

# Demand-system estimation: Update

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**Abstract.** The `nlsur` command is better suited to demand-system estimation than the suite of ado-files provided in Poi (2002, *Stata Journal* 2: 403–410) because it is faster and requires only one ancillary ado-file. This article replicates the results presented in Poi (2002) by using `nlsur` instead of `ml`.

**Keywords:** st0029\_1, nlsur, demand-system estimation, nonlinear estimation, maximum likelihood, demand equations

## 1 Introduction

In Poi (2002), I showed how to use Stata’s `ml` commands to fit the quadratic almost ideal demand system (QUAIDS) of Banks, Blundell, and Lewbel (1997). Although the programs presented in my earlier article continue to work, I strongly encourage users of Stata 10 and beyond to use the `nlsur` command instead. `nlsur` fits a system of nonlinear seemingly unrelated regressions by using iterated feasible generalized least squares, and for this class of models iterated feasible generalized least squares is equivalent to maximum likelihood estimation. Thus `nlsur` and `ml` will produce identical results.

Using `nlsur` has two clear advantages over `ml`. First, estimation of demand systems is typically much faster using `nlsur` rather than `ml` because `nlsur` uses an optimization algorithm designed specifically for least-squares problems that does not require the computation of second derivatives. Second, although both methods require a likelihood-evaluator program, the `ml` method requires several additional ancillary ado-files. On the other hand, `nlsur` requires just one ado-file.

## 2 Example

In [R] `nlsur`, the final example shows how to fit the almost ideal demand system of Deaton and Muellbauer (1980) to a model with four goods. Here I fit a QUAIDS model and verify that the results agree with those produced by using `ml`. Poi (2002) presents the estimating equations for the QUAIDS model along with the parameter restrictions implied by economic theory; because that article is freely available at the *Stata Journal* web site (<http://www.stata-journal.com>), I do not show those equations here.

To use `nlsur` to fit a demand system, we must first write a “function evaluator” program. That program accepts a list of variables and a parameter vector, and returns the predicted values for each equation. Accompanying this article is an ado-file that

implements the function evaluator program for a four-goods QUAIDS model. First, install that file by typing

```
. net sj 8-4
. net install st0029_1
```

Next, to fit the model, type

```
. webuse food
. nlsur quaid5 @ w1 w2 w3 lnp1-lnp4 lnexp, ifgnls nequations(3) param(a1 a2 a3
> b1 b2 b3 g11 g12 g13 g22 g23 g33 l1 l2 l3) nolog
(obs = 4048)
Calculating NLS estimates...
Calculating FG-NLS estimates...
FG-NLS iteration 2...
FG-NLS iteration 3...
FG-NLS regression
```

Equation		Obs	Parms	RMSE	R-sq	Constant
1	w1	4048	.	.1333097	0.9017*	(none)
2	w2	4048	.	.1024167	0.8480*	(none)
3	w3	4048	.	.0537732	0.7906*	(none)

\* Uncentered R-sq

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
/a1	.3136617	.008671	36.17	0.000	.2966669	.3306565
/a2	.2712567	.0067025	40.47	0.000	.2581201	.2843933
/a3	.1052015	.0034241	30.72	0.000	.0984903	.1119126
/b1	.0099745	.0107581	0.93	0.354	-.0111109	.03106
/b2	-.0261289	.0082873	-3.15	0.002	-.0423718	-.0098861
/b3	.0041683	.0043539	0.96	0.338	-.0043652	.0127018
/g11	.1214999	.0057199	21.24	0.000	.1102892	.1327106
/g12	-.0522583	.0039321	-13.29	0.000	-.059965	-.0445516
/g13	-.0351566	.00218	-16.13	0.000	-.0394294	-.0308839
/g22	.0644288	.00446	14.45	0.000	.0556873	.0731703
/g23	-.001202	.0019786	-0.61	0.544	-.00508	.002676
/g33	.0425055	.0017627	24.11	0.000	.0390506	.0459604
/l1	-.0025218	.0041982	-0.60	0.548	-.01075	.0057064
/l2	-.0000235	.0032452	-0.01	0.994	-.0063841	.006337
/l3	.0011219	.0017051	0.66	0.511	-.00222	.0044638

Because the error covariance matrix is identically singular (since expenditure shares sum to one), I dropped the fourth share equation during estimation. To recover the parameters of that equation, you can use `nlcom`:

(Continued on next page)

```

. nlcom (a1:_b[/a1]) (a2:_b[/a2]) (a3:_b[/a3])
>      (a4:1-_b[/a1]-_b[/a2]-_b[/a3])
>      (b1:_b[/b1]) (b2:_b[/b2]) (b3:_b[/b3])
>      (b4:-_b[/b1]-_b[/b2]-_b[/b3])
>      (g11:_b[/g11]) (g12:_b[/g12]) (g13:_b[/g13])
>      (g14:-_b[/g11]-_b[/g12]-_b[/g13])
>      (g22:_b[/g22]) (g23:_b[/g23])
>      (g24:-_b[/g12]-_b[/g22]-_b[/g23])
>      (g33:_b[/g33]) (g34:-_b[/g13]-_b[/g23]-_b[/g33])
>      (g44:-(_b[/g11]-_b[/g12]-_b[/g13]) -
>      (_b[/g12]-_b[/g22]-_b[/g23]) -
>      (_b[/g13]-_b[/g23]-_b[/g33]))
>      (l1:-_b[/l1]) (l2:-_b[/l2]) (l3:-_b[/l3])
>      (l4:-_b[/l1]-_b[/l2]-_b[/l3])

```

(output omitted)

These point estimates match those in Poi (2002, 408). The standard errors differ very slightly; the standard errors reported by `m1` are based on the Hessian of the likelihood function, whereas the standard errors reported by `nlsur` are based on an outer product of gradients calculation.

Fitting this model by using `m1` required about two minutes on my computer, while fitting the model by using `nlsur` required just nine seconds.

### 3 Summary

Demand-system estimation has become much easier in Stata with the introduction of the `nlsur` command in Stata 10. Using `nlsur` requires you to write or modify just one program file, and the speed of `nlsur` makes computationally intensive procedures like obtaining bootstrap standard errors practical. For those who frequently fit demand systems, a useful endeavor would be to write a wrapper command around `nlsur` to allow one to fit demand systems with different numbers of goods; choose among the almost ideal demand system, QUAIDS, and other specifications; and perhaps allow for different price indices to be used.

### 4 References

- Banks, J., R. Blundell, and A. Lewbel. 1997. Quadratic Engel curves and consumer demand. *Review of Economics and Statistics* 69: 527–539.
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#### About the author

Brian Poi is a senior economist at StataCorp.