UseR in the financial sector

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# Table of Contents

**Section 01**  –  Overview  

**Section 02**  –  The case of R  

**Section 03**  –  Multiple equation model  

**Section 04**  –  Summary  

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Overview
Overview

- Using R in the financial sector
  - The pros and cons.
  - Examples.

- A structural multiple equation model
  - Purpose.
  - Model setup.
  - Implementation and results.

- Summary
The case of R

02
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.

The pros & cons

PROS FIRST . . .

■ 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].
The pros & cons

... AND SOME CONS

- **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.
Life with R at Invesco

**EXAMPLES**

- 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).
Multiple equation model
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.
■ 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.
Tinbergen’s arrow diagram

\[
\begin{align*}
&eq^{us} & eq^{eu} & eq^{uk} & eq^{jp} & bd^{us} & bd^{eu} & bd^{uk} & bd^{ip} & exog.var. \\
\hline
& t - 1 & & & & & & & & \\
& t & & & & & & & & \\
& t + 1 & & & & & & & & \\
\end{align*}
\]
■ 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.
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.
Dynamic and static ex post forecasts

U.S. EQUITY AND BOND

U.S. equity

U.S. Treasuries

Actual, dynamic, and static forecasts are compared. The graphs show the performance of S&P 500 and U.S. Treasuries with different forecasting methods.
Dynamic and static ex post forecasts

EUROZONE EQUITY AND BOND

Eurozone equity

Eurozone Bunds

Return Euro 10Y Benchmark p.a. %
Dynamic and static ex post forecasts

U.K. EQUITY AND BOND
Dynamic and static ex post forecasts

JAPAN EQUITY AND BOND

Japan equity

Japan JGBs

Nikkei 225

Return JPY 10Y Benchmark p.a. %

1995 2000 2005

1995 2000 2005

actual
dynamic
static

actual
dynamic
static
Backtest

- 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.
## Backtest

### FORECAST ERROR MEASURES

<table>
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<tr>
<th></th>
<th>hit rate (pct.)</th>
<th>Theil's U</th>
<th>Bias</th>
<th>Variance</th>
<th>Random</th>
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<td>Eurozone equity</td>
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</table>
Backtest

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

Evolution of USD position

Annual returns: benchmark vs. simulated

- Benchmark
- Trade

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Evolution of EUR position

Annual returns: benchmark vs. simulated
Backtest

U.K.: BENCHMARK VS. SIMULATED PORTFOLIO (FUTURES)

Evolution of GBP position

Annual returns: benchmark vs. simulated

Benchmark
Trade

2001 2002 2003 2004 2005 2006 2007

2001 2002 2003 2004 2005 2006
Backtest

JAPAN: BENCHMARK VS. SIMULATED PORTFOLIO (FUTURES)

Evolution of JPY position

Annual returns: benchmark vs. simulated

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Summary

- The pros outweigh the cons; the experience from using R by practitioners 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.
Literature


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