

Chapter 14: Simultaneous Equations

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The naïve Keynesian macroeconomic model of the U.S. economy identified in UE, p. 477 will be used to demonstrate the two stage-least squares procedure. The data for this model is found in the EViews workfile named *macro14.wfl* and it is printed in UE, Table 14.1, p. 478. Two variables that are included in the macroeconomic model must be generated from other data series (see note at the bottom of UE, Table 14.1, p. 478).

Generating time series for taxes and net exports using structural equations (UE, p. 477):

Follow these steps to generate time series values for T (taxes) and NX (net exports) using the structural equations in the model:

- Step 1.** Open the EViews workfile named *Macro14.wfl*.
- Step 2.** To generate a new series named *T* for taxes, select **Genr** on the workfile menu bar, type $T=Y-YD$ in the **Enter equation:** window, and click **OK**. A new series icon for *T* is created in the workfile window.
- Step 3.** To generate a new series named *NX* for net exports, select **Genr** on the workfile menu bar, type $NX=Y-CO-I-G$ in the **Enter equation:** window, and click **OK**. A new series icon for *NX* is created in the workfile window.
- Step 4.** Select **Save** on the workfile menu bar to save your changes.

Estimating CO with least squares (UE, Equation 14.31, p. 481):

- Step 1.** Open the EViews workfile named *Macro14.wfl*.

- Step 2.** Select **Objects/New Object/Equation** on the workfile menu bar, enter $CO \ C \ YD \ CO(-1)$ in the **Equation Specification:** window, and click **OK** to reveal the regression output to the right.

- Step 3.** Select **Name** on the equation window menu bar, enter *OLS_CO* in the **Name to identify object:** window, and click **OK**.

- Step 4.** Select **Save** on the workfile menu bar to save your changes.

Dependent Variable: CO				
Method: Least Squares				
Date: 07/11/00 Time: 07:50				
Sample(adjusted): 1964 1994				
Included observations: 31 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-38.10541	29.77949	-1.279586	0.2112
YD	0.516486	0.116196	4.444959	0.0001
CO(-1)	0.461118	0.123244	3.741502	0.0008
R-squared	0.997921	Mean dependent var	2445.210	
Adjusted R-squared	0.997772	S.D. dependent var	642.2594	
S.E. of regression	30.31356	Akaike info criterion	9.752833	
Sum squared resid	25729.53	Schwarz criterion	9.891606	
Log likelihood	-148.1689	F-statistic	6719.462	
Durbin-Watson stat	0.892667	Prob(F-statistic)	0.000000	

Estimating two-stage least squares regression using EViews TSLS method (UE, 14.3.1):

To estimate the two-stage least squares model printed in UE, Equation 14.29, follow these steps:

Step 1. Open the EViews workfile named *Macro14.wf1*.

Step 2. Select **Objects/New Object/Equation** on the workfile menu bar, and select *TSLS – Two-Stage Least Squares (TSNLS and ARMA)* in the **Method** window under **Estimation Settings**; and the dialog will change to include an **Instrument list** window (see graphic on the right).

Step 3. Enter **CO C YD CO(-1)** in the **Equation Specification** window and **C G T NX CO(-1) R(-1)** in the **Instrument list** window.¹ The graphic above shows the relevant selections/entries highlighted in yellow. Click **OK** to reveal the **Estimation Output** view printed below. The yellow highlighted portions of the regression output reflect the selections made in the dialog window shown above.²

Dependent Variable: CO				
Method: Two-Stage Least Squares				
Date: 07/10/00 Time: 15:12				
Sample(adjusted): 1964 1994				
Included observations: 31 after adjusting endpoints				
Instrument list: C G T NX CO(-1) R(-1)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-24.73014	34.90233	-0.708553	0.4845
YD	0.441638	0.153839	2.870773	0.0077
CO(-1)	0.540309	0.163000	3.314782	0.0025
R-squared	0.997890	Mean dependent var		2445.210
Adjusted R-squared	0.997739	S.D. dependent var		642.2594
S.E. of regression	30.53734	Sum squared resid		26110.82
F-statistic	6615.725	Durbin-Watson stat		0.982576
Prob(F-statistic)	0.000000			

Step 4. Select **Name** on the equation window menu bar, enter *TSLS_CO* in the **Name to identify object** window, and click **OK**.

Step 5. Select **Save** on the workfile menu bar to save your changes.

¹ The constant, C, is always a suitable instrument, so EViews will add it to the instrument list if you omit it.

² EViews identifies the estimation procedure, as well as the list of instruments in the header. This information is followed by the usual coefficient, t-statistics, and asymptotic p-values. EViews uses the structural residuals in calculating all of the summary statistics. These structural residuals should be distinguished from the second-stage residuals that you would obtain from the second-stage regression if you actually computed the two-stage least squares estimates in two separate stages.

Estimating two-stage least squares regression using two distinct stages and OLS (UE, 14.3.1):

To estimate the two-stage least squares equation printed in *UE*, Equation 14.28, using ordinary OLS and two distinct phases, follow these steps:

- Step 1.** Open the EViews workfile named *Macro14.wf1*.
- Step 2.** To estimate the reduced form equation for *YD* (*UE*, Equation 14.27, p. 480), select **Objects/New Object/Equation** on the workfile menu bar, enter *YD C G NX T CO(-1) R(-1)* in the **Equation Specification** window, and click **OK**.
- Step 3.** To generate the forecast values from this equation, select **Forecast** on the equation menu bar, enter *YDF* in the **Forecast name** window, and click **OK**. EViews will create a new variable in the workfile named *YDF*.
- Step 4.** To estimate the second stage equation for *CO* (*UE*, Equation 14.29, p. 481), select **Objects/New Object/Equation** on the workfile menu bar, enter *CO C YDF CO(-1)* in the **Equation Specification** window, and click **OK**. Note that we have used the instrumental variable *YDF* instead of the actual variable *YD* for disposable income. The method, dependent variable, and variable names are highlighted in yellow in the OLS regression output shown below.
- Step 5.** Select **Name** on the equation window menu bar, enter *TSLS_OLS_CO* in the **Name to identify object** window, and click **OK**.
- Step 6.** Select **Save** on the workfile menu bar to save your changes.

Dependent Variable: CO				
Method: Least Squares				
Date: 07/05/00 Time: 15:44				
Sample(adjusted): 1964 1994				
Included observations: 31 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-24.73014	41.09577	-0.601769	0.5522
YDF	0.441638	0.181138	2.438126	0.0214
CO(-1)	0.540309	0.191924	2.815219	0.0088
R-squared	0.997075	Mean dependent var		2445.210
Adjusted R-squared	0.996866	S.D. dependent var		642.2594
S.E. of regression	35.95622	Akaike info criterion		10.09425
Sum squared resid	36199.78	Schwarz criterion		10.23302
Log likelihood	-153.4608	F-statistic		4771.906
Durbin-Watson stat	1.485932	Prob(F-statistic)		0.000000



Comparing the OLS, EViews TSLS, and OLS two-stage models:

To compare the coefficients, std. Errors, and t-statistics for the three models discussed in this chapter, open the equations named *OLS_CO*, *TSLS_CO* and *TSLS_OLS_CO*, by double clicking their respective icons in the workfile window, and compare the regression output. To facilitate the process, the output for the [OLS](#), [EViews TSLS](#) and [OLS TSLS](#) models are printed in this guide. Look at all three and compare the data printed in the **red-boxed area** for each regression. Note that the estimated coefficients are larger in the *OLS_CO* model compared to the *TSLS_CO* and *TSLS_OLS_CO* models. This supports the hypothesis that OLS estimates of coefficients have a positive bias in simultaneous equation models (simultaneity bias). Contrarily, TSLS estimated coefficients tend to have a downward bias. Note that the estimated coefficients are identical for the *TSLS_CO* and *TSLS_OLS_CO* models, but the standard errors (Std. Error in the EViews output) are smaller in the EViews TSLS estimated model, making the coefficients more significant (i.e., higher t-statistics). In order to get accurate estimates of standard errors and t-scores, the estimation should be done on a complete two-stage least squares program (like EViews TSLS). When OLS is used to estimate the second stage, it ignores the fact that the first stage was run at all (*UE*, footnote 11, p. 481).

The identification problem and the order condition (*UE*, 14.3.3):

In order to calculate two-stage least squares using the *TSLS – Two-Stage Least Squares (TSNLS and ARMA)* option, your specification must satisfy the order condition for identification, which states that there must be at least as many instruments as there are coefficients in your equation. The order condition for identification is easy to assess in EViews. Count, to make sure that the number of independent variables, not counting the constant, in the **Equation Specification:** window (i.e., *YD* & *CO(-1)*) is less than or equal to the number of predetermined variables in the **Instrument list:** window (i.e., *G*, *T*, *NX*, *CO(-1)* & *R(-1)*). See graphic in the [Two-stage least squares regression using EViews TSLS method](#) section above.

Exercises:

9. Open EViews and open the EViews workfile named *Macro14.wfl*.
 - a. Refer to [Estimating CO with least squares](#).
 - b. Refer to **Step 2** of [Estimating two-stage least squares regression using two distinct stages and OLS](#).
 - c. Refer to **Steps 3 & 4** of [Estimating two-stage least squares regression using two distinct stages and OLS](#).
 - d. Refer to [Estimating two-stage least squares regression using EViews TSLS method](#).
12. Double click the  `tsls_co` icon in the EViews *Macro14.wfl* workfile window to re-activate the *UE*, Equation 14.29. Click **Estimate** on the equation menu bar and click **OK**. The reason for this is to make sure that the residuals in the EViews workfile are from the *TSLS_CO* equation. If the  `tsls_co` icon is not in the workfile, you must go back and follow the steps outlined in [Estimating two-stage least squares regression using EViews TSLS method](#).
 - a. Follow the procedures outlined in [Chapter 9](#).
 - b.
13. Open EViews and open the EViews workfile named *Oats14.wfl*.
 - a.
 - b.
 - c.
 - d. Refer to [Estimating CO with Least Squares \(OLS\)](#) and [Estimating two-stage least squares regression using EViews TSLS method](#).
 - e. Refer to [Comparing the OLS, EViews TSLS, and OLS two-stage models](#).