The RATSletter

Volume 13, No. 1 **September, 2000**

Estima

RATS Version 5!!!!

The long-awaited RATS Version 5 will start shipping at the end of September. The Windows release will come first, followed shortly by UNIX and Macintosh. This features extensively reworked documentation, which is now distributed as two smaller manuals (the *User's Guide* and the *Reference Manual*) rather than one large one. Several important new instructions have been added, and many other instructions have additional options or features.

New to version 5 are these instructions:

- **CVMODEL** estimates structural VAR's.
- **ECT** adds error correction effects to a VAR.
- **DLM** works with state space models, employing Kalman filtering and smoothing.
- **PFORM** creates panel series from other sources
- **PREGRESS** performs fixed and random effects estimation.
- **DENSITY** computes empirical density functions.

If you didn't update to 4.3, you will also see the instructions added then: **NNLEARN** and **NNTEST** for neural networks and **LQPROG** for linear and quadratic programming. RATS 5 also includes substantial improvements in support for non-linear estimation, including constrained optimization, additional optimization methods and more flexible specification of parameter sets. See *Non-Linear Estimation*, page 2.

The remainder of the newsletter describes the most important changes with this release. However, we can't fit all of them into a four page newsletter. A complete list of the changes, plus a great deal of other information about RATS 5 is available on the Estima web site (www.estima.com). Over 50 RATS instructions have been affected by this update, mainly by the addition of new options. However, almost any existing program should work. (It's possible that it can be done more cleanly with RATS 5, but it will still work.) There are only a couple of minor incompatibilities (the RESIDS option on **KALMAN** has been renamed, and the DROP option on **NLPAR** has been eliminated).

Our goal at Estima is to make it easier to do good econometrics, not to make it easy to do bad econometrics. While we have made some modest changes to the interface (the WINDOW options on a number of instructions, like **PRINT** and **THEIL** can be especially handy), the emphasis in our work on Version 5 has been on providing greater capabilities.

Pricing information is provided on page 2. You can order the update using our convenient on-line ordering system on the Web site, or you can FAX or mail the enclosed order form. *Be sure you include your serial number on all orders.*

New Manuals

The manual has been reformatted into the standard 7"x9" size for computer manuals, and separated into two main books, the *User's Guide*, which describes the use of the program through fully worked examples, and the *Reference Manual*, which provides the full syntax of the individual instructions. Much has changed in econometrics since the last full rewrite of the manual in 1992, and that is reflected in the new manuals. Significant features that were added to the program with versions 4.2 and 4.3 have now been fully incorporated into the main documentation.

Among the topics which are now covered, or covered in much greater detail are:

- Structural (identified, Bernanke-Sims) VAR's
- Blanchard-Quah decomposition
- ARCH and GARCH models
- Markov switching models
- Neural networks
- Hazard models
- Maximum likelihood in the frequency domain
- State space models

Some of these were within the capabilities of version 4.3 and have been the subject of newsletter articles in the past. Others, however, rely upon new features of the program.

The chapter on *Simulations, Bootstrapping and Monte Carlo* has been completely rewritten to reflect the increased interest in these methods over the past decade. There is a new chapter on *Non-Linear Estimation* which better describes the algorithms used in RATS, and explains the significant improvements that Version 5 brings in support of non-linear methods (see the story on page 2).

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Update/Upgrade Pricing

The base price for *updating* a single-user license to Version 5 of the same product is $125. This applies if you are updating from WinRATS32 4.x to WinRATS32 5.0, WinRATS (16-bit) 4.x to WinRATS 5.0, RATS386 (any version) to RATS386 5.0, MacRATS PPC 4.x to MacRATS PPC 5.0, or MacRATS '020 (any version) to MacRATS '020 5.0

If you are *upgrading* to a more powerful version of RATS (for example, moving up from PC RATS, RATS386, or the 16-bit WinRATS to WinRATS32), the cost is just $200. So, if you have one of these old PC or Mac versions, you can get a brand new program for a mere $200. You get all the new capabilities, plus access to the many user procedures developed over the past ten years (check these out on the Web site). We think you'll find this to be a terrific bargain.

We are still producing RATS386, a DOS extended memory version. However, it is becoming increasingly difficult to maintain this and you are urged to shift to WinRATS32.

The first two letters of your serial number indicate which product you have, as shown in the table below. For example, if you have serial number WEJ353, you have WinRATS32. The first price is the straight update, if available. The second shows the upgrade price to the top of the product line (WinRATS32 for the first five products and MacRATS PPC for the Macintosh versions). We will also cross-upgrade from the MacRATS versions to WinRATS32 and vice versa.

Product	Prefix	Update	Upgrade (Win32 or PPC)
WinRATS32	WE	$125	—
WinRATS-Plus	WP	$125	$175
WinRATS	WS	$125	$200
RATS386	L3	$125	$200
PC–RATS	L1	—	$200
MacRATS PPC	MP	$125	—
MacRATS '020	M2	$125	$200
MacRATS	M1	—	$200

Shipping charges are $0 to locations in the U.S., $15 to Canada, $50 to other countries and U.S. possessions.

Serial numbers like Nxxxxx, Cxxxxx, and Vxxxxx are for network, cluster or workstation licenses. The update prices for those depend upon the number of nodes. Please call or email us regarding update pricing for your site. This might also be a good time to increase the number of nodes on your license.

The update is free (shipping included) for anyone with a maintenance contract purchased with version 4. It is also free (though shipping is extra) for any RATS product purchased after May 15, 2000. For the latter, the last four digits on the serial number will be N765 or above. If you are entitled to a free update, just fill out an order form to request your copy.

While you're ordering RATS 5, take a look at some of the extras offered by Estima: CATS (for cointegration analysis), the Enders books and the X11 seasonal adjustment module.

Non-Linear Estimation

In addition to the new instructions **CVMODEL** (*Vector Autoregressions*, page 4) and **DLM** (*State Space Models*, page 4), there have been major changes that affect most of the non-linear estimation instructions. First, the method of specifying the set of free parameters has been made much more flexible. While before the parameters had to be individual REAL variables, they now can be complete matrices, such as a VECTOR. This makes it much simpler to write an estimation routine which can be adjusted to handle, for instance, differing numbers of lags. In addition, sets of parameters now form a new PARMSET variable. These can be combined using a simple "+" operation, allowing models to be created in pieces and combined only when estimated.

Previous versions of RATS included one "derivative-free" estimation method (the Nelder-Mead simplex algorithm), and that was only available on a few instructions. Version 5 adds a genetic search procedure, which allows a much broader (but slower) search of the parameter space. Most of the estimation instructions now offer a choice of SIMPLEX, GENETIC and one or two derivative-based methods which are appropriate for the models being estimated. The instruction **FIND**, which was fairly limited in the past, now provides a choice of methods and options similar to the other non-linear estimation instructions.

With Version 5 you can impose equality or inequality constraints on the parameters by adding the conditions to the parameter set. Using the PARMSET data type, this can be done very simply by defining the base set of parameters and the constraints separately, and then "adding" them.

```
nonlin(parms=base) mu1 mu2 mu3 p11 p12 p13 $
   p21 p22 p23 p31 p32 p33
nonlin(parms=relax) ep14 ep24 ep34
nonlin(parms=symmetry) p12=p21 p13=p31 $
   p23=p32
```

The option PARMS=BASE+SYMMETRY on an estimation instruction like **NLSYSTEM** will impose the symmetry conditions on the parameters included in BASE, while the option PARMS=BASE will do the same estimation without the constraints.

Finally, it previously was impossible to write a loop to define a vector of formulas because the loop index would take the value at the time of execution, making all the formulas identical. This can now be avoided by prefixing the loop index with **&**, which forces the index to take the value from the time of its definition. For instance,

```
dec vector b(n)
dec vect[frml] blackf(n)
nonlin gamma b
do i=1,n
   frml blackf(i) s(i) = $
      (1-b(&i))*gamma+b(&i)*market
end do i
```

Functions, Functions and More Functions

Version 5 adds quite a few new functions. Some are simple "bookkeeping" functions which can simplify calculations: %XSUBVEC and %XSUBMAT extract from a larger matrix a subvector, or submatrix. %VEC strings a matrix out into a vector. %BLOCKSPLIT and %BLOCKGLUE can break a matrix into submatrices and put the pieces back together.

Others fill some holes in previous versions of RATS. %SORT, %RANK and %FRACTILES sort, rank and compute fractiles for a matrix or vector. These operations previously could be applied only to a data series.

The new function %DO allows a "loop" to be embedded within another calculation. This makes it easier to write formulas which can adapt to a changing number of states. For instance, the following computes the "ARCH" and "GARCH" parts for a model with *p* ARCH lags and *q* GARCH lags.

```
frml arcpart  = $
  v=0.0,%do(i,1,p,v=v+b(i)*u{i}**2),v
frml garchpart = $
  v=0.0,%do(i,1,q,v=v+c(i)*h{i}),%ovcheck(v)
frml hf = s+archpart+garchpart
```

The %S function also adds a capability previously unavailable in RATS: the ability to generate series names on the fly. %S(*label expression*) creates or references a series with name given by the expression. Combined with the %L function (which pulls the label off a series), this simplifies the process of repetitive operations with series. For instance,

```
dofor serlist = usgdp to ukgdp
   set %s('log'+%l(serlist)) = $
      log(serlist{0})
end do
```

creates series LOGUSGDP,...,LOGUKGDP for a set of GDP series.

Cross Section and Panel Data

Version 5 provides two new instructions to support the use of panel data within RATS. The first is **PFORM**, whose job it is to create a properly formed panel data series from either a collection of time series, or from a cross section-time series data set which isn't formatted as RATS would like (because, for instance, it is grouped by time rather than individual). The other is **PREGRESS**, which estimates linear regressions on panel sets using fixed or random effects. In addition, **PSTATS** can handle unbalanced as well as balanced data sets.

And while RATS still specializes in time series techniques, we've added some additional documentation on cross section methods, including ordered probits and hazard models.

Probability and Random Numbers

Version 5 offers the main probability distributions and their inverses: Normal, χ^2, *t* and *F*. Density functions are provided for the Normal, χ^2 and *t*, as well as the multivariate Normal. Factorials and binomial coefficients are now available as well. Random numbers can be drawn from uniform, Normal and gamma distributions, and now random matrices can be drawn from a Wishart distribution. Version 5 also provides the new instruction **DENSITY**, which can estimate a density either by binning or by kernel methods. For instance,

```
density gdpgrowth / sgrid sdensity
```

estimates a density function for GDPGROWTH using the default Epanechnikov kernel with default bandwidth.

The main change, though, has been a substantial increase in documentation. Techniques like Gibbs sampling and approximate randomization could be done with earlier versions of RATS—we've now included them as topics in the manual.

Graphics

The **SCATTER** instruction has received the most attention in this release. It now offers several new styles, including bars and filled polygons, to allow graphing histograms; it will now be possible to do overlay (two-scale or two style) graphs; grid lines and shading boxes can be included in either the horizontal or vertical directions. **SCATTER** and **GRAPH** now offer the option of log scales (**SCATTER** on either one or both axes).

Version 5 also offers the ability to save graphs automatically as formats other than just the RGF (RATS graphics format). You can now set up a program to produce many graphs and have them saved as PostScript or Windows Metafile.

Input and Output

RATS 5 supports a number of new input and output formats. It now can take input from Excel files through Excel 97. Data output can be comma-delimited or formatted as an HTML table, in addition to the formats previously available.

The **DISPLAY** instruction has been greatly improved. It can now output full arrays (which previously could be done only with **WRITE**), and has tab stops (left, right, centered and decimal) and improved picture codes for formatting numbers. Picture codes are now available also for the **PRINT** instruction so you can control the number of digits displayed.

Most instructions which produce table output (such as **PRINT**, **FORECAST** and **THEIL**) now include an option to present this in a (read-only) spreadsheet window (Windows and Macintosh only). This data can then be exported in any of several formats (including Excel, HTML, comma-delimited), considerably simplifying the task of reporting results.

Vector Autoregressions

Version 5 adds the instruction **CVMODEL**, which estimates Bernanke-Sims style covariance matrix models. This estimates by maximum likelihood almost any model of the form

$$\mathbf{A}\mathbf{u}_t = \mathbf{B}\mathbf{v}_t \;;\; E(\mathbf{v}_t\mathbf{v}_t') = \mathbf{D} \;;\; \mathbf{D}\ diagonal$$

under the assumption of Normal residuals. It is much more flexible than the old BERNANKE procedure, which could deal only with **B**=0 and a specific form for the **A** matrix. The following is an example of its use, estimating an **A** matrix of the form

$$\begin{bmatrix} 1 & 0 & 0 \\ -\gamma & 1 & 0 \\ -\delta & 0 & 1 \end{bmatrix}$$

```
nonlin gamma delta
dec frml[rect] afrml
frml afrml = ||1.0,0.0,0.0|$
             -gamma,1.0,0.0|$
             -delta,0.0,1.0||
compute gamma=0.0,delta=0.0
cvmodel(method=bfgs,factor=sfactor) $
   %sigma afrml
errors(model=model3,decomp=sfactor) * 24
```

In addition, it provides the simplex and genetic methods (see *Non-Linear Estimation*, page 2), in addition to the BFGS algorithm. The wider search provided by the genetic algorithm is extremely helpful with these models, as they often have a poorly behaved likelihood surface.

Other improvements are:

- The instruction **ECT** (for *E*rror *C*orrection *T*erm) can be included in a VAR definition to impose an error correction structure on the system.
- The residuals on a VAR and the forecasts or impulse responses from a system can now be saved into a VECTOR or RECTANGULAR of series using a simple option. These are much easier to handle than old blocks of numbered series.
- A VAR can now be defined using a MODEL option which combines the equations in a single entity. This considerably simplifies the syntax for instructions like **IMPULSE** and **ERRORS**. For instance,

  ```
  impulse(model=cmodel,results=imps) * 20
  ```

  can replace the old **LIST** and **CARDS** lines.
- **ESTIMATE** and **KALMAN** provide a COHISTORY option which allows you to save easily the coefficient history from a sequential estimation of a model.

State Space Models

RATS has had a version of the Kalman filter since its initial release. However, this was designed very specifically to estimate sequentially the coefficients of linear equations, from a VAR in particular. A more general use of the Kalman filter required either standing the existing setup on its head in order to redefine the state vector, or using one of the procedures KFILTER or KSMOOTH, which were still somewhat limited.

RATS 5 now adds the instruction **DLM**, short for *D*ynamic *L*inear *M*odel. This is designed to analyze models of the form

(1) $\mathbf{X}_t = \mathbf{A}_t\mathbf{X}_{t-1} + \mathbf{w}_t$, and

(2) $\mathbf{Y}_t = \mathbf{c}_t'\mathbf{X}_t + \mathbf{v}_t$

using the techniques of Kalman filtering and Kalman smoothing, or, to solve by dynamic programming the problem

(3) $\mathbf{X}_t = \mathbf{A}_t\mathbf{X}_{t-1} + \mathbf{B}_t\mathbf{U}_t + \mathbf{w}_t$

(4) $\mathbf{Y}_t = \mathbf{c}_t'\mathbf{X}_t + \mathbf{v}_t$, with the objective function

(5) $E\left(\mathbf{X}_0'\mathbf{Q}_0\mathbf{X}_0 + \sum_{t=1}^{T}\left\{\mathbf{X}_t'\mathbf{Q}_t\mathbf{X}_t + \mathbf{U}_t'\mathbf{R}_t\mathbf{U}_t\right\}\right)$

These can either be solved out, assuming that the matrices governing the processes are known; or, you can estimate free parameters within these matrices, by maximum likelihood for the state space model, or by minimizing the objective function over the choice of parameters for dynamic programming. The following is an example. Note how a mixture of fixed arrays and FRMLs of arrays are used for the different components, depending upon whether they are constant throughout the estimation, or vary either across time (which the YF formula does), or across parameter settings (AF).

```
nonlin mu phi theta
dec frml[rect] af
dec frml[vect] yf
dec frml[symm] sx0f
dec rect c
dec symm sw
compute sw=||1.0|1.0,1.0||
compute c=||1.0|0.0||
frml af = ||phi,theta|0,0||
frml yf = ||y-mu||
frml sx0f = %psdinit(af(t),sw)
dlm(a=af,y=yf,c=c,sw=sw,sx0=sx0f,$
  method=simplex,trace) 1960:2 1999:4
```

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