Description Remarks and examples Also see

Description

A shock to a control variable is problematic because it does not fit into the form of a structural model that is required to solve for the state-space form. This entry shows how to solve this problem by defining a new state variable and rewriting the equations.

Remarks and examples

Remarks are presented under the following headings:

The model

Equations (1)–(3) specify a model of consumption growth and growth in hours worked. The equation for consumption growth is subject to an additive shock.

$$c_t = (1-h)w_t + hE_t c_{t+1} + \epsilon_t \tag{1}$$
$$n_t = w_t - \gamma c_t \tag{2}$$
$$w_{t+1} = \rho w_t + \xi_{t+1} \tag{3}$$

Equation (1) specifies that consumption growth c_t is a linear combination of wage growth w_t, expected future consumption growth $E_t c_{t+1}$, and a consumption shock ϵ_t. Equation (2) specifies that the growth rate of hours worked n_t depends on wage growth and consumption growth. Equation (3) specifies an autoregressive process for wage growth. The structural parameter h controls the weights on wage growth and expected future consumption growth in the consumption equation.

One cannot solve the model in (1)–(3) for the state-space form because the shock ϵ_t is added to the control equation c_t in (1). Shocks to control variables must be reparameterized as new state variables so that the model can be solved for its state-space form. We define the shocks as new state variables instead of new control variables because the shocks are exogenous. We rewrite the model in (1)–(3) so that the additive shock is a new state variable in (4)–(7). Specifically, we define a new state variable z_t such that $z_t = \epsilon_t$ and write the model as

$$c_t = (1-h)w_t + hE_t c_{t+1} + z_t \tag{4}$$
$$n_t = w_t - \gamma c_t \tag{5}$$
$$w_{t+1} = \rho w_t + \xi_{t+1} \tag{6}$$
$$z_{t+1} = \epsilon_{t+1} \tag{7}$$

That we replaced ϵ_t with the new state variable z_t is the only difference between (4) and (1). Equations (5) and (6) are identical to their counterparts, (2) and (3). Equation (7) specifies the evolution of the new state variable z_t; it is similar to (6), except that it lacks an autoregressive component.

Parameter estimation

We estimate the parameters of the model in (4)–(7) using US data on consumption growth and growth in hours worked. We specify w and z as state variables. We specify c and n as control variables. Both c and n are treated as observed. We specify that w and z are subject to shocks.

```
. use https://www.stata-press.com/data/r19/usmacro2
(Federal Reserve Economic Data - St. Louis Fed, 2017-01-15)
. dsge (c = (1-{h})*(w) +  {h}*F.c + z)
>       (n = w - {gamma}*c)
>       (F.w = {rho}*w, state)
>       (F.z = , state)
(setting technique to bfgs)
Iteration 0:  Log likelihood = -2514.2527
Iteration 1:  Log likelihood =   -1264.15  (backed up)
Iteration 2:  Log likelihood = -1182.8885  (backed up)
Iteration 3:  Log likelihood = -1153.1143  (backed up)
Iteration 4:  Log likelihood = -1152.7297  (backed up)
(switching technique to nr)
Iteration 5:  Log likelihood = -1152.4548
Iteration 6:  Log likelihood = -1134.6813
Iteration 7:  Log likelihood = -1131.4432
Iteration 8:  Log likelihood =  -1131.283
Iteration 9:  Log likelihood = -1131.2826
Iteration 10: Log likelihood = -1131.2826
DSGE model
Sample: 1955q1 thru 2015q4                          Number of obs = 244
Log likelihood = -1131.2826
```

	Coefficient	Std. err.	z	P>|z|	[95% conf.	interval]
/structural						
h	.7642505	.0360272	21.21	0.000	.6936386	.8348625
gamma	.2726181	.1059468	2.57	0.010	.0649663	.4802699
rho	.6545212	.0485627	13.48	0.000	.55934	.7497023
sd(e.w)	2.904762	.1958651			2.520873	3.28865
sd(e.z)	2.077219	.1400659			1.802695	2.351743

The estimate of h is 0.76. Being greater than 0.5, this indicates that consumption growth depends more strongly on expected future consumption growth than on current wage growth.

Also see

[DSGE] **Intro 2** — Learning the syntax

[DSGE] **Intro 4** — Writing a DSGE in a solvable form

For suggested citations, see the FAQ on citing Stata documentation.