Gretl Function Package Guide

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Contents

Chapter 1

Introduction

1.1 The purpose of function packages

The primary purpose of gretl function packages is to add estimators, hypothesis tests or other analytical procedures to gretl's repertoire of built-in procedures. While function packages may also be used for other purposes (e.g. pedagogy, replication exercises), those made available via the gretl server are expected to extend gretl's functionality in non-trivial ways.[1]

1.2 The form of function packages

The core component of a gretl function package—in simpler cases, the sole component—is a `gfn` file. This is an XML file conforming to the Document Type Definition `gretlfunc.dtd`, which is supplied in the gretl distribution; the latest version can always be found online.[2] Such files contain

- the hansl code for at least one function;
- various items of metadata (author, version, date, etc.);
- help text for the function(s), or a pointer to help in PDF format; and
- a sample script that illustrates a call to the packaged function(s).

While it is possible in principle to create and edit a `gfn` file "manually", using a suitable text editor, this is not recommended. Gretl provides tools (both command-line and GUI) to create and maintain package files, such that authors are not required to mess with raw XML.

We will refer to packages that consist of a gfn file alone as "simple packages" (the included hansl code may not be simple, but the structure is).

The alternative to a simple package we will call a "zip package". Such packages take the form of a PKZIP archive containing a `gfn` file along with other materials, which may include PDF documentation (in place of plain text help), data needed by the package for internal use (for example, tables of critical values for some test statistic), and/or extra data files or scripts intended to supplement the required sample script. Zip packages can be built using command-line tools or with the help of the gretl GUI.

One point to note about zip packages is that the PKZIP wrapper is actually just a storage and transport format. When such a package is installed, it is unpacked in a suitable location. Further details on this package format can be found in chapter 5.

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[1] For an extended discussion of the rationale for such packages see "Extending gretl: addons and bundles" (Cottrell, 2011). Note, however, that the distinction between regular packages and "addons" in that document has become somewhat blurred, as regular packages have gradually acquired many of the rights and responsibilities previously confined to official gretl "addons". On the rights side, regular packages are now able to hook into the gretl GUI; on the responsibilities side, contributed packages are now subject to (minimal) vetting before they can appear in the public download area on the gretl server.

[2] See `http://sourceforge.net/p/gretl/git/ci/master/tree/share/functions/gretlfunc.dtd`.

1.3 Using this document

Chapter 2 gives an account of function packages from the user's point of view. Even those who are familiar with packages might want to take a look, since there are some finer points that might not be totally evident. Moreover, there are several changes and enhancements in recent gretl versions.

Chapter 3 gives a walk-through of the means of creating, refining and publishing function packages, both via the command-line and via the GUI.

Chapters 4 and 5 provide reference material on the details of package specification and structure, along with some tips on usage.

Chapter 2

For package users

2.1 The two package browsers

Since we'll be referring to the "browsers" for function packages quite a lot in the following, let us be clear up front about the two package browser windows in gretl and how they are accessed.

One of these windows shows the packages installed on your own computer. To open it, either select the menu item "File, Function packages, On local machine" or use the short-cut button labeled "fx" on the toolbar at the foot of the main gretl window. With a new installation of gretl there will not be much to see in this window at first.

The other browser shows all the packages available from the gretl server. It can be opened via the menu item "File, Function packages, On server." The same listing can be accessed via a web interface,[1] but for most purposes it will be more convenient to work from within gretl.

The two browsers are interconnected: from the "local machine" window you can open the "on server" one by clicking on the Network button in the toolbar (tooltip, "Look on server"), while from the latter you can open or focus the "local machine" window by clicking the Home button (tooltip, "Local machine"). They are also connected via drag-and-drop: one way of installing a package from the server is by selecting it in the server window and dragging it onto the local one.

When we use the term "package browser" below we will generally mean the local window; we'll add the qualification "on server" when we're talking about the other one. For screenshots of both browsers see section 2.2.1 below.

That said, let's move on to the business of getting hold of a function package of interest.

2.2 Acquiring a package

We'll focus here on packages available from the gretl server. These have passed a minimal checking procedure on the part of the gretl development team, designed to ensure that they are usable with the current version of gretl. This does not mean, however, that they are guaranteed to be bug-free, or to deliver accurate results; those responsibilities rest on the shoulders of the package authors.

Some authors may choose to make their packages available via other means. In that case, once the user has the package file available, either as a `gfn` file or a `zip` file (see section 1.2), the package can be installed using the instructions below (section 2.2.2).

2.2.1 Installing a package via the GUI

We'll use as an example Ignacio Díaz-Emparanza's `GHegy` package. Suppose you've read Ignacio's excellent paper on seasonal unit-root tests (Díaz-Emparanza, 2014) and you'd like to use his results. You were told a gretl package is available. Here's what you do. (We assume you have an Internet connection.)

Open gretl, and select "File, Function packages, On server". Since the package deals with seasonal unit roots, you'll probably want to look for the word "seasonal". After typing `seasonal` in the top-right search box and hitting the `Enter` key a few times, you find what looks like it (Figure 2.1).

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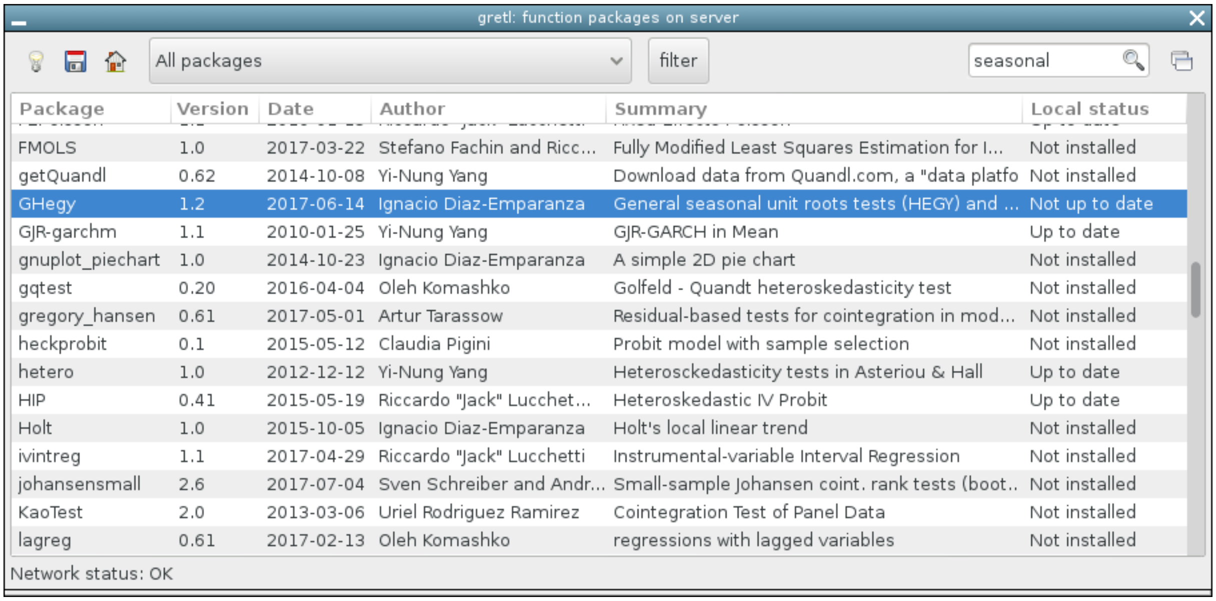
[1] See `http://gretl.sourceforge.net/cgi-bin/gretldata.cgi?opt=SHOW_FUNCS`.

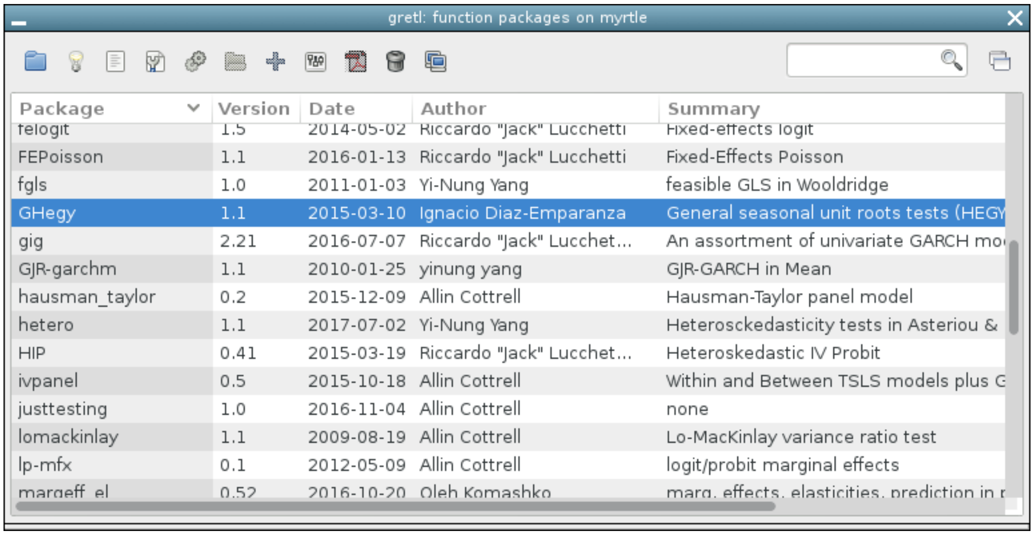


Package	Version	Date	Author	Summary	Local status
FMOLS	1.0	2017-03-22	Stefano Fachin and Ricc...	Fully Modified Least Squares Estimation for I...	Not installed
getQuandl	0.62	2014-10-08	Yi-Nung Yang	Download data from Quandl.com, a "data platfo	Not installed
GHegy	1.2	2017-06-14	Ignacio Diaz-Emparanza	General seasonal unit roots tests (HEGY) and ...	Not up to date
GJR-garchm	1.1	2010-01-25	Yi-Nung Yang	GJR-GARCH in Mean	Up to date
gnuplot_piechart	1.0	2014-10-23	Ignacio Diaz-Emparanza	A simple 2D pie chart	Not installed
gqtest	0.20	2016-04-04	Oleh Komashko	Golfeld - Quandt heteroskedasticity test	Not installed
gregory_hansen	0.61	2017-05-01	Artur Tarassow	Residual-based tests for cointegration in mod...	Not installed
heckprobit	0.1	2015-05-12	Claudia Pigini	Probit model with sample selection	Not installed
hetero	1.0	2012-12-12	Yi-Nung Yang	Heterosckedasticity tests in Asteriou & Hall	Up to date
HIP	0.41	2015-05-19	Riccardo "Jack" Lucchet...	Heteroskedastic IV Probit	Up to date
Holt	1.0	2015-10-05	Ignacio Diaz-Emparanza	Holt's local linear trend	Not installed
ivintreg	1.1	2017-04-29	Riccardo "Jack" Lucchetti	Instrumental-variable Interval Regression	Not installed
johansensmall	2.6	2017-07-04	Sven Schreiber and Andr...	Small-sample Johansen coint. rank tests (boot..	Not installed
KaoTest	2.0	2013-03-06	Uriel Rodriguez Ramirez	Cointegration Test of Panel Data	Not installed
lagreg	0.61	2017-02-13	Oleh Komashko	regressions with lagged variables	Not installed

Network status: OK

Figure 2.1: Finding GHegy among the packages on the gretl server

Skipping ahead a little, Figure 2.2 shows, for reference, the browser for *installed* packages—which we'll be mentioning from time to time—after GHegy has been installed.

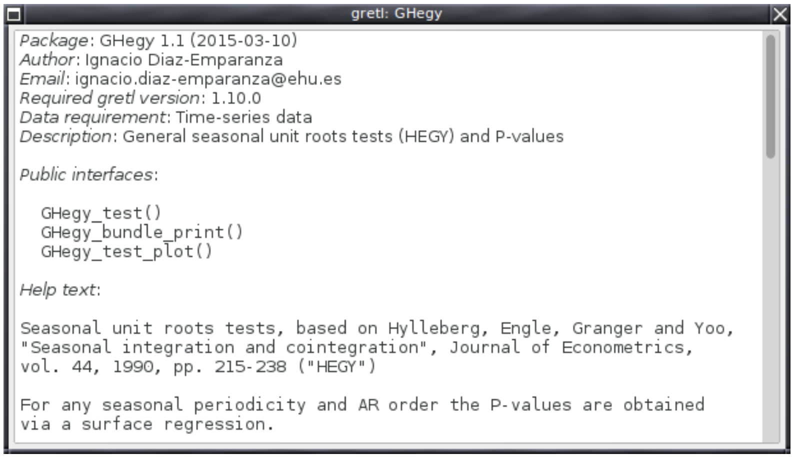


Package	Version	Date	Author	Summary
felogit	1.5	2014-05-02	Riccardo "Jack" Lucchetti	Fixed-effects logit
FEPoisson	1.1	2016-01-13	Riccardo "Jack" Lucchetti	Fixed-Effects Poisson
fgls	1.0	2011-01-03	Yi-Nung Yang	feasible GLS in Wooldridge
GHegy	1.1	2015-03-10	Ignacio Diaz-Emparanza	General seasonal unit roots tests (HEGY
gig	2.21	2016-07-07	Riccardo "Jack" Lucchet...	An assortment of univariate GARCH mo
GJR-garchm	1.1	2010-01-25	yinung yang	GJR-GARCH in Mean
hausman_taylor	0.2	2015-12-09	Allin Cottrell	Hausman-Taylor panel model
hetero	1.1	2017-07-02	Yi-Nung Yang	Heterosckedasticity tests in Asteriou &
HIP	0.41	2015-03-19	Riccardo "Jack" Lucchet...	Heteroskedastic IV Probit
ivpanel	0.5	2015-10-18	Allin Cottrell	Within and Between TSLS models plus G
justtesting	1.0	2016-11-04	Allin Cottrell	none
lomackinlay	1.1	2009-08-19	Allin Cottrell	Lo-MacKinlay variance ratio test
lp-mfx	0.1	2012-05-09	Allin Cottrell	logit/probit marginal effects
margeff_el	0.52	2016-10-20	Oleh Komashko	marg. effects, elasticities, prediction in

Figure 2.2: Browser for installed packages. It's quite easy to tell this apart from the "on server" window. Apart from their title-bars, this one has a lot more toolbar buttons (you can do more with a package once it is installed).

Returning to the installation process, to make sure what you've found is really what you want, you can get more information on the package, either by clicking on the "Info" icon (top-left in Figure 2.1), or by right-clicking on the package entry and selecting Info from the context menu. You'll be presented with a window like Figure 2.3.

Yes, this definitely looks like it. At this point, all you have to do is install the package: click on the "Install" icon in the browser window, or, again, right-click on the package entry. Gretl will now



Package: GHegy 1.1 (2015-03-10)
Author: Ignacio Diaz-Emparanza
Email: ignacio.diaz-emparanza@ehu.es
Required gretl version: 1.10.0
Data requirement: Time-series data
Description: General seasonal unit roots tests (HEGY) and P-values

Public interfaces:

```
  GHegy_test()
  GHegy_bundle_print()
  GHegy_test_plot()
```

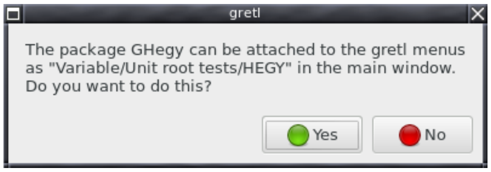
Help text:

```
Seasonal unit roots tests, based on Hylleberg, Engle, Granger and Yoo,
"Seasonal integration and cointegration", Journal of Econometrics,
vol. 44, 1990, pp. 215-238 ("HEGY")

For any seasonal periodicity and AR order the P-values are obtained
via a surface regression.
```

Figure 2.3: Get more info on GHegy

download the package from the server at Wake Forest University and install it.



The package GHegy can be attached to the gretl menus
as "Variable/Unit root tests/HEGY" in the main window.
Do you want to do this?

Figure 2.4: Let GHegy attach to a menu?

The final step of your installation is shown in Figure 2.4. Function packages may offer the option of integrating into gretl's GUI menus: in this case, the author chose to make it available among the other unit-root tests that gretl provides natively. You may choose to accept this option (which makes it handy to use the package from gretl's graphical interface) or not, if you don't want to clutter up your menus with anything more than the essential entries. Even if you say "No" here, however, the package will still be available to you from the GUI interface—it just won't have a dedicated menu entry. But note, this is not just a one-time option; see section 2.4.1 for an account of how to add or remove installed packages from gretl's menus.

Suppose, for now, you say "Yes" to GHegy's offer of a menu attachment. Then the HEGY unit-root test should be available where you'd expect to find it (Figure 2.5).[2]

2.2.2 Installing a package via the command line

An alternative mechanism is provided by gretl's `pkg` command, which can be invoked in the gretl console or in the command-line program gretlcli. In its "install" mode this command has three variants:

1. If you just type, for example,

   ```
   pkg install GHegy
   ```

   the presumption is that you mean to install a package named `GHegy` (either `.gfn` or `.zip`, that will be determined automatically) from the gretl server. So, another way of doing what we just walked through, if you know in advance exactly what you want.

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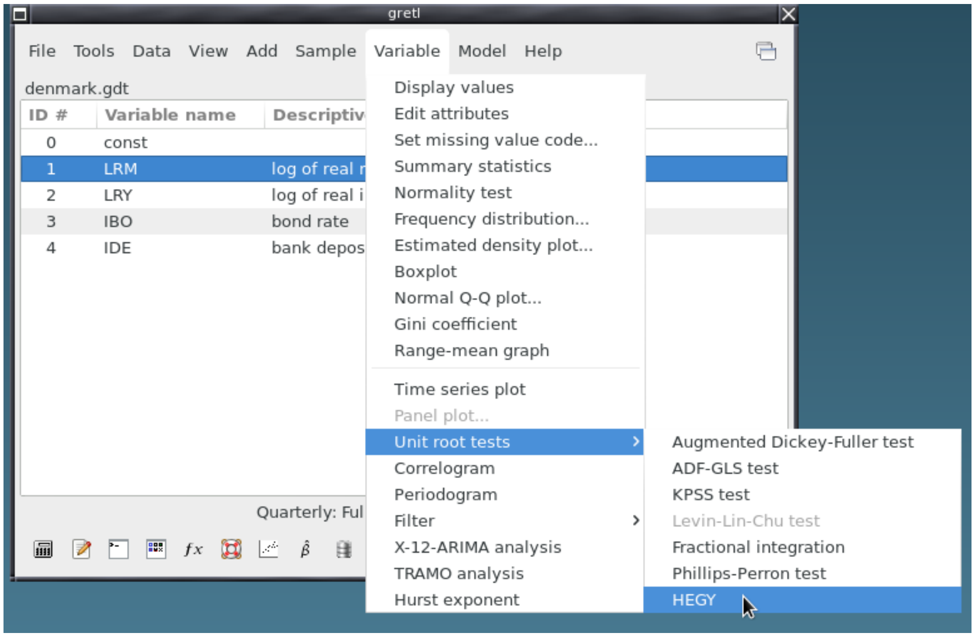
[2] You used to have to restart the program to get such dynamic menu items to appear, but from gretl 1.10.2 that's no longer necessary.



ID #	Variable name	Descriptiv
0	const	
1	LRM	log of real r
2	LRY	log of real i
3	IBO	bond rate
4	IDE	bank depos

Figure 2.5: The added menu item

2. Suppose a colleague has given you a link to a function package that's not on the gretl server. Then you can download and install it on your own machine using the full URL, as in

```
pkg install http://somewhere.net/gretl/splendid.gfn
```

3. Finally, suppose you have somehow got a copy of a function package independently of gretl: it's on your computer but not installed. Then, to install it you want the `--local` option (and you need to know the path to the file). So you might type

```
pkg install /Users/Me/Downloads/splendid.gfn --local
```

We have illustrated variants 2 and 3 of the `pkg` command with `gfn` files, but note that they will also work for packages in `zip` format.

2.2.3 Updating a package

Updating packages is easily done via the GUI. Look back at Figure 2.1: in the rightmost column of the browser for packages on the server you'll see a note of the local status of each available package, either "Up to date," "Not installed" or "Not up to date." (It may be necessary to expand the browser window or scroll to the right in order to see this column.) It's a good idea to visit this listing from time to time; if an installed package is marked as not up to date, just click the Install button to update it.

2.2.4 Uninstalling a package

This is also easily and intuitively done via the GUI. From the browser for locally-installed packages, select the package you want to get rid of and click on the "Unload/delete" icon, or right-click to the same effect.

You will be asked if you want to (a) unload the package from memory (only) or (b) remove it from your system. The former might be useful during an interactive session in which you want to clear up all the functions you have in memory and start from scratch with no possible confusion between functions you have written and those provided by a package. The latter is of course more radical, and requires you to reinstall the package if you change your mind.

Packages can also be removed via the command line: use the `pkg` command with the name of an installed package plus `--unload` or `--remove`. The former option unloads a package from memory and also removes its menu attachment, if any (see section 2.4.1); the latter option performs these actions but also deletes the package file(s).

2.3 Using function packages: the basics

The browser window for installed packages has quite a rich set of toolbar buttons and right-click context menu choices. If you're not sure what a button might do, try mousing over it to get a "tooltip." If you're still not sure, you might just try clicking it—gretl won't do anything destructive without asking for confirmation first!

We'll discuss some of the less obvious choices in the window later, but we would encourage you to explore.

2.3.1 Using packages via scripting

If you're interested in calling a function package via script you'll probably want to examine its "sample script." Hopefully this should provide a useful template. Opening the sample script is one of the options on right-clicking an installed package in the local package browser. Of course you should also read the help text for the function you want to call.

You'll want to start your script by using the `include` command to load the package in question, as in

```
include GHegy.gfn
```

Note that even if a package comes in zip format, it's the `gfn` file (which will be unpacked on installation) that you need to include. It will always have the same basename as the zip package that contained it.

The only effect of the `include` command above is to make the functions contained in the package available to you. To use them, you call them as if they were native gretl functions. So, for example, the sample script for `GHegy` contains the following commands:

```
include GHegy.gfn
open data9-3.gdt

# Tests with constant + dums + trend and fixed AR order 4,
# without printing the regression
bundle H1 = GHegy_test(reskwh, 0, 4, 3, 0)

# Tests with constant + dums, AR order determined by BIC with
# a maximum of 10, printing the regression
bundle H2 = GHegy_test(reskwh, 2, 10, 2, 1)
```

The purpose of the first two commands is obvious and needs no comment. However, the two invocations of the `GHegy_test` function may not be totally transparent. In general you should expect some documentation on (a) which functions are contained in the package and (b) their syntax: the parameters they accept, what they do, what they return.[3] To find this, go to the list of locally-installed packages and click on the "Info" icon. A text box will appear showing the documentation

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[3] This is something that the package authors are completely in charge of: we, as the gretl development team, try to ensure that packages obtained via the gretl server contain at least minimal documentation, but we cannot guarantee anything more.

provided by the package author. In the `GHegy` case, for example, not only are we told all we need to know about the `GHegy_test` function, but we also discover that the package contains two additional functions we can use, namely `GHegy_bundle_print` and `GHegy_test_plot`. So, for example, we could use the latter to enhance Ignacio's sample script, appending the line

```
GHegy_test_plot(&H2)
```

Running it will then produce a graphic similar to the one displayed in Figure 2.6.

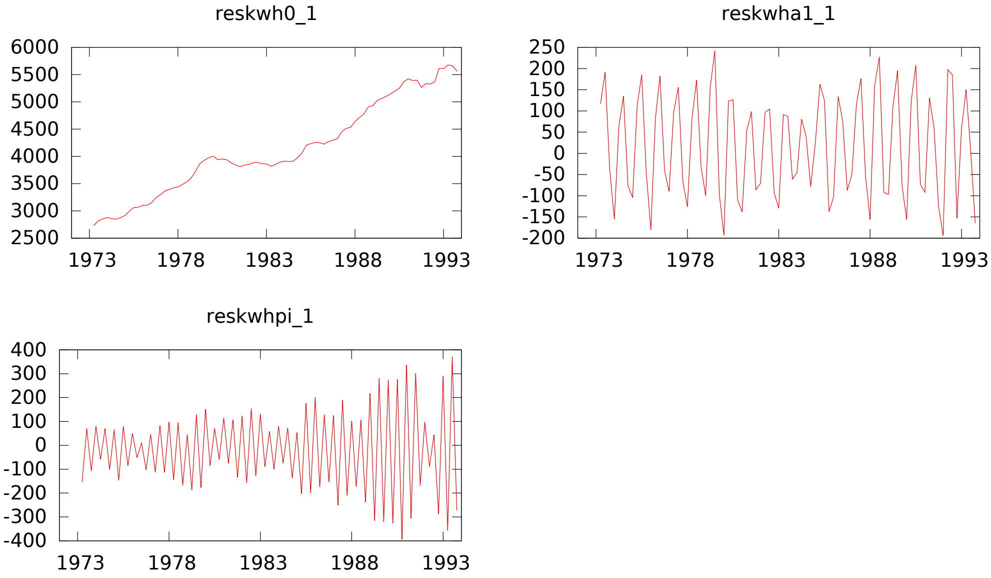

Figure 2.6: Output of the `GHegy_test_plot` function

Some more complex packages offer help documentation in PDF format, for example the `DPB` package (see Lucchetti and Pigini, 2015). If such documentation is available for a given package, the PDF button on the local package browser toolbar becomes active when the package is selected; clicking it will display the file in your default PDF reader.

Other than that, there's not much to say here. For help on scripting in general, see the *Hansl Primer* (Cottrell and Lucchetti, 2016).

2.3.2 Using packages via the GUI

Of course, if a package offers to attach to a gretl menu, and you accepted that offer when you installed the package (see p. 5) then you should know where to find it. But if a package doesn't have its own place in the menus, the package browser is the place to go to invoke it by GUI means.

You can launch a package by double-clicking on it. What exactly happens here depends on whether the package's data requirement is met. Most packages require that a dataset is open, and some have more specific requirements (time series data, or panel data).

If you have a suitable dataset in place you will get a dialog box to specify arguments to the function, much as you would with a built-in gretl procedure. (However, if the package offers more than one public interface you may get an initial dialog asking you to choose a particular function to call.) If the package's data requirement is not met, you'll be told what's wrong and asked if you'd like to run the sample script. This should load suitable data and "demo" the package.[4]

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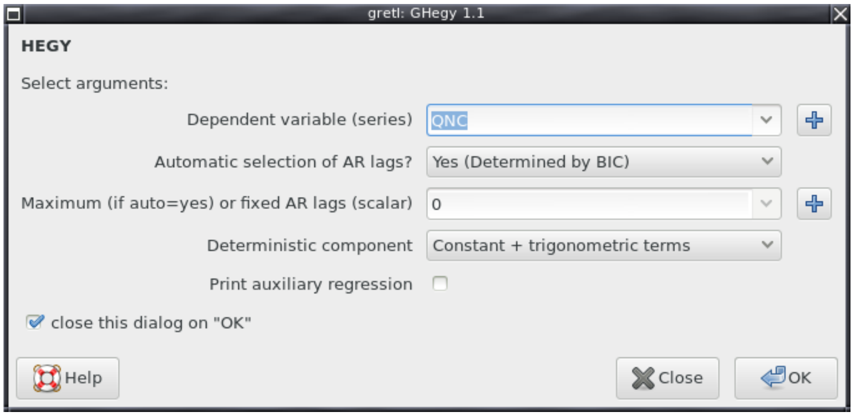
[4] By the way, if a package's sample script does not run correctly you are encouraged to report that to the author of the package or the `gretl-users` mailing list. Although gretl function packages carry no warranty it is supposed to be an absolute requirement that the sample script runs OK.



HEGY

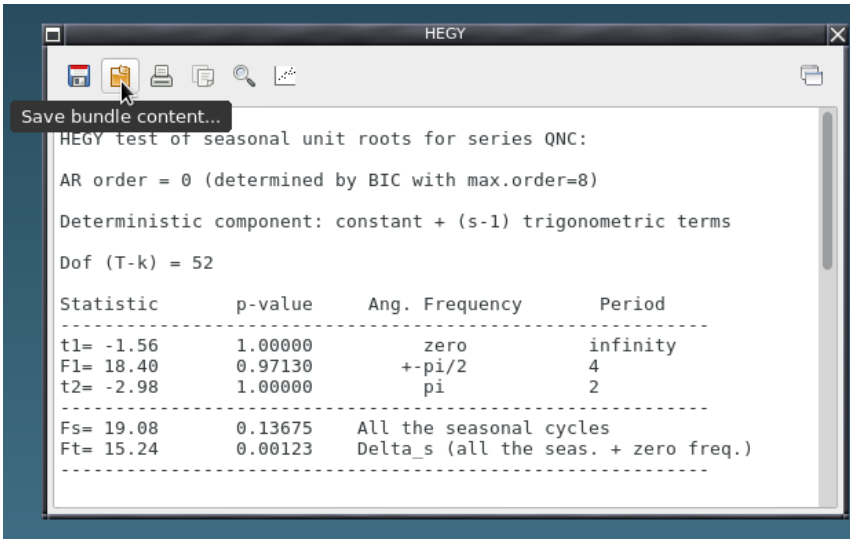
Select arguments:

Dependent variable (series): QNC
Automatic selection of AR lags?: Yes (Determined by BIC)
Maximum (if auto=yes) or fixed AR lags (scalar): 0
Deterministic component: Constant + trigonometric terms
Print auxiliary regression ☐

☑ close this dialog on "OK"

Figure 2.7: GUI call to the GHegy package

Figure 2.7 illustrates a function-call dialog, this one put up by the GHegy package. Each argument to the function is represented by either a drop-down selector or a check box. Note that the "+" button next to a selector allows you to define a new variable as an argument if you wish. Figure 2.8 then shows part of the output from this call.



```
HEGY test of seasonal unit roots for series QNC:

AR order = 0 (determined by BIC with max.order=8)

Deterministic component: constant + (s-1) trigonometric terms

Dof (T-k) = 52

Statistic        p-value      Ang. Frequency       Period
-----------------------------------------------------------
t1= -1.56        1.00000          zero            infinity
F1= 18.40        0.97130        +-pi/2            4
t2= -2.98        1.00000          pi              2
-----------------------------------------------------------
Fs= 19.08        0.13675     All the seasonal cycles
Ft= 15.24        0.00123     Delta_s (all the seas. + zero freq.)
-----------------------------------------------------------
```

Figure 2.8: Output window from call to GHegy

We have moved the mouse pointer over the "bundle" icon in the toolbar of this window to reveal the tooltip, "Save bundle content." What's going on here is that GHegy has constructed a gretl bundle containing various details of the unit root test, and we can extract these details if we wish. Package authors: for an account of how to do this sort of thing see section 3.4.

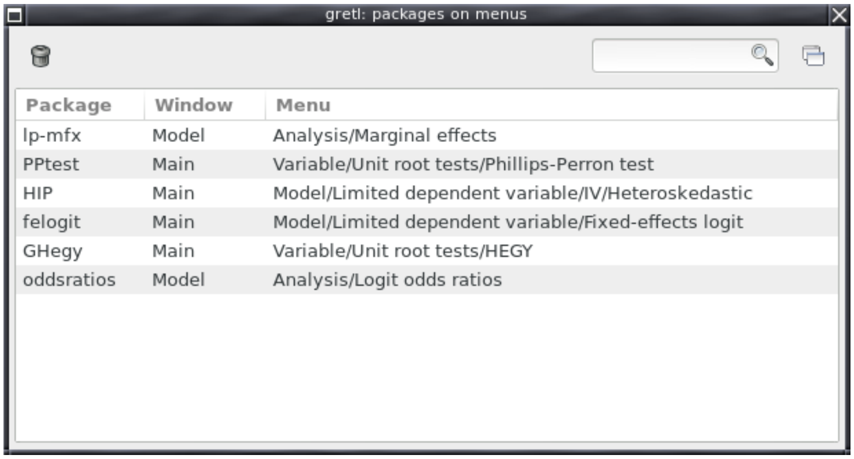
2.4 Some finer points

2.4.1 Managing menu attachments

We mentioned above that you can revise your initial choice of whether or not to have a function package insert itself into the gretl menus. We'll now explain how.

Again, start from the browser for installed packages. One of the buttons on the toolbar is a "+" icon (with tooltip "Add to menu"). This button should be active when you select a package which offers a menu attachment but is not currently attached. Click it and you'll get the sort of dialog shown above in Figure 2.4; say "Yes" to attach the package to the specified menu.

To go the other way—that is, remove a package from a menu—use the button with the "Preferences" icon (tooltip "Package registry"). This brings up a window showing the packages that are currently attached to menus (Figure 2.9). For each package you can see whether its attachment is in the main gretl window or in model windows (at present these are the only two possibilities), as well as the specific "path" to the menu item. To remove a package from the menus, use the delete button or the right-click menu. Removing a package from the menu system does not delete or disable the package, it just means it won't have its own menu item—which is easily reversed, as we have just seen.



Package	Window	Menu
lp-mfx	Model	Analysis/Marginal effects
PPtest	Main	Variable/Unit root tests/Phillips-Perron test
HIP	Main	Model/Limited dependent variable/IV/Heteroskedastic
felogit	Main	Model/Limited dependent variable/Fixed-effects logit
GHegy	Main	Variable/Unit root tests/HEGY
oddsratios	Model	Analysis/Logit odds ratios

Figure 2.9: The GUI package "registry": from here you can remove dynamic menu items

Changes made in this way will have immediate effect on main-window menus; the effect on model-window menus will be apparent only for newly opened windows.

2.4.2 What does "installed" mean?

We've talked about installing packages, but what exactly does it mean for a package to be installed? Basically, it means that the package file(s) are placed in one or other of two standard locations where gretl should always be able to find them automatically—for example, in response to the command "`include mypkg.gfn`" without any path specification.

These two standard locations are the "system" and "per-user" gretl function directories. In each case we're talking about a subdirectory named `functions`, the actual path to which differs by platform (and on MS Windows, by national language).

On an English-language Windows installation typical values are, for the system and per-user paths respectively,

```
C:\Program Files\gretl\functions
C:\Users\login\AppData\Roaming\gretl\functions
```

where "login" is a placeholder for your username. On Linux they are likely to be

```
/usr/share/gretl/functions
$HOME/.gretl/functions
```

and on Mac OS X

```
/Applications/Gretl.app/Contents/Resources/share/gretl/functions
$HOME/Library/Application Support/gretl/functions
```

where `$HOME` is your "home" directory, which is always defined on Linux and OS X.

However, you don't need to guess at these locations: in the gretl console you can do

```
eval $gretldir
eval $dotdir
```

to get the respective base directories on your system: append "`functions`" and you'll have the canonical package paths.[5]

When you install a package via gretl it will go to one of these locations, depending on the platform and whether or not you have permission to write to the "system" directory.

We said gretl will automatically find packages in these places. Well, there's one possible catch to look out for. The `gfn` file for a package may be placed in the `functions` directory itself, or in a subdirectory with the same name as the package; that is, on one or other of the following patterns:

```
functions/mypkg.gfn
functions/mypkg/mypkg.gfn
```

Here's the thing: if a package includes PDF documentation, or any other files besides the `gfn`, *it must be in its own subdirectory* (the second pattern). If the package consists of a gfn file only, then in general it should go directly into the functions directory (the first pattern). Gretl should get this right when installing a package for you but if you install a package by hand, copying it to the `functions` directory yourself, you need to pay attention to this point.

2.4.3 Examining a package in depth

Suppose you get interested in some function package to the point where you don't just want to use it—you want to see how it works, maybe borrow ideas from it, even fix bugs in the package or modify it for your own purposes.[6]

Once again, you can start from the browser window for packages "on local machine." The `View code` button or right-click menu item brings up a window showing all the function code. From here you may copy material and paste it into a script of your own.

Making changes to an existing package, however, cannot be done via the package browser window: it's necessary to go via the main-window menu item "File, Function packages, Edit package." This route will let you edit a package only if you have write permission on the file in question. Here's a plausible scenario: you have package `XYZ` installed, and you don't want to (or don't have permission to) mess with the installed version, but at the same time you'd like to do some exploration and/or experimentation. Solution: go to the web interface to gretl packages mentioned in section 2.1 and download a copy of `XYZ`, placing it somewhere other than one of the standard gretl function directories. Then go to "File, Function packages, Edit package..." and navigate to find the `gfn` file. (If the package is in zip format you'll have to unzip it first.)

In the package editor window, the button labeled `Edit function code` takes you into the hansl code (function by function, if the package contains more than one function). With a complex, multi-function package it may be difficult to get a good overview of the package in this way but here's an alternative: click the `Save...` button and select `Save as script`. This enables you to write out a gretl `inp` file containing all the functions in the package, which you can then open in gretl's script editor—or, of course, the text editor of your choice.

An alternative way of opening a specific package for editing, via the command line in a terminal window, is to invoke gretl with the flag `-p` plus the name of the package, as in

---

[5] OK, there's an exception here: on Mac OS X the path to the per-user functions directory, which is shown above, is not the same as the `$dotdir` path.

[6] If you do come up with any fixes or enhancements, then naturally we ask that you share them with the package author.

```
cd XYZ_work_dir
gretl -p XYZ.gfn
```

Either way, opening the specified `gfn` file for editing has the effect of loading the package into memory. Thereafter, operations related to `XYZ` will refer to the version you loaded initially.

2.4.4 Redirecting the package browser

Another way of getting at uninstalled `gfn` files is to redirect the function package browser. This can be done via the directory button at the left-hand end of the toolbar, which calls up a selection dialog. If you select a directory that turns out to contain no `gfn` files you just get a message to that effect, otherwise you are given the option of replacing the original contents of the browser window with the newly found packages.

When the browser is redirected in this way, clicking the directory button gives you two options: choose another directory, or revert to displaying the installed packages (which may come from more than one directory, as explained in section 2.4.2).

When the browser is newly opened it always shows the installed packages. However, gretl will remember (during a given session) which alternative `gfn` directory you visited last, and will offer that as the default selection on using the directory button.

Chapter 3

For package authors

Recall from section 1.2 that the core elements of a gretl function package are as follows:

1. One or more hansl functions;
2. the package metadata (author, version and so on);
3. documentation; and
4. an example script.

These elements are all contained in a `gfn` XML file. Optionally, you can ship additional material with your package (PDF documentation, a richer assortment of sample scripts, and so forth), in which case all the components including the `gfn` must be wrapped in a zip file.

In this chapter, we will go through the creation and maintenance of these basic ingredients, plus the process of baking them together into a working function package. This result can be achieved either by command-line methods or via gretl's graphical interface.

We'll start with the command line. Yes, we know that many readers may prefer to use a graphical interface whenever possible, but we recommend that you at least skim this section rather than skipping forward. The command-line approach is likely to pay off if you ever decide to tackle an ambitious function-package project.

3.1 Building a package via the command line

Here we assume you are at least somewhat familiar with the shell—that is, the command processor which awaits your input when you open a terminal window. So we assume you know how to perform simple operating-system tasks such as copying/deleting files, listing the contents of a directory and so on via the appropriate shell commands. A reminder of the basics is provided in Table 3.1. On unix-type systems (such as Linux and OS X) you can get help on a command by typing man followed by the command word, as in `man cp`. On windows, get help by typing the command word followed by a slash and a question mark, as in `copy /?`.

action	*unix*	*Windows*
copy file(s)	`cp`	`copy`
move files(s)	`mv`	`move`
delete files(s)	`rm`	`del`
make a directory	`mkdir`	`mkdir`
change directory	`cd`	`cd`
list files	`ls`	`dir`
emit a string	`echo`	`echo`

Table 3.1: Basic shell commands by platform

With the exception of subsection 3.1.3 all the commands used in this section have been tested on Windows' `cmd.exe` as well as the `bash` shell.

First of all, we strongly recommend that when starting work on a package you create a specific directory to hold the makings of the package. For illustration we'll suppose the package is called "mypkg". (Naturally, you should replace all occurrences of `mypkg` below with the actual name of the package you're building.) So, starting from some suitable point in your file system, you might begin with

```
mkdir mypkg
cd mypkg
```

Now, the minimum requirement for building your package (as a "simple package" or stand-alone `gfn` file) is the following set of files:

1. At least one (for now, let's just say one) hansl `inp` file containing definitions of the functions you wish to package. Let's call this `mypkg.inp`.
2. A `spec` file, which supplies metadata and tells gretl how the package should be assembled; call this `mypkg.spec`.
3. A sample script (`inp` file) which exercises your package; call this `mypkg_sample.inp`.
4. A text file containing help on the packaged function(s). The filename should have suffix `.md` if you're using gretl's markdown option (recommended: see Section 3.1.1 below).

The four files listed above are all UTF-8 text files that you can view and modify using any text editor of your choice (no word processors, please). Each text file corresponds to one of the four basic constituents of a `gfn` file. Therefore, once you have these four files ready, building the package is simply a matter of transcribing their contents into XML and putting everything together into the package file.

You will need to create such files in the current directory (or maybe copy or move them from elsewhere if you've already made a start). It's not absolutely necessary that *all* the filenames are regimented as shown (starting with the name of the package in each case), but as we'll see before long this can make life easier.

The `inp` file containing your function definitions we won't say much about here. If you're contemplating writing a package you should already be pretty comfortable with hansl. See the *Hansl Primer* (Cottrell and Lucchetti, 2016) if in doubt.

The requirements on the sample script and help text are set out in section 3.3. First we'll deal with the `spec` file. A simple case of this is shown in Listing 3.1.

Listing 3.1: Simple `mypkg.spec`

```
author = A. U. Thor
email = author@somewhere.net
version = 1.0
date = 2018-07-12
description = Suitable description goes here
tags = C13
public = myfunc
help = mypkg_help.md
sample-script = mypkg_sample.inp
min-version = 2017a
```

According to this spec, the package has a single public function, `myfunc`, and requires gretl 2017a or higher to run properly. For details on the specification keys used here (e.g. `tags` or `min-version`) see section 4.1.

In fact, writing a `spec` from scratch may be tricky. Some may prefer adapting a pre-existing template `spec` file; you can find one at `https://sourceforge.net/projects/gretl/files/misc/template.spec`. Regardless, you still may want to refer to chapter 4 for a fuller description of the various entries.

Now, assuming all the required files are in place, how do we actually build the package? Simple: the shell command

```
gretlcli --makepkg mypkg.inp
```

tells gretlcli to run `mypkg.inp`, hence loading your function definitions into memory; process the corresponding `spec` file (which must have the same basename as the `inp` file); load the auxiliary files (help, sample script); and, if all goes well, write out `mypkg.gfn`. For reference, using the `--makepkg` flag with gretlcli is just a convenient shorthand: it's equivalent to running the following script, using the `makepkg` command.

```
include mypkg.inp
makepkg mypkg.gfn
```

You can further abbreviate the above by using the "short" syntax for options, as in

```
gretlcli -m mypkg.inp
```

We've said this package offers a single public function, `myfunc`: that's the only function that will be made directly available to users. However, you may want to include one or more private "helper" functions, designed to be called only by `myfunc`. To do so, just put definitions of these functions into `mypkg.inp`; gretlcli will pick them up and, seeing that they don't appear in the `public` listing, will mark them as private.[1]

3.1.1 The markdown option

As mentioned above, a simple function package includes documentation in the form of a text file. Since gretl 2023b you can employ a simple variant of markdown, and we encourage package authors to do so. If you are unfamiliar with markdown you might want to take a look at `https://en.wikipedia.org/wiki/Markdown`.

Gretl's markdown variant currently supports the following features.

- First and second-level headings: start a (single) line with # or ##, respectively
- Boldface: `**text**`
- Italic: `*text*` or `_text_`
- Monospace: `‘text‘` (enclosed in ASCII left quotes)
- Itemized list: each item starts with "`- `" on a new line
- Enumerated list: each item starts with (e.g.) "`1. `" on a new line
- Code block: starts and ends with `‘‘‘` (three ASCII left quotes) on its own line

Note that itemized and enumerated lists cannot be nested.

URLs starting with `http[s]` automatically turn into hyperlinks. Paired ASCII straight double quotes are replaced by left- and right-hand quotes.

---

[1] To be quite explicit, the `makepkg` mechanism includes in the output package all the functions that are currently in memory—as package-private functions if they are not identified as public in the `spec` file. When using `makepkg` you should always start with a clean workspace and load only the relevant functions.

3.1.2 Adding extra material

Suppose now that you want to include with your package some extra material (say, a specialized data file). As explained earlier (again, see section 1.2), you will have to create a suitably organized zip file.

The first thing is to update the `spec` file to refer to the extra content: you'll want to add a line like

```
data-files = somedata.gdt
```

where we assume that the file `somedata.gdt` file exists and is in the `mypkg` directory. See section 4.4 for more details.

Creating the zip file can be done "by hand" if the command-line `zip` program is available (or substitute `pkzip` if it's available):

```
cd ..
zip mypkg/mypkg.zip mypkg/ mypkg/mypkg.gfn mypkg/somedata.gdt
```

Or you can have gretl take care of everything for you, by using the `makepkg` command: you can start `gretlcli` and issue the following command:

```
makepkg mypkg.zip
```

When the argument to `makepkg` is a filename with the `zip` extension, gretl will do one of two things:

- If a matching `gfn` file is found, this will be used the as the basis for the zipfile, with other components pulled in as specified.
- Failing that, if a matching `spec` file is found (plus the other files that it references), gretl will first build the `gfn` and then build the zipfile wrapper.

A neater way of doing this is to "pipe" the `makepkg` command into `gretlcli` directly from the command line, as in

```
echo makepkg mypkg.zip | gretlcli -b -
```

where the `-b` flag makes `gretlcli` operate non-interactively and the following dash tells the program to read commands from "stdin" instead of an `inp` file.

3.1.3 Using a Makefile

If you're working on a platform that supports the `make` utility, you might find a Makefile helpful. It is not obligatory to use this approach, but especially if your project is large, it can definitely make your life easier. MS Windows does not provide `make`, but it can be installed; see Appendix A to this chapter for some options.

`Make` is a program that gives you a consistent interface for performing complex tasks. Its usefulness is particularly evident when there is some dependency structure between the tasks you want to perform. For example, when building a large software project, there is a series of operations that must be performed in a certain order (compiling, linking, installing); or, as another example, when you have a large LaTeX document you have to compile it first, then run BibTeX, then compile it again, etc. `Make` is excellent at automating such tasks.

To run `make` you need a file, usually called `Makefile`, which contains a sequence of rules to tell the program "what to do when."[2] Listing 3.2 shows a very simple instance, though it does illustrate a small refinement in the package-building process.

---

[2] A complete tutorial on `make` can be found at http://www.gnu.org/software/make/manual/make.html.

Listing 3.2: Makefile for simple package

```
PKG = mypkg

$(PKG).gfn: $(PKG).inp $(PKG).spec $(PKG)_help.txt $(PKG)_sample.inp
        gretlcli --makepkg $(PKG).inp

install: $(PKG).gfn
        echo pkg install $(PKG).gfn --local | gretlcli -b -

clean:
        rm -f $(PKG).gfn
```

Running "`make`" in your project directory will rebuild `mypkg.gfn` if and only any of the source files have changed since the `gfn` was last produced; running "`make clean`" will delete the `gfn`. Here's the refinement: running "`make install`" will install the package (after rebuilding it, if required).

Warning: if you just copy and paste the example above into a text file, chances are it will not work. `Make` is quite fussy about the structure of the Makefile, particularly about the use of tabs versus spaces. Some details, and a more extended example, are provided in Appendix B to this chapter.

3.2 Building a package via the GUI

When you're building a package, it's a good idea to ensure you have a "clean" workspace. So if you've been running regressions, maybe using other packages, or whatever, we recommend saving your work, closing gretl, and restarting the program. That said, here's a walk-through of the process.

3.2.1 Load at least one function into memory

If you have a script file containing relevant function definitions, open that file and run it. Otherwise you can create a script file from scratch in the GUI script editor: include at least one function definition, and run the script.

For example, suppose you decide to package a function that returns the percentage change of a time series.[3] Open the script editor window and type

```
function series pc(series y "Series to process")
    series ret = 100 * diff(y)/y(-1)
    string dsc = sprintf("Percentage change of %s", argname(y))
    setinfo ret --description="@dsc"
    return ret
end function
```

Note that we have appended a string to the function argument, so as to make our interface more informative. This is not obligatory: if you omit the descriptive string, gretl will supply a predefined one (in this case, `series`).

Now run your function. You may want to make sure it works properly by running a few tests. For example, you may open the console and type

```
series x = uniform()
series dpcx = pc(x)
print x dpcx --byobs
```

---

[3] Strictly as an illustration, of course! Don't expect something like this to pass muster for inclusion on the gretl server.

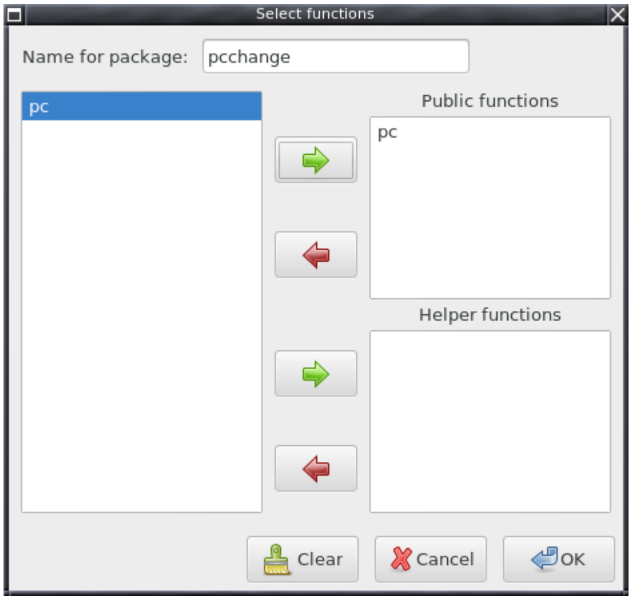
```
                 x          dpcx

 1    0.4428625
 2    0.3737993      -15.5947
 3    0.1570864      -57.9757
 4    0.6896227      339.0086
 5    0.8510148       23.4030
 6      0.07757      -90.8851
 7    0.1454557       87.5180
 8    0.8260684      467.9174
 9    0.4328073      -47.6064
10    0.3566473      -17.5967
```

Listing 3.3: Output of function check

You should see something similar to Listing 3.3. The function seems to work OK. Once your function is debugged, you may proceed to the next step.

3.2.2 Create your package

In the gretl main window, go to the "File, Function packages" menu, and select "New package." A first dialog should appear (see Figure 3.1), in which the left-hand panel lists all the functions you have available for packaging; you must specify the name of the package, one or more public functions to package, and zero or more "private" helper functions.

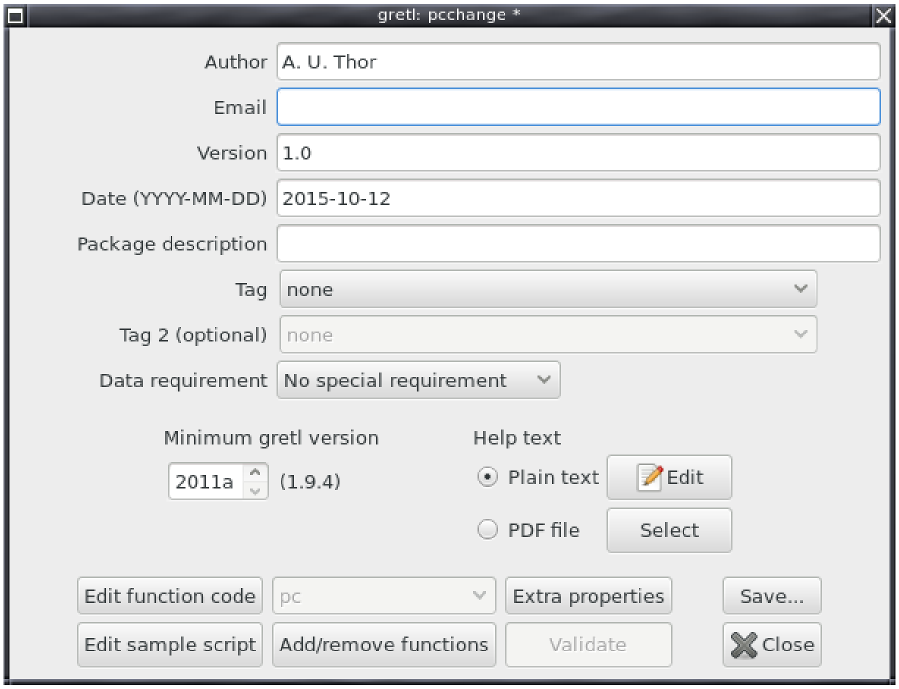


Name for package: pcchange

Public functions: pc

Figure 3.1: Starting a new function package: you specify a name for the package and select the functions to be included from the list on the left.

Public functions are directly available to users; private functions are part of the "behind the scenes" mechanism in a function package. So, at this point, you select the `pc` function from the left-hand panel and put it into the "Public functions" box. You also give the package a name. Leave off the `gfn` extension, that will be added as required; here we name the package `pcchange`.



Author A. U. Thor
Email
Version 1.0
Date (YYYY-MM-DD) 2015-10-12
Package description
Tag none
Tag 2 (optional) none
Data requirement No special requirement
Minimum gretl version 2011a (1.9.4)
Help text
● Plain text
○ PDF file

Figure 3.2: The package editor window

On clicking OK a second dialog should appear (see Figure 3.2), where you get to enter the package information (author, email, version, date, etc.). Unless you have a PDF file containing help, you should also enter help text for the public interface: use the Edit button to open a text entry window. (If you have documentation in PDF format, see section 3.2.3.) You have a further chance to edit the code of the function(s) to be packaged, by clicking on Edit function code. (If the package contains more than one function, a drop-down selector will be shown.)

And you get to (in fact, you *must*) add a sample script that exercises your package. This will be helpful for potential users, and also for testing. For this package, a suitable sample script might looks like this:

```
include pcchange.gfn
open denmark.gdt
series pcLRM = pc(LRM)
print LRM pcLRM --byobs
```

where (a) we've decided that the package is to be called pcchange, and (b) we're going to illustrate using Søren Johansen's Danish macroeconomic data (included with the gretl package). See section 3.3.2 for details on what's required of a sample script.

At this point you should also consider the metadata items Minimum gretl version, Data requirement and Tag. You can read all about these in section 4.1. For the moment, suffice it to say that since the function code above doesn't do anything exotic you may be OK leaving the minimum gretl version at its default value, though if you want to check when some function or command was introduced you can look at the gretl ChangeLog.[4] As for the data requirement, well, percentage changes from observation to observation probably don't make sense for cross-sectional data (which in most cases can be ordered any old how, arbitrarily), so you might pull down the list of options and select "Time-series data." And as regards the tag for this package, the most general category, "C10 Econometric and Statistical Methods: General" is probably the only one that's applicable.

Clicking the Save button in the package editor window brings up a little menu. At this stage it's just

---

[4] See `http://gretl.sourceforge.net/ChangeLog.html`.

the first item, Save gfn, that's relevant. If there's something missing from your package specification (e.g. no help text), you'll get a nag box when you select this item. Otherwise you'll see a dialog where you get to choose whether to save the gfn file to an "installed" location (see section 2.4.2) or in some other place (Figure 3.3).

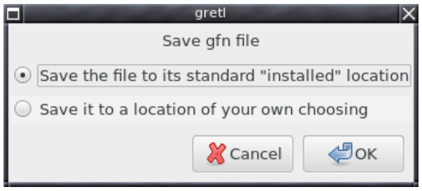

gretl
Save gfn file
● Save the file to its standard "installed" location
○ Save it to a location of your own choosing
Cancel
OK

Figure 3.3: Where do you want your new package to go?

If you select the first option you will get feedback on where the gfn file was actually written;[5] if you select the second you'll get a regular File Save dialog box. The advantage of the first choice is that the package will be found automatically by gretl. However, if you're just experimenting and don't want to "install" the package yet, by all means choose a different location.

Note that the dialog box shown in Figure 3.3 only appears when you are first saving a newly created package. Thereafter, Save gfn simply saves the package using the existing path to the gfn file.

3.2.3 Adding PDF documentation

The prerequisite here is that you have available a suitable PDF file containing documentation for your package. We can't help you with that. But if you have such a file, then click on the PDF file radio button to the right of the "Help text" field in the package editor. If you have already entered plain-text help you will see a dialog box warning you that this will be lost (not right away, but if and when you save the package). Otherwise you go straight to a file chooser window where you select the PDF file.

To be included with your package, the PDF file must (a) be in the same location as the gfn file, and (b) have the same "basename" (for example `mypkg.pdf` if the package is called `mypkg`). Nonetheless, you can select a PDF file of any name from any location, and gretl will take care of copying it into place under the correct name. But please note: if gretl has to copy the file into place, any changes made to the PDF in its original location will *not* propagate to the copy included in the package. Having selected PDF documentation, however, you can use the Select button (see Figure 3.2) to check where gretl is finding the file, or to update it from another location.

Please note: PDF help is an *alternative* to plain text help; you cannot combine the two (not at present, anyway).

3.2.4 Saving a zip file

In the little menu that is brought up by the Save button in the package editor window, one of the items is "Save zip file...". This item becomes active if and only if the following conditions are satisfied:

- Your package offers PDF documentation and/or additional data files. That is, the specified materials can't all be packed into the straight gfn XML format.
- The gfn file is up-to-date with any current changes made in the package editor.

If you think you ought to be able to save a zip file but that option is not enabled, chances are the gfn file needs to be saved first (to keep things in sync).

---

[5] Technical note: this option will take care of saving the gfn to a named subdirectory of the relevant `functions` directory, if the specification includes PDF documentation or other additional files.

3.2.5 Check your package!

Before sharing your package with others, you must check that it actually works, outside of the package-editing context. You need to emulate the context of somebody who has installed your package from scratch.

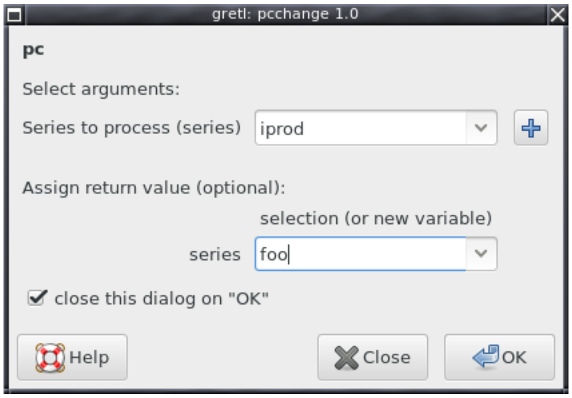
First off, that means that if you didn't choose to write your package into a standard location at the step in section 3.2.2 you should do so now. Use the "Save..." button in the GUI package editor or see section 2.2.2 for other options.

Once your package is in the right place, close gretl then reopen it. Now go to "File, Function packages, On local machine". If all has gone OK so far, you should see the file you packaged and saved, with its short description. If you click on "Info" you get a window with all the information gretl has gleaned from the package. If you click on the "View code" icon in the toolbar of this new window, you get a script view window showing the actual function code. Fine.

Now, back to the "Function packages" window. Think for a moment: you required time-series data (didn't you?) so you should know that a double-click on your package will just offer the option of running your sample script if time-series data are not loaded (section 2.3.2). And if you're following directions you have no dataset open at present. OK, it's worth trying that; your sample script really, really should work regardless (section 3.3.2), so go ahead and double-click.[6]

Now, if that went OK, let's next try a "clean" invocation of your function. (Close and restart gretl if you've messed with your package at all in the interim.) First we'll load suitable data—preferably something different from the sample script, for example the file `np.gdt` (From Nelson and Plosser, also supplied with gretl among the sample datasets, under the Gretl tab). We'll compute the rate of change for the variable `iprod` via your new function and store the result in a series named `foo`.

Return to "File, Function packages, On local machine," find your package, and double-click on it. A window similar to that shown in Figure 3.4 will appear. Notice that the description string "Series to process," supplied with the function definition, appears to the left of the top series chooser.



pc

Select arguments:

Series to process (series) iprod

Assign return value (optional):

selection (or new variable)

series foo

☑ close this dialog on "OK"

Figure 3.4: Using your package

Click OK and the series `foo` will be generated. Yay! See Figure 3.5 (right-click on `foo` in the gretl main window and choose Time series plot).

3.3 Common requirements

Whether you're building a function package from the command line or composing a package via the gretl GUI, certain requirements must be met if your package is to be made available via the gretl server. Here we spell out what's needed in regard to the help text and the sample script.

---

[6] By the way, here's another thing: after loading the function(s) from the package, open the GUI console. Try typing `help pc`: the help text you entered should be presented.

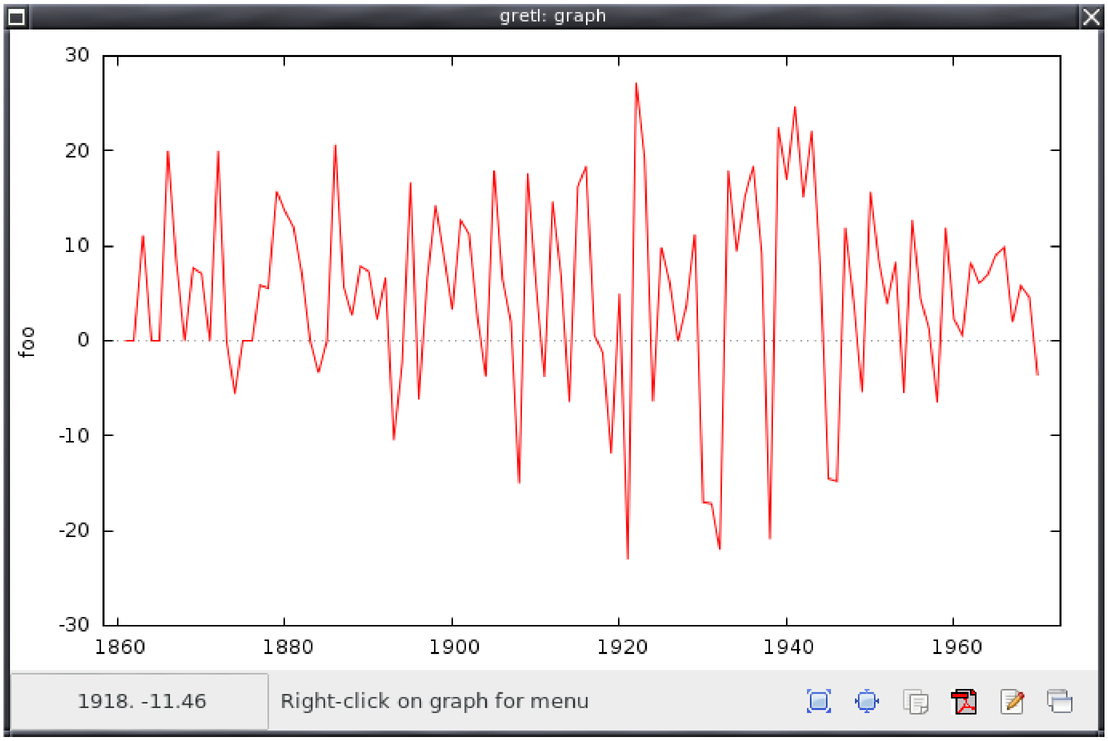


Figure 3.5: Percent change in industrial production

3.3.1 Help text

This must give a clear (if brief) account, in English, of what the package does, and also what each parameter does, for each public function, insofar as explanation is reasonably required. (A boolean `verbose` parameter probably doesn't need much if any comment, but most parameters do need comment.)

If the help is not in PDF format it must be encoded in UTF-8 (or plain ASCII, which is a proper subset of UTF-8). Unless you use the markdown option (see section 3.1.1) we recommend that lines of plain text are kept to around 70 characters in width: some people may like to run gretl windows at full-screen size, but many of us do not!

3.3.2 Sample script

This is crucial. The sample script *must* work "out of the box" on all platforms, and *must not* take too long to execute.

The sample script is what curious users are likely to run if they just want to see what a package does and check that it's not broken. It's what we gretl developers want to run for the same reasons, but also in the process of regression-testing new gretl release candidates. It's important that a gretl release doesn't break existing packages, but we can't assess that if a package's sample script is broken in the first place.

Here are the key things to watch out for in relation to sample scripts:

Include yourself: Right at the top, the sample script must `include` the `gfn` file in question. This will never do any harm, and is needed when the script is run "from scratch", without the package being already loaded. The name of the `gfn` file should be given without any added path, and without quotation marks, as in

```
include mypkg.gfn
```

Dataset: If the package requires that a dataset be in place the sample script *must* arrange for this in a portable manner. The options are as follows.

1. Open a data file that's supplied with the gretl distribution (that is, under the Gretl, Greene or Ramanathan tabs in the built-in datafile browser). But if none of the supplied data files are suitable, then
2. construct an artificial dataset using the `nulldata` command and gretl's random-number generation facilities, or
3. specify a downloaded data file using the `http` prefix with the `open` command, or
4. include a suitable data file in your package—this requires that the package be in zip format.

In the case of artificial data, the script should include a `set seed` command so that the results are reproducible. In the case of downloaded data the URL should be reasonably stable, not something that's likely to disappear or be moved before long.

In no case should a datafile be specified with a full path, as in

```
open /usr/share/gretl/...       # No!
open C:\Program Files\gretl\... # No!
```

This is obviously not portable, and is never necessary when opening a supplied data file, given gretl's path-searching capability.

Execution time: Some packages carry out Monte Carlo analyses and/or bootstrapping and we all know that such procedures are inherently time consuming. Nonetheless, a sample script should execute on current hardware in a reasonably short time—preferably less than 15 seconds and certainly less than a minute. Otherwise both casual users and testers will lose patience. If this means that only a "toy" example can be run, that's OK. The author can add comments to the script saying that this is just an illustration, serious use requires many more iterations. And/or one can add a more "realistic" invocation of the function(s), commented out, with a statement such as "Uncomment this for a real test".

Commenting out: In some cases an author may wish to indicate alternative ways of calling his or her package. That's fine, but if an alternative call requires a dataset other than the one opened by the script it must be commented out; we don't want any lines in the sample script that will generate errors when the script is called "as is".

The intent of the sample script in a gfn package is not just "a rough idea of how you might call this package", or "something that ran OK for the author on some machine at some time", but something that will run for any user of gretl on any platform, without modification, provided only that their gretl installation satisfies the stated version requirement of the package.

3.4 Gretl package idioms

The previous section set out certain basic requirements that must be met if a package is to be published (on which see section 3.5). Nothing in the present section is a requirement as such, but we urge you to take a look at our discussion of the "idioms" that are found in many of the best packages. If your package "speaks gretl" fluently that will give users a better experience and make a more noteworthy contribution to the gretl ecosystem.

Two main points are considered here (they often, but do not have to, go together), namely offering a gretl bundle as the return value from a packaged function, and offering placement of a function package on one or other of the gretl menus.

3.4.1 Working with bundles

The use of a bundle as the return type for a function allows it to pass back a conveniently wrapped collection of information of various kinds and dimensions. Furthermore, a package can contain functions whose job is to access and process "its own" bundles, thereby offering convenient GUI or scripting functionality for the user.

There's a close analogy between this facility and the built-in handling of models in gretl. You specify a model via a dialog box, and what happens? Execution burrows off into libgretl, where the calculations are done and the results assembled into a data structure called a `MODEL`, which is then returned to the GUI. The GUI program then puts up a window displaying various aspects of the model. In the background the full `MODEL` is "attached" to the window, and the menu items in the window call functions that access the underlying data structure to display things not shown by default (e.g. the residuals), to make graphs (e.g. the residual correlogram), to carry out diagnostic tests, and so on.

A function that returns a bundle can do just this sort of thing, and wherever it's appropriate we recommend that this facility be exploited.

Let's see how this works by constructing a little example. We could make a package containing just this function,

```
function bundle bunret (scalar x)
  bundle b
  b.x = x
  b.mat = I(3)*x
  return b
end function
```

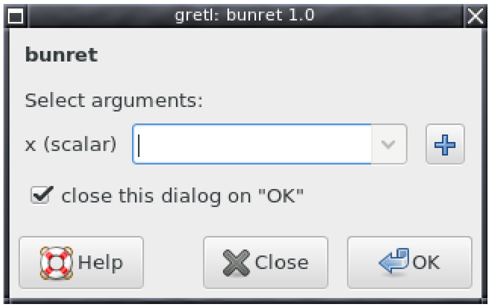
with the following sample script:

```
include bunret.gfn
bundle b = bunret(42)
```

Now this function and the bundle it returns are frankly silly, but that's alright. Our focus is on how gretl handles bundles and we don't want to get distracted by interesting econometric content. Let's create a menu entry for the package, under gretl's `Tools` menu. In the GUI package editor you would go to "Extra properties", open the "Menu attachment" tab, type in `bunret` for the label, select "main window" in the Window selector, and in the pane below, select Tools. In CLI mode you would add these lines to the project's `spec` file:

```
label = bunret
menu-attachment = MAINWIN/Tools
```

What happens when we call this function via the menu? In the first instance we get this dialog



Something may seem strange here: the function `bunret` returns a bundle, but we're not seeing a slot to specify assignment of the return value. But let's continue. If we type some value into the `x` argument selector and click OK we get the window shown in Figure 3.6, which gives two view of the top part with two different menu buttons activated.

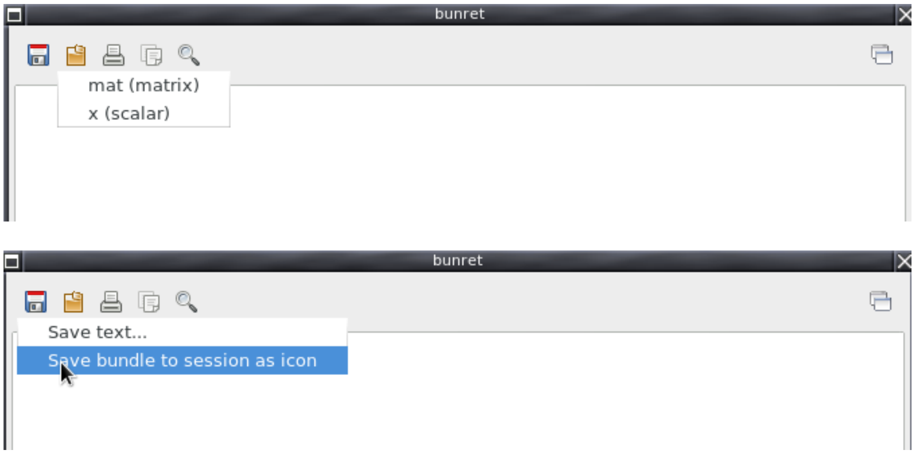


Figure 3.6: bunret output window

So although we didn't get the option of assigning the bundle in the function-call dialog, gretl has snagged the bundle on our behalf, and will let us save its contents individually (upper picture), or the whole thing "as an icon" (lower picture).

Another thing is noteworthy about the output window: its text area is empty. That shouldn't be a surprise because the bunret function doesn't print anything. Functions don't *have* to print anything, and gretl's built-functions generally do not, they just return something useful. However, if a function is intended for GUI use it probably should give some visible output, or in other words it should be "command-like."

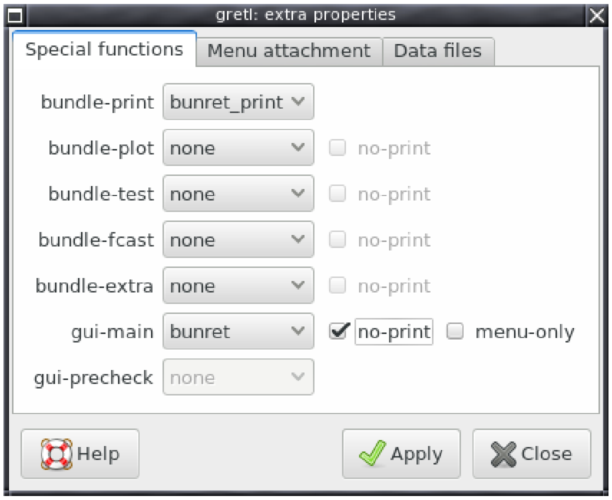
So let's revisit the package code. We could add suitable printing commands within the `bunret` function itself, but for reasons that will become apparent shortly, let's instead write a separate printing function and add it to the package.

```
function void bunret_print (bundle *b)
  printf "=== Hello from bunret_print ===\n\n"
  printf "The x member of %s is %g\n\n", argname(b), b.x
  printf "The matrix member is\n\n%10.3f\n", b.mat
end function
```

Having added this function (note, it should be public) we could then call it from the main `bunret` function, but we won't do that. Instead we'll select this function for the `bundle-print` role in our package. In the GUI, you go to the "Special functions" tab under "Extra properties" to do that. And while we're at it, since the package now has two public functions, we'll select `bunret` for the `gui-main` role and in addition mark it as "no print," because it's not going to do any printing itself (Figure 3.7). In CLI mode, this means adding three `spec` lines:

```
gui-main = bunret
bundle-print = bunret_print
no-print = bunret
```

Here's how things will now work if we go back and call `bunret` from the menu: gretl will snag the bundle as before, will notice that this function is no-print, and will see if the `bunret` package has a bundle-printer function. Since it does, it will call that function on the bundle and put the result into the output window, which will therefore no longer be blank. Your package's bundle window is now somewhat like a gretl model window: it shows you some stuff and allows you the possibility of saving some or all of it.



bundle-print: bunret_print
bundle-plot: none ☐ no-print
bundle-test: none ☐ no-print
bundle-fcast: none ☐ no-print
bundle-extra: none ☐ no-print
gui-main: bunret ☑ no-print ☐ menu-only
gui-precheck: none

Figure 3.7: Selecting functions for special roles

In addition, if the user decides to save your bundle "as an icon," then subsequently double-clicking on the icon will again invoke the bundle-print function, and re-create a window like the original one.

☞ A word to the wise, in relation to the last Figure: clicking on Help in the "Extra properties" window brings up help text that is both specific to the active tab and reasonably complete. 'Nuff said.

One more refinement here. This is a bit of a stretch when we're looking at a little toy package, but you probably want to think about both GUI users and users who may wish to call your package via scripting. In the former case, as we've said, some visual feedback is wanted, but in the latter case it should probably be optional (assuming your function returns something).

Listing 3.4 shows a modification of our toy package to accommodate this. Hopefully it should be self-explanatory. We would now make `GUI_bunret` the `gui-main` function and mark it as `no-print`. Plain `bunret` (now intended for script use) would not be "no-print" any more: it's silent by default but the user can make it print by supplying a non-zero value for the optional second argument. In CLI mode the relevant `spec` file lines would be:

```
public = GUI_bunret bunret bunret_print
gui-main = GUI_bunret
bundle-print = bunret_print
no-print = GUI_bunret
```

Further reading: For more on the special roles for functions within packages see sections 4.2 and 4.3. In particular section 4.3 explains the requirements for a function to be a candidate for a "bundle special" role. For a discussion of how a real package—`gig`, or GARCH in gretl, by Jack Lucchetti—does this sort of thing see section 4 of Cottrell (2011), and for the internals of `gig` itself, find `gig` in the browser for packages on your local machine and select "View code."[7] The GUI-related functions are found towards the end of the code listing: start from `gig_bundle_print` and `GUI_gig_plot`. You can also open `gig` in the package editor and inspect its "Extra properties." The chapter titled "User-defined functions" in Cottrell and Lucchetti (2017), besides providing essential background for package writers, details various refinements available when defining parameters to a function for use in the GUI.

---

[7] Depending on your platform, you may have to install gig first. Since `gig` is an official "addon" rather than a contributed package, installation is via the menu item "Help, Check for addons" in the gretl main window.

Listing 3.4: Toy package with GUI-specific function

```
function void bunret_print (bundle *b)
  printf "=== Hello from bunret_print ===\n\n"
  printf "The x member of %s is %g\n\n", argname(b), b.x
  printf "The matrix member is\n\n%10.3f\n", b.mat
end function

function bundle bunret (scalar x, bool verbose[0])
  bundle b
  b.x = x
  b.mat = I(3)*x
  if verbose
    bunret_print(&b)
  endif
  return b
end function

function bundle GUI_bunret (scalar x)
  return bunret(x)
end function
```

3.4.2 Model-related packages

The packages we've considered above offer "top-level" functionality, in the sense that if they are to be shown in a menu they would naturally appear somewhere in gretl's main window.

One can also write packages that do something interesting based on data embedded in a gretl model—create a graph, run a test, do a piece of analysis. Such functions (which may, but are not required to, return bundles) have their proper place in menus on a gretl model window, not the main menus.

Here's an overview of how such packages work.

1. The user estimates a model in the GUI and gretl constructs a window to show the output.
2. In the process of setting up the model-window menus, we check to see if any possibly relevant model-related packages are available.
3. If so, we run a "pre-check" (see below) to determine if the package can handle the particular sort of model in question.
4. If yes, we add a menu item for the package, and selecting this item pulls up a function call dialog for the package.
5. The function is then executed in an environment in which gretl's model-related accessors, such as `$uhat`, target the displayed model.

Let's consider this in some more detail. First, how do we tell if any possibly relevant packages are available? The mechanism here relies on the package "registry" discussed in section 2.4. This information is stored between gretl sessions in a file named `packages.xml` in the user's gretl functions directory, which is automatically read on start-up.

Second, how do we tell, for each model-related package, if it can actually do something with a model that we're displaying? Two criteria are relevant here, both under the control of the package author.

First there's the `model-requirement` field in the package `spec` file. Valid entries for the field are the gretl command-words corresponding to the various built-in estimators (`ols`, `logit`, `mle` and so on). So for a function specifically designed to handle logit models one could specify

```
model-requirement = logit
```

(or make the equivalent selection under the "Menu attachment" tab of the "Extra properties" window in the GUI package editor).

The above would imply that your package can handle all (and only) logit models. In some cases you may want more fine-grained control (e.g. you can handle both logit and probit, but only the binary variants of these estimators). In that case you can use a second mechanism, specifying a `gui-precheck` function (section 4.2).

This special function should not be included in the listing of public interfaces; it is intended only for internal use by gretl. It must take no arguments and must return a scalar, which is interpreted as an error code (0 for OK, non-zero for not-OK). On execution it has access to the $-variables for the model in question. Among these is the `$command` accessor, which gives the command-word for the estimator. So, for example, the pre-check function for a package which targets binary logit and probit models might look like Listing 3.5 (it could be written a good deal more tersely, but the example shows the logic very explicitly).

```
function scalar lpbin_precheck (void)
  string c = $command
  if c != "logit" && c != "probit"
    # can't handle this estimator
    return 1
  elif !isdummy($ylist[1])
    # logit/probit but non-binary, can't handle it
    return 1
  endif
  return 0
end function
```

Listing 3.5: GUI pre-check for binary logit or probit

Anything printed by a `gui-precheck` function goes to `stderr`. This can be useful for debugging, but in the "production" version of a package the checker should operate silently.

3.4.3 Example: bandplot

For a simple but idiomatic example of a model-related package, you might take a look at bandplot (version 0.3 or higher), which creates a plot displaying a confidence band for the effect of a selected regressor in the context of a multiple regression. In GUI use, this package latches onto windows displaying models estimated via OLS, attaching itself to the Graphs menu.

Here's the relevant part of `bandplot.spec`:

```
description = Confidence band plot
min-version = 1.10.1
gui-main = GUI_bandplot
label = Confidence band plot
menu-attachment = MODELWIN/Graphs
model-requirement = ols
public = GUI_bandplot bandplot
no-print = GUI_bandplot bandplot
menu-only = GUI_bandplot
help = bandplot.help
gui-help = bpgui.help
```

The purpose of the optional `gui-help` keyword is to specify help text to be presented in response to the Help button in a dialog box. Note that in the online help for core gretl commands, a distinction is made (maybe not quite as consistently as it should be) between text to be shown for scripting use and text to be shown if the user clicks on Help. The former may refer to option flags and arguments, the latter to buttons and pull-down lists. The `gui-help` spec file item extends this possibility to function packages. The string to the right of the equals sign should give the name of a plain text (UTF-8) file containing the GUI-specific help text. In the GUI you can edit or add GUI help under "Extra properties" via a button in the "Menu attachment" tab.

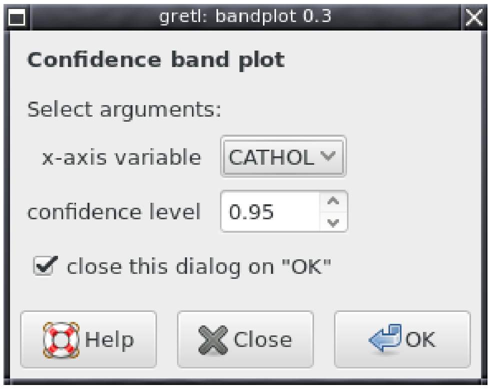
You may wonder, what happens if your package offers PDF documentation but you also choose to give some `gui-help` text? Answer: when the user clicks on Help in your GUI function-call dialog, she will see the GUI help text in the first instance, but the window showing this text will display a hyperlink to the PDF doc.

This package also illustrates some special GUI-related inflections in the parameter listing for a user-defined function. Here's the signature of `GUI_bandplot`, designed to be called from a menu:

```
function void GUI_bandplot (int xvar[$xlist] "x-axis variable",
     scalar conf[0.5:0.99:0.95:.01] "confidence level")
```

Take the `conf` parameter first. Besides the usual `[min:max:default]` fields for a scalar parameter, you can add a fourth field to specify a "step". This is used only for non-integer scalar parameters. To make the step value active, the other three numerical fields must also be given. In this case `conf` will be represented by a "spin-button" with a minimum of 0.5, a maximum of 0.99, an initial value of 0.95, and a *step* or increment of 0.01 when the button is clicked. The step specifier is ignored outside the context of a GUI function-call dialog. (This is not specific to model-related packages.)

The `xvar` parameter above illustrates a a facility specific to model-related packages, and in particular to packages that target models carrying a list of regressors: you can replace the usual `[min:max:default]` fields for an integer-valued parameter with a single special symbol, `[$xlist]`. The effect is that in a GUI dialog the parameter is represented by a drop-down list showing the names of the regressors (skipping the constant, if any). See Figure 3.8.



gretl: bandplot 0.3

Confidence band plot

Select arguments:

x-axis variable: CATHOL

confidence level: 0.95

☑ close this dialog on "OK"

Figure 3.8: Call to bandplot, with special parameter-list inflections. Note the spin-button selector for `conf` (scalar) and the drop-down selector for `xvar` (int) as described in the text.

Based on the user's selection from the list, the argument is filled out with the 1-based index of the position of the selected regressor in the array of coefficients. For example, if the list of regressors is `const x1 x2 x3` then the drop-down list will show `x1`, `x2` and `x3`, and if the user selects `x2` the value 3 will be given to `xvar`.

The idea is that if a package wants to single out a regressor, much the most user-friendly way of conveying this to the user is to show a list of names. There is no way that a package can arrange for this in advance, so we want a means of signaling to gretl that the list should be constructed at runtime, based on the particular model. But please note, this special feature is not ignored in non-GUI use; it will cause trouble. That's one reason why, as we saw in the spec file extract above, `GUI_bandplot` is marked as `menu-only`. Note that the `menu-only` attribute is also visible and settable via the GUI package editor (Figure 3.7).

The other reason why `GUI_bandplot` is "menu-only" is evident from the first line of code in the function, namely

```
matrix b = $coeff
```

This assumes that the model-related `$`-accessors are primed to refer to a valid model that, moreover, was estimated via OLS. That's a safe assumption when coming off a model-window menu (pre-screened by `model-requirement` and/or `gui-precheck`), but in general it's not at all safe.

3.4.4 No-print, once again

We've already come across the `no-print` attribute of packaged functions, but it's worth revisiting this in the context of functions whose sole job is to produce a graph or plot of some kind (whether or not they are model-related).

By default, when a packaged function is invoked via the GUI a window is opened showing the command along with any printed output, but for graph-only output such a window is superfluous and potentially confusing. You can suppress the text window by marking the function in question as `no-print`. This applies to bandplot, but would also apply to a main-window function whose job is just to produce a plot.

3.5 Publishing a package

If you decide that you'd like to publish a package—that is, make it available via the channels described in section 2.2—here's the procedure.

Preliminary: please double-check your package to ensure you have met the requirements in section 3.3. This will save everyone's time.

3.5.1 Uploading to the gretl server

If you don't already have a login to the gretl package server, you need to begin by creating one (please note, this is not the same thing as a sourceforge login).[8]

With a login in hand, there are two ways of uploading a package using gretl. There's also a way of doing this independently of gretl, via the shell, though this may not be convenient on MS Windows.

First gretl method: open your package's gfn file in the GUI package editor (you can get there via the package browser, or via the main-window menu item "File, Function packages, Edit package"). On clicking the Save... button you'll find an item titled Upload to server. This will ask for your login information then perform the upload. If your package specification is such that a zip package is needed, gretl will take care of building an up-to-date zip file and uploading that.

Second gretl method: In the main gretl window, go to "File, Function packages, Upload package" and choose the package to upload. The file selection dialog will offer a choice of looking for gfn or zip files. If you select a gfn file and gretl determines that it's actually a zip file that needs to be uploaded, it will attempt to build the zip package first.

Shell method: Listing 3.6 shows two shell scripts, the first suitable for uploading a stand-alone gfn package and the second for uploading a zip package. The first three lines of each would, of course, have to be filled out appropriately for your case. These recipes rely on various components that

---

[8] The URL will be given to you by gretl if you go to upload a package via the GUI, but for reference it's `http://gretl.sourceforge.net/apply/`.

are standard kit on unix-type systems such as Linux and OS X: a Bourne-type shell; the basic utility programs basename and stat; and the curl program for doing the actual upload. See Appendix A for some comments on doing this sort of thing on MS Windows.

Listing 3.6: Shell scripts for uploading packages

```
# (1) simple gfn file variant
user=your_gretl_login
password=your_gretl_password
pkg=/path/to/your_package.gfn

savename=‘basename $pkg‘
curl -F login="${user}" -F pass="${password}" \
-F "pkg=@${pkg};filename=${savename};type=text/plain;charset=utf-8" \
https://gretl.sourceforge.net/cgi-bin/gretldata.cgi


# (2) zip file variant
user=your_gretl_login
password=your_gretl_password
pkg=/path/to/your_package.zip

bytes=‘stat $pkg --printf="%s"‘
savename=‘basename $pkg‘
echo "Uploading $pkg ($bytes bytes) as $savename ..."

curl -F login="${user}" -F pass="${password}" -F datasize="${bytes}" \
-F "pkg=@${pkg};filename=${savename};type=application/x-zip-compressed" \
https://gretl.sourceforge.net/cgi-bin/gretldata.cgi
```

3.5.2 Staging

When your package is successfully uploaded, it first goes into a “staging” area on the server, and the gretl developers who are responsible for package-checking are notified by email. Before too long, hopefully, you should hear from one of the developers, with a response of Accept, Reject, or Revise and Resubmit.

Typically, packages will be rejected only if they are considered too trivial, if it turns out that they’re really just duplicating functionality that’s already available in gretl, or if they clearly make no attempt to comply with the stated requirements (section 3.3 again). Revise and Resubmit is a likely response if your package seems basically sound but some improvements are warranted.

Once your package is accepted it is moved out of staging and will appear in the public package listing, both within gretl (“On server”) and via the web interface.

3.6 Maintaining a package

Once you’ve uploaded a function package to the gretl server, hopefully that won’t be the end of the story: unless your package was totally perfect on its first release (Ha!) you’ll want to revisit it from time to time with fixes or enhancements in mind.

The question arises: if your initial work was via the GUI, or via the CLI, are you thereby committed to that mode of operation forever? Certainly not. You can mix and match the two approaches, subject to some basic requirements—although, if your package is truly complex, we advise sticking with the commmand-line approach throughout.

Case 1: You started via the GUI but you'd like to explore maintaining your package by CLI means. Fine, you can disassemble your `gfn` file by opening it in the GUI package editor, going to the "`Save...`" button and selecting the options `Save as script` (decline the option to save the sample script along with the packaged functions) and `Write spec file` (accept the options to save the auxiliary files). This will create the source files you need to rebuild your package by CLI means (section 3.1).

Case 2: You started via the CLI but you'd like to explore maintaining your package by GUI means. Fine, you know that the `makepkg` command will create a `gfn` file, which you can then open in the GUI package editor to make changes. But you'd be wise to use the "`Save...`"-button options, as described above, to keep your text-file sources in sync with your GUI-edited `gfn` File, so that on the next revision it doesn't matter where you start.

Appendix A: The CLI on Windows

If you would like to use the command-line approach under MS Windows you must make a preliminary choice: you can either

- stick to the native Windows way of doing things, or
- install software which mimics a unix environment on Windows.

The first option is simpler, and probably best for most users. In this case you will presumably be using `cmd.exe` as your shell. The advantage of the second option is that it provides a much more powerful and versatile shell, but if you just want to do the sorts of things discussed in section 3.1 `cmd.exe` is quite adequate, with some help from a few small additions. We offer some more detail on the two options below.

Native Windows: cmd.exe

This supports all the commands shown in section 3.1 except that the `make` utility is not present. But `make` for Windows can be downloaded from the GnuWin32 project on sourceforge: see `http://gnuwin32.sf.net/packages/make.htm`, which provides a nice easy self-installer. You may also want command-line `zip` and `unzip` from GnuWin32: `http://gnuwin32.sf.net/packages/zip.htm`. (In both cases you should select the option “Complete package, except sources”.)

For anyone who’s interested but not very familiar with `cmd.exe`, a basic guide follows. First, to get easy access to the program go to the Windows desktop, right-click, and select New, Shortcut. You’ll be asked for the location of the target for the shortcut. Most likely this should be

```
c:\windows\system32\cmd.exe
```

(but you can browse to find it if need be). Click Next, give the item a name, then Finish. Now right-click on the new shortcut and select Properties: let’s make this dude a bit more functional.

1. Under the Shortcut tab, find “Start in:”; this is the directory in which the shell will start and by default it’s the directory that contains `cmd.exe`, which is *not* a useful place to be for our purposes. Change it to `%userprofile%` and it will open in your personal file space (make it something more specific if you like).
2. Under the Font tab, choose a decent TrueType font in place of the primitive raster default, for example Lucida Console at size 14.
3. Under the Layout tab, Window Size panel, give yourself a comfortable height for the window—say, 35 lines.
4. If you like, under the Colors tab select black for “Screen text” and white for “Screen background” to get a more modern look.

Having fixed its properties, double-click on the new shortcut and you should have a fairly decent-looking terminal window. The `cmd.exe` window is sometimes called a “DOS box.” In fact it has nothing to do with DOS—a long-obsolete 16-bit operating system—but its default appearance is indeed a nasty blast from the past. Hopefully we’ve improved on that.

A couple of other things are needed to get a usable shell: the programs we’ll be using have to be in the PATH, and we need a decent text editor.

As regards the PATH, the gretl installer gives you the option of adding the directory holding gretl and gretlcli, but that leaves the GnuWin32 utilities. In `cmd.exe` you can do something like

```
PATH %PATH%;c:\program files\gnuwin32\bin
```

or on a 64-bit system

```
PATH %PATH%;c:\program files (x86)\gnuwin32\bin
```

(with any adjustment needed for the specifics of your system). That will work, but only for the duration of your current shell session. You can add directories to the PATH permanently by diving into “Advanced system settings” under Control Panel’s “System” item, but there’s another approach that may be preferable, namely creating an AutoRun file for use with `cmd.exe`. This can handle PATH as well as other things. Here’s an example:

```
@echo off
DOSKEY ls=dir /B
DOSKEY edit="C:\Program Files\Notepad++\notepad++.exe" $*
DOSKEY profile=notepad %USERPROFILE%\profile.cmd
PATH %PATH%;c:\program files (x86)\gnuwin32\bin
```

To activate this you would type the above (or a variant that works for you) into Notepad and save it as `profile.cmd` in the directory that corresponds to %USERPROFILE% for you.[9] Then open the Registry editor, `regedit.exe`, and navigate to HKEY_CURRENT_USER → Software → Microsoft → Command Processor. Right-click in the right-hand pane and select Add String Value: give the new entry the name AutoRun and the value

```
%USERPROFILE%\profile.cmd
```

This little file will then be run whenever you start `cmd.exe`.

The last line of `profile.cmd` puts the GnuWin32 programs into the path as promised. The other lines are just illustrative of what’s possible. DOSKEY establishes an alias, so the first instance allows you to type `ls` to get a directory listing, the second allows you to type, e.g., “`edit Makefile`” and have your Makefile opened by Notepad++, and the third lets you type `profile` to open your shell AutoRun file in Notepad in case it needs updating.

Speaking of Notepad++, unless you already have a personal favorite text editor we strongly recommend using this program. The `notepad.exe` supplied with Windows is a truly feeble piece of software, easily confused by variant line-endings and inclined to hide or misconstrue the true content of some text files. Notepad++ is very full-featured (it knows about the syntax of Makefiles, for example) and also easy to use. It’s free under GPL and available from http://notepad-plus-plus.org/.

One more point: it’s not always understood that you can launch GUI programs from `cmd.exe`. We’ve alluded to one instance above—typing `edit` at the command prompt to open a file in Notepad++—but here’s another that can be useful. Having built a gfn file using make under the shell (see Figure 3.9) you can easily open it for inspection in the gretl GUI with

```
gretl mypkg.gfn
```

No need to mess with File Open dialogs since you’re already in the directory where `mypkg.gfn` is located.

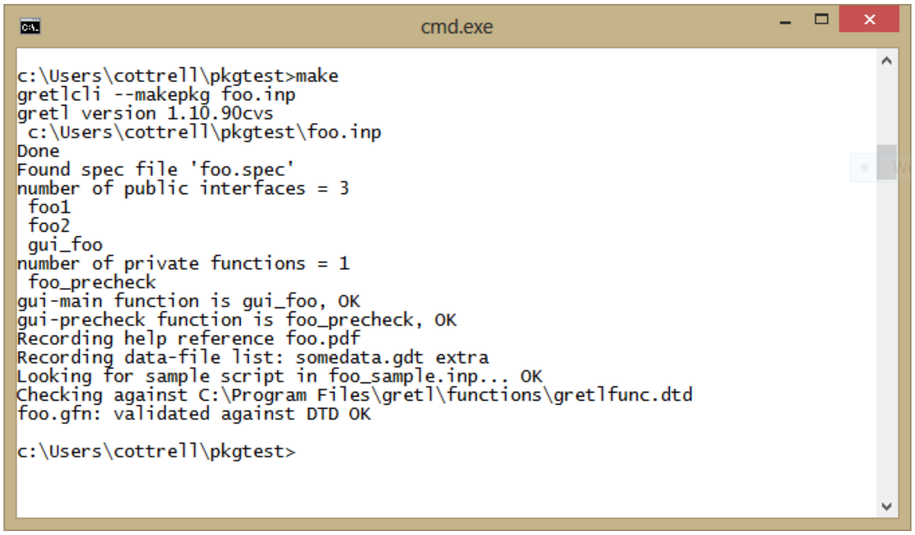
Alternative: a unix-type shell

There are two main packages which provide a unix-type shell on Windows, CygWin and MSYS2. Both are likely to take some getting used to for anyone unfamiliar with unix idioms.

We won’t get into details here, but if you’re interested in this approach we recommend trying MSYS2. You can find an account of this software in section 2 of “Building gretl on MS Windows”

---

[9] You can determine this by typing “`echo %USERPROFILE%`” at the shell prompt (without the quotes).



```
c:\Users\cottrell\pkgtest>make
gretlcli --makepkg foo.inp
gretl version 1.10.90cvs
 c:\Users\cottrell\pkgtest\foo.inp
Done
Found spec file 'foo.spec'
number of public interfaces = 3
 foo1
 foo2
 gui_foo
number of private functions = 1
 foo_precheck
gui-main function is gui_foo, OK
gui-precheck function is foo_precheck, OK
Recording help reference foo.pdf
Recording data-file list: somedata.gdt extra
Looking for sample script in foo_sample.inp... OK
Checking against C:\Program Files\gretl\functions\gretlfunc.dtd
foo.gfn: validated against DTD OK

c:\Users\cottrell\pkgtest>
```

Figure 3.9: Running make to build a gfn file on Windows

at https://gretl.sourceforge.net/winbuild/gretl-winbuild.pdf. For building function packages (as opposed to building gretl itself) you'll just need a few packages beyond a basic MSYS2 install, namely `make`, `zip` and `unzip`.

As a final note, even if you decide not to go "all the way" with command-line methods, using gretlcli under either cmd.exe or a unix-type shell is a nice way of exploiting certain gretl features (output redirection, use of environment variables, etc.) and may be quite useful in it own right.

Appendix B: Makefile basics

Here we give a brief summary of some aspects of Makefile syntax and usage that are likely to be useful for package-building with gretl.

A Makefile has (or can have) two main parts: a first section which defines variables, and a second section which defines rules. The initial definition of variables is optional but it allows for convenient shorthand when writing the rules, and also allows for easy "portability" (names can be changed in just one place).

Each Makefile rule has (up to) three components: a *target*; zero or more *dependencies*; and zero or more *instructions* for making the target. The target should be up against the left margin and followed by a colon. The dependencies, if any, should be listed following the colon. The instructions should be listed directly below the target line, offset from the left margin with a single tab character.[10]

Listing 3.7 shows a variant of the simple Makefile from section 3.1.3, where we have added PDF documentation to the package. In this example the initial section defines just one variable, PKG. Note the special syntax for using the value of a Makefile variable in the rules: the name of the variable must be placed in parentheses, preceded by a dollar sign: `$(PKG)`.

This Makefile specifies five targets. The first target (in this case, the gfn file) is invoked if you simply type "`make`"; to invoke the other targets you have to name them, as in "`make install`".

If a target has no dependencies (like `clean` here) its associated instructions are carried out unconditionally, so "`make clean`" will always attempt to delete the three files that can be generated by `make`. By the way, using the `-f` ("force") flag with the `rm` ("remove") command means that it will

---

[10] Explicit instructions are not always necessary, since `make` knows natively how to build certain kinds of targets. However, it doesn't know anything about gretl files.

Listing 3.7: Makefile for package with PDF documentation

```
PKG = mypkg

$(PKG).gfn: $(PKG).inp $(PKG).spec $(PKG)_sample.inp
	gretlcli --makepkg $(PKG).inp

$(PKG).pdf: $(PKG).tex
	pdflatex $<
	bibtex $(PKG)
	pdflatex $<
	pdflatex $<

$(PKG).zip: $(PKG).gfn $(PKG).pdf
	echo makepkg $(PKG).zip | gretlcli -b -

install: $(PKG).zip
	echo pkg install $(PKG).zip --local | gretlcli -b -

clean:
	rm -f $(PKG).gfn $(PKG).pdf $(PKG).zip
```

not seek confirmation, nor will it complain if the file to be deleted doesn't actually exist.[11]

If the target of a Makefile rule is the name of a file, and the rule has dependencies, then the instructions will be carried out if and only if any of the dependencies were modified more recently than the target file. So "`make`" (with this Makefile) will simply report

```
make: 'mypkg.gfn' is up to date.
```

if the `gfn` file has already been built and nothing has changed since among the files listed as dependencies.

On the other hand, if a target does not name a file, but is rather a generic identifier such as `install`, it will get built regardless. So "`make install`" in this example will always (re-)install the package.

A couple of things should be noted about the `$(PKG).pdf` target: the `bibtex` instruction is wanted only if the TEX source contains a bibliography (which it probably should); and we use here the built-in Makefile variable "`$<`", which refers to the first (or only) dependency of a rule.

Makefile rules are applied recursively—this is what makes `make` so powerful. So, for example, "`make install`" will not fail just because the `zip` file has not yet been built, so long as the Makefile contains a recipe for building the latter (which of course it does). By the same token, if you invoke the `install` target when the `zip` file already exists, it will be checked automatically for up-to-dateness and rebuilt if necessary—which also means that the `gfn` and PDF files will be checked and possibly rebuilt.

Any files specified as dependencies must either (a) feature as the target of a rule, or (b) be provided as "primitive" inputs. In this example the primitives are the `inp` file containing function definitions, the `spec` file for the package, the sample script, and the TEX source for the documentation. Everything else gets generated by `make`.

---

[11] This rule contain the only unix-specific idiom in the Makefile: under `cmd.exe` you would substitute `del` for `rm -f`.

Chapter 4

Package specification details

Here we list and explain the usage of all the currently allowed elements in the specification of a function package. We focus on the `spec` file (from which a gretl function package may be constructed by command-line means) but we also indicate the representation of each specification element in the GUI package editor.

We begin with a few general points on the `spec` file. Each entry in this file takes the form

`keyword` = *value(s)*

Where multiple values are allowed, they should be separated by spaces. An entry can be continued over more than one line if required, using a trailing backslash (\) as the continuation character. Blank lines are ignored, as are lines beginning with the hash mark (#), which can be used to insert comments. As usual with gretl files, any non-ASCII characters should be UTF-8 encoded.

4.1 Basic elements

The elements described in the section apply to all function packages, whether or not they offer an interface specifically designed for use via the gretl GUI and whether or not the main public function(s) return a gretl bundle.

Elements in the first block below are all represented in the upper panel of the GUI package editor window (see Figure 3.2).

`author` (required): The name of the author of the package. Multiple names may be given, separated by "and", although note that this string may be truncated for presentation purposes in some contexts.

example: `author = Riccardo "Jack" Lucchetti and Allin Cottrell`

`email` (required): The email address to which correspondence should be directed. Only one address should be given.

example: `email = cottrell@wfu.edu`

`version` (required): The version number for the package release. This should be parseable as an integer or floating-point number (in the C locale). That is, it should contain only digits and at most one dot (`.`).

example: `version = 1.2`

`date` (required): The date on which the release was prepared, in ISO 8601 format, YYYY-MM-DD.

example: `date = 2015-03-28`

`description` (required): A short plain-text (UTF-8) string describing what the package does.

example: `description = logit/probit marginal effects`

`data-requirement` (optional): If this element is supplied, it must be one of the following strings: `no-data-ok`, `needs-time-series-data`, `needs-qm-data` (meaning, quarterly or monthly time-series data), or `needs-panel-data`. Note that the *default* requirement is that a dataset of some sort is in place (cross sectional, time series or panel). If your function does not take any series or list arguments (for example, it does something with matrices), you should use `no-data-ok` to indicate that a dataset is not required.

example: `data-requirement = needs-panel-data`

`tags` (required): Here you must specify at least one "tag" for your package based on the classification developed by the American Economic Association for use with the *Journal of Economic Literature* (hence known as *JEL tags*). This is to help users who are searching on the gretl server for packages that will perform some specific function. If you supply more than one tag, the tags should be separated by spaces. You can find a listing of the available tags at `http://gretl.sourceforge.net/cgi-bin/gretldata.cgi?opt=SHOW_TAGS`.

example: `tags = C13`

`min-version` (required): The identifier for the minimum gretl version on which the package is supported. Ideally, this should truly be the first gretl version on which the package will run OK, but if in doubt it is preferable to specify a later version (users can always update) rather than an earlier one (on which the package might fail and give the user a bad impression). See section 4.5 for further details.

example: `min-version = 2018a`

The remaining "basic" elements are represented in the GUI in various ways, as described below.

`public` (required): A list of names of the public interfaces offered by the package.

example:
```
public = GUI_lp_mfx lp_mfx_print mlogit_mfx \
         mlogit_dpj_dx ordered_mfx
```

GUI: this list can be accessed and modified via the Add/Remove functions button.

`sample-script` (required): the name of a hansl script (`.inp`) file that serves as exemplar for use of the package.

example: `sample-script = keane-mfx.inp`

GUI: access and edit via the Edit sample script button.

`help` (required): The name of the file in which Help for this package can be found. This must be either a UTF-8 text file (with or without usage of markdown, see section 3.1.1) or a PDF file. The basename of the file should be the same as that of the package (as in `mypkg.gfn` and `mypkg.pdf`). The filename suffix must be `.pdf` for PDF or `.md` for markdown; for non-markdown text the suffix is not crucial but `.txt` is suggested.

example: `help = lp-mfx_help.txt`

4.2 GUI-related elements

The elements described in this section are applicable only if at least one function in the package is designed to be called via gretl's graphical interface. In the GUI package editor these elements are shown in one or other tab of the the window that appears on clicking the Extra properties button.

`menu-attachment` (optional): Specifies a place within the gretl menu system under which the package should be made available. At present packages can attach to menus (a) in the main gretl window and (b) in windows displaying model estimates (only). In specifying a `menu-attachment` these are represented by the strings `MAINWIN` and `MODELWIN` respectively. The "path" to the entry for your package should start with one of these identifiers; this should be followed by one or more slash-separated elements, using the internal representation of the menu tree in `gretlmain.xml` or `gretlmodel.xml`—these XML UI files can be found in the gretl source package or in git.[1]

example: `menu-attachment = MODELWIN/Analysis`

---

[1] See `http://sourceforge.net/p/gretl/git/ci/master/tree/gui/`.

`label` (conditionally required): A very short string that can be displayed in a GUI menu. This is relevant only if the package specifies a `menu-attachment`, in which case it is required.

example: `label = Marginal effects`

`gui-main` (optional): This entry is relevant only if a package offers more than one public interface. Its effect is to select one particular interface when a user accesses the function package via the gretl GUI (other public interfaces can be selected via the command line if the user so chooses). If a package offers multiple public interfaces and `gui-main` is *not* specified, the user will be given a choice of interfaces whenever he or she calls the package. (If a package offers only one public interface, we can think of this as implicitly its "gui-main".)

example: `gui-main = GUI_lp_mfx`

`gui-help` (optional): The name of a UTF-8 file containing GUI-specific help text, to be shown when the user clicks on Help in a dialog box representing the package. Such text may make reference to buttons, pull-down lists and the like rather than using language appropriate to command-line usage.

example: `gui-help = bpgui.help`

`menu-only` (optional): A list of public interfaces (in practice, probably only one) that are specifically designed to be called from a suitable GUI menu and that should *not* be offered via the browser for installed packages. If any function falls in this category it's likely to be the one designated as `gui-main`.

example: `menu-only = GUI_lp_mfx`

`model-requirement` (optional): When the "gui-main" function of a package is designed to be called from a menu in a gretl model-output window, this element can be used to indicate that only models of a certain type are supported (and therefore the package will shown only for such models). The right-hand value should be the gretl command-word corresponding to the supported estimator. See also `gui-precheck`.

example: `model-requirement = tobit`

`gui-precheck` (optional): Applies only when a `menu-attachment` is specified. This element identifies a function to be called to check whether the package is supported in context. It offers a more flexible testing mechanism than `model-requirement`.

The `gui-precheck` function should not be included in the listing of public interfaces; it is intended only for internal use by gretl. It must take no arguments and must return a scalar. On execution it has access to all the $-accessors for the model in question. On this basis the function should return 0 if the model is supported, non-zero otherwise.

example: `gui-precheck = lp_mfx_precheck`

`list-maker` (optional): Applies only when a model-window `menu-attachment` is specified. This element identifies a function to be called to construct a list of series bearing some specific relationship to the gretl model which the package "targets," from which the user is then expected to select a member. This is a generalization of the `$xlist` mechanism described in section 3.4.3 above, and is best explained by example. In the `exogtest` package the designated `list-maker` function reads as follows:

```
function list exogtest_listmaker (void)
  bundle m = $model
  list L = m.xlist - m.instlist
  if nelem(L) == 0
    funcerr "No endogenous regressors were found"
  endif
  return L
end function
```

This function constructs a list of endogenous regressors from a model estimated via gretl's `tsls` command (details of which are presumed to be available as members of the `$model` bundle). This then provides an automatic listing of candidate arguments for the `xvar` parameter to the package's `GUI_exogtest` function, the signature of which is

```
function bundle GUI_exogtest (int xvar[$mylist] "regressor to test")
```

The dummy default value of `$mylist` is understood by gretl to mean the user's selection from the list returned by the `list-maker` function.

Note that the `list-maker` function must take no arguments (but can assume access to `$model`) and must return a list (or fail with an error message if no suitable list members are available). It should be a function private to the package.

example: `list-maker = exogtest_listmaker`

`ui-maker` (optional): This element allows fine-tuning of the dialog box shown when a package is called via gretl's graphical interface. At present the following points can be configured (more options may be added in future):

- A given parameter (of any type) can be marked as dependent on a specified boolean parameter.
- A parameter of type `int` can be given a data-dependent default, minimum and/or maximum value, to be fixed at run time.
- A parameter of type `list` can be inflected in up to three ways (illustrated below).

These things are achieved by including in the package a private function which returns a bundle, holding a sub-bundle for each parameter to be inflected. This is most easily explained by example. Here's the (slightly simplified) signature of the `gui-main` function for a package currently in development:

```
function bundle GUI_rf (\
   series y "dependent variable",
   list X "independent variables",
   int n_train[50::] "training observations",
   bool use_seed[0] "set random seed",
   int seed[0:2147483647:1234567])
```

Now consider the following private function, which is designed to inflect the GUI representation of the above:

```
function bundle rf_ui_maker (void)
   maxstr = "ceil(0.9*$nobs)"
   defstr = "ceil(0.65*$nobs)"
   bundle b
   b["seed"] = _(depends="use_seed")
   b["n_train"] = _(maximum=maxstr, default=defstr)
   b["X"] = _(singleton=0, exclude="y", no_const=1)
   return b
end function
```

In this example the parameters `seed`, `n_train` and `X` are inflected. For `seed`, the `depends` keyword indicates that its sensitivity should depend on the boolean parameter `use_seed`: it will be "grayed out" unless the `use_seed` check-box is checked. For `n_train`, its maximum and default values are configured via the strings `maxstr` and `defstr`: these are treated as expressions to be evaluated at run time, factoring in the size of the current dataset. Finally, the list parameter `X` has three inflections: `singleton=0` means that a list with a single series member is not acceptable; `exclude="y"` means that if a given series is selected for the role of `y` (the first parameter) it should not be shown as a candidate member of `X`; and `no_const=1` says that the automatic `const` series should not be a candidate either.

The `ui-maker` is called internally when the relevant dialog box is to be shown, and on successful execution the directives in the returned bundle are followed.

example: `ui-maker = rf_ui_maker`

`no-print` (optional): A list of public interfaces that are not designed to print anything. Consider, for example, a package whose job is to produce a special graph based on model data. By default, when a packaged function is invoked via the GUI a window is opened showing the command along with any printed output, but for graph-only output such a window is superfluous and potentially confusing. You can suppress the text output window by adding such a function to the `no-print` list.

4.3 Bundle-related elements

The elements described below are applicable only if at least one public function in the package returns a bundle. In the GUI package editor these appear under the Special functions tab in the Extra properties window.

`bundle-print` (optional): Identifies a given function that can be used to print the content of a bundle produced by the package.

example: `bundle-print = oddsratios_print`

`bundle-plot` (optional): Identifies a given function that can be used to produce some sort of plot or graph using the content of a bundle produced by the package.

example: `bundle-plot = Brown_print`

`bundle-fcast` (optional): Identifies a function that generates a forecast based on a bundle's content.

example: `bundle-fcast = regls_fcast`

Functions selected for the special bundle-related roles may be public (if it makes sense to allow users to call them directly) or private (if they're designed to be called only via GUI hooks). In either case they must conform to certain rules, as follows.

- In all cases the first argument must be a bundle-pointer.
- In the case of `bundle-fcast` this is followed by two mandatory integer arguments giving the start and end of the sample range for the forecast. In other cases the second argument, if present, must be an `int` that controls the function's behavior in some way, and it must have a specified default value.
- Any further arguments must have default values (meaning that they can be omitted).

Taking the gig package as an example, we have:

```
function void gig_bundle_print(bundle *model)
```

and

```
function void GUI_gig_plot(bundle *model, int ptype[0:1:0] \
                           "Plot type" {"Time series", "Density"})
```

That is, gig's `bundle-print` function has no options, but its `bundle-plot` function has a control parameter `ptype`. Note how this parameter is set up: it has a minimum value of 0 and a maximum of 1 (these options could be extended), and 0 is the default. Further, the parameter is given a name for display in the GUI, "Plot type", and it also has strings—"Time series" and "Density"—associated with its two possible numerical values. The latter strings will be used to populate a menu on the window displaying a gig bundle.

4.4 Extra elements

At present there are five spec file entries in this category; in the GUI package editor they appear in the Extra properties window under the tabs Data files, Dependencies, and Menu attachment.

`data-files`: Specifies an extra file or subdirectory that should be included in the package. Use of this option is valid only if the package takes the form of a zipfile. If just one extra file is to be included you may give its name as the parameter to `data-files` (as in the example below); if several extra files are to be packaged, put them into a subdirectory and give its name as parameter. See chapter 5 for examples, and in particular section 5.4 for the special meaning of including a subdirectory named `examples`.

example: `data-files = special.gdt`

`depends`: Specifies one or more packages upon which the given package depends. This information should be added if the package calls functions that reside in other packages. Use of this option ensures that when your package is loaded, any dependencies are also loaded. For example, there's a package named `extra` which provides various utility functions that are not available as gretl built-ins. If your package uses functions from `extra` you should include the following line in its spec file.

example: `depends = extra`

`provider`: This should be used if your package requires access to the *private* functions of another package, a particularly close form of dependency. Only one package can be specified in this way. In the GUI this feature is represented by a check box against the first entry under the Dependencies tab. In the spec file, specifying a package as provider automatically includes it as a dependency.

example: `provider = extra`

`wants-data-access`: In some cases your package may need to read data outside of the active sample range. This could be pre-sample initial values in a dynamic model, or it could be post-sample values of exogenous regressors used for out-of-sample (conditional) forecasting. But since a user-written hansl function is normally restricted to the incoming sample specified by the caller of the function, this would not be possible. In such situations, your package should specify this switch, and if upon execution the gretl user agrees, your relevant packaged function may use the `smpl` command to reset the active sample inside the function even beyond the incoming limits. (The original sample will be restored when exiting the function, as always.) In the GUI package editor this item appears under Menu attachment.

example: `wants-data-access = true`

`R-depends`: This should be used if your package depends on R for its functionality. You should give an R version with which the package is known to work, along with the names and known-good version numbers of any R packages it requires. The example below might be suitable for a package that requires R and its glmnet package. Multiple elements should be separated by spaces

example: `R-depends = R 3.5.3 glmnet 2.0-18`

`R-setup`: This is specific to packages that call upon R. The required parameter is the name of a private hansl function, whose role is to define an R function. The hansl function should take no arguments and should not return anything (that is, be of type `void`). It should just be a thin wrapper over a gretl `foreign` block, as illustrated in Listing 4.1.

This mechanism depends on access to the R shared library, which will usually be available when R is installed. The idea is that the R function in question is "registered" with the R library when your package is loaded, and can thereafter be called—with the prefix "`R:`"—as if were a native gretl function, avoiding the need for further use of a `foreign` block. In relation to Listing 4.1, once `foo` is registered with R, hansl code in your package can call `R:foo` (with suitable arguments, of course) and retrieve whetever it returns, without need for further use of gretl's `foreign` apparatus.

To gain a fuller understanding of this facility, please refer to Chapter 44 of the the *Gretl User's Guide*, in particular section 44.7, "Further use of the R library". Here we'll just note that when a package includes an `R-setup` function it is tested for applicability when the package is first loaded. If the `R` library cannot be found or the `R` code that defines a function is not successfully executed, the problem should be quickly apparent.

example: `R-setup = foo_setup`

Listing 4.1: Example of an `R-setup` function

```
function void foo_setup (void)
   foreign language=R --quiet
   foo <- function(<args>) {
      # R code goes here
   }
   end foreign
end function
```

4.5 A note on gretl versioning

Since 2015 gretl version identifiers have taken the form "year of release plus sequential letter"—as in `2018a`, `2018b` and so on—and this form should be used when specifying the minimum gretl version required by a package via its `spec` file. Note that you can consult the gretl ChangeLog (`http://gretl.sourceforge.net/ChangeLog.html`) to determine when commands or functions of interest were introduced. A reasonable policy would be to specify a minimum gretl version dating from, say, two or three years prior to the writing of your package, unless the package depends on more recently added functionality.

Chapter 5

Zip package details

5.1 Basic specification

At minimum, a zip package must contain a top-level directory with the same name as the package itself, and this directory must contain the `gfn` file. Suppose the name of the package is `mypkg`; in that case the minimal zipfile looks like this (as shown by the `unzip` program with its `-l` option to list the contents of an archive):

```
Archive:  mypkg.zip
  Length      Date    Time    Name
---------  ---------- -----   ----
        0  2015-06-07 10:54   mypkg/
    10708  2015-06-07 10:54   mypkg/mypkg.gfn
---------                     -------
    10708                     2 files
```

There would be little point in creating a package with just the content shown above; the advantage of the zipfile format lies in the possibility of including extra materials that cannot be stuffed into a `gfn` file. Such materials fall into four main categories:

- PDF documentation. This should take the form of a pdf file with the same basename as the package, included in the top-level package directory. Thus, to continue the example above, the directory `mypkg` might contain `mypkg.pdf` as well as `mypkg.gfn`.
- Data to support a sample script. This answers the case where a package author wishes to use specific data, not present in the gretl distribution, with his or her sample script. For example, the `almonreg` package contains the datafile `almon.gdt` to permit replication of Shirley Almon's original modeling.
- Data for internal use. For example, gretl matrix files containing tables of critical value for some hypothesis test implemented by the package.
- Extra examples: scripts and/or data files that go beyond the required sample script to give users a full sense of the scope and usage of a complex package.

5.2 Example: almonreg

Here's a fairly simple real case, the `almonreg` package:

```
Archive:  almonreg.zip
  Length      Date    Time    Name
---------  ---------- -----   ----
        0  02-12-2015 13:27   almonreg/
    55861  02-12-2015 13:27   almonreg/almonreg.pdf
     4409  02-12-2015 13:27   almonreg/almonreg.gfn
     1969  02-12-2015 13:27   almonreg/almon.gdt
---------                     -------
    62239                     4 files
```

The relevant portion of the almonreg spec file, calling for inclusion of the PDF and gdt files, reads thus:

```
help = almonreg.pdf
data-files = almon.gdt
```

Note that when the almonreg sample script opens the data file `almon.gdt` it must employ the `--frompkg` option to tell gretl where to find the file:

```
open almon.gdt --frompkg=almonreg
```

5.3 Example: GHegy

Another illustration: Ignacio Díaz-Emparanza's GHegy package (abbreviated):

```
Archive:  GHegy.zip
  Length      Date    Time    Name
---------  ---------- -----   ----
        0  2015-03-12 13:51   GHegy/
    18610  2015-03-12 13:51   GHegy/GHegy.gfn
        0  2015-03-12 13:51   GHegy/coeffs/
    52960  2015-03-12 13:51   GHegy/coeffs/CFt_c_fijo.mat.gz
    53276  2015-03-12 13:51   GHegy/coeffs/CFt_cD_fijo.mat.gz
    42990  2015-03-12 13:51   GHegy/coeffs/Ct2_c_BIC.mat.gz
    ...    ...                ...
---------                     -------
  3798063                     83 files
```

In this instance we don't have PDF documentation, but we do have a large number of gzipped gretl matrix files, holding response-surface coefficients by means of which the package is able to compute P-values for the HEGY seasonal unit-root test. The relevant spec file clause is

```
data-files = coeffs
```

Note that putting `coeffs` (the name of a directory) into the data-files list ensures that all the contents of this directory will be included in the zip package. At run time GHegy can access its matrix files using the accessor variable `$pkgdir`, which will expand to the appropriate platform-dependent path, as in

```
string matname = sprintf("%s/coeffs/CFt_c_fijo.mat.gz", $pkgdir)
matrix C = mread(matname)
```

5.4 Example: HIP

Our final illustration is the HIP package (which now has official "addon" status), written by Jack Lucchetti and Claudia Pigini. Looking in the zipfile we see:

```
Archive:  HIP.zip
  Length      Date    Time    Name
---------  ---------- -----   ----
        0  03-19-2015 19:58   HIP/
        0  03-19-2015 19:58   HIP/examples/
    75210  03-19-2015 19:58   HIP/examples/camtriv_chap14.gdtb
      657  03-19-2015 19:58   HIP/examples/camtriv_chap14.inp
     1941  03-19-2015 19:58   HIP/examples/MonteCarlo.inp
   383278  03-19-2015 19:58   HIP/HIP.pdf
```

```
     27691  03-19-2015 19:58   HIP/HIP.gfn
 ---------                     -------
    488777                     7 files
```

We have PDF documentation plus an `examples` directory. The latter is special: if a zip package contains a directory named `examples` (*exactly* that, in English and all lower case), then in the GUI function package browser the “Resources...” button (open folder icon) and menu item become active. Selecting this item opens a file dialog pointing at the examples directory, from which you can open any scripts or datafiles that are provided. These are intended to supplement the required sample script.

Bibliography

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_______ (2017) *Gretl User's Guide*, gretl documentation. URL `http://sourceforge.net/projects/gretl/files/manual/`.

Díaz-Emparanza, I. (2014) 'Numerical distribution functions for seasonal unit root tests', *Computational Statistics and Data Analysis* 76: 237–247.

Lucchetti, R. and C. Pigini (2015) 'DPB: Dynamic panel binary data models in gretl'. gretl working papers 1, Università Politecnica delle Marche (I), Dipartimento di Scienze Economiche e Sociali. URL `http://ideas.repec.org/p/anc/wgretl/1.html`.