Holt 1.0

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1 Holt's local linear trend

This package uses Holt's double exponential smoothing method to obtain an estimation of the linear trend of a series, which may vary locally, and to obtain forecasts for the series. The model used is:

$$Y_t = T_t + u_t$$

where T_t is the local trend and u_t a random error. The estimation of the local trend for period $t + \ell$ (with $\ell > 0$), or the forecast of the observation $Y_{t+\ell}$, based on information in t is:

$$\hat{T}_t(\ell) = \hat{Y}_t(\ell) = S_t + \ell\, b_t$$

being

$$\begin{aligned} S_t &= \delta_1 Y_t + (1-\delta_1)(S_{t-1} + b_{t-1}) \\ b_t &= \delta_2(S_t - S_{t-1}) + (1-\delta_2)b_{t-1} \end{aligned}$$

with $0 < \delta_1 < 1$ and $0 < \delta_2 < 1$. Initial values for S_t and b_t may be calculated in several alternative ways. In this package there is the possibility of setting them by means of a linear trend estimation along the full sample, along the first half of the sample or based on the first two observations.

2 Command-line use

The function available for command-line and scripting use is named Holt. It returns a bundle (to be described below) and takes the following arguments:

name	*type*	*comment*	*default value*
y	series	the dependent variable	-
δ_1	scalar	smoothing parameter for the level	0.3
δ_2	scalar	smoothing parameter for the slope	0.1
init	integer	Initial values based on:	2
		0: the first two observations;	
		1: a regression with the whole sample;	
		2: a regression with the first half of the sample	
pred	integer	number of final observations for	0
		evaluating the quality of the predictions	

We illustrate two calls to this function by reference to the sample script included in the package. This script begins with

```
include Holt.gfn
open data3-6.gdt
```

The data file `data3-6.gdt` contains two annual time series running from 1959 to 1994, namely Ct (Personal consumption expenditures in constant 1992 dollars) and Yt (Per capita disposable personal income in constant 1992 dollars). These comes from 1996 Economic Report of the President, Table B-27, Page 311.

The next command uses Holt's method to estimate a local linear trend, with $\delta_1 = 0.3$ and $\delta_2 = 0.1$ and forecast the last three observations of the sample. This time we use initial values calculated from a regression with the whole sample (*init*=1) and use *pred=3* which implies that the Holt function is used with the sample from 1959 to 1991. The last three observations (from 1992 to 1994) are forecasted and the function reports the Mean Square Error (MSE) and the Mean Absolute Error (MAE) of the predictions.

```
bundle bHolt=Holt(Ct,0.3,0.1,1,3)
```

The next two lines of the script use Holt's method to estimate a local linear trend and forecast 4 observations out of the sample. The first one allocates space at the end of the sample to put the new values, so extending the dataset up to 1998. The values of Ct and Yt for these years are assigned as 'missing observations', (with value NA).

```
dataset addobs +4
```

The next line invokes the Holt function with parameters $y = Ct$, $\delta_1 = 0.3$, $\delta_2 = 0.1$ and save the result. Initial values are calculated from a regression with the first half of the sample (*init*=2, which being the default value could

also be omitted). Not writing any value for *pred*, this is left at its default value [0] so, no intra-sample predictions are made. The resulting trend will have values forecasted out of the sample. (In spite of the added observations, a value of *pred* different from zero makes that the forecasts are made only for the values in the sample).

```
bundle bHolt=Holt(Ct,0.3,0.1,2)
```

3 GUI use

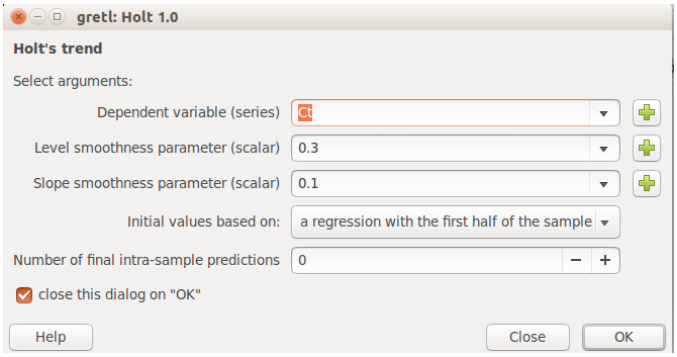

Figure 1: Holt package dialog box

This package may be invoked by means of the graphical user interface (GUI) of *gretl*. This may be done through the gretl menu `/Tools/Function packages`. When the package is executed, a dialog box as in Figure 1 emerges. All the parameters appearing in this window are auto-explicative, except, perhaps, the last one *Number of final intra-sample predictions* which corresponds to the parameter *pred* mentioned above, i.e. is the number of observations at the end of the sample used to calculate MSE and MAE of the forecasts.

The output window of the package may be seen in Figure 2. It presents the values of the original series and the smoothed trend and (optionally) the MSE and MAE of the predictions. By clicking on the second icon of the window (starting from the left side), the estimated trend may be saved to the gretl dataset and clicking on the last icon a graph of the original series and the trend is displayed.

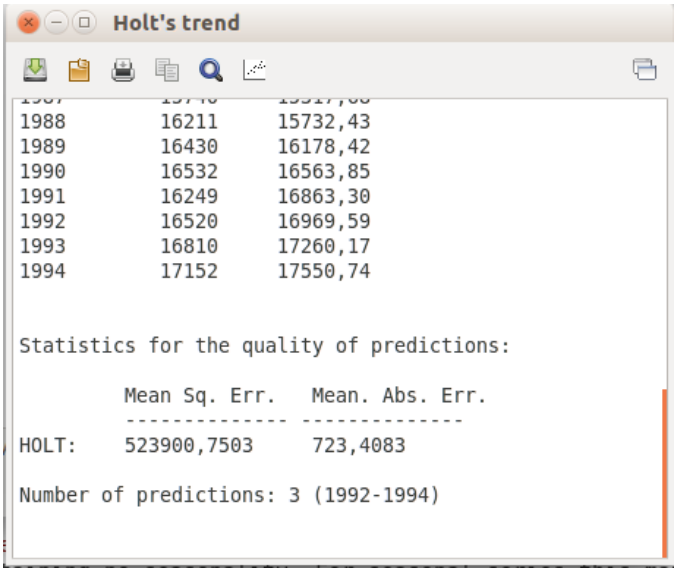

Figure 2: Output of the package

Notes:

- IMPORTANT: If you want to make some forecasts out of the sample, you need to extend the sample before hand in the number of observations that you want. For example, in a console or in a *hansl* script:

  `dataset addobs +4`

  or in the GUI: `/Data/Add obs.`

- This method is suitable for annual series, monthly or quarterly series containing no seasonality. For seasonal series this may result in a *trend* distorted by the seasonal cycles. In this case, the Holt-Winters method may be used for making forecasts (see Winters package). For trend-extraction it is better to use another methods (Butterworth filters, X12Arima, structural models, etc).

Reference:
Econometría. Series temporales y predicción, (1993). Jose M. Otero. Ed: AC. Madrid.