LIMDEP

Version 7.0

User's Manual

Revised Edition

by

William H. Greene

Econometric Software, Inc.

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LIMDEP

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Preface

LIMDEP is a flexible computer program for estimating the sorts of models most frequently analyzed with cross section data. Its range of capabilities include basic linear regression and descriptive statistics, the full set of techniques normally taught in the first year of a graduate econometrics sequence, and many advanced techniques such as nested logit models, parametric duration models, Poisson regressions with right censoring and nonlinear regressions estimated by instrumental variables and the GMM. *LIMDEP*'s menu of options is as wide as that of any other general purpose program available, though, as might be expected, longer in some dimensions and shorter in others (notably time series analysis). This is not an all purpose program which will solve every imaginable problem. In spite of claims to the contrary, that program does not exist. If it did, it would be impossibly cumbersome. Rather, our guiding principle in the construction of *LIMDEP* is a desire to make as many of the widely used techniques and nonlinear models as simple to apply as possible. *LIMDEP* is best suited to the analysis of cross sections and relatively standard problems of time series analysis, such as ARMAX models, distributed lags, and low order autocorrelation.

This program has developed over many years (since 1980), initially to provide an easy to use tobit estimator - hence the name, '***LIM***ited ***DEP***endent variable models.' The accumulated suggestions of many colleagues, students, and users too numerous to thank individually have led to the current package. In particular, the help of Aline Quester, Nathaniel Beck, Andrea Long, David James, Bill Spitz, Charles Hallahan, Terry Seaks, Rich Goldstein and Steffen Kuehnel has been considerable. Version 7.0 continues our periodic cycle of collecting, then incorporating the many suggestions we receive from our users. We also update *LIMDEP* every few years to incorporate new developments in econometrics and to meet the changing demands of our users.

Version 7.0 also reflects the major participation of David Hensher and Michael Lowe at Econometric Software, Inc., Australia. The Windows 95/NT version of *LIMDEP* was developed in collaboration with Michael Lowe.

To the best of our knowledge, the code of this program is correct as described. However, no warranty is expressed or implied. Users assume responsibility for the selection of this program to achieve their desired results and for the results obtained.

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Preface to Version 7.0

Version 7.0 of *LIMDEP* continues our efforts to produce major upgrades to the program while maintaining compatibility with earlier versions. Version 7.0 features a new set of estimation programs including **NLOGIT**, an *optional* FIML estimator for nested logit models, enhanced capabilities, a redesigned interface and, with this revision, full conversion to the Windows 95/NT operating system.

Revised Interface

Current *LIMDEP* users will see vast improvements in *LIMDEP*'s interface, such as:

- Conversion of the user interface to the Windows 95/NT operating systems
- Redesigned screens for input and output
- Greater use of menus and function keys
- Expanded **HELP** and a slightly abbreviated manual which is now in the help file.
- Greater use of algebraic syntax in mathematical commands (e.g., **b'x** instead of **Dot(X,b)**.)
- Full use of algebra in all logical expressions
- More informative diagnostics and a complete trace of execution, with diagnostics and indexation of commands to the output file
- Improved formats in all program output
- A program for constructing output tables of several sets of estimates

New Models

Version 7.0 features the following new estimation programs:

- Nested tobit models
- Grouped data models with sample selection
- Count data models with altered probability of the zero outcome
- Count data models with sample selection
- Bivariate probit models with heteroscedasticity
- Multivariate and multinomial probit models
- Random coefficients models
- Partial observability models
- Nonlinear multiple equations models and GMM estimators
- Bivariate tobit model
- Random effects tobit, probit, and logit models
- Fixed and random effects models for count data
- Random parameters logit model
- Models of heterogeneity and underreporting for count data

In addition to the new estimators, many new features have been added for manipulating panel data. With Version 7.0, all data panel models may be based on unbalanced data sets.

Nested Logit Models

NLOGIT is a full information maximum likelihood estimator for two to four level nested logit models. This full-featured, extremely flexible estimator is, to our knowledge, the only FIML estimator of its kind available as part of an integrated econometrics package. Users of **NLOGIT** will have all of *LIMDEP*'s functions available to them. **NLOGIT** is an *optional* feature of *LIMDEP* 7.0 and is sold separately.

New Programming Features and Tools

Version 7.0 offers added power and enhanced capabilities to existing commands as well as new programming features such as:

- Completely revised and simplified matrix algebra program
- Subroutines with parameter lists
- Loops using **DO FOR, DO WHILE**, and **DO UNTIL**
- Indexation of variables in lists for looping over a set of variables
- Revisions of the editor
- Major enhancements to **MINIMIZE**
- Bootstrapping and subsampling
- New commands for analyzing model results such as restrictions and hypothesis tests.

Marginal Effects

The computation of marginal effects has been automated for all of the limited and qualitative dependent variable models. This will eliminate the large amount of effort that was needed to obtain partial effects in models such as the multinomial logit, sample selection, and various probit models. With the addition of **;Marginal Effects** to the model command, you will now obtain a full set of statistical output (identifier, estimate, P-value, and t-ratio) for all estimated marginal effects computed at the overall sample means and at the means of additional strata that you may specify.

Constraints and Tests

All models estimated with *LIMDEP* may now be specified with equality and fixed value restrictions. The **;Rst=specification** feature that was introduced in Version 6.0 to allow cross equation equality restrictions in the multinomial logit model has now been extended to all of the other nonlinear models in *LIMDEP*'s menu. This option allows you to force coefficients in a model to equal other coefficients or to take fixed values rather than be estimated.

LIMDEP contains many tools for carrying out hypothesis tests, including Wald, LM, and LR tests. The programming features now make it easier to carry out tests of nonnested hypotheses. Version 7.0 provides a new feature that will allow Wald tests of any number of sets of linear or nonlinear restrictions of the parameters of any model. Every model command can be followed immediately by as many **WALD;... restrictions$** commands as desired. A standard set of labels is provided which makes them simple to use and invariant to the model specification. (Version 6.0's **;Test** option requires that parameters be identified as B(j) where j is the position of the parameter in the coefficient vector. Thus, if the specification changes, so must the restriction. In Version 7.0, coefficients are denoted B_name, where 'name' is the name of the variable multiplied by the coefficient. This does not change from one model to another.)

Incompatibilities Between the Windows and DOS Versions

There are a number of major differences between the Windows and DOS versions of *LIMDEP* 7.0, including, of course, the obvious change to a screen, menu oriented interface. But, we emphasize that the differences that do exist concern only how instructions are given to the program. There are no differences in the statistical capabilities of the two programs or in their other data manipulation routines. In general, many options exist in the Windows program that are not available in the DOS program. In addition, some of the commands in the DOS program are absent from the Windows program, or are handled in a different fashion. The following lists the major differences in the basic operation of *LIMDEP*:

- **DEMO**: The Windows program does not contain the demonstration.
- **DISK**: Features of the file system are handled using Windows' standard features
- **EDIT**: The screen text editor in the Windows program replaces the DOS command prompt.
- **EXTRACT**: Large data sets are no longer handled with temp files. (See Chapter 5.)
- **LOAD/SAVE**: These work as before, but operate more easily in the File menu.
- **PAUSE**: Output is accumulated in the output window, and can be reviewed as desired.
- **PRINT**: Data listings should be sent to a file, then printed later if necessary.
- **RESET**: This operation is handled with the Project menu.
- **REVIEW**: This command is now available in the Tools menu.
- **SHOW**: You can bring a file into the editor, but better to switch to another window. To SHOW a file, just use File:Open in the main screen menu.
- **STATUS**: Operation of the project window replaces this function. (See Chapter 3.)
- **STOP/EXIT/QUIT**: Select File:Exit to leave *LIMDEP*.
- **SYSTEM**: You can just open a DOS window for this function.

This manual contains separate instructions on operation of the two programs. Other differences between the Windows and DOS programs are described in Chapters 2 and 3. A full summary of the Windows menus is given in Section 3.10.

Incompatibilities Between Versions 6.0 and 7.0

Version 7.0 is nearly fully backward compatible with Version 6.0. The only substantive difference is in the matrix commands listed below, though users of the bivariate probit model should make note of the change in the way that fitted values are computed for this model. Users of Version 6.0 may note that SAVE files written by Version 7.0 are far smaller than their Version 6.0 counterparts. This is due to a much more efficient way of storing the information. Nonetheless, SAVE files written with Version 6.0 can be read by Version 7.0. We do suggest that Version 6.0 SAVE files be recreated with 7.0, as some additional information is being placed in the newer files. (Of course, SAVE files written by Version 7.0 cannot be read by Version 6.0.)

Matrices

In matrix commands and programs, a matrix that is specified by enumerating its elements must now be enclosed in square brackets, i.e., '[...].'. This applies to both sets of numbers which comprise matrices and to sets of matrices which comprise partitioned matrices. For examples,

MATRIX ; A = 1,2 / 3,4 $ must now be **MATRIX ; A = [1,2 / 3,4] $**
and **MATRIX ; A = M11/M21,M22 $** must now be **MATRIX ; A = [M11/M21,M22] $**.

Because of the variety of different arrangements that may appear, the effect of omitting the brackets is unpredictable. In most cases, a diagnostic will appear, but in others, a matrix different from the intended one will be created without apparent error. For instance, the first example above creates a 1H1 matrix containing 1.0000.

Panel Data Models

Frontier models with panel data previously used

; Pds = T for fixed number of periods,
; Lhs = Y,Ti for variable number of periods.
They now use **; Pds = T** where T is the fixed number of periods,
or **; Pds = Ti** where Ti is the count variable for variable group sizes.

This same syntax is also used for **LOGIT**, **TOBIT**, **PROBIT**, and **POISSON**. Since none of these four commands with variable number of periods (or fixed for **TOBIT** and **POISSON**) were available in Version 6.0, **FRONTIER** is the only command actually changed by this update.

Loglinear survival models (**SURV ; Model = ...**) with time varying covariates that were set up like panels were previously specified with

SURV ; Lhs = Time, Censor, Ti ; ...

where **Ti** gives the number of records, which could vary by observation, or could be fixed. This syntax is still supported, but users may use, instead,

SURV ; Lhs = Time, Censor ; Pds = T or Ti,

where **Ti** may be a number if every observation has the same number of periods, or it may be a variable, used exactly the same as before.

Bivariate Probit Predictions

Predicted values for the bivariate probit model are computed as follows:

1. Compute the four cells for the bivariate distribution based on $\mathbf{b_1}'\mathbf{x}_1$, $\mathbf{b_2}'\mathbf{x}_2$,D. We then compute

$$P[y_1=1,y_2=1] = BVN(\mathbf{b_1}'\mathbf{x}_1,\mathbf{b_2}'\mathbf{x}_2,D)$$
$$P[y_1=1,y_2=0] = M(\mathbf{b_1}'\mathbf{x}_1) - P[y_1=1,y_2=1] = P[y_1=1] - P[y_1=1,y_2=1]$$
$$P[y_1=0,y_2=1] = P[y_2=1] - P[y_1=1,y_2=1]$$
$$P[y_1=0,y_2=0] = 1 - P[y_1=1,y_2=0] - P[y_1=0,y_2=1] - P[y_1=1,y_2=1]$$

2. The prediction is then the (y_1,y_2) associated with the cell with the largest probability.

In Version 6.0, the bivariate frequency distribution listed after the coefficient output was computed using the univariate probabilities. I.e., If $\mathbf{b_1}'\mathbf{x}_1 > 0$, predict $y_1=1$, and likewise for y_2. In Version 7.0, the bivariate distribution is used instead.

SAVE Files

Version 6.0 provided a method of using a 'SAVE' file to store some intermediate results. (See the Version 6.0 manual, page 60.) In particular, this file allowed you to put in a file

1. The listing of variables produced with the **;List** option on model commands,
2. The parameters and covariance matrices after estimation, and
3. The raw second moments, means, standard deviations, covariance matrix, and correlation matrix from **DSTAT**.

This has been discontinued. All of the results above can be placed directly into the output file. For 1, it is automatic. For 2 and 3, simple **MATRIX** commands, with **;List** will produce the same results. The use of this type of file has been discontinued. *Note this **not** the file associated with the **SAVE** command discussed above.*

OR in Logical Expressions

In Version 6.0, the '+' character was used to indicate 'OR' in logical expressions, such as **CREATE;If(AGE=0 + INCOME=0)BADDATA=1$** in which **BADDATA** equals 1 if **AGE** equals 0 or if **INCOME** equals 0. In Version 7.0, the operator '|' is used instead. Thus, the counterpart to the command above is **CREATE;If(AGE=0 | INCOME=0)BADDATA=1$**

BEEP and NOBEEP

The **BEEP** and **NOBEEP** commands have been dropped. In addition, all beeping at the end of file entry, procedure entry, etc. has been discontinued. (*LIMDEP* is quieter.)

Some Common Questions

The following are some of the questions most commonly asked about using *LIMDEP*:

In reading a data file, *LIMDEP* claims to have reached the end of the file after reading exactly one half of the observations. Why?

1. Your format statement is inadequate. For example:

   READ ; File = ... ; Nvar = 3 ; Format = (2F5.3) ...

   This command reads three variables but gives only two format codes. This requires two lines of data per observation. The second line is used to give the third variable, and one number is lost.
2. (Very unlikely) You do not have a format statement. But, the data file that you are using has lines that are over 300 characters wide. *LIMDEP* reads 300 characters. If it does not find all of the values it expects, it goes to the next line.

The iterations failed to converge. A diagnostic stated that a minimum of the function could not be found.

This is common with models with correlation coefficients, such as the selection models and the bivariate probit models. It should not happen with univariate probit or any kind of logit models. It should be quite rare with LDVs such as the tobit model. Check:

1. Scaling the data. Are the variables of very different magnitudes? Try to avoid this. This is especially problematic in routines that involve quadrature (random effects probit/ordered probit) and in routines that fit correlation coefficients (bivariate probit).
2. Collinearity is also a problem in nonlinear models.

A strategy: When you are having trouble estimating a model, try estimating it with a very small subset of the variables. Choose one or two independent variables (for each equation if necessary) and estimate with just them (even if you do not believe the specification). Build up the model from a small base. When problems emerge, you will know where to look in the data.

Why isn't *LIMDEP* able to read my Excel spreadsheet file?

Current Windows versions of these programs write an enormous amount of superfluous (for our purposes) information into these files, and *LIMDEP* gets confused by it. But, if you use either of these programs to create your data, at the time you wish to *write* the spreadsheet file, go to the menu of file types and choose the .WK1 format. *LIMDEP* will be able to read the .WK1 file.

The log-likelihood function for my model is positive. Is this possible?

Log-likelihood functions are only required to be negative for models with discrete dependent variables. Tobit models, regression models, duration models, etc. are based on continuous distributions. Thus, the log-likelihoods for these models can be positive.

During the iterations, I get a diagnostic that a variance (or standard deviation) is not positive or that a correlation coefficient is outside the admissable range (-1,+1). Does this mean my estimates are not useable?

No. *LIMDEP* searches for the maximizer of a log-likelihood by taking a step from a valid parameter estimate toward a new estimate. If the new estimate is invalid, as in the query, *LIMDEP* issues a warning, then tries a shorter step. If the iterations ultimately did converge, then the warnings can be ignored. If convergence is not achieved, the warnings might be helpful in finding out why.

The Cox proportional hazards model seems to take a very long time to iterate.

It does. This model is extremely computation intensive. Every iteration requires essentially N^2 passes through the data, not just one.

Can I expand the data array?

For the DOS program, use a temp file. You can in the mainframe version. See the Appendix. In the Windows program, you need only adjust the workspace to whatever amount of space you need. The program handles everything else. See Section 3.10.2.

My computations require a matrix larger than 10000 cells.

Unfortunately, this limit is hard coded into *LIMDEP*. On the other hand, you should *never* have to create a matrix whose length is the number of observations in the sample. Chapter 10 contains extensive details on how to handle data matrices. Chances are there is a way to do your computations without having to create a matrix this large.

If you believe you have found a bug in *LIMDEP*, please do the following:

If it is something obvious, just write or call and let us know. We'll fix the program and send a replacement with alacrity. But, it is much more likely that it will be something subtle. For example, suppose *LIMDEP* crashed in the middle of an iteration because it tried to take the square root of a negative number. This sort of thing usually requires us to execute the program with your data and your commands. Try to produce the error with as small a data set and command set as possible. Send us enough material, including your trace file and the data, so that we can reproduce the problem. When we find the problem, we'll fix it and replace your program. Please try to avoid sending huge data sets. Also, in almost all cases, it is extremely helpful if you can send us the TRACE.LIM file that is associated with your problem run.

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