Simulating Klein's Model I using EViews

Robert Dixon
Department of Economics at the University of Melbourne

In a book published in 1950, Lawrence Klein reported three Keynesian macroeconomic models of the U.S. economy for the period 1921-41, a period which includes the great depression. The smallest of his three models, known as Model I, has been widely cited.[1] An advantage of the model for our purposes is that because it is so small it is easy for us to understand the dynamic mechanisms which are at work in the model.

The equations of Klein's Model I are set out below:[2,3]

$$Cons_t = 16.60 + 0.017\ P_t + 0.216\ P_{t-1} + 0.81\ (PWB_t + GWB_t)$$

$$I_t = 20.3 + 0.15\ P_t + 0.616\ P_{t-1} - 0.158\ K_{t-1}$$

$$PWB_t = 1.50 + 0.439\ PSO_t + 0.147\ PSO_{t-1} + 0.13\ TIME$$

$$PSO_t = Cons_t + I_t + (G_t - GWB_t)$$

$$P_t = PSO_t - PWB_t - T_t$$

$$K_t = K_{t-1} + I_t$$

$$GNP_t = Cons_t + I_t + G_t$$

where:[4]

	Cons	=	private consumption expenditure.
	P	=	profits net of business taxes.
	PWB	=	wage bill of the private sector.
	GWB	=	wage bill of the government sector.
	I	=	(net) private investment.
	K	=	stock of (private) capital goods (at the end of the year).
	PSO	=	aggregate output of the private sector.
	TIME	=	an index of the passage of time, 1931 = zero.
	G	=	government expenditure plus net exports.
	T	=	business taxes.
	GNP	=	gross national product.

[1] For the beginner I would recommend reading Klein himself (1950) or Theil, Boot and Kloek (1965) first. Some econometrics is necessary in order to follow Theil and Boot (1962).

[2] I have departed from the notation of Klein and others in a number of respects. At the same time I follow Klein in defining government expenditure (G) to include both the governments' own wage bill and its purchases from the private sector - some authors do not. Since we are usually interested in the behaviour of GNP I have included an identity for that variable in addition to providing an expression for the output of the private sector. Both C and CON are protected names in EViews and so I have labelled Consumption as Cons.

[3] The coefficients in the equations given below are the 2SLS estimates from Greene (2000, p 699). Klein himself estimated the coefficients of the model using a number of different techniques including least-squares and more sophisticated methods. Different commentators use different sets of estimates of the coefficients.

[4] All variables (except TIME, obviously) are measured in constant prices.

Most of this should be straightforward. The consumption function is premised on the assumption that the propensity to consume out of wage income (PWB + GWB) differs from the propensity to consume out of profit income. It is also hypothesised that although consumption out of wages depends only upon current wage income, consumption out of profits depends upon both current and lagged (net) profit income. The investment equation asserts that investment depends upon current and lagged (net) profits and also upon the size of the inherited capital stock, reflecting (in part at least) the extent of replacement investment. The private sector wage bill (loosely related to the demand for labour) is hypothesised to depend upon current and lagged levels of private sector output and union wage push. The increasing pressure from unions for wage increases is modelled as a linear function of time, hence the appearance of the time trend on the R.H.S. of the equation for the private sector wage bill. Finally, we have four identities. One expresses an equality between the level of private sector output and the demand for the various products of the private sector.[5] The next states that profits net of tax are the difference between private sector output in the one hand and the private sector's wages bill and business taxes on the other. The next identity states that the capital stock in any period depends upon the size of the stock at the end of the previous period plus the level of current net investment. The final identity expresses GNP as the sum of all production undertaken in the economy.[6]

In the model as set out above, we have 7 endogenous variables (Cons, I, PWB, PSO, P, K and GNP), 3 lagged endogenous variables (P, K and PSO - we will need starting values for these variables in any simulation) and 4 exogenous variables including the time trend (G, T, TIME and GWB - in any simulation we will need complete data sets for each of these variables). Klein provides us with relevant historical data for the US economy over the period 1920-1941. This allows us to conduct a historical simulation (in which we use observed values of the exogenous variables and the observed starting values of the lagged endogenous variables) in order to see how well his model "tracks" the actual movement of GNP (and other variables) in the U. S. economy over the inter-war period. We may also use his model to undertake policy experiments, for example, changing the level of G relative to T, in order to assess the impact of fiscal policy.

I have created an EViews file containing the model as set out above together with Klein's data for the U.S. economy over the period 1920-1941. The file is called klein.wfl and can be down-loaded to your computer. Notice that I have stored the actual data for GNP in the file, under the notation AGNP. This data is not used in the model simulation phase, I have put it there to enable you to compare actual and simulated values of GNP more easily.

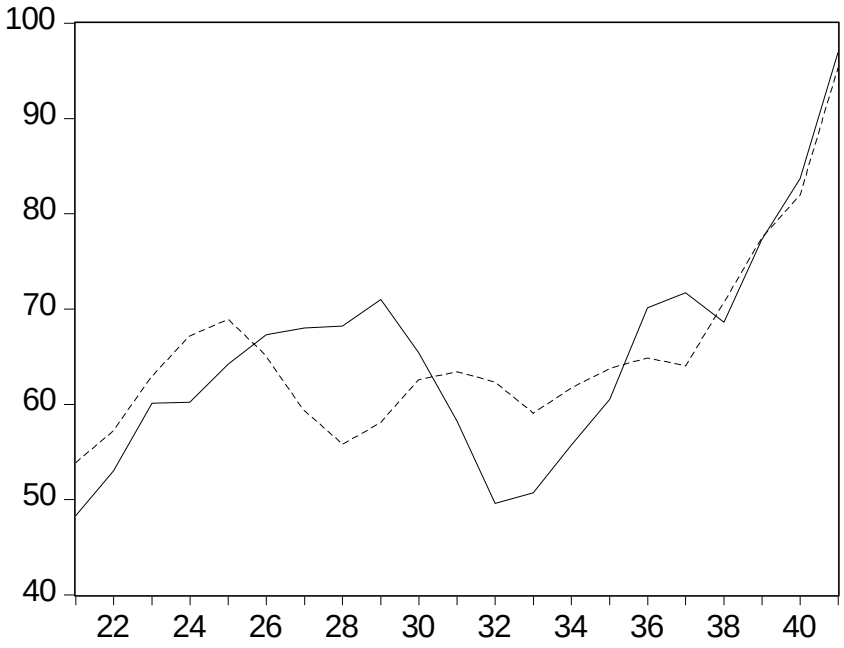
In the diagram on the next page I depict the actual levels of GNP in the U.S. economy over the period 1920-1941, together with the simulated level of GNP using Klein's

[5] The value of government purchases from the private sector will equal (G - GWB).

[6] Many interpreters of the Klein Model have failed to notice that Klein himself uses the symbol Y for C+I+G-T and not C+I+G alone.

model. Notice that the model is not tracking the historical data at all well. It shows a recession beginning in 1926 when in fact GNP continued to grow until 1929. The actual course of the Great Depression (1929-1936) is not picked up, and the minor recession prior to the outbreak of WW2 occurs one year early in Klein's model.

Set out below is a plot of actual GNP (solid line) against simulated GNP (dotted line) where the simulated values are form the model as set up in klein.tsp before modification.



However, despite its poor performance in historical simulation, the model may still be used for policy simulation because in so doing we are concerned with comparing the behaviour of the model under different assumptions, and not with comparing the behaviour of the model with actual outcomes. An interesting policy experiment, and one which also gives insight into the stability of the model involves: (i) performing the historical simulation as discussed above, then (ii) varying the amount of government expenditure, holding everything else constant, in just one year. In all other years the values of all the exogenous variables (including G) are kept at their historical levels. Comparing the time path of (say) GNP in the two cases, should give us some insight into the consequences of an increased government expenditure (ceteris paribus) on the aggregate level of economic activity. I suggest that you proceed as follows:

(i) Download and run the file using Klein's data. Note the simulated values for GNP in each year.

(ii) Edit the file so as to raise the value of G by $1 billion in 1921, (i.e. change the value of G for 1921 from 6.6 to 7.6) but leave all other values of G, and the data for all other variables in the file, unchanged.

(iii) Run the amended file and compare the simulated values of GNP in this "shocked" run with those obtained earlier.

(iv) Note the difference in the level of GNP in the two simulations in each year after the shock. What can we say about the impact effects of a cet. par. change in government expenditure on GNP? What can we say about the dynamic effects of a cet. par. change in government expenditure on GNP? Why is there a cycle in GNP? Is the model stable or unstable?[7] Can we say anything about the size of the government expenditure multiplier (i.e. the total effect of a unit rise in G upon GNP)?[8]

References

W. Greene (2000), Econometric Analysis, 4th edition, Prentice-Hall.

L. Klein (1950), Economic Fluctuations in the United States 1921-1941, Wiley, pp. 58-80.

H. Theil and J. Boot (1962), "The Final Form of Econometric Equation Systems" Review of the International Statistical Institute, 30, pp. 136-52. Reprinted in A. Zellner (ed.), Readings in Economic Statistics and Econometrics, Little, Brown and Co, 1968, pp. 611-30.

H. Theil, J. Boot and T. Kloek (1965), Operations Research and Quantitative Economics, McGraw-Hill, pp. 77-86.

[7] That is, after a shock, does it "settle down" or does it show signs of either explosive oscillations or monotonic increases or decreases?

[8] In this model the sum of GNP "differences" over 20 periods is equal to $2.5bill. The keynesian government expenditure multiplier in this model over the 20 year period is $(\Sigma\Delta GNP)/\Delta G) = \$2.5bill/\$1bill = 2.5$. Strictly speaking in calculating the (long run) multiplier we should allow for an infinite number of periods but it is clear from the figure that once we get to around 20 periods we have picked up the major effects. Students studying econometrics may like to read the article by Theil and Boot (1962) or an econometrics text for a lengthier, more mathematical and more precise discussion of these matters.