Title

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intro 6 — Identification

Description Remarks and examples Reference Also see

Description

We can estimate only the parameters of DSGE models whose parameters are identified. We discuss how to find the identification problems and how to fix them.

Remarks and examples

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The parameters that maximize the likelihood function are the maximum likelihood (ML) estimates of ML estimators like the one in `dsge`. When there is a unique vector of parameters that maximizes the likelihood function, the parameters are identified and we can estimate them. When there is more than one parameter vector that produces the same maximum value of the likelihood function, the parameters are not identified, and we cannot estimate them because there is no way to choose among the sets of equally best parameters.

`dsge` and all other commands that implement ML estimators check for identification at the solution by checking that the matrix of second derivatives, known as the Hessian, is full rank at the maximum. This test works only when the maximization algorithm arrives at a candidate maximum. In addition, it provides no information about which parameters are not identified.

For many models, when the parameters are not identified, the only output produced by a standard ML estimator is an ever growing series of "not concave" messages. This issue is especially relevant to DSGE models because it is easy to write down theoretical DSGE models whose parameters are not identified.

`dsge` uses the Iskrev (2010) diagnostic to resolve this issue. The Iskrev diagnostic detects lack of parameter identification and reports which parameters are not identified at specific parameter values. By default, `dsge` performs the Iskrev diagnostic at the initial values and at the solution values.

Instead of looking at the rank of the Hessian, the Iskrev (2010) diagnostic checks that all the parameters affect the autocovariances of the observed control variables. When there is a one-to-one relationship between the autocovariances for the observed control variables and the model parameters, the parameters are identified. Intuitively, this one-to-one relationship allows us to back out the model parameters from the autocovariances that we can always estimate from the data. When some of the parameters do not affect the autocovariances of the observed control variables, there is no one-to-one relationship and the model parameters are not identified.

Simply adding restrictions to parameters can make the parameters of an unidentified model identified. This fact is frustrating but intuitive. When the parameters are not identified, they are not uniquely determined by the data generated by the true model. Only adding restrictions, either by defining constraints or by changing the equations, can identify the parameters.

Example 1: A model with two unidentified parameters

Consider the following model of inflation p_t, output growth y_t, and the interest rate r_t.

$$
\begin{aligned}
p_t &= \beta E_t(p_{t+1}) + \kappa y_t \\
y_t &= E_t(y_{t+1}) - \gamma\{r_t - E_t(p_{t+1}) - \rho z_t\} \\
\beta r_t &= p_t + \beta u_t \\
z_{t+1} &= \rho z_t + \epsilon_{t+1} \\
u_{t+1} &= \delta u_t + \xi_{t+1}
\end{aligned}
$$

This model specifies how the observed control variables p_t and r_t depend on the unobserved control variable y_t, on the state variables z_t and u_t, and on the shocks ϵ_t and ξ_t.

Let's try to estimate the parameters of this model.

```
. use http://www.stata-press.com/data/r15/usmacro2
(Federal Reserve Economic Data - St. Louis Fed, 2017-01-15)
. dsge (p = {beta}*E(F.p) + {kappa}*y)
>      (y = E(F.y) -{gamma}*(r - E(F.p) - {rhoz}*z), unobserved)
>      (r = (1/{beta})*p + u)
>      (F.u = {rhou}*u, state)
>      (F.z = {rhoz}*z, state)
identification failure at starting values
    Constrain some parameters or specify option noidencheck.  Likely source of
    identification failure: {kappa} {gamma}
r(498);
```

The error message indicates that `kappa` and `gamma` do not influence the autocovariances independently; they are linearly dependent. If a list of linearly dependent parameters is supplied, then you must constrain all but one of them prior to estimation. We constrain `gamma`.

```
. constraint 2 _b[gamma]=1
```

And we apply the constraint to the model:

```
. dsge (p = {beta}*E(F.p) + {kappa}*y)
>      (y = E(F.y) -{gamma}*(r - E(F.p) - {rhoz}*z), unobserved)
>      (r = (1/{beta})*p + u)
>      (F.u = {rhou}*u, state)
>      (F.z = {rhoz}*z, state),
>      constraint(2)
(setting technique to bfgs)
Iteration 0:   log likelihood =  -128443.1
Iteration 1:   log likelihood = -3610.8865  (backed up)
Iteration 2:   log likelihood = -1066.3053  (backed up)
Iteration 3:   log likelihood =  -919.1875  (backed up)
Iteration 4:   log likelihood = -815.49521  (backed up)
(switching technique to nr)
Iteration 5:   log likelihood = -805.28492  (backed up)
Iteration 6:   log likelihood = -790.04311
Iteration 7:   log likelihood = -773.86016
Iteration 8:   log likelihood =  -755.6535
Iteration 9:   log likelihood = -753.96757
Iteration 10:  log likelihood = -753.57754
Iteration 11:  log likelihood = -753.57134
Iteration 12:  log likelihood = -753.57131
```

```
DSGE model
Sample: 1955q1 - 2015q4                         Number of obs     =        244
Log likelihood = -753.57131
 ( 1)  [/structural]gamma = 1
```

	OIM Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/structural						
beta	.5146687	.078349	6.57	0.000	.3611076	.6682298
kappa	.1659038	.0474064	3.50	0.000	.0729889	.2588187
gamma	1	(constrained)				
rhoz	.9545255	.0186424	51.20	0.000	.9179871	.9910639
rhou	.7005496	.0452601	15.48	0.000	.6118414	.7892577
sd(e.u)	2.318197	.3047421			1.720914	2.915481
sd(e.z)	.650711	.1123848			.4304409	.8709811

The remaining free parameters of the model are identified and can be estimated.

◁

Keep in mind that the Iskrev (2010) diagnostic is performed at specific parameter values. Sometimes, the parameters of a model cannot be identified at a vector of parameter values but can be identified at practically any other nearby vector. This problem arises when simple initial values cause terms to cancel out. If you suspect that the identification diagnostic is finding a problem because of initial values, you can either specify `noidencheck` or specify other seemingly random initial values.

▷ Example 2: Suppressing the identification check

We suppress the identification check in an attempt to estimate the parameters without imposing additional constraints. We specify the `iterate(50)` option in case the parameters are not identified.

```
. dsge (p = {beta}*E(F.p) + {kappa}*y)
>      (y = E(F.y) -{gamma}*(r - E(F.p) - {rhoz}*z), unobserved)
>      (r = (1/{beta})*p + u)
>      (F.u = {rhou}*u, state)
>      (F.z = {rhoz}*z, state),
>      noidencheck iterate(50)
(setting technique to bfgs)
Iteration 0:   log likelihood = -1597221.6
Iteration 1:   log likelihood =  -5097.544  (backed up)
Iteration 2:   log likelihood = -1073.3293  (backed up)
Iteration 3:   log likelihood = -978.36896  (backed up)
Iteration 4:   log likelihood = -818.00268  (backed up)
(switching technique to nr)
Iteration 5:   log likelihood = -808.99197  (not concave)
Iteration 6:   log likelihood = -778.94324  (not concave)
Iteration 7:   log likelihood = -761.39371  (not concave)
Iteration 8:   log likelihood = -755.33513  (not concave)
Iteration 9:   log likelihood = -754.55068
Iteration 10:  log likelihood = -753.60217  (not concave)
Iteration 11:  log likelihood =  -753.5846  (not concave)
Iteration 12:  log likelihood = -753.58018  (not concave)
Iteration 13:  log likelihood = -753.57404  (not concave)
Iteration 14:  log likelihood = -753.57267  (not concave)
Iteration 15:  log likelihood =  -753.5721
Iteration 16:  log likelihood = -753.57131
Iteration 17:  log likelihood = -753.57131  (not concave)
Iteration 18:  log likelihood = -753.57131  (not concave)
```

```
Iteration 19:  log likelihood = -753.57131  (not concave)
Iteration 20:  log likelihood = -753.57131  (not concave)
Iteration 21:  log likelihood = -753.57131  (not concave)
Iteration 22:  log likelihood = -753.57131  (not concave)
Iteration 23:  log likelihood = -753.57131  (not concave)
Iteration 24:  log likelihood = -753.57131  (not concave)
Iteration 25:  log likelihood = -753.57131  (not concave)
Iteration 26:  log likelihood = -753.57131  (not concave)
Iteration 27:  log likelihood = -753.57131  (not concave)
Iteration 28:  log likelihood = -753.57131  (not concave)
Iteration 29:  log likelihood = -753.57131  (not concave)
Iteration 30:  log likelihood = -753.57131  (not concave)
Iteration 31:  log likelihood = -753.57131  (not concave)
Iteration 32:  log likelihood = -753.57131  (not concave)
Iteration 33:  log likelihood = -753.57131  (not concave)
Iteration 34:  log likelihood = -753.57131  (not concave)
Iteration 35:  log likelihood = -753.57131  (not concave)
Iteration 36:  log likelihood = -753.57131  (not concave)
Iteration 37:  log likelihood = -753.57131  (not concave)
Iteration 38:  log likelihood = -753.57131  (not concave)
Iteration 39:  log likelihood = -753.57131  (not concave)
Iteration 40:  log likelihood = -753.57131  (not concave)
Iteration 41:  log likelihood = -753.57131  (not concave)
Iteration 42:  log likelihood = -753.57131  (not concave)
Iteration 43:  log likelihood = -753.57131  (not concave)
Iteration 44:  log likelihood = -753.57131  (not concave)
Iteration 45:  log likelihood = -753.57131  (not concave)
Iteration 46:  log likelihood = -753.57131  (not concave)
Iteration 47:  log likelihood = -753.57131  (not concave)
Iteration 48:  log likelihood = -753.57131  (not concave)
Iteration 49:  log likelihood = -753.57131  (not concave)
Iteration 50:  log likelihood = -753.57131  (not concave)
convergence not achieved
DSGE model
Sample: 1955q1 - 2015q4                         Number of obs     =        244
Log likelihood = -753.57131
```

	OIM					
	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/structural						
beta	.5146672	.078349	6.57	0.000	.3611059	.6682285
kappa	.424358	.	.	.	.	.
gamma	.3909567	.1117155	3.50	0.000	.1719983	.609915
rhoz	.9545256	.0186424	51.20	0.000	.9179872	.991064
rhou	.7005485	.0452604	15.48	0.000	.6118397	.7892573
sd(e.u)	2.318203	.3047446			1.720915	2.915492
sd(e.z)	.6507122	.1123847			.4304422	.8709822

```
Note: Parameters not identified at reported values.
```

We see a long list of `not concave` messages, indicating that the parameters are indeed not identified without additional constraints. We could remove the option limiting the number of iterations, and the command should produce `not concave` iterations indefinitely.

◁

Reference

Iskrev, N. 2010. Local identification in DSGE models. *Journal of Monetary Economics* 57: 189–202.

Also see

[DSGE] **intro 5** — Stability conditions

[DSGE] **intro 7** — Convergence problems