Lecture XXI: Macroeconomic Policy, Trade, and Agriculture

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My Credentials

- Moss, Charles B. 1987. *The Effect of Macroeconomic Factors on the Well-Being of a Representative Midwestern Crop and Livestock Farm* Unpublished Ph.D. Dissertation, Purdue University.

A Simple Macroeconomic Model

- One way to develop a macroeconomic model is to start with the definition of Gross National Product (Aggregate Income).

$$Y = C\left(Y,r\right) + I\left(Y,r\right) + G + M\left(Y\right) \tag{1}$$

  - Y - Aggregate Income
  - $C\left(Y,r\right)$ - Consumption
  - $I\left(Y,r\right)$ - Investment
  - G - Government spending
  - $M\left(Y\right)$ - Net Exports (Exports minus Imports)
- Next, we ask how this could change – totally differential aggregate income

$$dY = C_Y dY + C_r dr + I_Y dY + I_r dr + dG + M_Y dY \tag{2}$$

Making Policy Statements

- How does this become useful – let us collect the changes

$$(1 - C_Y - I_Y - M_Y)\, dY + (-C_r - I_r)\, dr = dG. \quad (3)$$

rearranging this relationship slightly

$$\frac{dY}{dG} = \frac{1}{1 - C_Y - I_Y - M_Y} + \frac{C_r + I_R}{1 - C_Y - I_Y - M_Y}\frac{dr}{dG} \quad (4)$$

- At a simple level $1 - C_Y - I_Y - M_Y \ll 1$ for the solution to be mathematically stable (not explosive).

Policy and Parameters

- These values are typically known as multipliers.
- C_Y is the marginal propensity to consume from current income (say 0.85)
- I_Y is the effect of income on the demand for investment (say 0.05)
- M_Y is the effect of income on the net exports (say -0.02)
- Looking at the first part of dY/dG

$$\frac{1}{1 - C_Y - I_Y - M_Y} = \frac{1}{0.12} = 8.3333 \quad (5)$$

- Thus, the 'pure' multiplier effect is that a \$ 1 increase in government spending increases overall income by \$ 8.3333.

Interest Rate Effect

- The forgoing discussion leaves out the indirect effect on the interest rate.
  - C_r as the interest rate increases, consumption declines (-0.05)
  - I_r as the interest rate increases, the amount of investment in the economy declines (-0.10)

$$\frac{dY}{dG} = 8.3333 + \frac{-0.05 - 0.10}{0.12}\frac{dr}{dG} = 8.3333 - 1.25\frac{dr}{dG} \quad (6)$$

- The question is then – what is the impact of government spending on the interest rate?

Money Market Equilibrium

- We need another relationship. I will use the money market equilibrium

$$\frac{M}{P} = L\left(Y, r\right) \tag{7}$$

where M is the money supply and P is the price level.

- There are other closure conditions. For example, we could close the model with a labor market equilibrium

$$\frac{w}{P} = f'\left(L, K\right) \tag{8}$$

where w is the wage rate, L is the employment level, and K is the level of capital.

Completing the Macroeconomic System

- Again, we assume that the money market is in equilibrium and totally differentiate the equation yielding

$$\frac{dM}{P} - \frac{M}{P^2}dP = L_Y dY + L_r dr \tag{9}$$

- I want to bring Equation 3 and Equation 9 together in "Matrix Form"

$$\begin{bmatrix} (1 - C_Y - I_Y - M_Y) & (-C_r - I_r) \\ L_Y & L_r \end{bmatrix} \begin{bmatrix} dY \\ dr \end{bmatrix} = \begin{bmatrix} dG \\ \frac{dM}{P} - \frac{M}{P^2}dP \end{bmatrix} \tag{10}$$

Completing the Macroeconomic System, Continued

- Using our previous discussion on changes in the income equation

$$\begin{bmatrix} 0.12 & -0.15 \\ L_Y & L_r \end{bmatrix} \begin{bmatrix} dY \\ dr \end{bmatrix} = \begin{bmatrix} dG \\ \frac{dM}{P} - \frac{M}{P^2} dP \end{bmatrix} \quad (11)$$

- Parameterizing the money market equilibrium is a little more difficult, but assume that as aggregate income increases - there is less money in the money market ($L_Y < 0$ or $L_Y = -0.005$). Similarly, we assume that as the interest rate increases, the supply of money increases ($L_r > 0$ or $L_r = 0.02$).

Completing the Macroeconomic System, Continued

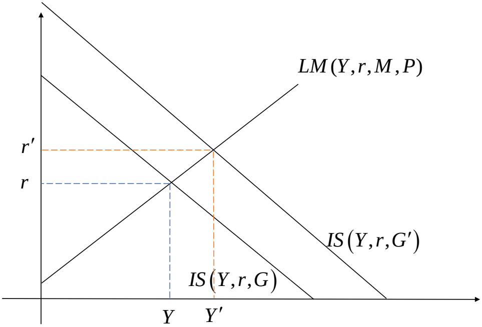
- Hence,

$$\begin{bmatrix} 0.12 & -0.15 \\ -0.005 & 0.02 \end{bmatrix} \begin{bmatrix} dY \\ dr \end{bmatrix} = \begin{bmatrix} dG \\ \frac{dM}{P} - \frac{M}{P^2} dP \end{bmatrix} \tag{12}$$

- Suppose we want to analyze dG, therefore we set $dM = dP = 0$ yielding

$$\begin{bmatrix} 0.12 & -0.15 \\ -0.005 & 0.02 \end{bmatrix} \begin{bmatrix} dY \\ dr \end{bmatrix} = \begin{bmatrix} dG \\ 0 \end{bmatrix}$$
$$\begin{bmatrix} 0.12 & -0.15 \\ -0.005 & 0.02 \end{bmatrix} \begin{bmatrix} \frac{dY}{dG} \\ \frac{dr}{dG} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \tag{13}$$

The Macroeconomic Equilibrium



More Mathematics than You Want

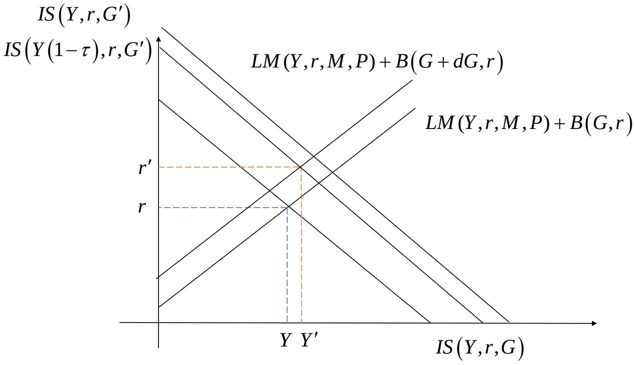
- So, what is the impact of governments spending on aggregate income?
- Using matrix algebra

$$\begin{bmatrix} \frac{dY}{dG} \\ \frac{dr}{dG} \end{bmatrix} = \begin{bmatrix} 0.12 & -0.15 \\ -0.005 & 0.02 \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$
$$\begin{bmatrix} \frac{dY}{dG} \\ \frac{dr}{dG} \end{bmatrix} = \begin{bmatrix} 12.121212 & 90.90909 \\ 3.030303 & 72.72727 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} \tag{14}$$
$$\begin{bmatrix} \frac{dY}{dG} \\ \frac{dr}{dG} \end{bmatrix} = \begin{bmatrix} 12.1212 \\ 3.0303 \end{bmatrix}$$

Side Model – Tax, Spend, and Issue Bonds

- One important point is that government spending must come from somewhere.
- If government spending comes from taxes, we change the consumption function $C\left(Y \times (1-\tau), r\right)$.
- If the government spending comes from issuing bonds $dG - \tau Y \Rightarrow B\left(G + dG - \tau Y, r\right)$.
- We could replace the consumption function into the aggregate income equation and add the bond function to the moneymarket.

Graphics – Tax, Spend, and Issue Bonds



Working's Law

- Two different terms for the same concept:
  - Engel's Law - the additional amount of food consumed declines as income increases.
  - Working's Law - the share of income spent on food declines as the logarithm of income increases.
- Let's use the second relationship

$$w_F = \alpha_F + \beta_F \ln(Y)\ ,\ \beta_F \ll 0 \tag{15}$$

- The concept is that an increase in government spending probably yields a very small increase in the demand for agricultural output.

Open Market Macroeconomics

- The largest potential impact of macroeconomics on agriculture typically comes through the exchange rate.
- To develop this, we need to develop the relationship between the balance of payments and the exchange rate.
- Two components of the balance of payments:
  - Current Account - the demand for currency related to the goods account (net exports).
  - Capital Account - the demand for currency related to the desire of individuals outside the U.S. economy to invest in the United States.

Determining the Exchange Rate

- Let us start by developing an equilibrium relationship for the exchange rate.
  - Let e be the exchange rate.
  - Let $M(Y,e)$ be a slightly expanded net export function.
  - Let $I_F(r,e)$ be the capital account - the demand for investments in the United States.

$$e = f\left(M\left(Y,e\right), I_F\left(r,e\right)\right) \tag{16}$$

- The goods market equilibrium is now slightly different

$$\begin{aligned} Y &= C\left(Y,r\right) + I\left(Y,r\right) + G + M\left(Y,e\right) \\ dY - C_Y dY - C_r dr - I_Y dY - I_r dr - M_Y dY - M_e dE &= dG \\ \left(1 - C_Y - I_Y - M_Y\right) dY + (-C_r - I_r) dr + (-M_e) de &= dG \end{aligned} \tag{17}$$

Determining the Exchange Rate, Continued

- We also need to extend the money market equilibrium to consider the demand for money for foreign investments

$$
\begin{aligned}
\frac{M}{P} &= L\left(Y,r\right) + I_F\left(r,e\right) \\
L_Y dY + L_r dr + I_{Fr} dr + I_{Fe} de &= \frac{dM}{P} - \frac{M}{P^2} dP \qquad (18) \\
L_Y dY + \left(L_r + I_{Fr}\right) dr + I_{Fe} de &= \frac{dM}{P} - \frac{M}{P^2} dP
\end{aligned}
$$

Determining the Exchange Rate, Continued

- Finally, we totally differentiate Equation 16 to close the exchange rate market

$$\begin{aligned} de &= f_M M_Y dY + f_M M_e de + f_I I_{Fr} dr + f_I I_{Fe} de \\ -f_Y M_Y dY &- F_I I_{Fr} dr + \left(1 - f_M M_e - f_I I_{Fe}\right) de = 0 \end{aligned} \tag{19}$$

Bringing the Parts Together

$$\begin{bmatrix} (1 - C_Y - I_Y - M_Y) & (-C_r - I_r) & -M_e \\ L_Y & (L_r + I_{Fr}) & I_{Fe} \\ -f_Y M_Y & -f_i I_{Fr} & (1 - f_M M_e - f_I I_{Fe}) \end{bmatrix} \begin{bmatrix} dY \\ dr \\ de \end{bmatrix} = \begin{bmatrix} dG \\ \frac{dM}{P} - \frac{M}{P^2} dP \\ 0 \end{bmatrix} \tag{20}$$

Effect on Trade