

Description

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

Remarks and examples

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`, `dsge1`, 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. `dsge1` performs the Iskrev diagnostic on the linear approximation to the nonlinear model at the steady state implied by the initial values and checks again 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 https://www.stata-press.com/data/r19/usmacro2
(Federal Reserve Economic Data - St. Louis Fed, 2017-01-15)

. dsge (p = {beta}*F.p + {kappa}*y)
> (y = F.y -{gamma}*(r - F.p - {rhoz}*z), unobserved)
> (r = (1/{beta})*p + u)
> (F.u = {rhoz}*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 κ and γ 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 γ .

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

And we apply the constraint to the model:

```
. dsge (p = {beta}*F.p + {kappa}*y)
> (y = F.y -{gamma}*(r - F.p - {rhoz}*z), unobserved)
> (r = (1/{beta})*p + u)
> (F.u = {rhoz}*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 thru 2015q4

Number of obs = 244

Log likelihood = -753.57131

(1) [/structural]gamma = 1

	Coefficient	Std. err.	z	P> z	[95% conf. interval]	
/structural						
beta	.5146687	.0783489	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
rhov	.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.

Reference

Iskrev, N. 2010. Local identification in DSGE models. *Journal of Monetary Economics* 57: 189–202. <https://doi.org/10.1016/j.jmoneco.2009.12.007>.

Also see

[DSGE] [Intro 5](#) — Stability conditions

[DSGE] [Intro 7](#) — Convergence problems

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