ECON7350: Applied Econometrics for Macroeconomics and Finance

Tutorial 4: Dynamic Relationships

At the end of this tutorial you should be able to:

- derive the ECM representation of an ARDL(p, l, s) model;
- create a function in R;
- estimate IRFs to permanent and one-off shocks as well as LRMs;
- construct confidence intervals for IRFs and LRMs;
- Select and adequate set of ARDL models and draw inference on dynamic relationships.

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Problems

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1. Derive the ECM representation of the following ARDL$(1, 1, 2)$ model:

$$y_t = a_0 + a_1 y_{t-1} + b_0 x_t + b_1 x_{t-1} + c_0 w_t + c_1 w_{t-1} + c_2 w_{t-2} + \epsilon_{y,t}.$$

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   Which parameter(s) in the resulting ECM are long-run multiplier(s) and adjustment parameter(s)?

2. Create a function in R to compute coefficients $\theta_0, \ldots, \theta_h$ in

$$\theta(L) = b(L)/a(L) = \theta_0 + \theta_1 L + \cdots + \theta_h L^h + \cdots,$$

   where $a(L) = a_0 + a_1 L + \cdots + a_p L^p$ and $b(L) = b_0 + b_1 L + \cdots + b_q L^q$.

3. Create a function in R to compute IRFs (to both one-off and permanent shocks) up to horizon h as well as the LRMs for the ARDL(p, l, s):

$$a(L) y_t = a_0 + b(L) x_t + c(L) w_t + \epsilon_{y,t}.$$

4. The file `wealth.csv` contains observations on:

   - c_t: the log of total real per capita expenditures on durables, nondurables and services;

- a_t: the log of a measure of real per capita household net worth (including all financial and household wealth); and
- y_t: the log of after-tax labour income.

The sample period from 1952Q2 through 2006Q2 (see Koop, G., S. Potter and R. W. Strachan (2008) "Re-examining the consumption-wealth relationship: The role of uncertainty" *Journal of Money, Credit and Banking*, Vol. 40, No. 2.3, 341-367).

(a) Estimate an ARDL$(1, 2, 2)$ specified for c_t and use the functions created in Questions 2 and 3 to obtain the estimated IRFs to permanent shocks in a_t and y_t as well the LRMs. Hint: to estimate the ARDL parameters, try the `ardl` function that is provided by the `ARDL` package.

(b) Estimate the ECM representation of the ARDL$(1, 2, 2)$ and report the results. How do the LRMs in the estimated ECM compare to those computed in part (a)? Hint: use the `recm` and `multipliers` functions to convert the output produced by `ardl`.

(c) Use the function `ardl_irfs_ci` that is provided in the file `ardl_irfs_ci.R` to construct 68% confidence intervals for the IRFs obtained in part (a).

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The function `ardl_irfs_ci` takes the following inputs:

- `ardl_est`: this is the output of `ardl`;
- `h`: the maximum IRF horizon (default is 40);
- `cumirf`: whether to compute IRFs to a permanent shock (default is `TRUE`);
- `conf`: the confidence level of the intervals (default is 0.95).

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It returns the following outputs:

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- `lb`: an $h \times k$ matrix of lower-bounds for confidence intervals;
- `md`: an $h \times k$ matrix of mid-points for confidence intervals;
- `ub`: an $h \times k$ matrix of upper-bounds for confidence intervals.

Note that k is the number of independent variables in the ARDL, so that column j of `lb`, `md` and `ub` is related the confidence intervals for IRFs to a shock in the jth independent variable.

(d) Compare the values in `md` to the IRFs estimates obtained in part (a).

(e) Use the LRM estimates and standard deviations obtained in part (b) to construct 68% confidence intervals for the LRMs, assuming the sampling distributions of the LRM estimators are approximately normal. How do they compare to the IRF confidence intervals obtained in part (c)?

(f) Construct an adequate set of ARDL(p, l, s) models for c_t.

(g) Draw inference about the dynamic relationship between expenditures and wealth.