**Creating plots and tables of estimation results using `parmest` and friends**

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- Why save estimation results?
- The `parmest` package: `parmest` and `parmby`.
- Creating confidence interval plots using `descsave` and `factext`.
- Concatenating multiple analysis results using `dsconcat`.
- Plotting *P*-values using `smileplot`.

**Why save estimation results?**

- Statisticians make their living by producing confidence intervals and $P$-values.
- Unfortunately, the confidence intervals and $P$-values in a Stata log are in no fit state for delivery to an end user.
- At the very least, they need to be formatted and tabulated to be fit for publication.
- And, for immediate impact, it is even better to plot them.
- Former SAS users in particular are accustomed to being able to produce output data sets, and want to do the same in Stata.

## The `parmest` package: `parmest` and `parmby`

- My first response to this problem was `parmest`, which saves the results of the most recent Stata estimation command as a data set with 1 observation per parameter and data on parameter names, labels, estimates, confidence limits and $P$-values.

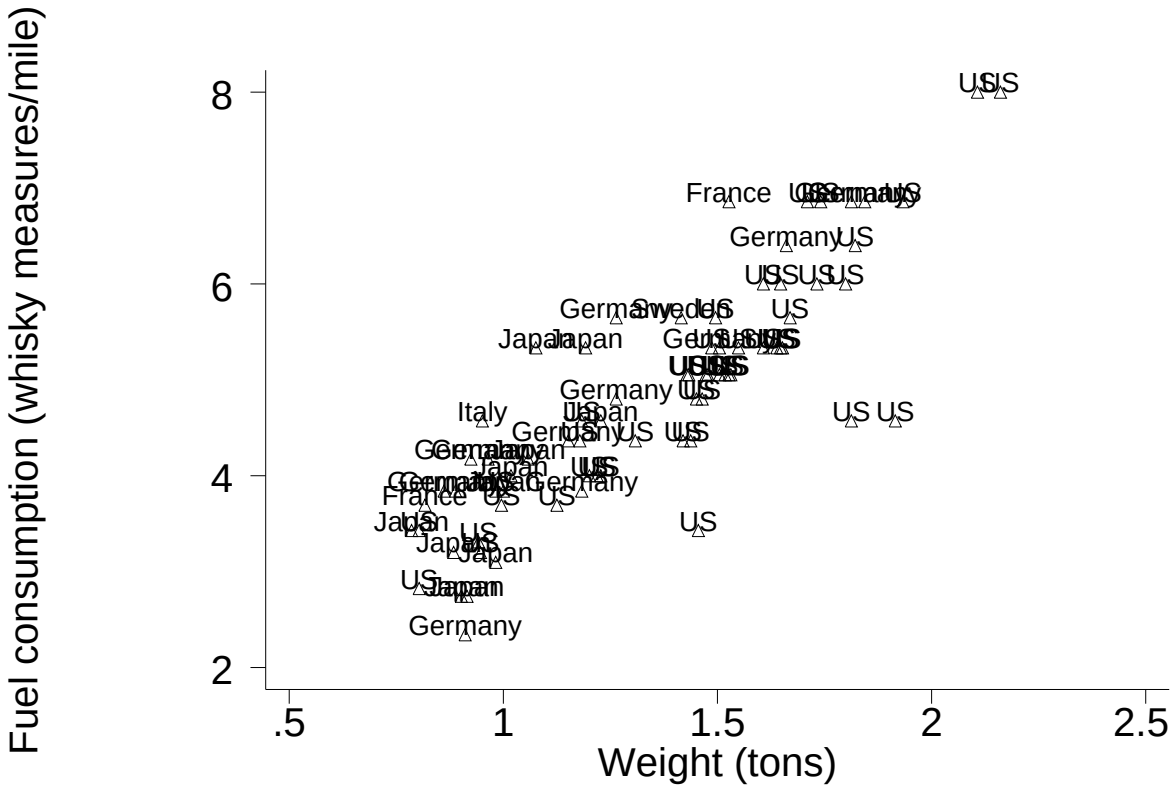
- Nowadays, I use `parmby`, a "quasi-byable" front end to `parmest` (although the `by` option is not compulsory). `parmby` calls a Stata estimation command (such as `regress`), and creates an output data set with 1 observation per parameter or 1 observation per parameter per by-group, and data on a wide range of estimation results.

- `parmby` is therefore like `statsby`, except that it creates an observation *per parameter* per by-group, instead of an observation per by-group.

- The data set created by `parmest` or `parmby` can be saved to disk, stored in memory (overwriting the pre-existing data), or both.

## Fuel consumption and weight by country for cars in the `auto` data

- In the `auto` data, we define a numeric variable `country`, encoding a car's country of origin.
- We also define two variables `wmpm` (fuel consumption in whisky measures per mile) and `tons` (weight in tons).
- The graph plots `wmpm` against `tons`, labelling data points by `country`.



### An example program using `parmby`

The following program uses `parmby` to fit a regression model of fuel consumption with respect to weight and country of origin, and to store the results in memory, overwriting the existing data. It then specifies a sensible format for the confidence intervals, describes the data set, and lists the confidence intervals.

```
parmby "xi:regress wmpm tons i.country,nohead",label norestore;
format estimate min95 max95 %8.2f;
describe;
list parm label estimate min95 max95,noobs;
```

**Output of the example program (1)**

`parmby` calls `regress`, prints the results in the usual Stata log format, and saves them.

```
. parmby "xi:regress wmpm tons i.country,nohead",label norestore;
Command: xi:regress wmpm tons i.country,nohead
i.country          _Icountry_1-6       (naturally coded; _Icountry_1 omitted)
------------------------------------------------------------------------------
        wmpm |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        tons |   3.400347   .2313002    14.70   0.000      2.93867    3.862024
 _Icountry_2 |    .549941   .1911327     2.88   0.005     .1684385    .9314435
 _Icountry_3 |   .4380153   .2245559     1.95   0.055    -.0102001    .8862307
 _Icountry_4 |   1.280447    .428687     2.99   0.004     .4247846     2.13611
 _Icountry_5 |   1.328566   .6041275     2.20   0.031     .1227229     2.53441
 _Icountry_6 |   .8254644   .5920764     1.39   0.168     -.356325    2.007254
       _cons |   .0094969   .3515232     0.03   0.979    -.6921464    .7111402
------------------------------------------------------------------------------
```

Note that cars typically consume 2.94 to 3.86 extra whisky measures of petrol per additional ton-mile. The other parameters are country effects and an intercept (in whisky measures/mile).

## Output of the example program (2)

The data set created by `parmby` has one observation per parameter, and variables as shown:

```
. describe;

Contains data from C:/WINDOWS/TEMP/ST_1r0003.tmp
  obs:             7
 vars:            10                          1 Jun 2003 16:48
 size:           546 (99.4% of memory free)
-------------------------------------------------------------------------------
              storage  display     value
variable name   type   format      label      variable label
-------------------------------------------------------------------------------
parmseq         byte   %12.0g                 Parameter sequence number
parm            str11  %11s                   Parameter name
label           str13  %13s                   Parameter label
estimate        double %8.2f                  Parameter estimate
stderr          double %10.0g                 SE of parameter estimate
dof             byte   %10.0g                 Degrees of freedom
t               double %10.0g                 t-test statistic
p               double %10.0g                 P-value
min95           double %8.2f                  Lower 95% confidence limit
max95           double %8.2f                  Upper 95% confidence limit
-------------------------------------------------------------------------------
Sorted by:  parmseq
```

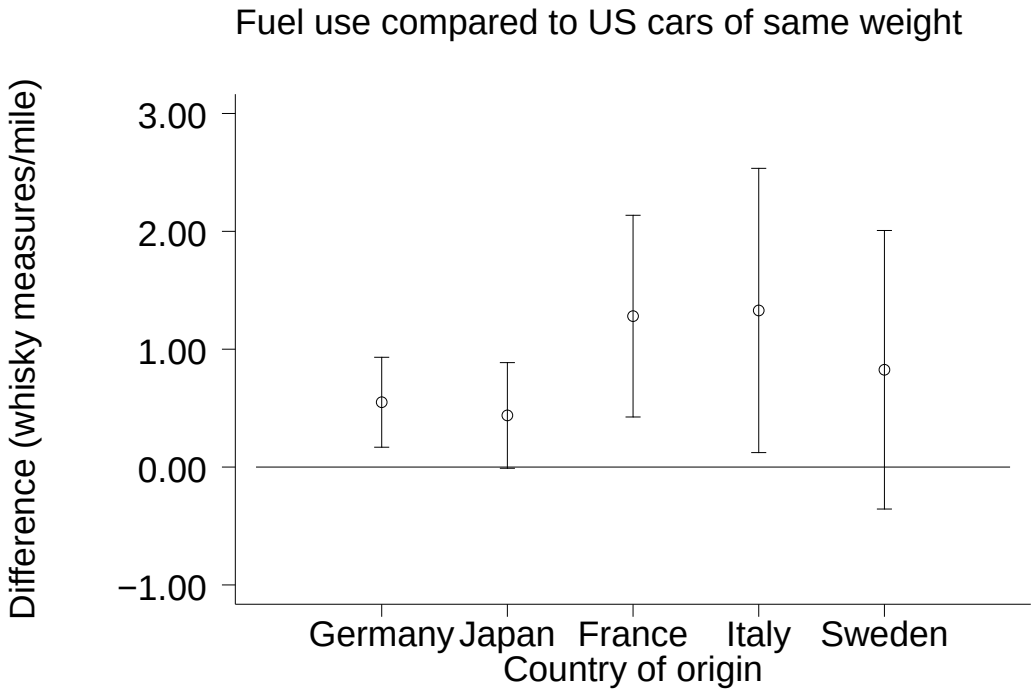
**Output of the example program (3)**

The parameters are listed with labels and formats, and are a bit more user-friendly than before. The variable `label` contains the variable label of the $X$-variable corresponding to the parameter, which may be a dummy variable created by `xi`.

```
. list parm label estimate min95 max95,noobs;
       parm           label  estimate     min95     max95
       tons  Weight (tons)      3.40      2.94      3.86
_Icountry_2     country==2      0.55      0.17      0.93
_Icountry_3     country==3      0.44     -0.01      0.89
_Icountry_4     country==4      1.28      0.42      2.14
_Icountry_5     country==5      1.33      0.12      2.53
_Icountry_6     country==6      0.83     -0.36      2.01
      _cons       Constant      0.01     -0.69      0.71
```

We could cut and paste these results into a Word (or TEX) table, possibly using tools such as `outsheet` (official Stata), or `ciform` and/or `listtex` (downloadable from SSC). *However* ...

- . . . it would be better if we knew, at a glance, which dummy variable belonged to which country.
- And it would be even better if we could plot the confidence intervals, instead of just tabulating them.
- This graph shows the expected differences in fuel consumption between non-US cars and US cars of the same weight.



**Creating confidence interval plots using `descsave` and `factext`**

- `descsave` is an extension of official Stata's `describe`. It lists variable attributes (types, formats, variable labels and value labels), and produces output files.

- One of these output files is a Stata do-file, which reconstructs these attributes when called, if variables exist with the same names and modes (numeric or string).

- `factext` is a program which can read factor values from string variables (such as `label` in the `parmby` output) containing `xi`-style dummy variable labels. It may run a do-file created by `descsave` to reconstruct the variable attributes of the factors.

- If `parmby` is used together with `xi`, `descsave` and `factext`, then factors in the input data set, used with `xi`, can be reconstructed in the output data set, with values from the dummy variable labels created by `xi`. These factors can then be used in confidence interval plots and tables.

**A simple program using `descsave`, `parmby`, `xi` and `factext`**

This program uses `descsave` to save the attributes of the variable `country` to a temporary do-file, then uses `parmby` and `xi` to carry out the same regression analysis as before, then uses `factext` to reconstruct the variable `country` in the output data set using the temporary do-file, then lists the confidence intervals, and finally produces the CI plot that we saw earlier.

```
tempfile tf0;
descsave country,do(‘tf0’);
parmby "xi:regress wmpm tons i.country,nohead",label norestore;
factext,do(‘tf0’);
format estimate min95 max95 %8.2f;
list parm label country estimate min95 max95,noobs;
grap estimate min95 max95 country,
 xsc(1,7) xlab(2(1)6) ylab ylin(0) s(O..) c(.II)
 t1("Fuel use compared to US cars of same weight")
 l1("Difference (whisky measures/mile)");
```

**Output data set created using `descsave`, `parmby`, `xi` and `factext`**

This time, the output data set contains a new variable `country`, similar to the one in the input data set. This was reconstructed by `factext`, using dummy variable labels stored in the variable `label` and the do-file stored by `descsave`.

```
. list parm label country estimate min95 max95,noobs;
```

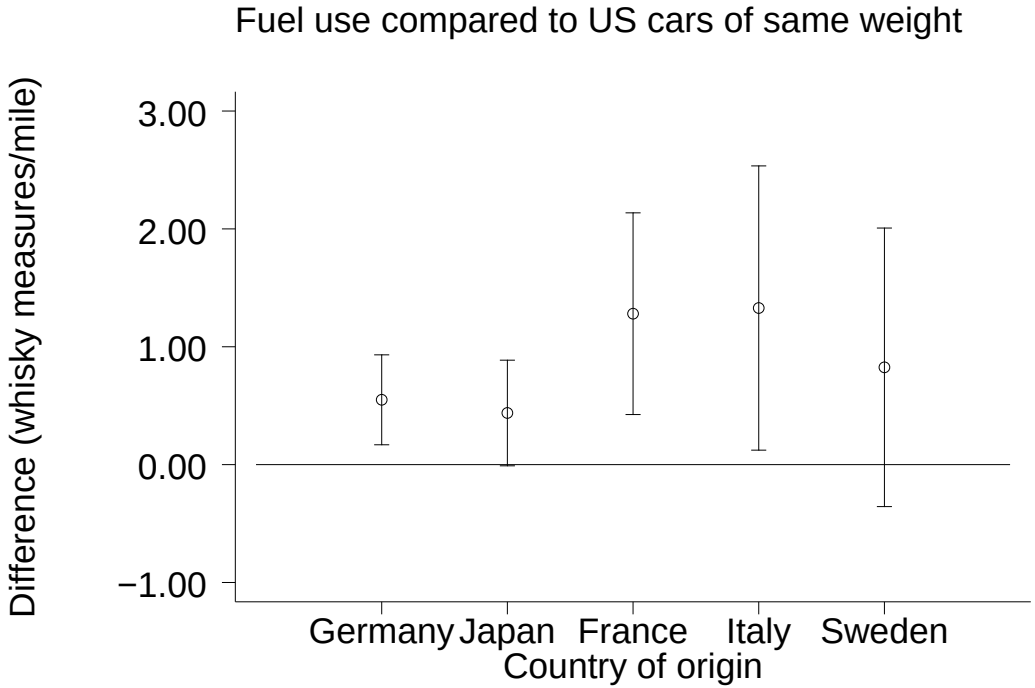
| parm | label | country | estimate | min95 | max95 |
|---|---|---|---|---|---|
| tons | Weight (tons) | . | 3.40 | 2.94 | 3.86 |
| _Icountry_2 | country==2 | Germany | 0.55 | 0.17 | 0.93 |
| _Icountry_3 | country==3 | Japan | 0.44 | -0.01 | 0.89 |
| _Icountry_4 | country==4 | France | 1.28 | 0.42 | 2.14 |
| _Icountry_5 | country==5 | Italy | 1.33 | 0.12 | 2.53 |
| _Icountry_6 | country==6 | Sweden | 0.83 | -0.36 | 2.01 |
| _cons | Constant | . | 0.01 | -0.69 | 0.71 |

**Plot from the output data set created using `descsave`, `parmby`, `xi` and `factext`**

- Finally, the confidence interval variables `estimate`, `min95` and `max95` are plotted against the reconstructed variable `country`.

- Note that the variable and value labels for `country` were automatically reconstructed by `factext`, and did not have to be restated anywhere in the program.

- Therefore, if we change the variable and value labels in the `auto` data and re-run our program, then the changes will appear automatically in the graph.



**Using `parmby` and `dsconcat` to save multiple analyses**

- Usually, we do multiple analyses in a Stata do-file, instead of just one as in the previous examples. So we would like to use the original data set a few times before finally overwriting it.

- Fortunately, `parmby` output data sets can be saved to disk using the `saving` option, leaving the original data intact. So multiple calls to `parmby` can produce multiple output files, possibly temporary.

- These multiple output files can be concatenated into the memory to form one long data set, using the program `dsconcat`.

- In this long data set, we want to know which analysis each fitted parameter belongs to. `parmby` can help us by creating numeric and string identifier variables `idnum` and `idstr` in the output data set for each analysis.

### A program using `parmby` and `dsconcat`

This program carries out unadjusted and adjusted regression analyses of fuel consumption with respect to weight and US origin. It uses `parmby` to save the results of each analysis in a temporary output file (identified by values of the variables `idnum` and `idstr`), and then concatenates the output files using `dsconcat`:

```
tempfile tf1 tf2 tf3;
parmby "regress wmpm tons,nohead",label idnum(1) idstr(Unadj.)
 saving(‘tf1’,replace);
parmby "regress wmpm us,nohead",label idnum(2) idstr(Unadj.)
 saving(‘tf2’,replace);
parmby "regress wmpm tons us,nohead",label idnum(3) idstr(Adj.)
 saving(‘tf3’,replace);
dsconcat ‘tf1’ ‘tf2’ ‘tf3’;
format estimate min95 max95 %8.2f;
sort idnum idstr parmseq;
by idnum idstr:list parm label estimate min95 max95,noobs;
```

**Output data set created by `dsconcat` from multiple `parmby` outputs**

There is one observation per parameter. The different analyses are identified by the variables `idnum` (numeric ID) and `idstr` (string ID).

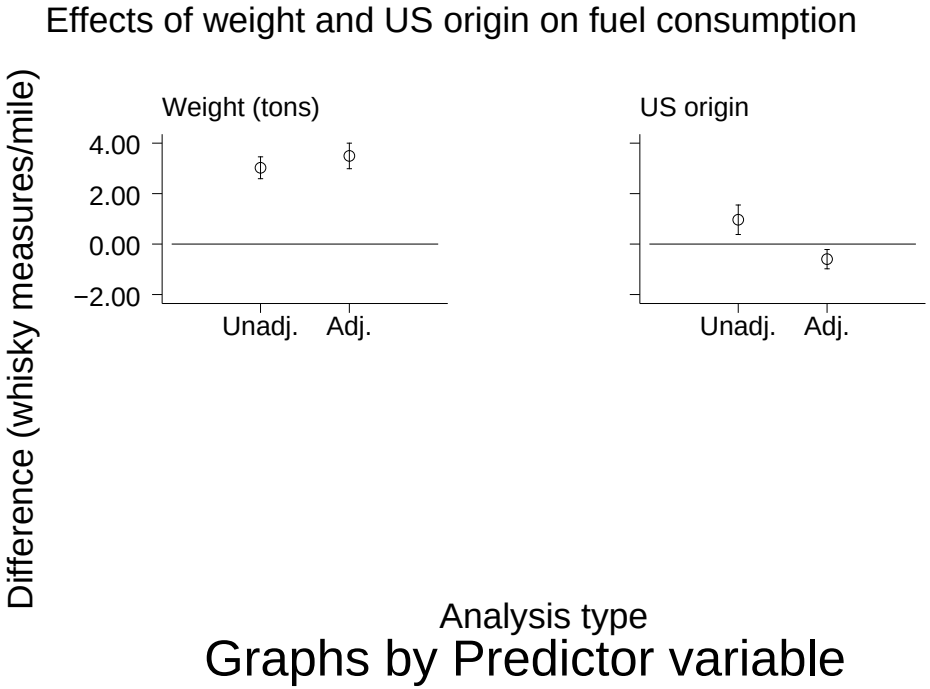
```
. by idnum idstr:list parm label estimate min95 max95,noobs;

-------------------------------------------------------------------------------
-> idnum = 1, idstr = Unadj.
     parm          label  estimate     min95     max95
     tons  Weight (tons)      3.03      2.59      3.46
    _cons       Constant      0.74      0.14      1.34

-------------------------------------------------------------------------------
-> idnum = 2, idstr = Unadj.
     parm          label  estimate     min95     max95
       us      US origin      0.97      0.38      1.55
    _cons       Constant      4.14      3.65      4.63

-------------------------------------------------------------------------------
-> idnum = 3, idstr = Adj.
     parm          label  estimate     min95     max95
     tons  Weight (tons)      3.50      2.99      4.00
       us      US origin     -0.60     -0.98     -0.21
    _cons       Constant      0.53     -0.06      1.11
      0.53     -0.06      1.11
```

**Plot from the output data set created using `parmby` and `dsconcat`**

- With a few more lines of Stata code, we can create these plots from the data in the long data set created by `dsconcat`.

- Note that each plot contains parameters from two analyses (unadjusted and adjusted).

- We see that US cars consume more fuel per mile than non-US cars, but less than non-US cars of the same weight.



**Plotting $P$-values using `smileplot`**

- As well as saving estimates and confidence limits, `parmby` also saves $P$-values. (And many other estimation results, if requested by the user.)

- This is very useful if we are carrying out multiple analyses, and we want to know whether a result is still "significant" as one result out of many.

- The program `smileplot` is used on data sets created using `parmby`. It plots $P$-values on the $Y$-axis against parameter estimates on the $X$-axis.

- The $P$-values are plotted on a reverse log scale. (So, the higher they are, the more significant they are.)

**Example: Red blood cell fatty acid composition and oily fish consumption in pregnant women (ALSPAC study, Bristol University)**

- 4720 pregnant women contributed 1-6 blood samples each, and also reported current fish consumption on a food frequency questionnaire.

- The blood samples were assayed, using chromatography, for composition of the red blood cell membrane (40 different fatty acids as a percent of total fatty acids).

- Consumption of oily fish (eg mackerel) was reported as never/rarely, once per fortnight, 1-3 times per week, or over 3 times per week.

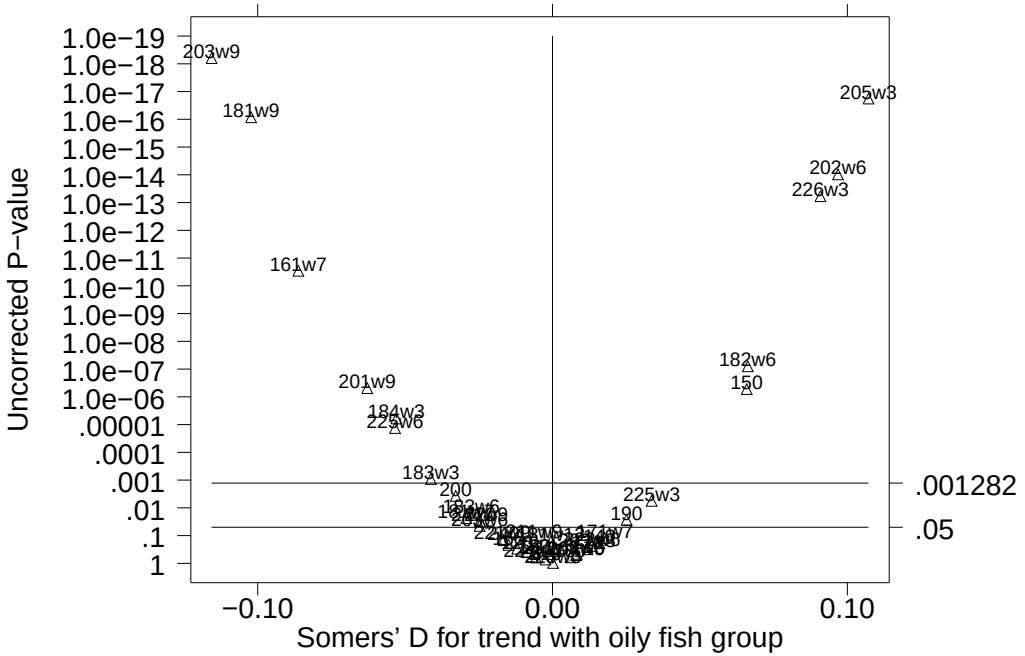
- The association of each fatty acid percentage with reported oily fish consumption was measured using Somers' $D$, which is the difference between two probabilities. Given two samples from women with different reported oily fish consumption, these are the probability that the woman consuming *more* oily fish had the higher fatty acid percentage, and the probability that the woman consuming *less* oily fish had the higher fatty acid percentage.

**Smile plot of Somers' $D$ for fatty acid percentages with respect to oily fish consumption group**

- The data points are 40 individual fatty acid percentages, each with a Somers' $D$ estimate for trend with oily fish group.

- The $X$-axis reference line indicates a Somers' $D$ of zero under the null hypothesis.

- The $Y$-axis reference lines indicate the $P$-value thresholds, uncorrected (lower) and Sidak-corrected for 40 parameter estimates (upper). The upper reference line is called the **parapet line**.



**Unofficial Stata packages mentioned or used in this presentation**

These packages are all downloadable from SSC using the `ssc` command (see `help ssc`).

| **Package** | **Description** |
|---|---|
| `ciform` | Format three numeric variables as a confidence interval for tabulation |
| `descsave` | Extension of `describe`, producing output files |
| `dsconcat` | Concatenate a list of Stata data files into the memory |
| `factext` | Extract values of factors from string variables, eg `label` in a `parmby` output |
| `listtex` | Output variables to a file to be inserted into a general TEX or HTML table |
| `parmest` | Save estimation results as a data set with 1 obs. per parameter (includes `parmby`) |
| `sencode` | Extension of `encode`, with string values coded in order of appearance |
| `smileplot` | Create a smile plot of $P$-values against parameter estimates |