E 4160: Econometrics–Modelling and Systems Estimation
Computer Class # 3

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26 September 2011

Data sets for today (already posted on the web page):

- KonsData2Nor.zip
- ADLfromVAR_d.zip

We will work with the following batch files:

- Seminar2Ex1Models.fl (posted last week: It summarizes work we did in Seminar 2)
- Seminar2EX1ModelsSUE.fl (posted 26/9, shows example of Super Exogeniety test)
- Seminar2EX1ModelsSUE.fl (posted 26/9, shows example of ECM formulation

Recursive graphs of parameters I

Consider the model

$$y_t = \beta_1 + \beta_2 x_t + \varepsilon_t,\ t = 1, 2, \ldots, T, \tag{1}$$

A simple and intuitive method for assessing the hypothesis that the parameters β_1, β_1, $\sigma = \sqrt{Var(\varepsilon_t)}$ are stable are by graphing the results of recursive estimation:

1. Estimate on a short sample: $t = 1, 2, ..., T_1$, $T_1 < T$.
2. Extend the sample with one single observation, and estimate the model on the sample with $T_1 + 1$ observation
3. Continue until all observations are part of the sample.
4. The sequence of estimates, $\hat{\beta}_1(j)$, $\hat{\beta}_2(j)$, and $\hat{\sigma}(j)$ $(j = T_1, T_1 + 1, \ldots, T)$, can be plotted in time graphs

Recursive graphs of parameters II

Pc-Give plots e.g., $\hat{\beta}_2(j)$ together with $\pm 2\sqrt{Var(\hat{\beta}_1(j)}$, and $\hat{\sigma}(j)$ together with the *1-step residuals*, which are

$$y_{T_1+N} - \hat{\beta}_{1,T_1+N} - \hat{\beta}_{2,T_1+N}\, x_{T_1+N}, \quad N = 1, 2, \ldots, T - T_1$$

Chow-tests of parameter stability

- If we have a hypothesis about when a structural break occurs we can test that hypothesis
- Let T_1 denote the last period with the "old" regime and let $T_1 + 1$ denote the first period of the "new";

$$y_t = \beta_1 + \beta_2 x_t + \varepsilon_t, \; t = 1, 2, \ldots, T_1 \text{ and}$$
$$y_t = \gamma_1 + \gamma_2 x_t + \epsilon_i, \; i = T_1 + 1, 2, \ldots, T.$$

then

$$H_0\colon \beta_1 = \gamma_1, \beta_2 = \gamma_2 \text{ vs } H_1\colon \beta_1 \neq \gamma_1, \beta_2 \neq \gamma_2.$$

- In the multivariate case:

$$H_0\colon \beta_1 = \gamma_1, \beta_2 = \gamma_2, \beta_3 = \gamma_3, \ldots, \beta_K = \gamma_K$$

- There are two well known statistics for these cases, both due to Chow (1960) and referred to as *Chow tests*.

2-sample Chow-test

Refer to Greene Ch 6.4, and use his notation for Sum of Squared Errors, SSE (which of course corresponds to RSS or SSR in other books):
SSE_1 is for the first sample ($t = 1, 2, .., T_1$) SSE_2 is for the second.
$SSE_U = SSE_1 + SSE_2$. SSE_R is the SSE when the whole sample is used, i.e. under H_0

$$F_{Chow2} = \frac{SSE_R - SSE_U}{SSE_U} \cdot \frac{(T-4)}{2} \sim F(2, T-4).$$

In general

$$F_{Chow2} = \frac{SSE_R - SSE_U}{SSE_U} \cdot \frac{T-2K)}{K} \sim F(K, T-2K)).$$

"Insufficient observations" Chow-test

- Consider $T - T_1 < K$. Same SSE_R (full sample) but SSE_U is only on the basis of the first T_1 observations. This "predictive" Chow-test is given as

$$F_{ChowP} = \frac{SSE_R - SSE_U}{SSE_U} \cdot \frac{T_1 - K}{T - T_1} \sim F(T - T_1, T_1 - K)$$

- If we have no clear idea about the dating of a regime shift, a graph with the whole sequence of predictive Chow tests is useful.
- Chow tests rely on constant and equal variances of the disturbances. Hence, it is good practice to plot the recursively estimated $\hat{\sigma}$.

Recursive Chow-test

The Test-Menu Graphics in PcGive contains three version of the F_{ChowP} test!

- *1-step test*: the sample size T_1 is increased by one observation sequentially, and $N = T - T_1$ is always 1.
- *Break-point Chow test* (called *N-dn CHOWS* in the graphs): Here T_1 is increased by one observations, then by 2 and so on until $T_1 = T$. Hence, $N = T - T_1$ is decreasing through the sequence of tests.
- Forecast Chow test (called *N-up CHOWS* in the graphs): Here T_1 is kept fixed and N is first 1, then 2, and so on until $N = T_1 - T$. Hence, $N = T - T_1$ is increasing through the sequence of tests.
- All the Recursive Chows are scaled by (1-off) critical values. (1% level is the default) so that the critical values becomes a straight line at unity.

Testing invariance and super exogeneity I

To test a hypothesis of lack of invariance we need to investigate two issues:

1. Test the null hypothesis of no-structural breaks in the marginal model
2. Test the null hypothesis of stability in the conditional model in the same period that there is a structural break

We have several tools available:

- Recursive estimation and recursive graphs
- Recursive Chow tests,
- Find significant dummy variables that represent structural breaks in a marginal model, and test the significance of those dummies in the conditional model.

Testing invariance and super exogeneity II

If the break-dummies are insignificant, we do not reject the hypothesis that the conditional model is invariant to this structural break, and that the explanatory variable in question is super-exogenous.

- Invariance and super-exogeneity are "relative properties"
  - The parameters of a conditional model may be invariant to some structural breaks elsewhere in the system (i.e., in the marginal part of the system),
  - But not against "all thinkable changes"

Testing invariance and super exogeneity III

- Concrete example: In the Norwegian consumption function example it seems like the conditional model has some degree of invariance with respect to the deregulation of the housing and credit market,
  - but not against the change in VAT in 1970!
- A structural break in a conditional model is not always a nuisance: it can have a clear interpretation and make sense in the light of theory, like in the VAT case
  - But the break needs to be represented (modelled as Greene says) otherwise it becomes an omitted variable (remember the impact the omission of D_t had on the mis-specification tests)

Example using

- KonsData2Nor.in7
- Seminar2Ex1ModelSUE.fl

Short and long-run multipliers. I

- Consider again the final equation for *LCP* from Seminar 2.
- It seems to have quite "complicated dynamics"!

Two questions are then of interest:

1. What is the effect of shocks to income and wealth, not only in the period of the shock, but also the dynamic and long-run effects?
2. Does the equation have a sensible interpretation if we abstract from shock and assume that we are on a stable-growth path.

As you are aware of, both questions are central in dynamic economic theory, well known from your courses in macroeconomics. We get immediate answers to these questions by choosing *Test Menu-Dynamic analysis.*

When we abstract from the dummies for simplicity, and use symbols instead of numbers for the coefficients, the model is

$$
\begin{aligned}
LCP_t &= \beta_0 + \phi_1 LCP_{t-1} + \phi_2 LCP_{t-2} + \phi_4 LCP_{t-4} \\
&\quad + \beta_{10} LRCa_t + \beta_{20} LF_t + \beta_{21} LF_{t-1} + \beta_{22} LF_{t-2} + \varepsilon_t
\end{aligned}
$$

Re-write in equilibrium-correction model (ecm) form.

$$
\begin{aligned}
\Delta LCP_t &= \beta_0 + (\phi_1 + \phi_2 + \phi_4 - 1) LCP_{t-1} - \phi_2 \Delta LCP_{t-1} \\
&\quad - \phi_4 \Delta_3 LCP_{t-1} \\
&\quad + \beta_{10} LRCa_t + \beta_{20} \Delta LF_t + (\beta_{20} + \beta_{21} + \beta_{22}) LF_{t-1} \\
&\quad - \beta_{22} \Delta LF_{t-1} + \varepsilon_t
\end{aligned}
$$

where, for example:

$$\begin{aligned} \Delta LCP_t &= LCP_t - LCP_{t-1} \\ \Delta_3 LCP_{t-1} &= LCP_{t-1} - LCP_{t-4} \end{aligned}$$

Collect levels variables and differenced variables.

$$\begin{aligned} \Delta LCP_t &= \beta_0 - \phi_2 \Delta LCP_{t-1} - \phi_4 \Delta_3 LCP_{t-1} + \beta_{20} \Delta LF_t - \beta_{22} \Delta LF_{t-1} \\ &+ (\phi_1 + \phi_2 + \phi_4 - 1) LCP_{t-1} + \beta_{10} LRCa_t \\ &+ (\beta_{20} + \beta_{21} + \beta_{22}) LF_{t-1} + \varepsilon_t \end{aligned}$$

Set all Δ −terms to zero. Then solve for the stationary value of LCP

$$LCP = B_0 + B_1 LFRCa + B_2 LF$$

We get the estimates for the two long-run coefficients B_1 and B_2 from the estimates of $(\phi_1 + \phi_2 + \phi_4 - 1), \beta_{10}$ and $(\beta_{20} + \beta_{21} + \beta_{22})$:

$$\begin{aligned} \widehat{B}_1 &= -\frac{\widehat{\beta_{10}}}{(\widehat{\phi_1 + \phi_2 + \phi_4 - 1})} \\ \widehat{B}_2 &= -\frac{\widehat{\beta_{20} + \beta_{21} + \beta_{22}}}{(\widehat{\phi_1 + \phi_2 + \phi_4 - 1})} \end{aligned}$$

Show example in PcGive.
Alternatively, use Non-Linear Least Ssquares (NLS) to estimate B_1 and B_2 directly.
This is also shown in the batch file, for reference