the number of tests per case. Theoretical background can be found e.g. in Hethcote, H.W. (1989).



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Covid Data

<http://www.arto-luoma.fi/covid.html>

RiskDemo

<https://CRAN.R-project.org/package=RcmdrPlugin.RiskDemo>