UseR in the financial sector

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Overview

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The case of R

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Life before R at Invesco

Let's not kid ourselves: the most widely used piece of software
for statistics is Excel.[a]

- Use of MS Excel (VBA) was ubiquitous.

- Hence, statistical analysis was confined to MS Excel.

- RATS was used as sole econometric software package.

- Stock Selection: Indicator analysis have been directly computed on the SQL-databases.

- Reports have been processed manually.

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[a] Brian D. Ripley ('Statistical Methods Need Software: A View of Statistical Computing') Opening lecture RSS 2002, Plymouth (September 2002), cited from package `fortune` by Achim Zeileis.

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The pros & cons

- Transparency: one can look under the hood.

- Powerful: Rich language, highly customisable, speed.[a]

- Interfaces: C/C++, FORTRAN/Fortran, Java, tcl/TK, *etc.*

- Connectivity: ODBC, (D)COM, ftp, socket, *etc.*

- Reporting: Sweave, R2HTML, graphics (bmp, jpg, Metafile, pdf, png, ps).

- Support: Documentation, books, Wiki, dedicated email lists, conferences, courses.

- R is free, no license/upgrade issues.

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[a] Quoting Tom Maycock from the RATS list (21 February 2007): "[RATS-L] RATS 6.3 Tip: SMPL option on PRINT: ... print(smpl=percent>100.0) / percent ...".
In R the same is: percent[percent > 100.0].

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- Learning: R can be a real challenge for the novice.

- Econometric packages: Still some unchartered waters.

- Complexity: R, its CRAN-packages and projects are evolving at a breath-taking pace.

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Life with R at Invesco

- Centrally distributed as a software package with Rtools, Emacs/ESS, MikTeX, AucTeX, MinGW.

- Accessing proprietary database written in Delphi *via* (D)COM interface.

- Econometric modelling of financial markets (TAA).

- Enhancing/speeding up indicator calculations for stock selection.

- Automated reporting (pdf- and html-output).

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Multiple equation model

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Purpose

- Today's capital markets are highly interdependent.

- This interdependence takes place across countries and/or across assets.

- Model's purpose: exploit these interdependencies for one-step-ahead forecasts.

- Take explicitly macroeconomic variables into account, such that it can be employed for scenario analysis too.

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Structure

- Dependencies and interdependencies between the equities & bond markets across countries are taken explicity into account.

- A linkage between each of the countries bond market to the equity market is implemented *via* the term spread.

- Aside of financial instruments, key macroeconomic variables are included in the model too.

- End-of-month data for S&P 500, EuroSTOXX, FTSE all share, Nikkei 225 and 10-year benchmark yields (10-year + for U.K) are used as endogenous variables.

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Tinbergen's arrow diagram
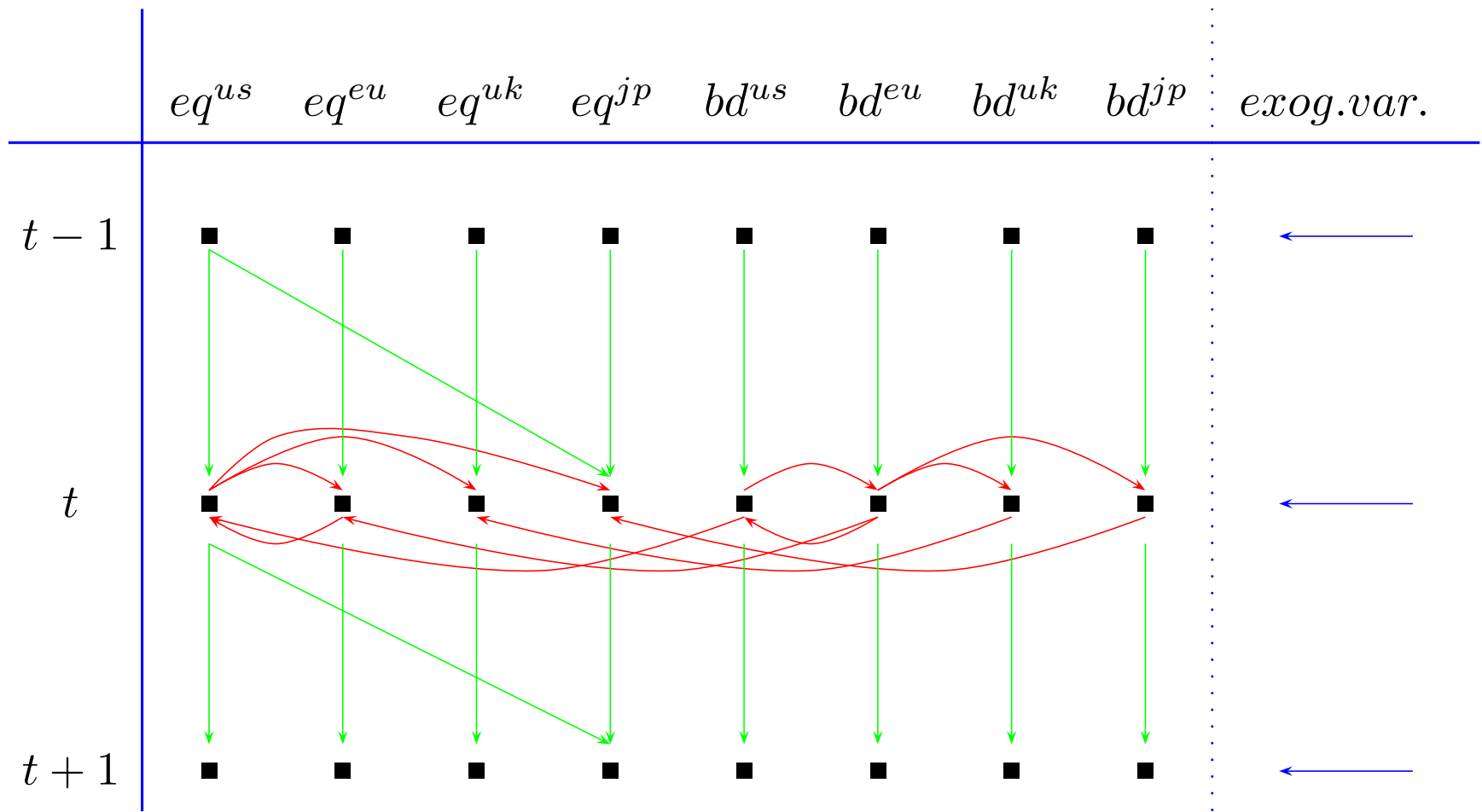
Estimation, solving and forecasting

- The reaction functions are estimated by OLS (end-of-month data, sample: 01.1992 − 12.2006).

- The estimated reaction functions and the identities are grouped together to form the model.

- The model is solved for the endogenous variables by applying the Gauß-Seidel algorithm.

- One-step ahead forecasts can be generated without further information.

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Technicalities

- R is used as an interface to the Fair-Parke program.[a]

- Within the R script, the necessary data to run the model is imported and transformations are calculated where applicable.

- The set of time series is then exported to a suitable formatted ASCI-file to be read into the FP-program.

- The output of the FP-program is written to ASCI-files, which are then imported to R for further processing and analysis.

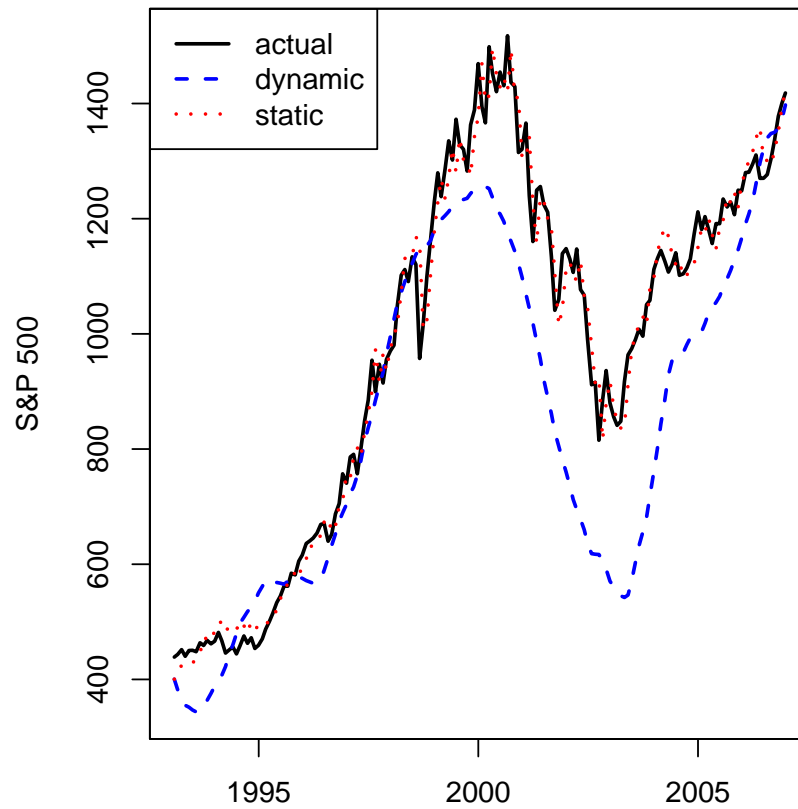- The FP input file creation is simplified and structured through a GUI written in tcl/TK.

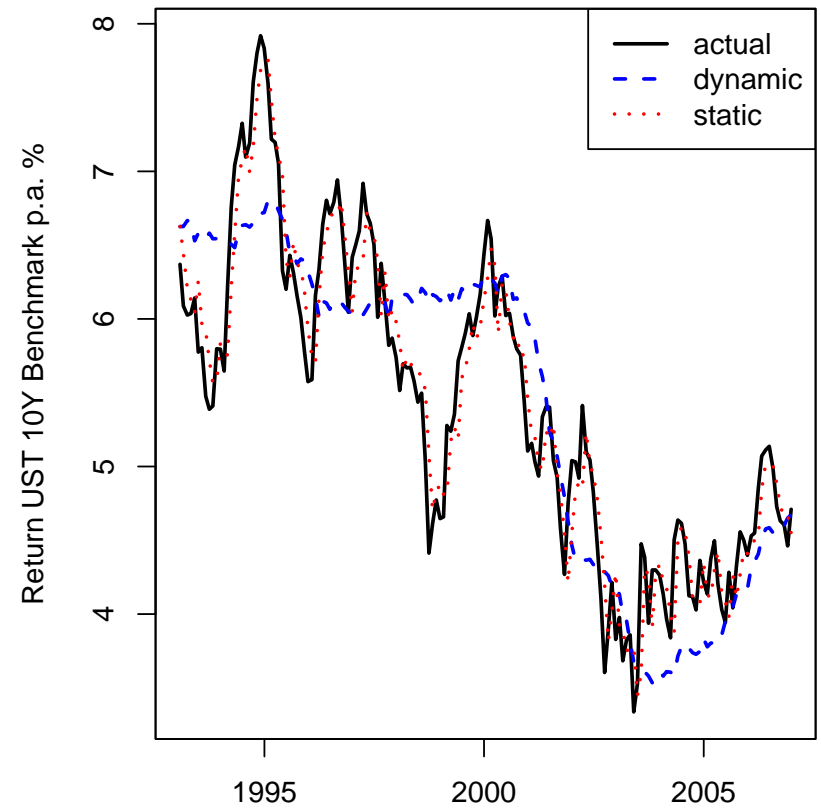[a]The Fair-Parke program itself is written in FORTRAN and is available at: http://fairmodel.econ.yale.edu/fp/fp.htm.

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Dynamic and static ex post forecasts

U.S. EQUITY AND BOND
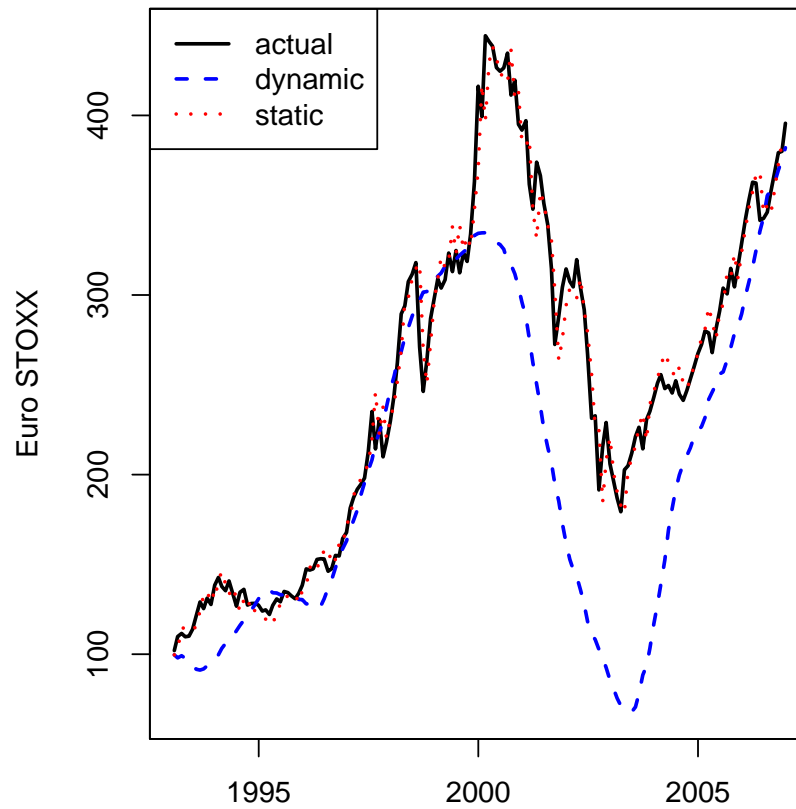
U.S. equity

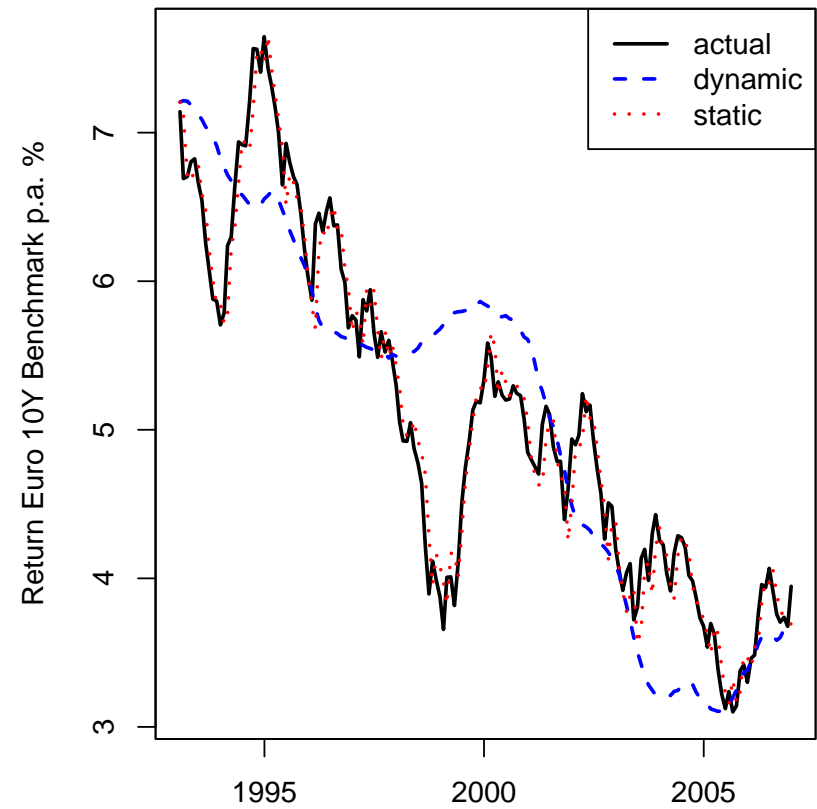**U.S. Treasuries**

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Dynamic and static ex post forecasts

EUROZONE EQUITY AND BOND

Eurozone equity

Eurozone Bunds
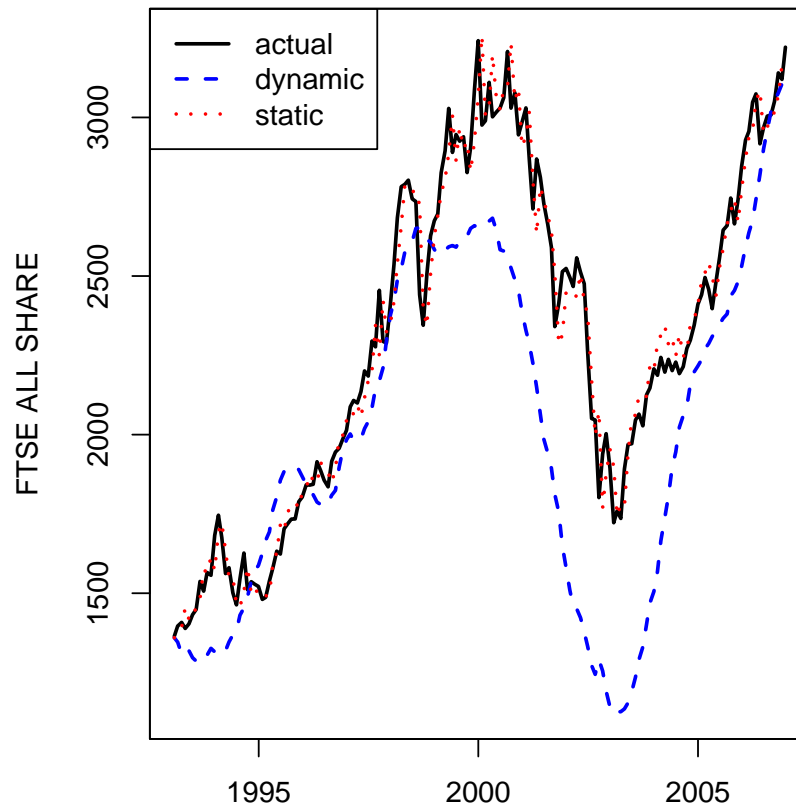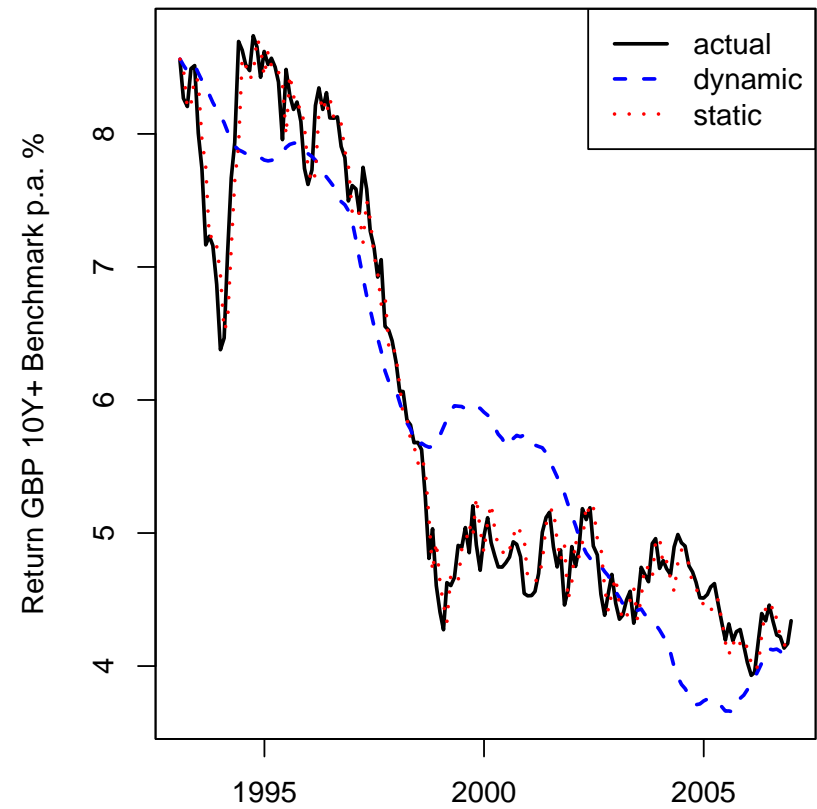
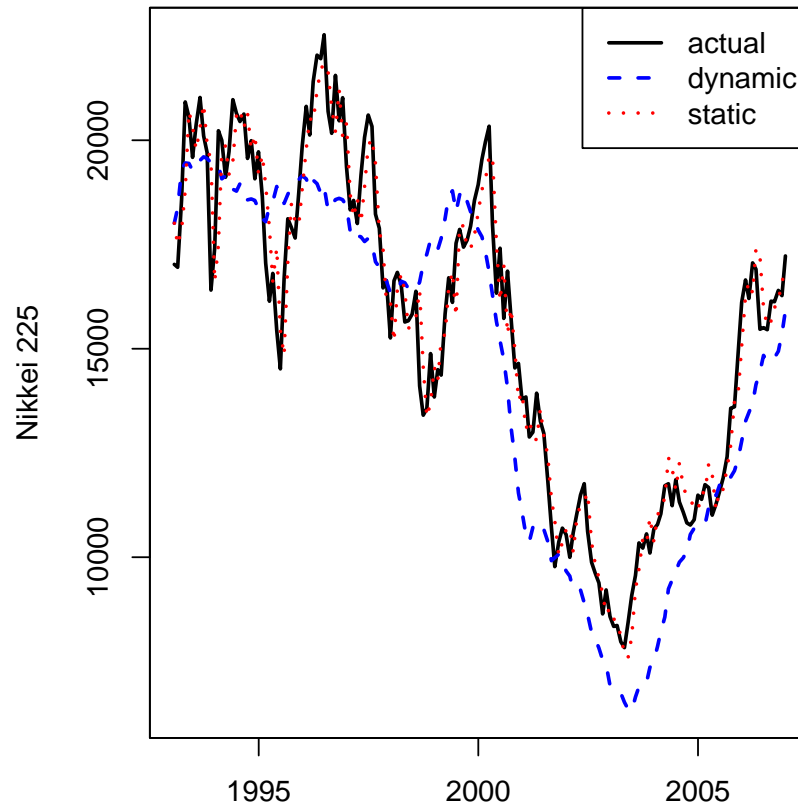# Dynamic and static ex post forecasts

U.K. EQUITY AND BOND

U.K. equity

U.K. Gilts
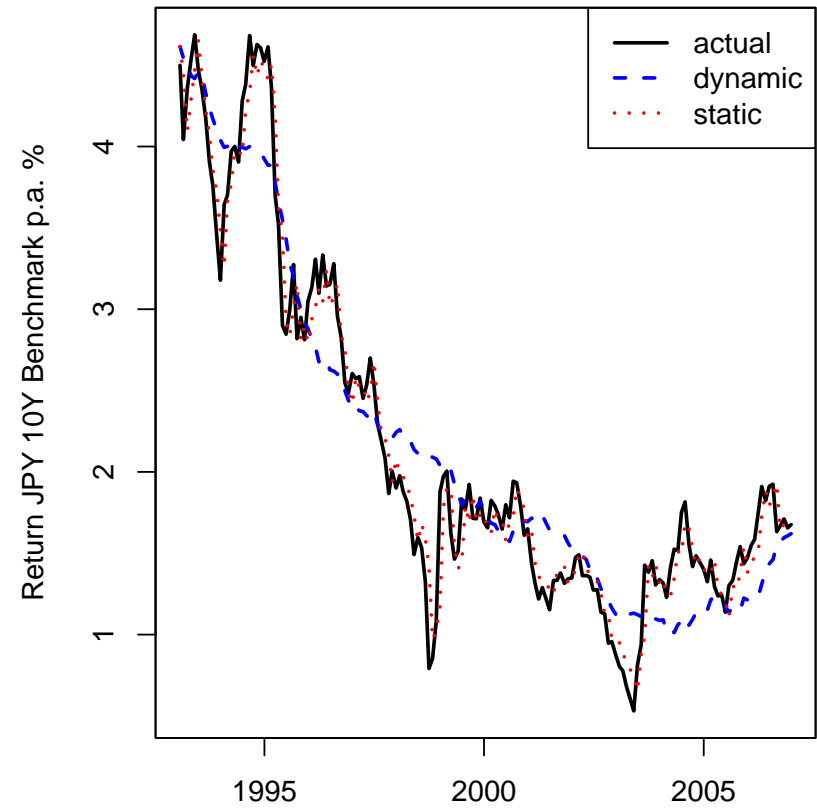
Dynamic and static ex post forecasts

JAPAN EQUITY AND BOND

Japan equity

Japan JGBs

Backtest

- Backtest period runs from 01.2001 until 12.2006.

- The model is estimated and solved recursively, thereby the one-month ahead forecasts are generated (end-of-period).

- Qualitative and quantitative forecast measures are calculated, *i.e.* hit rates, Theil's U and its decomposition.

- Finally, trade performance based on futures are computed for holding initial cash positions of 10,000 USD, EUR, GBP and JPY, respectively.

- The benchmark for all is the one-month money market rate.
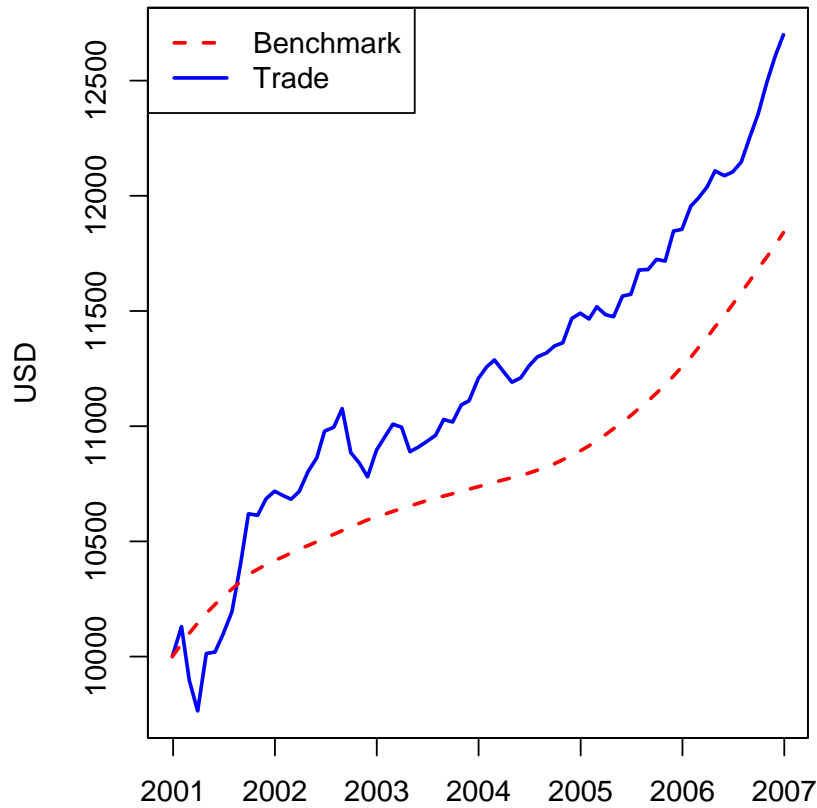
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Backtest

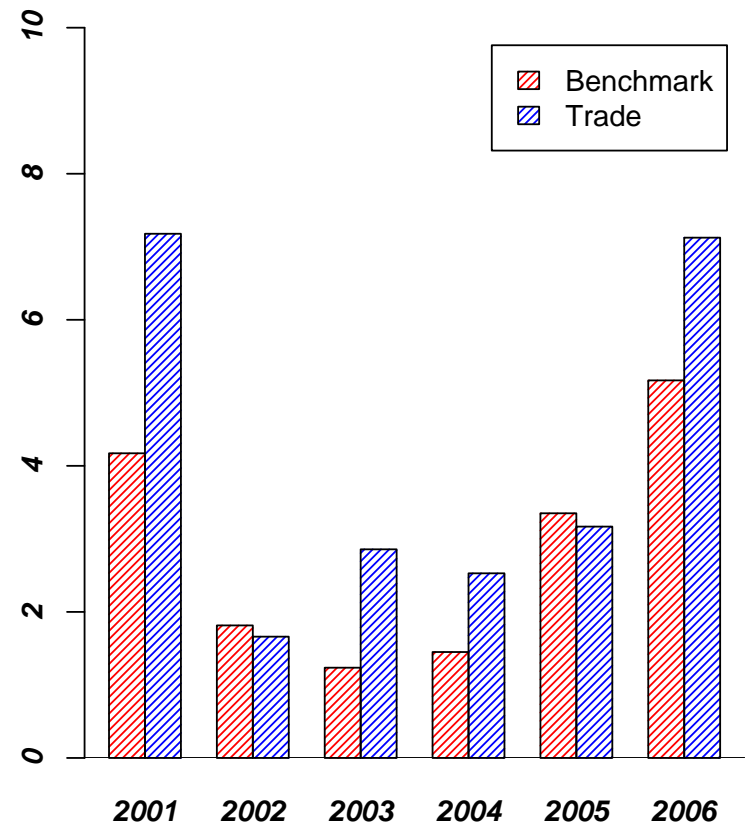|	hit rate (pct.)	Theil's U	Bias	Variance	Random
Eurozone equity	73	0.645	0.086	0.124	0.790
U.S. equity	70	0.669	0.126	0.058	0.816
U.K. equity	63	0.664	0.232	0.051	0.717
Japan equity	59	0.640	0.167	0.057	0.776
Eurozone bond	69	0.498	0.137	0.023	0.840
U.S. bond	73	0.497	0.055	0.164	0.781
U.K. bond	62	0.614	0.126	0.147	0.726
Japan bond	76	0.329	0.032	0.000	0.968

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Backtest

U.S.: BENCHMARK *VS.* SIMULATED PORTFOLIO (FUTURES)

Evolution of USD position

Annual returns: benchmark vs. simulated

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Backtest

Evolution of EUR position

Annual returns: benchmark vs. simulated

Backtest

Evolution of GBP position

Annual returns: benchmark vs. simulated

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Backtest

Evolution of JPY position

Annual returns: benchmark vs. simulated

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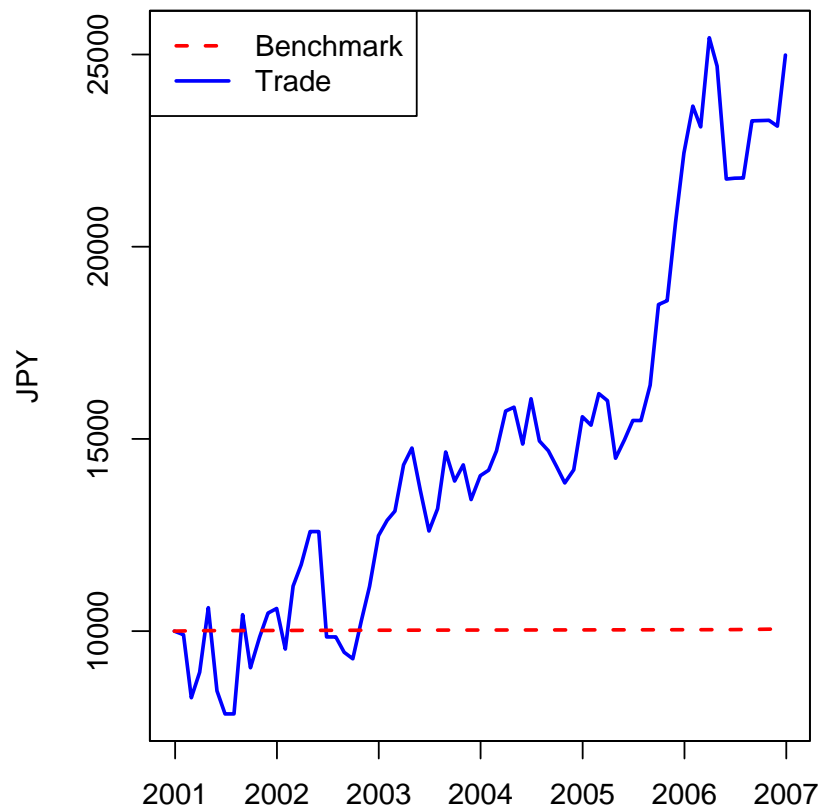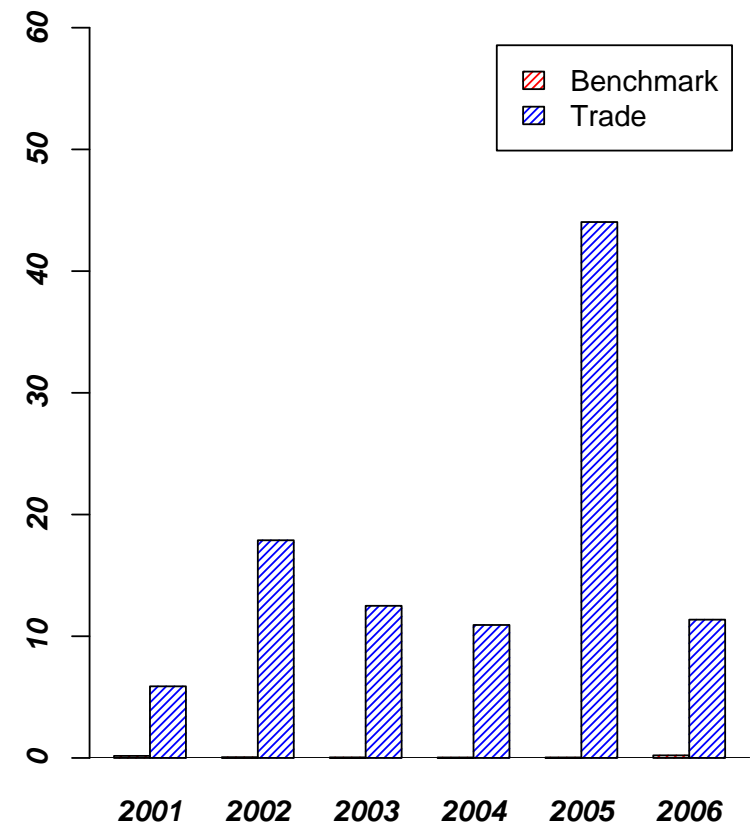
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Summary

- The pros outweigh the cons; the experience from using R by practioneers on a day-to-day is throughout positive.

- It has been demonstrated how easily R can be employed and integrated with other software, *i.e.* the Fair-Parke program.

- Results from a simple structural multiple equation model look promising in terms of forecast performance.

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Literature

⋆ Barrett, R., M. Berry, T. F. Chan, J. Demmel, J. Donato, J. Dongarra, V. Eijkhout, R. Pozo, C. Romine and H. Van der Vorst, *Templates for the Solution of Linear Systems: Building Blocks for Iterative Methods*, 2nd edition, 1994, Philadelphia, PA: SIAM.

⋆ Fair, R., *Specification, Estimation, and Analysis of Macroeconomic Models*, 1984, Cambridge, MA: Harvard University Press.

⋆ Fair, R., *Testing Macroeconometric Models*, 1998, Cambridge, MA: Harvard University Press.

⋆ Fair, R., *Estimating How the Macroeconomy Works*, 2004, Cambridge, MA: Harvard University Press.

⋆ Greene, W. *Econometric Analysis*, 5th edition, 2002, Upper Sadle River, NJ: Prentice Hall.

⋆ Judge, G., R. Hill, W. Griffiths, H. Lütkepohl and T. Lee, *Introduction to the Theory and Practice of Econometrics*, 2nd edition, 1988, New York, NY, John Wiley & Sons Inc.

⋆ Judge, G., R. Hill, W. Griffiths, H. Lütkepohl and T. Lee, *The Theory and Practice of Econometrics*, 1985, New York, NY: John Wiley & Sons Inc.

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