

# The RATSletter

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## What's Inside

We have quite a bit of news to share with you.

First, we are continuing our improvements to the RATS program. To that end, we are releasing version 5.04. A description of the new features is provided in the next column. If you have RATS Version 5.00 through 5.03, you can download the update at no charge from our website. You simply need to download and run a patch file that updates your existing copy of RATS. You need to be careful to get the patch for your current version, as a patch over 5.02 is different from 5.03. Macintosh and UNIX users can request a free copy of the update via e-mail. To request your update, just e-mail us at [estima@estima.com](mailto:estima@estima.com). Please be sure to include your name and your RATS serial number in the e-mail.

You can also purchase a copy of the update on CD. The cost is just \$15 for users who already have Version 5.0. If you are using an older version of RATS, please visit our website or contact us for details on updating.

If you want to avoid the small charges for the interim releases, you can get a "maintenance contract." For a single user license, the cost is \$150 to receive all 5.xx releases, plus 6 when it becomes available. The shipping charge is the same as our current charge for a RATS package (\$0 for US, \$22 for Canada and US Possessions and \$50 elsewhere). Call for pricing on multi-user licenses.

Walter Enders, the author of *Applied Econometric Time Series* and the *RATS Handbook for Applied Econometric Time Series* has written an "e-book" entitled *RATS Programming Manual*. This can be downloaded (at no charge) from our web site. This provides a very detailed discussion of the programming features of the RATS language, in almost all cases starting with simple examples, then "jazzing them up" to provide better output and greater flexibility. A fuller description of the book is provided on page 3. We would like to thank Prof. Enders for contributing this important piece of work.

We are continuing to develop a set of example programs to demonstrate the techniques covered in various textbooks. As of this writing, we have a full set from three books, ranging from introductory forecasting through advanced graduate econometrics. See the story on page 4.

As part of this process, we have written or improved upon quite a few procedures, including some old favorites like BJIDENT. See the list on page 2. Note, by the way, that we now have an alphabetical list of all the procedures, plus an internal search engine to allow a search of the website and the procedure files by topic.

## New Features of RATS 5.04

### User Interface

We've added quite a few toolbar icons. Among these are "I" and "O" (for the *Window-Use for Input*, *Window-Use for Output* operations), and an often-requested tool bar button for *File-Clear Program*.

There is also a new button which brings up a dialog for locating the name or syntax of a RATS function. With nearly 200 functions, it can be hard (even for us) to keep track of the names and parameter orders. This is similar to the "Insert Function" operation in Excel: the functions are grouped into categories, and if you select one, you can fill in the arguments within the dialog box. RATS will even allow you to do a syntax check, to make sure you have valid arguments.

The matrix editor brought up with the **MEDIT** instruction has "max" and "min" buttons which will move the selector to the largest and smallest values in the table, respectively. This can be very handy when scanning, for instance, for a minimum AIC value.

### Graphics

The **GRTEXT** instruction has been greatly improved. You can add text that covers multiple lines by using "\" to show line breaks. There is a new **POSITION** option which allows you to place the text in one of the four corners (**UPLEFT**, **UPRIGHT**, **LOLEFT**, **LORIGHT**). If you use the **GRTEXT** before the **GRAPH** or **SCATTER** instruction, you can position the text in the **RIGHTMARGIN**, which adds a text box on the right, then shifts the graph over. There is also a **BOX** option, which puts a box around the text. The "\" for line breaks can also be employed in key labels. See page 4 for more on **GRTEXT**.

**GRAPH** has a new choice for the location of the key (**KEY=ATTACHED**), which locates the key labels near the lines on the graph. This places the keys at locations at which the labeling will be as unambiguous as possible.

### Programming

RATS will now issue a trace back when it encounters a (RATS) error (like incompatible dimensions in a matrix operation) during the execution of a procedure. We have found this *extremely* useful in the few months we've had it in operation. It will now identify the line number and procedure at which the error occurred, and the line number and procedure which called it, and so on, through the entire list of callers. With some RATS procedures now including many thousands of lines of code, and hundreds of sub-procedures, we suspect that many users will also find this to be a major step.

(continued on page 4)

## New and Updated Procedures

There are quite a few new procedures available, as well as some significant improvements on some of our more popular procedures. Many of the changes in the old procedures have been additions to the graphics, particularly a greater use of the **GRTEXT** instruction to add numerical information about fit (such as  $Q$  statistics) to the graphs. (These, by the way, aren't yet using the improvements on **GRTEXT** which have been added with RATS 5.04).

### Updated Procedures

**BJIdent** has been updated to allow control of the number of autocorrelations computed, and has a **METHOD** option to allow choice between Burg and Yule-Walker algorithms. While the Burg method is the default, many other software packages use the Yule-Walker algorithm. This change will allow students to get results matching those obtained with other software. **BJEst** has seen similar changes.

**DFUnit** (for Dickey-Fuller Unit Root tests) has been updated with improved output. The default test method has also been changed to the  $t$ -test form.

**PDL** (Polynomial Distributed Lags) was substantially rewritten. It now will automatically generate a graph of the lag coefficients, and includes a number of new options.

**PFUnit** (for Phillips-Perron Unit Root tests) has been updated in parallel with **DFUnit**.

### New Procedures

**CrossCorr** (in **CROSSCOR.SRC**) computes and graphs cross correlations of two series, presenting the information as a 2x2 matrix of graphs, with the autocorrelations of the two series, lag and lead cross correlations in separate graphs.

**Imhof** uses the Imhof algorithm to compute the CDF of the quadratic form  $\mathbf{x}'\mathbf{A}\mathbf{x}$  where  $\mathbf{x}$  is a vector of  $N(0,1)$  variables. This can also be used to get the CDF of the ratio  $\mathbf{x}'\mathbf{A}\mathbf{x}/\mathbf{x}'\mathbf{B}\mathbf{x}$  since  $P(\mathbf{x}'\mathbf{A}\mathbf{x}/\mathbf{x}'\mathbf{B}\mathbf{x} \leq z) = P(\mathbf{x}'(\mathbf{A} - \mathbf{B}z)\mathbf{x} \leq 0)$ .

**RegANOVA** prints an analysis of variance table for the last linear regression.

**RegCorrs** computes and graphs autocorrelations, displaying also the  $Q$  statistic, AIC and SBC criteria for the residuals from the last regression or ARIMA estimation.

**RegCrits** computes Akaike, Schwarz Bayesian, Hannan-Quinn and FPE criteria for the last regression.

**RegPartCorr** (from **REGPCORR.SRC**) computes the partial correlations for the last linear regression.

**VARLagModel** (from **VARLAGMD.SRC**) computes the  $N \times N$  matrix of sums of the lag coefficients in the  $(I - A(L))y(t) = u(t)$  representation of a VAR model. This is the same matrix which **ESTIMATE** generates as **%VARLAGSUMS**, but can be used when the coefficients have been reset as part of a Monte Carlo procedure. Something like this is needed in order to do Monte Carlo analysis of a Blanchard-Quah decomposition.

## RATS in the Classroom

### Classroom RATS

We are continuing to offer the "Classroom" version of RATS, which is identical to the standard version of RATS in every way, except that it is limited to handling a maximum of 6,000 data points at any given time (for instance, 30 series of 200 data points each). *Classroom RATS* is available in two formats (at two price levels): with or without printed versions of the manuals.

Both versions include complete electronic copies of the manuals in Adobe's PDF format, so the only difference is the added convenience of having the printed books.

With the printed version of the manuals, the price for Classroom RATS is \$60. Without the hard copy documentation, the price is just \$40.

Professors can order copies themselves for resale to their students, or place an order through a university bookstore (minimum order of 5 copies).

### Student Discounts

For students who need more data-handling capability, we offer \$200 student discounts off any of the standard PC or Macintosh products. For example, WinRATS-32 is just \$300 with the discount, rather than the usual price of \$500. Proof of student status, such as a letter from a faculty member or a copy of a current registration receipt, is required.

### Network and UNIX/Linux Licenses

Estima also offers pricing plans for Network Windows or Macintosh or multi-user UNIX/Linux installations. Please contact Estima for a quote. Quite a few universities have old UNIX/mainframe licenses which haven't been updated and probably won't, as the old hardware is no longer in use. We'll offer a discount even for crusty old licenses for schools wishing to get up-to-date.

### Manuals

We're now on our second printing of the RATS version 5 manual. The second printing brings the documentation up to date with release 5.03. If you want to get a newer set of documentation, the cost is \$50 (plus shipping outside the U.S.)

## Econometric Society North American Summer Meeting

The North American Summer Meeting of the Econometric Society will be held in our hometown of Evanston, Illinois from June 26 through June 29. We're planning some type of reception for our users, so check our web site for information in June if you're going to be attending.

## RATS Programming Manual by Walter Enders

The *RATS Programming Manual* is an “e-book” which can be downloaded free of charge from the Estima web site (<http://www.estima.com/enders>). It was written by Walter Enders from the University of Alabama, author of *Applied Econometric Time Series* and the *RATS Handbook for Applied Econometric Time Series*, both published by Wiley and available for purchase from our web site. The description that follows was provided by Prof. Enders.

The idea for the *RATS Programming Manual* was born when I was invited to give an intensive two-day workshop on RATS at the Federal Reserve Bank of St. Louis. Workshop participants all had advanced degrees in economics or statistics and most were comfortable with the standard features of RATS. Shortly after, I was invited to present a similar two-week mini-course at the Catholic University in Brasilia.

The *RATS Programming Manual* is intended for those who are already familiar with RATS. The level is geared to the applied econometrician conducting the type of research that is suitable for the professional journals. As such, the manual emphasizes the instructions and options that enable you to simplify repetitive tasks, write your own advanced programs and procedures, and work with vectors and matrices.

The first chapter considers linear regression, nonlinear least squares and maximum likelihood estimation. The second chapter illustrates the new features introduced in RATS 5.0 that enable you to better estimate VARs and error-correction models. Special emphasis is given to the estimation of structural VARs using RATS’ new matrix handling instructions. Instead of focusing on particular econometric techniques, the last four chapters are organized around key programming concepts as they pertain to RATS. Towards that end, a number of simple programming ideas are introduced and subsequently refined into reasonably sophisticated programs. Since it is impossible to illustrate even a small portion of the vast number of potential programs you can write, the manual tries to teach by example. All of the examples use the single data set MONEY\_DEM.XLS and all of the examples are compatible with RATS 5.0. The outline is

- Chapter 1:** Linear and Nonlinear Estimation
- Chapter 2:** VARs and Error-Correction Models
- Chapter 3:** Loops over Dates and Series
- Chapter 4:** IF Statements and Monte Carlo Experiments
- Chapter 5:** Vector and Matrix Manipulations
- Chapter 6:** Writing Your Own Procedures

Let me borrow a few sentences from the first chapter. I tell my students that state-of-the-art research requires them to go “off the menu.” I’m being a bit facetious, but by the time a procedure is on the menu of an econometric software package, it’s not new. This book is especially for those of you who want to start the process of “going off the menu.”

## Multivariate GARCH, Revisited

We’ve updated our example of bivariate GARCH (GARCHMV.PRG, available on the web site) to include Robert Engle’s Dynamic Conditional Correlation (DCC) model (“Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models”, *Journal of Business and Economic Statistics*, July 2002).

This adds DCC to the roster of simple MV-GARCH, constant correlation, BEKK and vec that are demonstrated in that program. We’ve also made some other minor changes to the method of calculating the recursions in the existing models to provide extra flexibility in working on extensions. There are comments in the program’s header that describe these other changes.

DCC (as implemented in this example) uses univariate GARCH processes for each of the variances, plus a bivariate GARCH(1,1) model with scalar parameters, which is used only to provide the (time-varying) correlation between the two processes. This is one of the latest in a number of proposals to extend the GARCH model to multivariate settings (in practice, usually bivariate).

A straightforward extension, which uses a separate GARCH recursion on the three components of a 2x2 covariance matrix, faces all kinds of numerical problems. With separate models for the variances and the covariance, there is nothing constraining a model to produce a correlation at each time period that is less than one; nothing, that is, except an undefined likelihood function if a non-positive definite covariance matrix occurs. DCC, and most of the other methods cited, are parameterized to enforce positive definiteness.

With the simple extension, if the correlations among the return series are far enough from one, it’s quite possible that the model will estimate successfully, but it can be quite a different story if they are close to one. In testing our improvements to the non-linear estimation routines, we found that this type of model (with series with high correlation) is not easily approached using the “hill-climbing” methods like BFGS or BHHH.

Time and again, we found that the estimates would stall, pushing up a bump that ended up near the rather vague boundary where the model goes bad at one of the time periods. Despite an inability of the hill-climbing procedure to make improvements, a round of iterations with the genetic algorithm would find better points, often not all that far away in the parameter space.

Even if you get apparently well-behaved estimates, we would recommend the use of the genetic method as a check on the optimality.

## RATS 5.04, continued from 1

## Non-Linear Estimation

We made quite a few internal improvements in our non-linear estimation procedures, which are included in RATS 5.04 (most of these made it into 5.03 as well). We tested these on some problems known to be extremely difficult, such as the NIST benchmarks for non-linear least squares. One change which will be obvious to anyone running a non-linear estimator with the TRACE option is that we provide quite a bit more information about the progress from iteration to iteration. For the “hill-climbing” methods, this includes the cosine of the angle between the gradient and direction vector, an adjusted squared gradient (the adjustment is to correct for scale effects), and a “diagnostic measure.”

The diagnostic measure ranges between 0 (“perfect”) and 5 depending upon how well the estimation has been proceeding over the previous iterations. Pushing this in the “bad” direction are very short step sizes, squared gradients which go up, rather than down, and changes to the direction vector forced by a (nearly) zero or even negative cosine in the gradient-direction vector angle. This is used within RATS to determine if the hill-climbing process is stalling, and to make adjustments, such as trying more of a “steepest ascent” step to try to break out of the stall. It’s also used to determine whether estimation actually has converged when it seems to be impossible to improve upon the last iteration.

## Procedure Libraries

With RATS 5.04, you can designate a “library” of procedures to be loaded automatically, using either a /PROC option on the command line, or the instruction ENV PROC=*library name*. There will also be a preference file item you can set for this. The procedure library gets loaded right away, and will be reloaded if you clear the program to start a new analysis. Under Windows, for instance, you can set up several icons for RATS which load different procedure libraries, perhaps with support routines for different courses that you’re teaching, and another for your own research.

We’ve also taken the (probably long overdue) step of changing the default on the SOURCE instruction to NOECHO.

## New Functions, Operators

The operators .\* and ./ have been added to do element by element multiplication and division for matrices with identical dimensions. %EQNXVECTOR extracts the “x” vector for the explanatory variables of an equation at a given time period. %MATPEEK and %MATPOKE pull information out of (peeking) and put information into (poking) a larger matrix using an input set of coordinates and a vector.

## Textbook Examples

We’ve now added data sets and programs for doing the examples from two other textbooks: *Basic Econometrics*, 4<sup>th</sup> ed by Damodar Gujarati (McGraw-Hill) and *Elements of Forecasting* (2<sup>nd</sup> ed) by Francis Diebold (Southwestern). You can find these on the “Procedures and Examples” pages on our web site (www.estima.com). Both use some of the newly developed or improved procedures (see page 2). These are in addition to those for Wooldridge’s *Econometric Analysis of Cross Section and Panel Data*, which we described in the November 2002 newsletter. We’re working on several more texts, so keep an eye on the web site. At this point, our aim is to choose books that will provide us with a fairly broad range of examples. While the data sets are specific to the textbooks chosen, the techniques aren’t. Many of the examples are extensively commented, and sometimes include some extra analyses, and so can be quite helpful if you’ve adopted a different text.

In addition to these, there are other books which explicitly include discussions of RATS programs, including Enders’ *RATS Handbook for Applied Econometric Time Series*, Tsay’s *Analysis of Financial Time Series* (Wiley), Hayashi’s *Econometrics* (Princeton), and DeLurgio’s *Forecasting Principles and Applications* (McGraw-Hill). The Enders, Tsay and Hayashi books (among others) are available from Estima. Check the web site for pricing.

## Using GRTEXT

The instruction GRTEXT (G**R**aphics Text) has been around since version 4.2, but probably hasn’t had as much use as it deserves. The only procedure in which we’ve used it before was the CUMPDGM.SRC. GRTEXT allows you to place text on a graph at a specified location *within* a graph, not just on the margins with headers and axis labels. The use of an instruction like this can have significant advantages over an alternative procedure of generating a graph and then adding text manually. First, it’s perfectly reproducible. Second, it can be used to show numerical information. The following is taken from the updated BJEST procedure:

```
disp(store=qs) 'q=' %cdstat 'p-value' %signif
disp(store=cs) 'aic=' %aic 'sbc=' %sbc
...
grtext(entry=2,y=-.9,align=left,size=16) qs
grtext(entry=2,y=-.8,align=left,size=16) cs
```

To the graph of the residual correlations, this adds the Q stat and significance, and the AIC and SBC, putting them towards the lower left corner of the graph. Someone with several test ARIMA models would be able to look at just about all the relevant information for evaluating the fit of the model by looking at the graph with the included numbers.

For version 5.04, this can be simplified by using the \\ line break and POSITION option

```
disp(qstore=qs) 'q=' %cdstat 'p-value' %signif $
' \\aic=' %aic 'sbc=' %sbc
...
grtext(position=lolleft,size=16) qs
```

## The RATSletter

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