IS-Curve Simulation

Carsten Lange, California State Polytechnic University, Pomona
www.csupomona.edu/~clange

1 Economic Theory

The model is based on a closed economy meaning that import and exports are not considered. For the public sector the model assumes that taxes as well as government expenditures (T^{aut} and G^{aut}) are autonomous (they are determined by factors outside the model). In the simulation both government expenditures and taxes are initially set to 200 assuming a balanced public budget but the user can change both to 100 and 300 respectively.

$$G = G^{aut} \text{ with } G^{aut} = \{100, \mathbf{200}, 300\} \quad (1)$$

$$T = T^{aut} \text{ with } T^{aut} = \{100, \mathbf{200}, 300\} \quad (2)$$

While the assumption of autonomous government expenditures is somehow justified, the assumption of autonomous taxes is unrealistic because tax revenue is closely correlated to income in the real world. A more sophisticated model would include taxes that increase with the income level. However, the most important conclusions of a Keynesian goods market model can be also explained with the simplified model used here.

The model further assumes that consumption is positively correlated with disposable income ($Y - T^{aut}$) and that it is also determined by factors outside of the model (c and C^{aut}; initially set to 0.8 and 160 respectively):

$$C = c\,(Y - T^{aut}) + C^{aut} \text{ with } C^{aut} = \{100, \mathbf{160}, 200\} \text{ and c} = \{0.79, \mathbf{0.8}, 0.81\} \quad (3)$$

The user can change the autonomous amount of consumption (C^{aut}) as well as the propensity to consume (c). The user can also change the level of production although Y is not an autonomous variable. In equilibrium Y is determined by equation (6), which will be explained later. For now, please note that **Y determines production and income at the same time**. This is because any production leads either to wage or to some kind of capital income (including profit). Since profit is defined as the residual after subtracting wage income and other types of capital income from the value produced, the sum of capital and wage income must equal the value produced.

Overall investment (I) is assumed to be negatively correlated with the interest rate (r) and also to be determined by other factors (i.e. autonomous Investment; I^{aut}). Both I^{aut} and *r* are determined outside of the goods market model.

$$I = \alpha\, r + I^{aut} \text{ with } I^{aut} = \{1950, 2050, 2150\},\ \alpha = \{-50\} \text{ and r} = \{5\} \quad (4)$$

The user can change the level of autonomous investment. However, the user can neither change α nor r. The reasoning for the latter is that *r* is determined in the money market and that *r* becomes endogenous when a broader model (LM curve) is considered.

The overall demand in the modeled economy is determined by:

$$Y^{dem} = C + \mathrm{I} + \mathrm{G} \quad (5)$$

In a goods market equilibrium the demand for goods (Y^{dem}) matches production/supply (Y). The income that leads to equilibrium is called the equilibrium income (Y^*). In equilibrium $Y^* = Y^{dem} = Y$ and Y^{dem} in equation (5) can be substituted with Y^*. Further, substituting *C* with equation (3), *I* with equation (4), and G^{aut} with equation (2) leads to equation (6):

$$Y^* = c\,(Y^* - T^{aut}) + C^{aut} + \alpha\, r + I^{aut} + \mathrm{G}^{\mathrm{aut}}$$

$$\Leftrightarrow$$

$$Y^* = \frac{1}{1-c}\,(C^{aut} + \alpha\, r + I^{aut} + \mathrm{G}^{\mathrm{aut}} - \mathrm{c}\,\mathrm{T}^{\mathrm{aut}}) \quad (6)$$

Note that all variables on the right side of the equation are autonomous variables or parameters (i.e. their values are clearly determined by a number). Thus, the equilibrium income can be calculated for these values. If we start plugging in various values for the interest rate *r* we can calculate pairs of r and Y^* that lead to an equilibrium. If we plot these values we get the so called IS-curve. This curve reflects all combinations of income and interest rate that lead to an equilibrium in the goods market. It is important to understand that equation (6) and the IS-curve reflect just the condition for an equilibrium. If we choose a *Y* that is not equal to Y^* as determined by equation (6) there is no equilibrium in the goods market (the chosen *Y/r*-combination is not located on the IS-curve !!!).

Try it out in the simulation. First, use a calculator to determine Y^* according to equation (6). Second, choose a *Y* that differs from the calculated Y^*. You will find that your r/Y combination is not located on the IS-curve and that Y^{dem} does not equal *Y*. In contrast, if you use a value for Y that equals Y^* as determined by equation (6), you will find out that the r/Y combination is located on the IS-curve and that Y^{dem} indeed equals Y.

2 Simulating Government Policy in the IS Curve Simulation

Initially, when the simulation starts, the goods market is in equilibrium. *Y* equals the equilibrium income Y^* as determined by equations (6) and therefore $Y^{dem} = Y$. Let us assume that the government wants to stimulate the economy and increases government expenditures from 200 to 300 (please change G^{aut} accordingly). Consequently, Y^{dem} will increase by 100 and $Y^{dem} > Y$. Since the IS model assumes underemployment the firms will most likely respond to an excess demand with an increase in production. Note that possible price changes are not considered in the IS model which seems reasonable for such a basic model especially considering that there is plenty of unused production capacity when underemployment is high.

If you increase Y by 100 you might think that now after production increased the gap between demand and supply is closed. Try it out and don't forget to click the Update button. What you see is that demand increased again – now by 80. Why? The answer is in the consumption

function. When production increased by 100 so did income. If income increases by 100 then consumption will increase by 80 (see equation (3) and check the simulation). The increase in consumption will increase demand and leeds to a situation where demand increases by 80 and now again is bigger than production (supply).

Increase production again to close the demand gap (now by 80) and click Update. Consumption will increase again so will demand. Keep closing the gaps and you will see that eventually production and demand will be equal (or at least asymptotically equal).

Bottom line – an increase of government expenditures led to an increase of income that was 5-times bigger (income and production increased by 500). This is called the multiplier effect.

Was this effect predictable? Yes, if you look at equation (6) you can see that an increase of G^{aut} by 100 will make the right-hand side of the equation 500 units larger (this is because G^{aut} is multiplied by $\frac{1}{1-c} = \frac{1}{1-0.8} = 5$. If the right-hand side of equation (6) gets 500 units larger so must the left-hand side. This means the equilibrium income (the income that will be finally reached when the adjustments reach a new equilibrium) increases by 500.

Try other economic policies such as stimulating investment (increase I^{aut}) or stimulating consumption (increase C^{aut} or c or both). Before you do this in the simulation, try to predict the results using equation (6).

Enjoy the IS-Curve simulation.