

# A Guide to Simulation with EViews<sup>1</sup>

(Version 7.0)

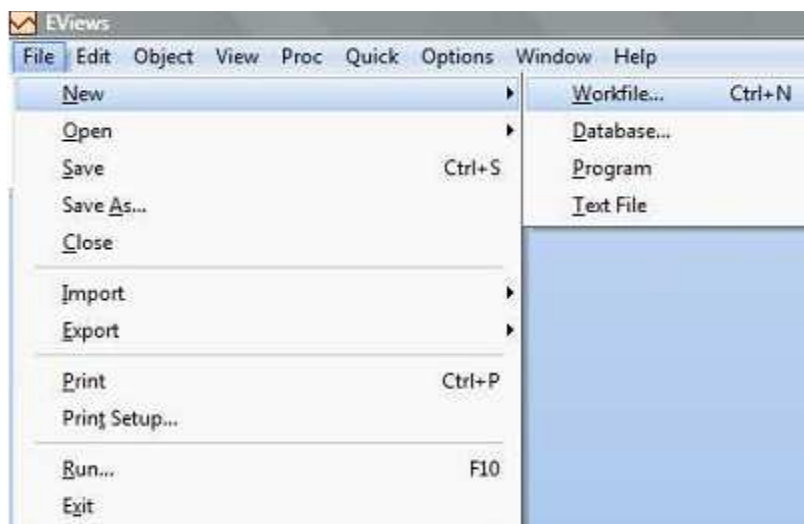
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## 1.0 Preamble

- Simulation involves solving for unknown values of the endogenous variables in a model. A model in Eviews is a set of simultaneous equations that are used for forecasting and simulation. Unlike other objects in Eviews that contain system of equations, models do not contain unknown coefficients to be estimated. Instead, models use estimated coefficients and projected values of the exogenous variables to simulate the unknown values for the endogenous variables.

## 2.0 Creating a System of Equations

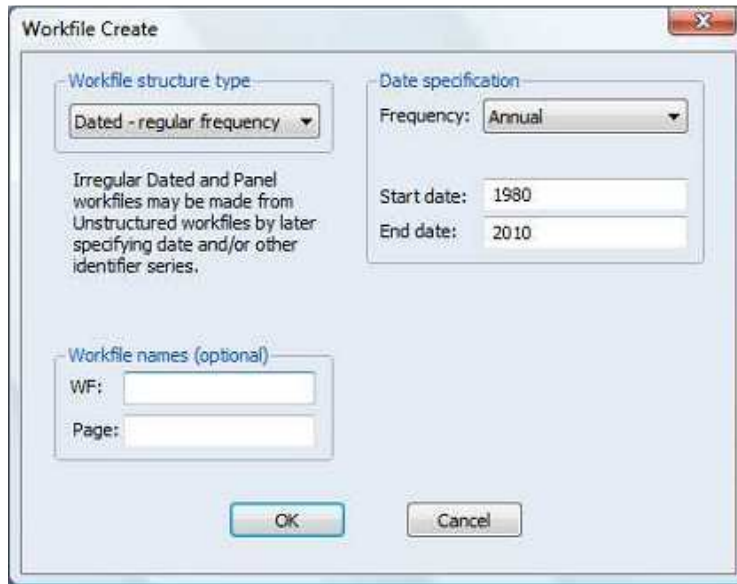
- First, we need to open an Eviews workfile: click **File / New / Workfile** on the *Toolbar* of the *Main Window*



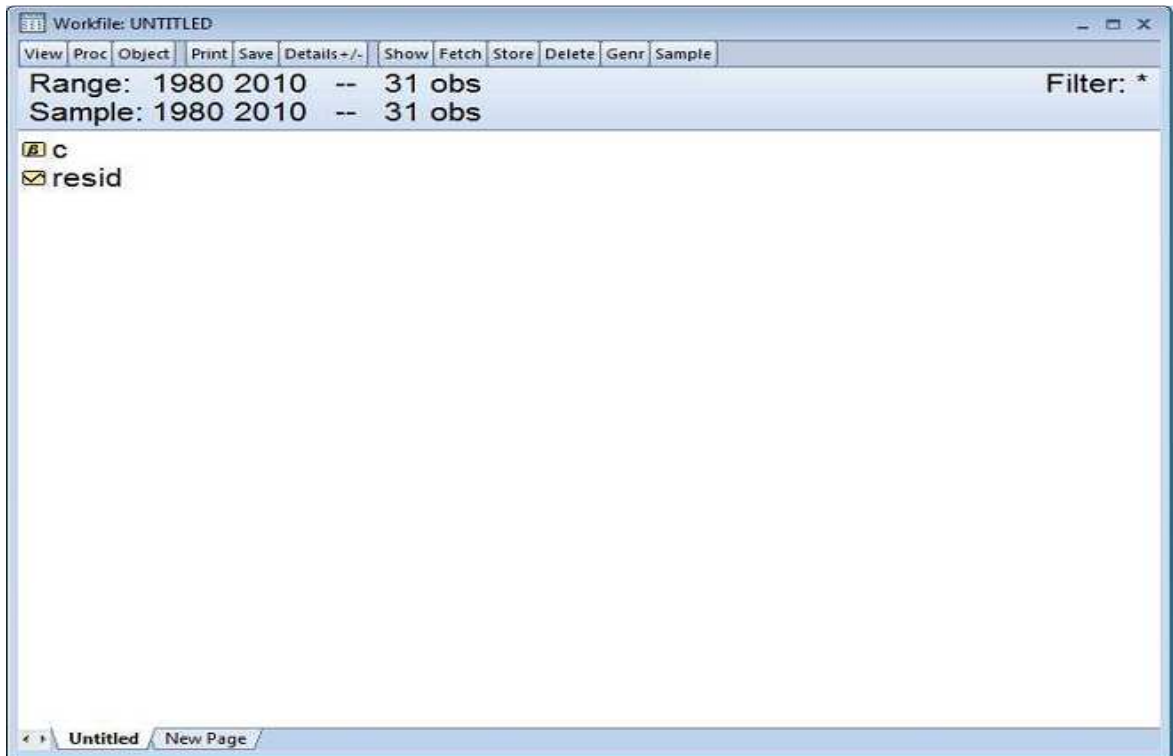
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✓ A *Workfile Range* window appears

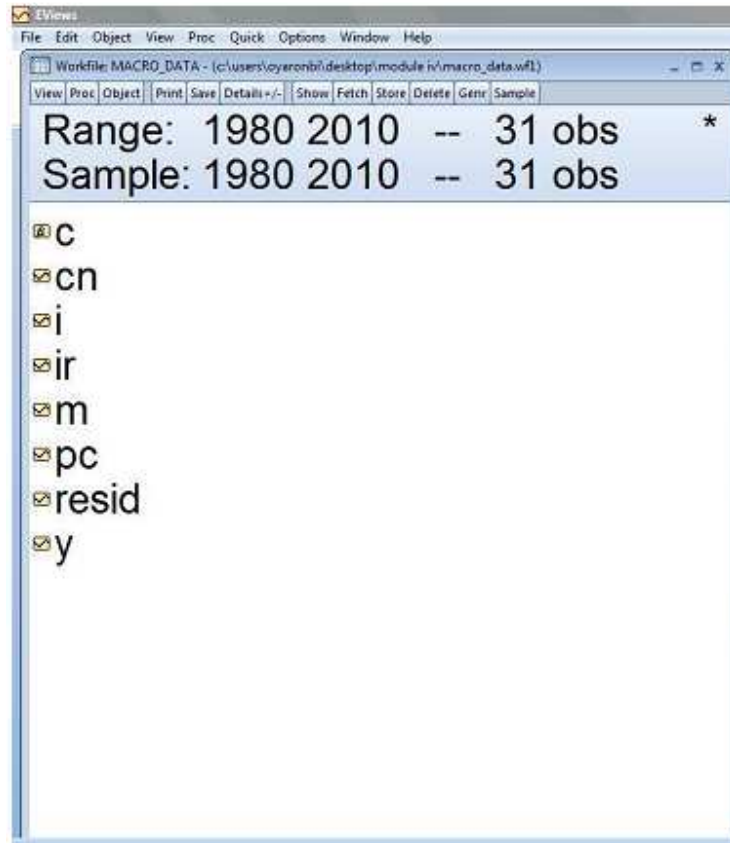


- Choose **Workfile structure type**, **Frequency**, **Start date** and **End date**
  - ✓ When you click OK, an *Untitled Workfile* appears with 2 items: **C** and **RESID**



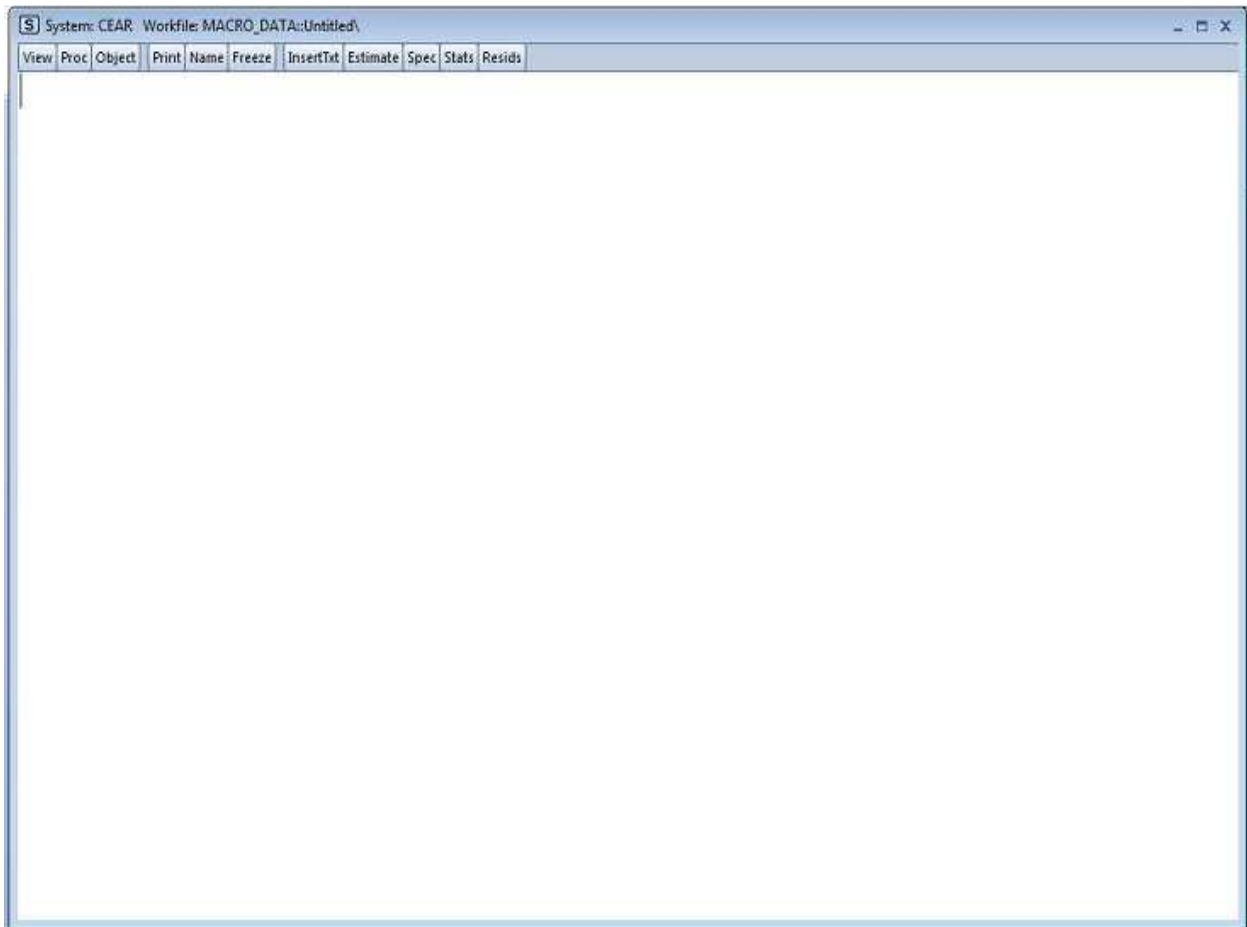
➤ **Load your data into Eviews**

We can use the “*drag & drop*” method since all the variables are of interest to us (see my presentation on *Getting Started with Eviews 7*). The Eviews workfile is updated to include the new variables as shown below:



The new variables included are cn - consumption, i - investment, m - money supply, pc - personal consumption, ir - interest rate, and y - income.

- Click **Objects in the Workfile toolbar / New Object / System**. When you click **OK**, an empty *System Window* should appear. In the dialog that appears, type in a name for your model (say "CEAR")



### 3.0 SPECIFYING A MODEL

#### 3.1 *Before Entering Equations*

- Eviews is not case sensitive and neither does it distinguish between subscript and superscript.

In other words,  $C_{tS}$  is identical to CNTS in Eviews.

- To enter an equation with  $t$  lags, we use the sign (-t) after the variable.

For example, we have:

$$cn = c(1)+c(2)*cn(-1)+c(3)*y(-1)+c(4)*rir(-1)+c(5)*rir(-2)$$

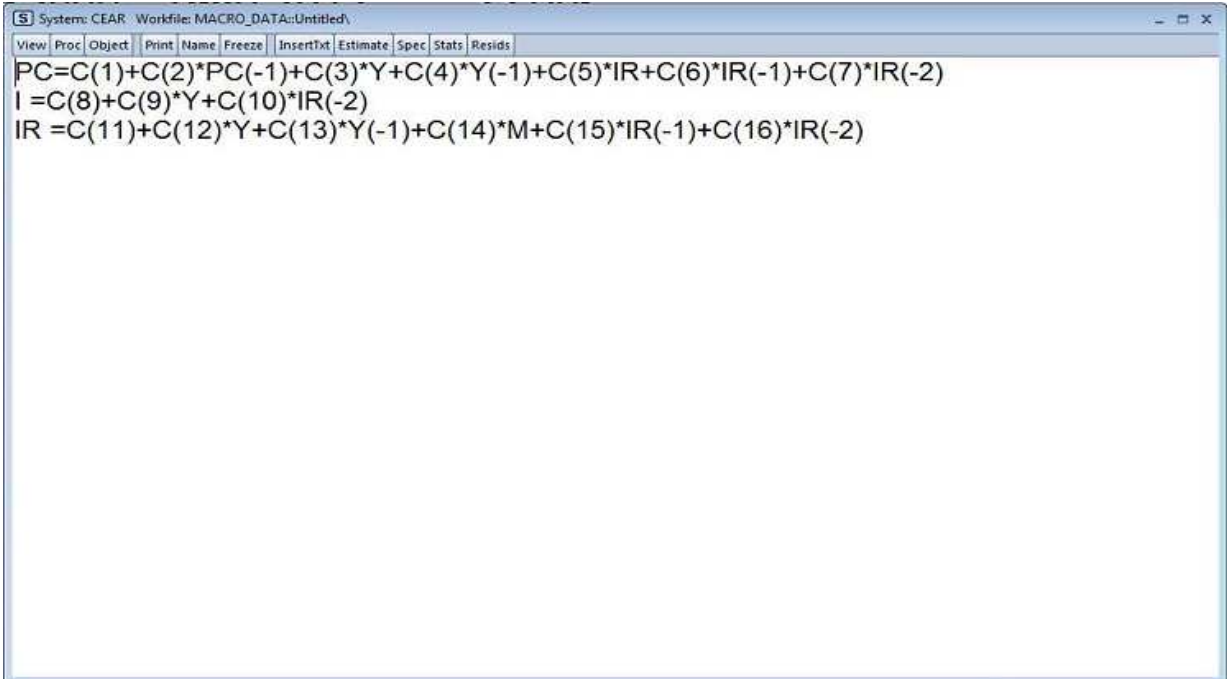
- We can also use the command  $d(cn)$  which is equivalent to  $cn-cn(-1)$ .

$$\text{So } cn=d(cn)+cn(-1)$$

- In addition to the behavioural equations, some models may have identities that allow the model to solve for the endogenous variables.
- Before trying to solve the model, we must make sure we have at least as many equations as there are endogenous variables to solve for in the model. We must set up our equations in a way that each equation has a different endogenous variable as the first series on the left-hand side.

### 3.2 Entering Equations

- As an example, a system of equations in the System Window looks like the following:



The screenshot shows a window titled 'System: CEAR - Workfile: MACRO\_DATA:Untitled\'. The window contains three equations entered in a text area:

```

PC=C(1)+C(2)*PC(-1)+C(3)*Y+C(4)*Y(-1)+C(5)*IR+C(6)*IR(-1)+C(7)*IR(-2)
I=C(8)+C(9)*Y+C(10)*IR(-2)
IR=C(11)+C(12)*Y+C(13)*Y(-1)+C(14)*M+C(15)*IR(-1)+C(16)*IR(-2)

```

**Note the following about the model:**

- ❖ There are three behavioural equations
- ❖ C(1) to C(16) represent the structural parameters. It is more convenient to number the coefficients serially as demonstrated above.

- ❖ PC, I and IR are endogenous variables; Y(-1), PC(-1), IR(-1), and IR(-2) are predetermined variables while M and Y are exogenous variables.
- The estimation output obtained after applying OLS should appear like the one shown below:
- We have been previously taught how to estimate simultaneous-equation models. Nonetheless, to estimate our model with OLS, click estimate from the System Window / choose OLS estimator / OK

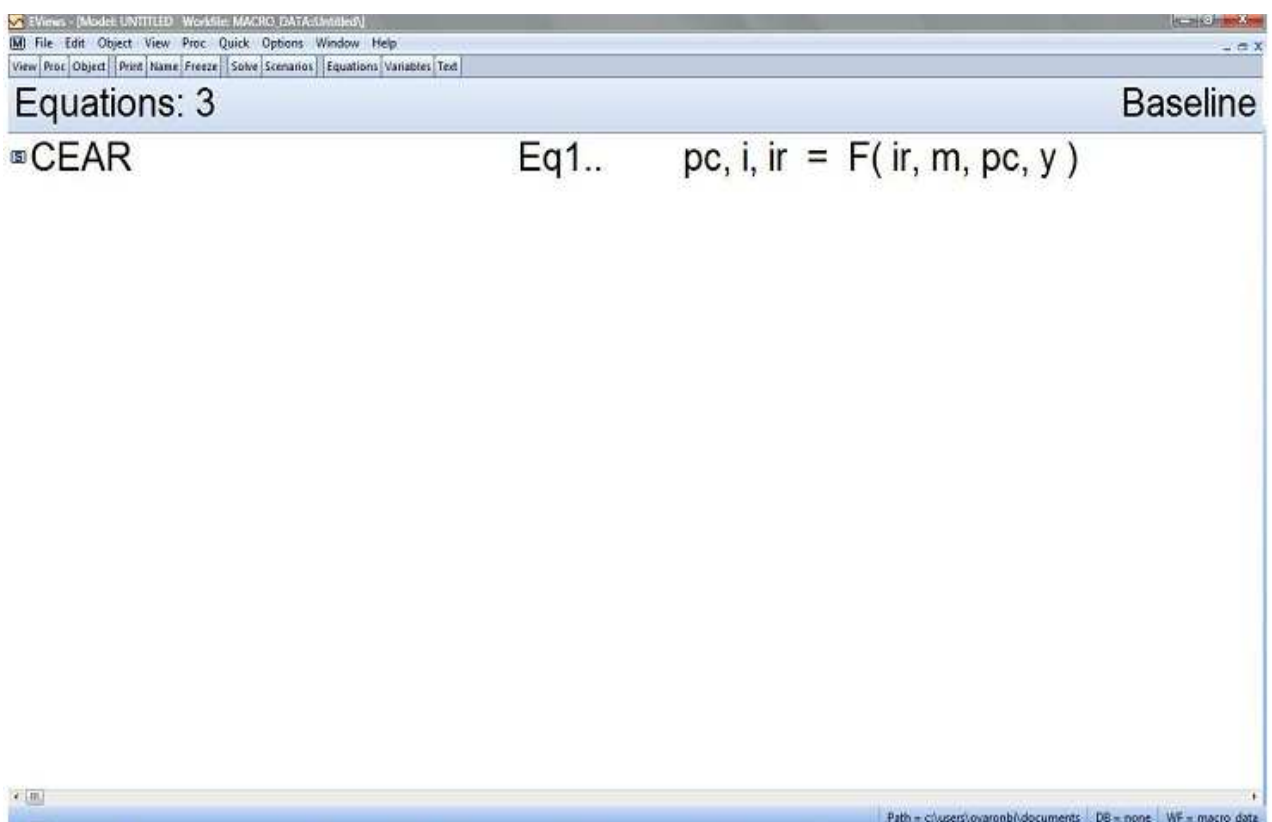
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-4.083698	4.672961	-0.873900	0.3851
C(2)	0.950500	0.036048	26.36756	0.0000
C(3)	0.637656	0.875967	0.727945	0.4690
C(4)	-0.233749	0.891580	-0.262174	0.7939
C(5)	0.011857	0.006607	1.794786	0.0769
C(6)	-0.015333	0.007474	-2.051561	0.0439
C(7)	0.019546	0.006561	2.978972	0.0040
C(8)	-95.84903	7.751690	-12.36492	0.0000
C(9)	9.345688	0.719122	12.99597	0.0000
C(10)	0.045876	0.017449	2.629089	0.0105

## 4.0 Model Simulation

This will require using the estimated coefficients above to predict all the endogenous variables. Also, it allows for the consideration of different scenario analyses. The following steps are involved:

### 4.1 Make a Model

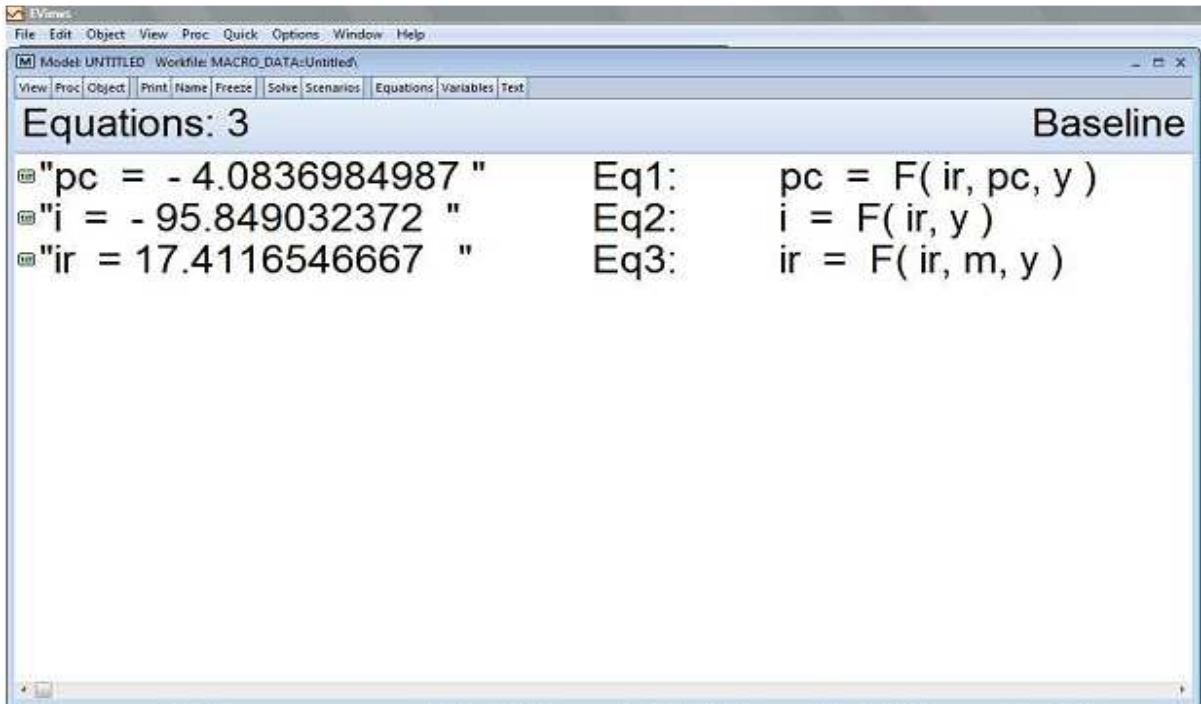
From the estimation output, click **Proc / Make Model**. This shows the system of equations specified.



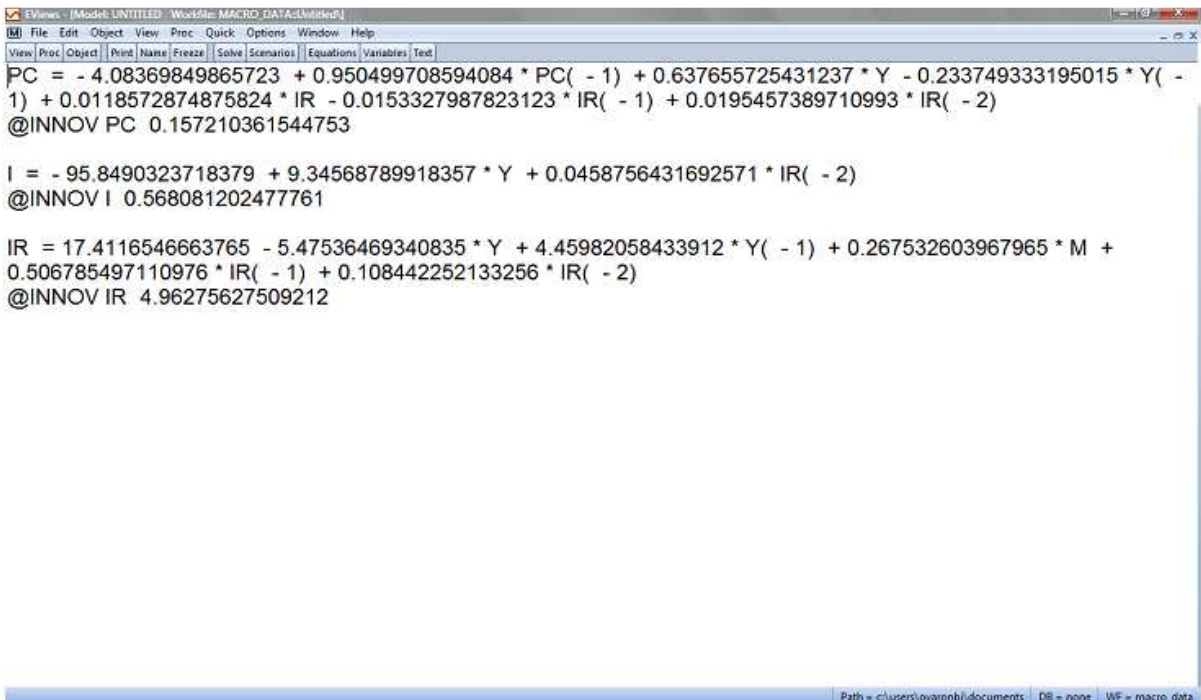
To view all the equations, click **Proc / Links / Break All Links**

Note that the variables on the left hand side of the equations are the endogenous variables while those on the right hand side are the explanatory variables.



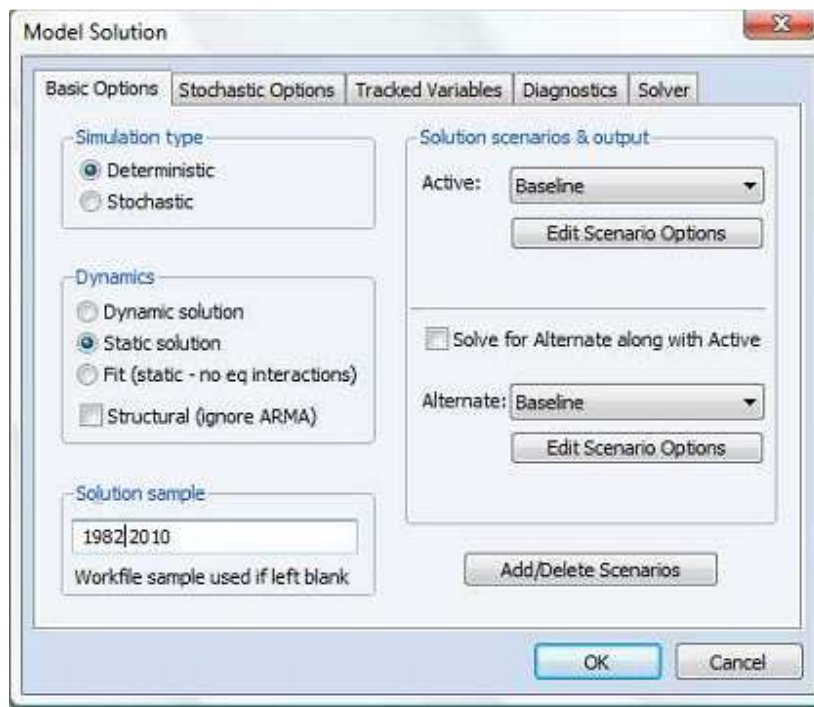


To view all the equations with their estimated coefficients, Click **text**  
 Note that these are the coefficients obtained after applying OLS.



## 4.2 Solving a Model

Having viewed the estimated equations, the next stage is to solve for the endogenous variables. To do this, click on the **solve** button in the model window button bar.



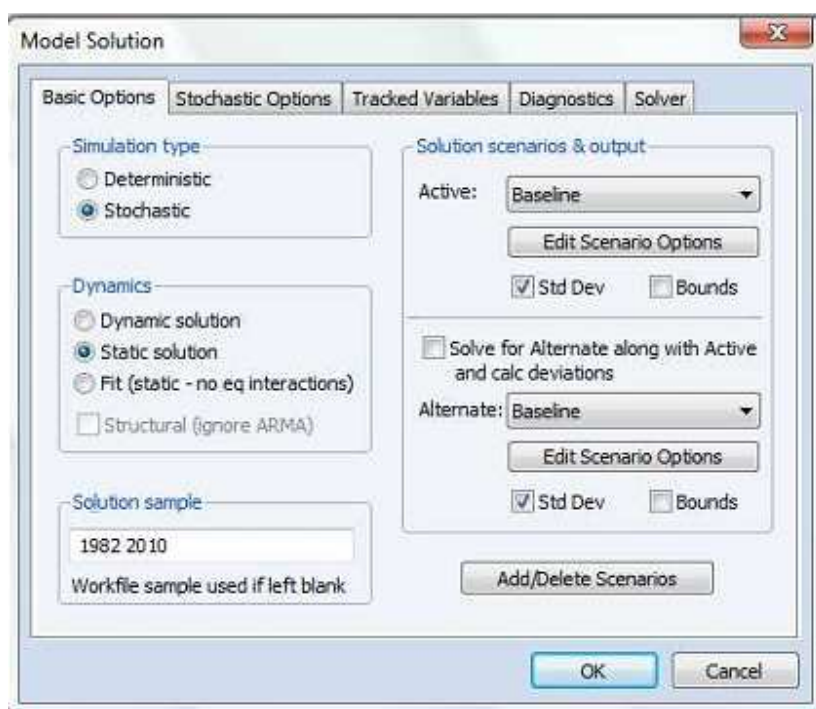
➤ Let us consider the basic options shown in the dialog box above:

### ❖ Simulation type:

- ✓ **Deterministic:** This involves solving the model without simulating the residuals. In addition, all the estimated coefficients are used in the simulation at their point estimates likewise all the exogenous variables are held constant.
- ✓ **Stochastic:** With this option, the equations of the model are solved and simulated with residuals. Also, the coefficients and exogenous variables of the model are varied randomly. For stochastic simulation, the model solution generates a distribution of

outcomes for the endogenous variables in every period. We approximate the distribution by solving the model many times using different draws for the random components in the model then calculating statistics over all the different outcomes.

As a preliminary exercise, it will be more appropriate to consider the two options in order to have an idea of the sensitivity of the results to various sorts of error.



## ❖ Dynamics

- ✓ **Static solution:** This is usually used when dealing with *in-sample simulation* where the predicted values of the endogenous variables in model can be compared with the historical data. Of course, this will require using the actual values of all the explanatory variables (both the exogenous and the lagged endogenous variables of the

model). The predictive ability of the model can be evaluated based on the in-sample simulation.

- ✓ **Dynamic solution:** This is the option for *Out-of-Sample Simulation*. Under this, we have to forecast all the exogenous variables. The future paths of the exogenous variables may be based on the likely policy direction of the economy as to what will actually happen. Statistically, there are different approaches of forecasting time series ranging from the Naive, Simple Average, Simple Moving Average, Weighted Moving Average, Trend Projection to Exponential Smoothing methods. These methods are briefly discussed below.

- (i) **Naive Method:** The forecast for next period (say period T+1) will be equal to the current period's ( period T) value.

**For example:**

- $Y_{T+1} = Y_T$
- $Y_{T+2} = Y_{T+1}$
- $Y_{T+n} = Y_{T+n-1}$

- (ii) **Simple Average Method:** The forecast for next period (say period T+1) will be equal to the average of all past historical values.

**For example:**

- $$Y_{T+1} = \frac{1}{T} \sum_{t=1}^T Y_t$$

- $$Y_{T+2} = \frac{1}{T+1} \sum_{t=1}^{T+1} Y_t$$
- $$Y_{T+n} = \frac{1}{T+n-1} \sum_{t=1}^{T+n-1} Y_t$$

**(iii) Simple Moving Average Method:** The forecast for next period (say period T+1) will be equal to the average of a specified number of the most recent observations, with each observation receiving the same emphasis (weight).

**For example:**

- $$Y_{T+1} = \frac{Y_T + Y_{T-1} + Y_{T-2}}{3}$$
- $$Y_{T+2} = \frac{Y_{T+1} + Y_T + Y_{T-1}}{3}$$
- $$Y_{T+n} = \frac{Y_{T+n-1} + Y_{T+n-2} + Y_{T+n-3}}{3}$$

**(iv) Weighted Moving Average Method:** The forecast for next period (say period T+1) will be equal to a weighted average of a specified number of the most recent observations.

**For example:**

- $$Y_{T+1} = w_1 Y_T + w_2 Y_{T-1} + w_3 Y_{T-2}$$
- $$w_1 + w_2 + w_3 = 1;$$

we can assume  $w_1 = 0.5$ ;  $w_2 = 0.3$ ;  $w_3 = 0.2$

Therefore;  $Y_{T+1} = 0.5Y_T + 0.3Y_{T-1} + 0.2Y_{T-2}$

- $Y_{T+2} = 0.5Y_{T+1} + 0.3Y_T + 0.2Y_{T-1}$
- $Y_{T+n} = 0.5Y_{T+n-1} + 0.3Y_{T+n-2} + 0.2Y_{T+n-3}$

(iv) **Trend projection method:** This involves regressing the variable under consideration on a time trend.

That is:  $Y = a + bTrend$

The trend term can also be non-linear depending on the behaviour of the series being examined.

(v) **Exponential smoothing method:** The new forecast for next period (period t) will be calculated as follows:

New forecast = Last period's forecast +  $\alpha$ (Last period's actual value - Last period's forecast)

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

Or

$$F_t = \alpha A_{t-1} + (1-\alpha)F_{t-1}$$

Where  $\alpha$  is a smoothing coefficient whose value is between 0 and 1;  $F_t$  denotes forecast at period t and  $A_t$  is the actual at period t

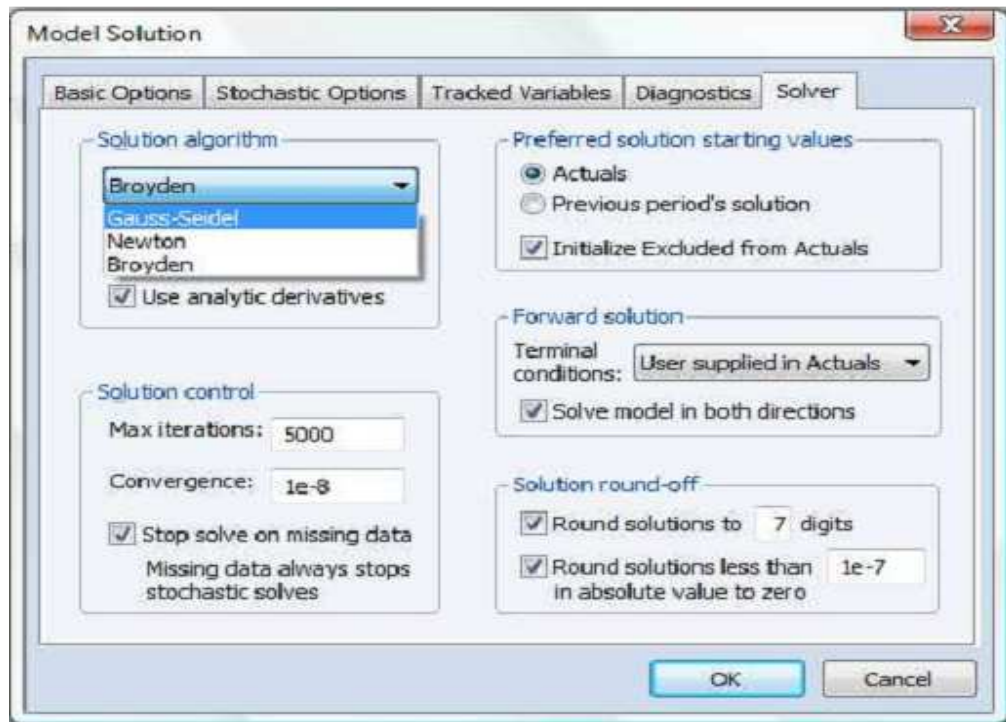
❖ **Solution sample:**

This is the simulation period. For the in-sample simulation, the estimation period is usually the simulation period. However, due to lagged variables in the model, one must adjust this period so as to avoid initializing the solution with missing values. In the case of our model, we set the sample to 1982 2010. **Why?**

For out-of-sample simulation period however, this rests on the underlying objective of the model. Generally, it captures n-period ahead forecasts. For the purpose of our exercise, we set the sample to 2011 to 2012 (implying a 2-year ahead forecast). Thus, the period initially indicated in the workfile will now be extended to 2012. **How?**

- ❖ **Solver:** This is essentially the algorithm used to solve the model. In the literature there are three approaches of solving a model period. They are:
  - ✓ **Gauss-Seidel:** This is an iterative algorithm, where at each iteration we solve each equation in the model for the value of its associated endogenous variable, treating all other endogenous variables as fixed. The Gauss-Seidel less computationally demanding when compared to other methods and it performs well on most econometric models.
  - ✓ **Newton:** This algorithm can handle a wider class of problems than Gauss-Seidel, but requires considerably more working memory and has a much greater computational cost when applied to large models.
  - ✓ **Broyden:** This is a modification of Newton's method (often referred to as a quasi-Newton or secant method) and requires more iterations to converge to a solution than the Newton. However, the Broyden spends less than the time required to solve the model by Newton's method.

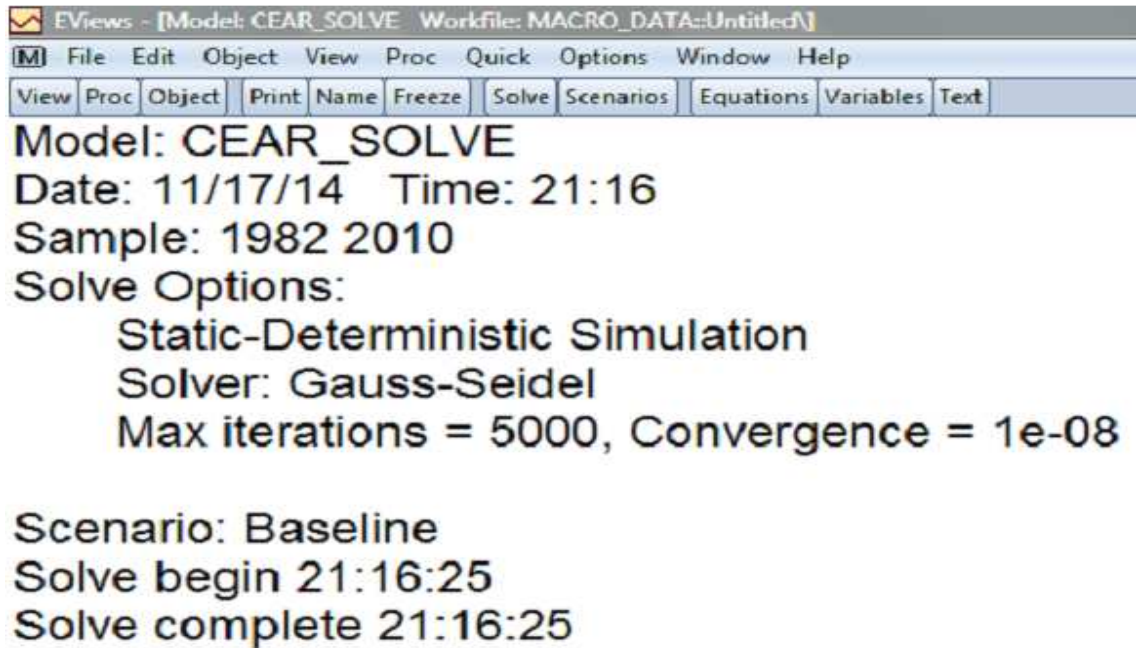
In any case, for a typical macro-econometric model, the Gauss-Seidel technique is preferred and its application has remained prominent in macro-econometric literature.



Let us consider a Static-Deterministic Simulation for our exercise:

- *Deterministic / Static solution / 1982 2010 / Solver / Gauss-Seidel*
- By clicking OK, the Model solution is displayed as shown below



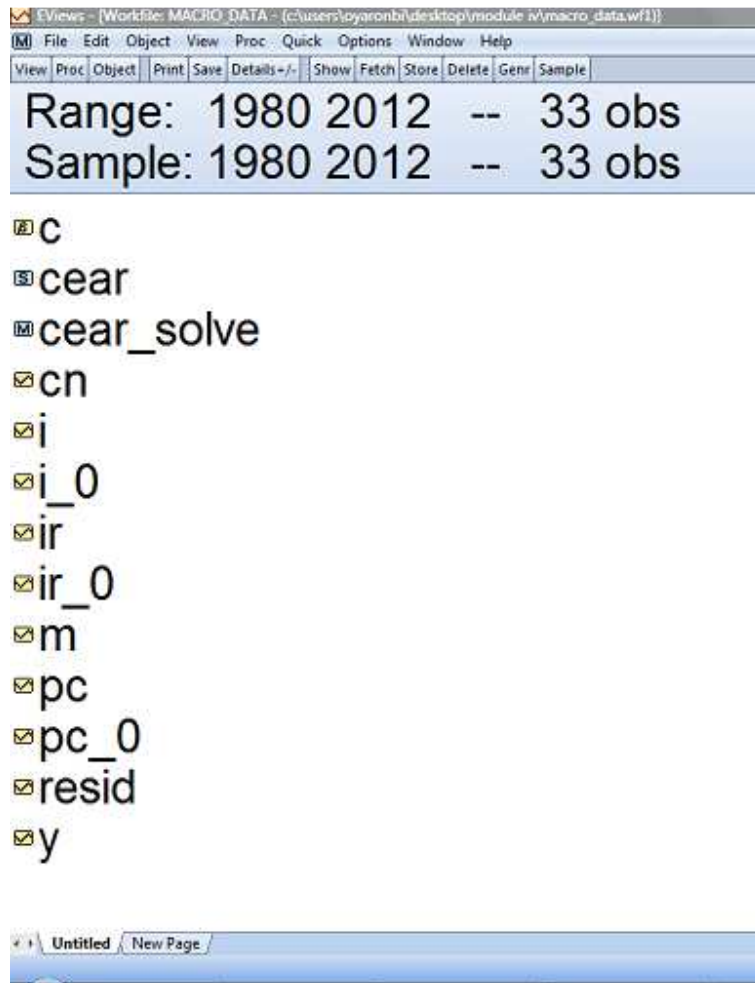


The screenshot shows the EViews software interface. The title bar reads "EViews - [Model: CEAR\_SOLVE Workfile: MACRO\_DATA::Untitled]". The menu bar includes "File", "Edit", "Object", "View", "Proc", "Quick", "Options", "Window", and "Help". Below the menu bar is a toolbar with buttons for "View", "Proc", "Object", "Print", "Name", "Freeze", "Solve", "Scenarios", "Equations", "Variables", and "Text". The main window displays the following text:

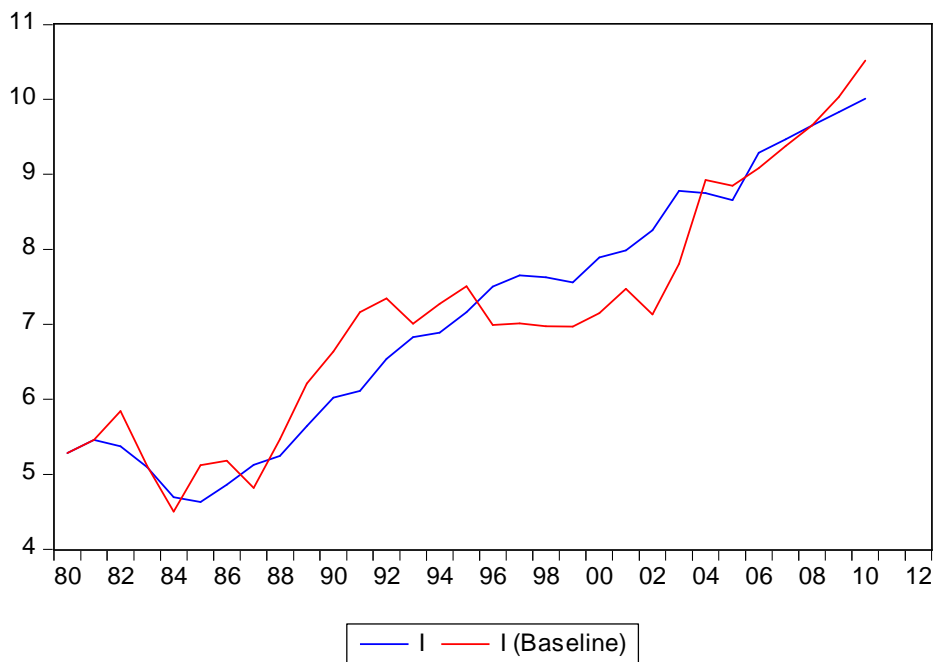
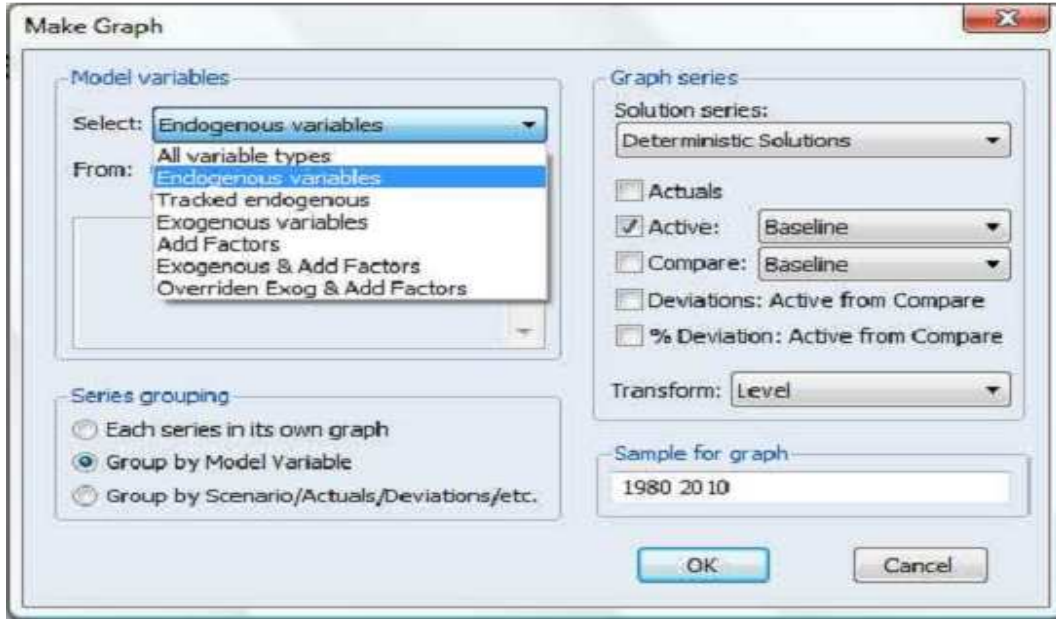
```
Model: CEAR_SOLVE
Date: 11/17/14 Time: 21:16
Sample: 1982 2010
Solve Options:
    Static-Deterministic Simulation
    Solver: Gauss-Seidel
    Max iterations = 5000, Convergence = 1e-08

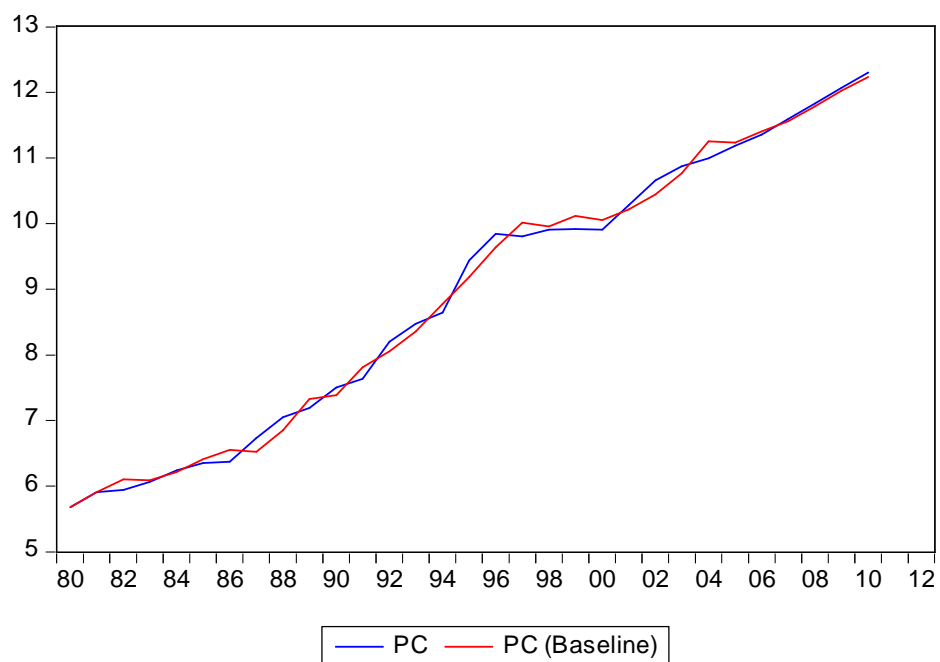
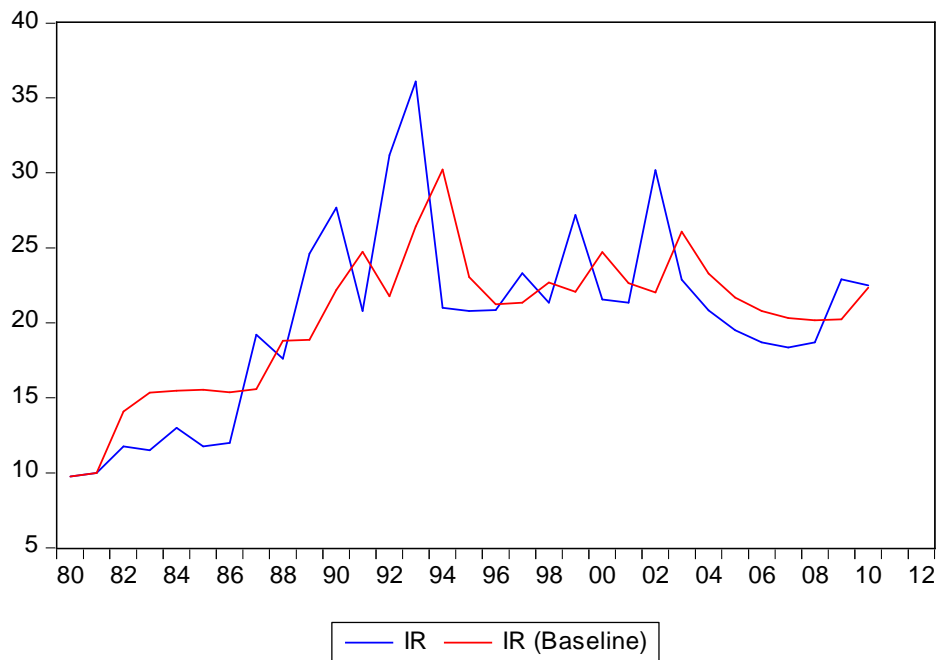
Scenario: Baseline
Solve begin 21:16:25
Solve complete 21:16:25
```

- You will observe that the solution is already saved as "CEAR\_SOLVE"
- Check the workfile to view the baseline results for the endogenous variables. The updated workfile should appear like this:



- Note that `_0` denotes Static-Deterministic Solution and it distinguishes the baseline from the actual
- We can compare the actual with the baseline graphically. To do this, double click the filename for model solution "*cear\_solve*" then click *Proc/Make Graph*



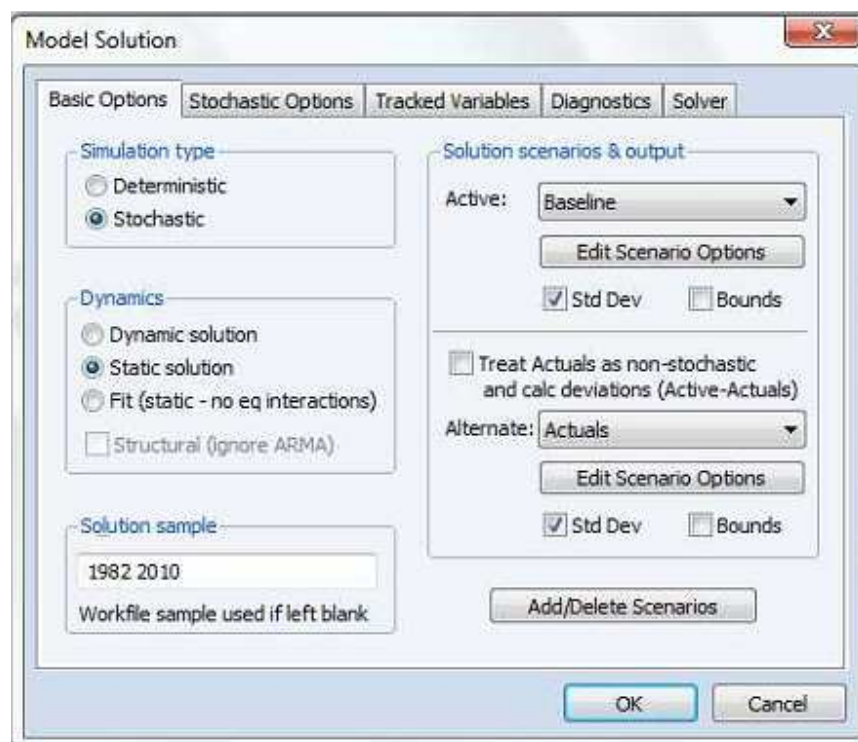


- If we intend to consider another option for model solution, we need to create a scenario for ease of comparison. This allows us to store the results obtained from this new option uniquely while also retaining the results from the previous options. Scenario 1 is created by default. Therefore, if we are considering more than one

additional option, we have to create relevant scenarios in order to have a unique label for each of the options.

### An Illustration:

- Recall, we have previously considered Static-Deterministic Simulation
- One may be interested in comparing the results with Static-Stochastic Simulation:
- To do this, we are to recall the model solution by double clicking "*cear\_solve*" and thereafter, click *solve*



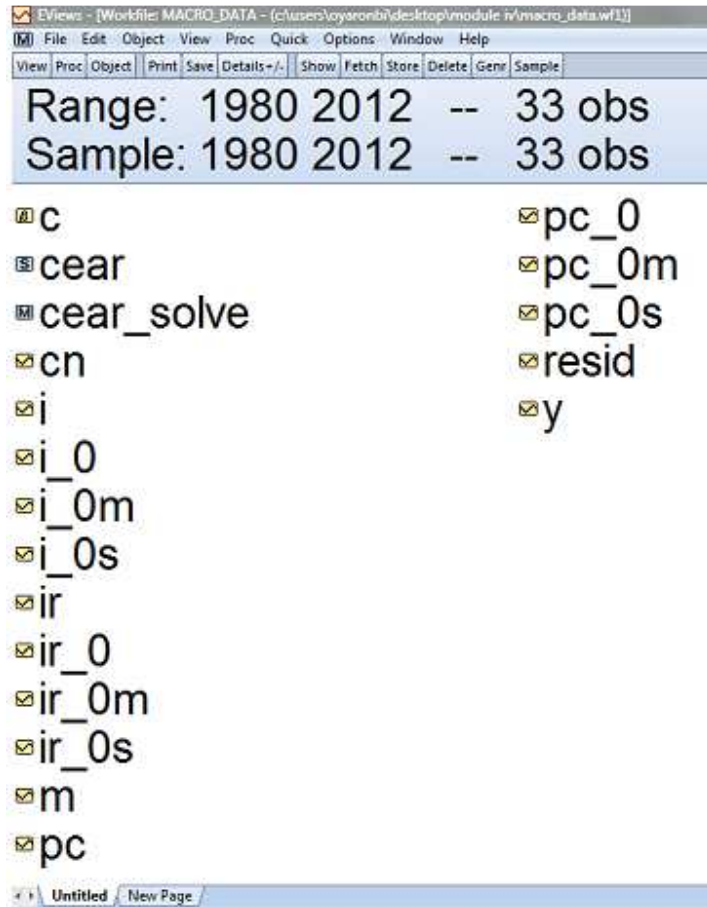
- The model solution is provided below:
- For each of the endogenous variables, both the mean and standard deviation are simulated.

```
File Edit Object View Proc Quick Options Window Help
View Proc Object Print Name Freeze Solve Scenarios Equations Variables Text
Model: CEAR_SOLVE
Date: 11/16/14 Time: 18:32
Sample: 1982 2010
Solve Options:
  Static-Stochastic Simulation
  Solver: Gauss-Seidel
  Max iterations = 5000, Convergence = 1e-08
  Requested repetitions = 1000, Allow up to 2 percent failures
  Solution does not account for coefficient uncertainty in linked equations
  Track endogenous: mean, standard deviation

Calculating Innovation Covariance Matrix
Sample: @ALL
Matrix scaled to equation specified variances

Scenario: Scenario 1
Solve begin 18:32:27
  Repetitions 1-200: successful 18:32:27
  Repetitions 201-400: successful 18:32:27
  Repetitions 401-600: successful 18:32:27
  Repetitions 601-800: successful 18:32:27
  Repetitions 801-1000: successful 18:32:27
Solve complete 18:32:27
1000 successful repetitions, 0 failure(s)
```

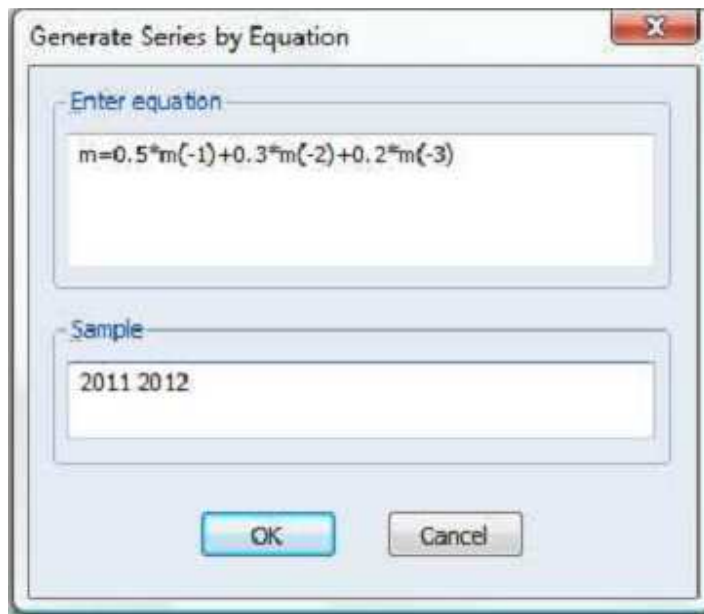
➤ The updated workfile is shown below:



- Note \_0m and \_0s are for Static-Stochastic Solution.
- Let us now consider **out-of-sample simulation**. Under this, we can evaluate the impact of different scenarios on the endogenous variables.
- Recall, we have to first of all determine the future paths for all the exogenous variables.
- In the case of our model, we have two exogenous variables namely Income (y) and Money Supply (m).
- We can choose y as our policy variable while we allow m to follow its natural pattern (Do nothing).
  - We can assume a three-year weighted moving average for Money Supply with the most recent year, 0.5; year prior to that, 0.3; year prior to that, 0.2:

The formula:  $m=0.5*m(-1)+0.3*m(-2)+0.2*m(-3)$

- To do this in Eviews, from the workfile window click *genr* and type the formula.
- Note that our out-of-sample period is 2011 to 2012

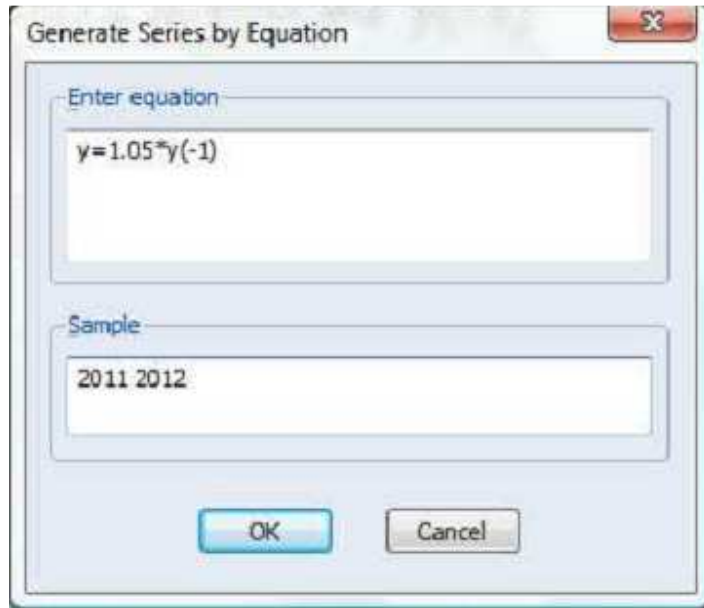


- We can then assume the following scenarios for y:
  - Annual Increase in y by 5%
  - Annual Decrease in y by 5%
  - Allow y to follow its natural path (Do nothing)

Taking each in turn:

- To increase y by 5%; we can as well use the *genr*
- The formula:  $y=1.05*y(-1)$

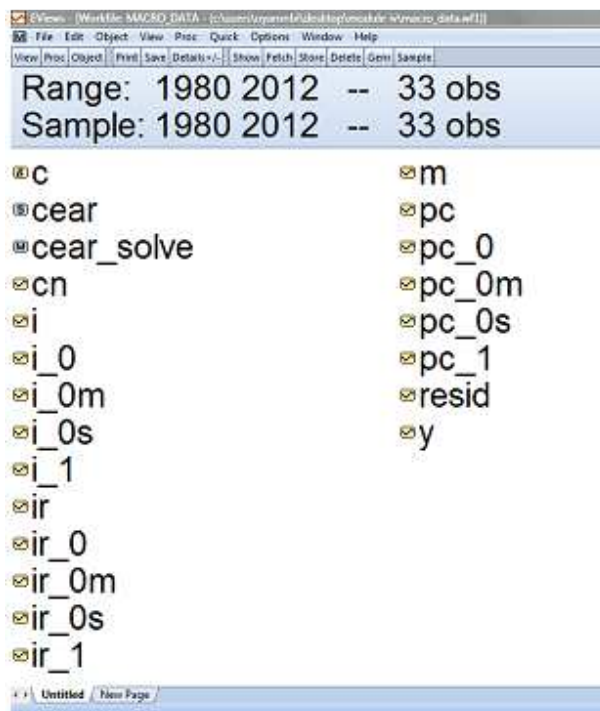




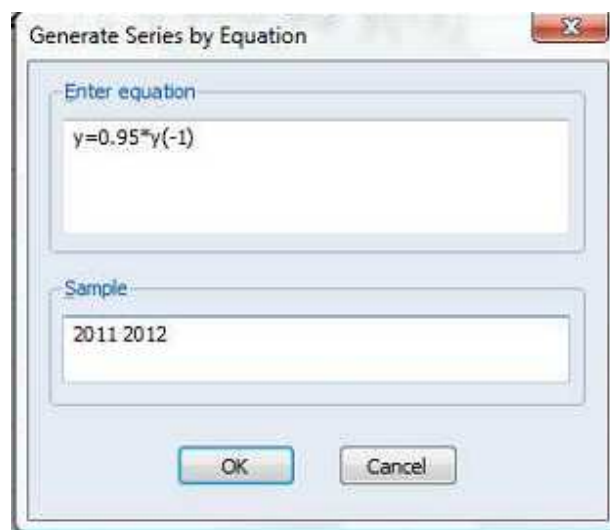
- We can now simulate the endogenous variables given the projected future paths of exogenous variables.
- To do this, we need to first create a scenario to distinguish our results from the previous ones.
- We can use the default scenario (scenario 1) for the solution and therefore simulation results produced under this will be suffixed by **\_1**
- Let us now proceed to the **out-of-sample simulation**
- From the model solution "*cear\_solve*",
- Click *solve / Deterministic / Dynamic solution / 2011 2012 / Solver / Gauss-Seidel / OK*



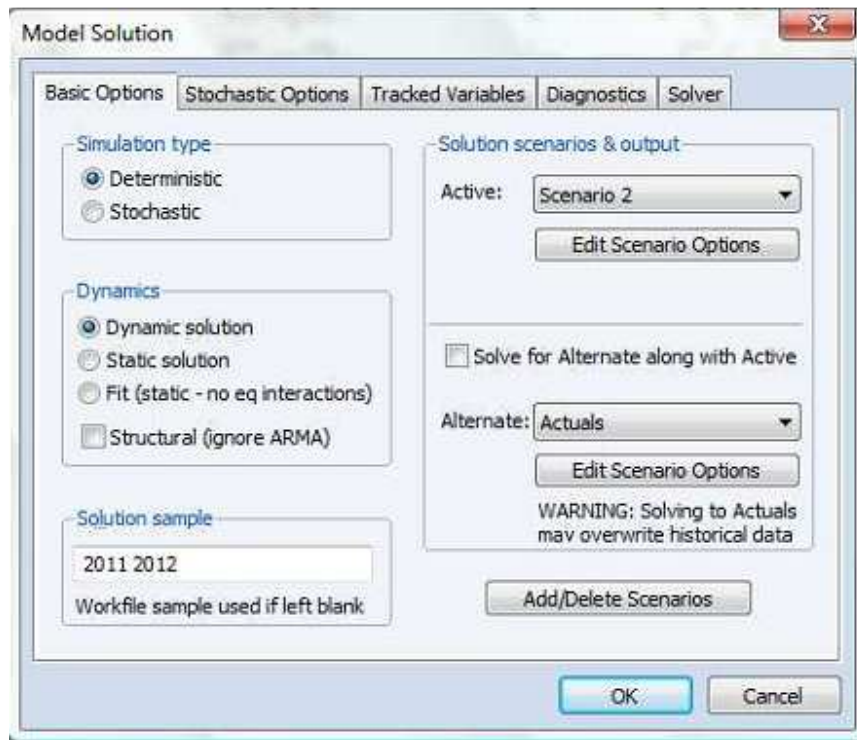
- By viewing the workfile, we can see that the number of objects has increased to include the new results. Note the variables with **\_1**; they represent the out-of-sample forecasts for our endogenous variables.



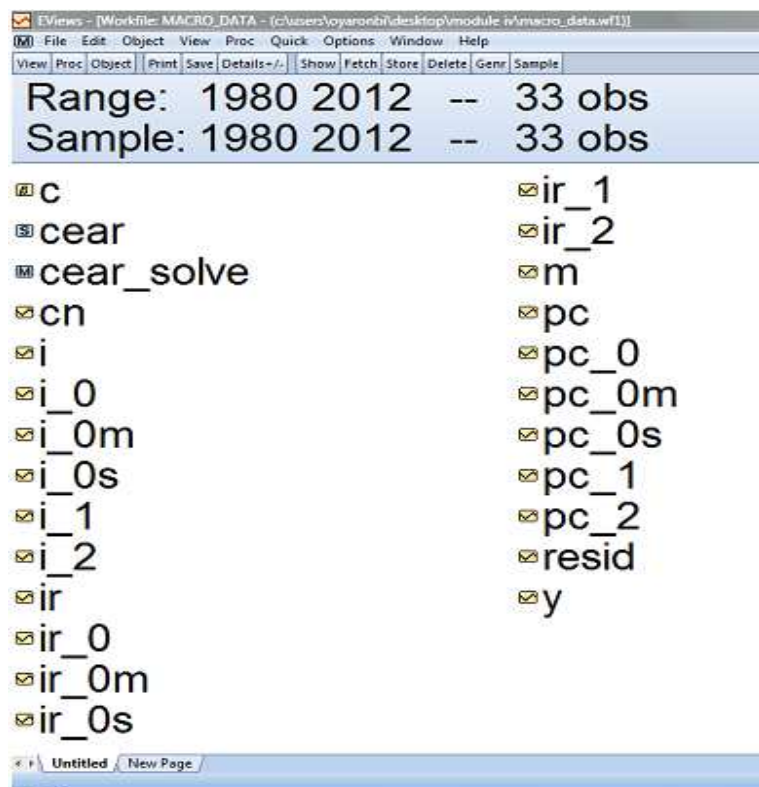
- We can follow the same procedure for the second scenario which is to reduce income by 5%
- The formula:  $y=0.95*y(-1)$ 
  - That is, from the workfile window, click *genr* and type the given formula



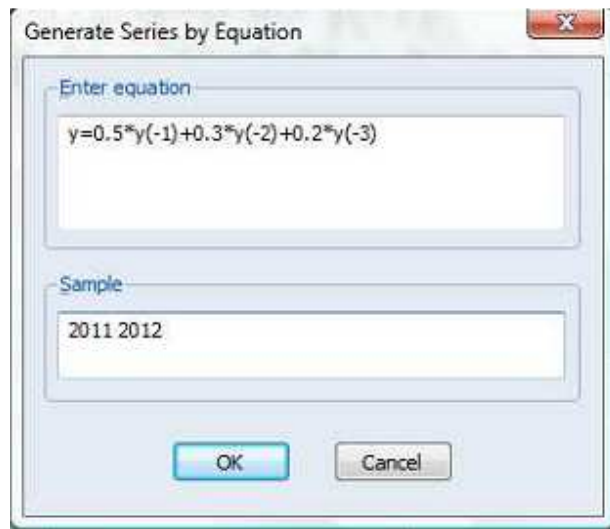
- Now we have to create Scenario 2 for the solution obtained here.
- Double click "*cear\_solve*" and then click *Scenario / Create New Scenario / OK*
  - Thereafter, click *solve / Deterministic / Dynamic solution / 2011 2012 / Solver / Gauss-Seidel / OK*



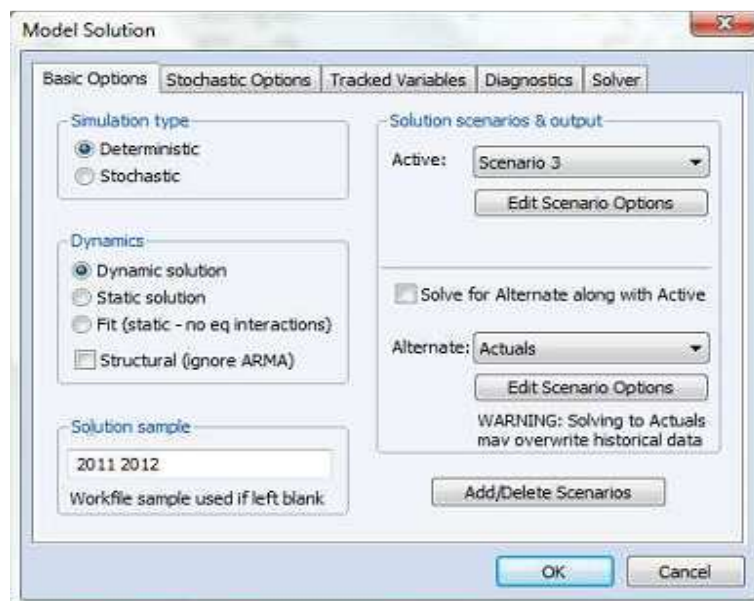
➤ The updated workfile is shown below with new results suffixed by 2

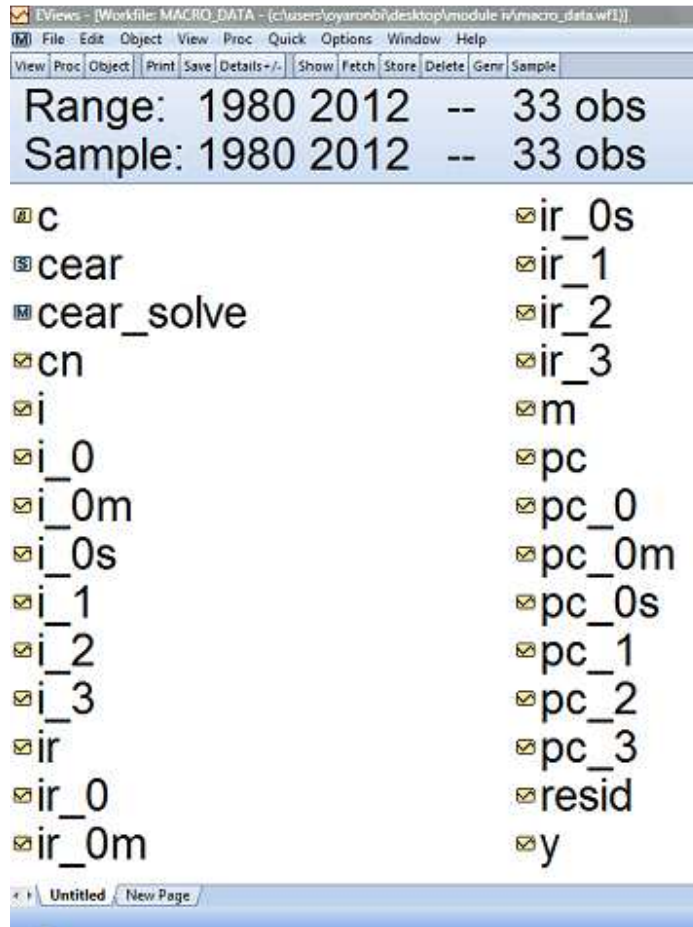


- Allowing  $y$  to follow its natural path:
- Like  $m$ , we can also assume a weighted moving average for  $y$  given as:  $y=0.5*y(-1)+0.3*y(-2)+0.2*y(-3)$



- Again, from the Model solution "*cear\_solve*", click *Scenario / Create New Scenario / OK*
- This gives Scenario 3 and the simulation results are suffixed by *\_3*
- Then, click *solve / Deterministic / Dynamic solution / 2011 2012 / Solver / Gauss-Seidel / OK*





- We can easily tabulate the simulation results and examine how the endogenous variables respond to the three scenarios.

Period	I_1	I_2	I_3	IR_1	IR_2	IR_3	PC_1	PC_2	PC_3
2010	10.01196	10.01196	10.01196	22.50833	22.50833	22.50833	12.30242	12.30242	12.30242
2011	15.98835	5.437221	10.39755	19.71778	25.89938	22.99327	12.86602	12.21942	12.5234
2012	21.5097	0.407454	10.44295	17.53704	27.99791	23.01273	13.65699	11.89575	12.73079

**Note the following about the results:**

- An increase in  $y$  by 5% leads to a higher level of consumption and investment and a reduction in interest rate
- Conversely, a decrease in  $y$  by the same magnitude reduces the level consumption and investment and increases the rate of interest

- Thus, increasing the level of income appears to have beneficial effects on the selected macroeconomic variables than reducing it.
- Also, increasing the level of  $y$  is preferred to leaving it to grow naturally.
- However, if the economy is not buoyant enough as to increase the level of  $y$  by 5%; then, allowing it to follow its natural path is preferred to reducing it by 5%.
  - $I_1 > I_3 > I_2$
  - $IR_1 < IR_3 < IR_2$
  - $PC_1 > PC_3 > PC_2$
- Participants may consider other plausible scenarios to demonstrate their understanding of a typical macro-econometric model used for policy analysis.
- Enjoy!!!!