Macroeconomics

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Remember in the model of $Y = C(Y - T) + I(r) + G$, we have either assumed $Y$ is fixed and then used the model to determine the endogenous variable $r$, or we have assumed $r$ is fixed and used the model to determine $Y$ as the endogenous variable.

But both $Y$ and $r$ are important macroeconomic variables that economists want to explain and make predictions about. It is thus desirable to treat both $Y$ and $r$ as endogenous variables. To goal here is to build a model that does exactly that.

Suppose we now treat both $Y$ and $r$ as our model’s endogenous variables. Then the equation

$$Y = C(Y - T) + I(r) + G$$  \hspace{1cm} (1)

is called the $IS$ equation or $IS$ curve.

The $IS$ equation provides a link between $r$ and $Y$, but it is not enough for determining both $r$ and $Y$. All we need is one more equation that links $r$ and $Y$ together. We look into the money market to find that missing equation.
1 Money

What is Money? Economists use the term *money* to mean specifically the stock of assets that can be readily used as a medium of exchange to make transactions.

The measure of the quantity of money usually includes *currency* and *demand deposits*.

Currency is the sum of outstanding paper money and coins. Most day-to-day transactions use currency as the medium of change.

Demand deposits represent the funds people hold in their checking account. Assets in a checking account are almost as convenient as currency.

Money, once defined as currency and checking deposits, is the type of asset that does not earn interest for its holder.

There are other more broadly defined measures of money which include for instance saving deposits, time deposits, and Treasury securities.
2 The Demand for Money

Let $M$ denote the amount of money balances. Let $M^d$ denote the demand for (nominal) money balances. Let $M^s$ denote the supply of (nominal) money balances. Let $P$ denote the price level.

Note in the model we are developing, both $M^s$ and $P$ will be treated as exogenous variable. In particular, $M^s$ will be treated as a policy instrument for the Federal Reserve Bank for conducting monetary policy.

Assume the demand for money is described by

$$M^d = P \times L(r, Y)$$

where $r$ is the interest rate, $Y$ is the GDP or national income, and the function $L$ is called the money demand function.

This money demand function states that the demand for money varies proportionally with the price level. That is, if the level of price changes by a certain percent, then the demand for money will change by the same percent.

The demand for money decreases as $r$ increases. That is, holding $Y$ constant, the money demand function $L(r, Y)$ is downward sloping in $r$. The idea is that the interest rate
is the opportunity cost of holding money: it is what you forgo by holding some of your financial assets as money.

On the other hand, an increase in $Y$ causes the demand for money to also increase. The idea here is that when $Y$ increases, more buying and selling will take place that requires the use of money to make payments.

The money demand equation can also be written as:

$$\frac{M^d}{P} = L(r, Y)$$

(2)

where $\frac{M^d}{P}$ is called the demand for real money balances.
3 Money Market Equilibrium

When the money market is in equilibrium, the demand for money must be equal to the supply of money:

\[ M^s = M^d \]

or,

\[ M^s = P \times L(r, Y) \]

or

\[ \frac{M^s}{P} = L(r, Y) \] (3)

The above equation is called the equilibrium condition for the money market. It is also called the \( LM \) equation or \( LM \) curve.
Example 1 Let

\[ L(r, Y) = 100 - r + 0.5Y \]

Let \( M = 100 \) and \( P = 1 \). Then the \( LM \) equation is

\[ 100/1 = 100 - r + 0.5Y \]

or

\[ r = 0.5Y \]

This equation says in order for the money market to clear, interest rate must increase as \( Y \) increases.

Suppose again \( L(r, Y) = 100 - r + 0.5Y \) and \( P = 1 \). But we leave \( M^s \) unspecified. The the \( IS \) curve is

\[ M^s = 100 - r + 0.5Y \]

which in turn implies

\[ r = 100 - M^s + 0.5Y \]

This shows that, holding \( Y \) fixed, an increase in money supply reduces the interest rate.
4 The IS – LM Analysis

We now put the IS and LM equations together to obtain a system of two equations with two unknowns:

\[ IS : \quad Y = C(Y - T) + I(r) + G \]
\[ LM : \quad \frac{M^s}{P} = L(r, Y) \]

where \( T, G, M^s \) and \( P \) are exogenous variables.

Example 1

Let \( T = G = 0 \). Let \( C(Y - T) = 0.5(Y - T) \). Let \( I(r) = 100 - 10r \). Let \( P = 1 \) and \( L(r, Y) = Y - 10r \). Let \( M^s \) be left unspecified.

Then the IS equation is

\[ Y = 0.5Y + 100 - 10r \]

or

\[ Y = 200 - 20r \]

and the LM equation is

\[ M^s = Y - 10r \]

Substitute the IS equation into the LM equation to get

\[ M^s = 200 - 20r - 10r = 200 - 30r \]
and so
\[ r^* = \frac{(200 - M^s)}{30} \]

and
\[ Y^* = 300 - 20 \times \left(\frac{200 - M^s}{30}\right). \]

Clearly, as \( M^s \) increases, \( Y^* \) increases and \( r^* \) decreases.

Suppose initially \( M^s = 100 \). Suppose there is now a productivity slowdown which shifts the investment function to
\[ I(r) = 90 - 10r, \]
which, in turn, drives the economy into a “recession”.

Now as an economist you know several ways through which you can pull the economy back from the recession and restore the initial \( Y^* \).

(1) Suppose you want to pursue an expansionary monetary policy to offset the effect of the lower investment. By how many percentage points should increase \( M^s \)?

(2) What are other policy changes you can pursue to achieve the same objective?
We now take a step further to consider the more general situation where all of the three policy instruments, $T$, $G$, and $M^s$ are left unspecified. This will allow us to consider both the fiscal and the monetary policies in one comprehensive model.

Let $C(Y - T) = C_0 + m(Y - T)$. Let $I(r) = I_0 - 10r$. Let $P = 1$ and $L(r, Y) = Y - 10r$. Let $T, G$, and $M^s$ be left unspecified. Note here $0 < m < 1$ is the consumer’s constant marginal propensity to consume.

The IS equation is

$$Y = C_0 + I_0 + m(Y - T) - 10r + G$$

or

$$(1 - m)Y = C_0 + I_0 - mT - 10r + G$$

The LM equation is

$$M^s = Y - 10r$$

From the LM equation we have $Y = M^s + 10r$. Substitute this into the IS equation to get

$$(1 - m)(M^s + 10r) = C_0 + I_0 - mT - 10r + G$$

or

$$(1 - m)M^s + 10(1 - m)r = C_0 + I_0 - mT - 10r + G$$
and so

\[ 10(1 - m) + 10]r = C_0 + I_0 - mT + G - (1 - m)M^s \]

and so

\[ r^* = \frac{C_0 + I_0 - mT + G - (1 - m)M^s}{20 - 10m} \]  \hspace{1cm} (4)

Substitute the above into the LM equation to obtain

\[ Y^* = M^s + 10r^* = M^s + 10 \frac{C_0 + I_0 - mT + G - (1 - m)M^s}{20 - 10m} \]

or

\[ Y^* = \frac{M^s - mT + G + C_0 + I_0}{2 - m} \] \hspace{1cm} (5)

Clearly, as \( M^s \) increases, \( Y^* \) increases and \( r^* \) decreases. As \( G \) increases, \( Y^* \) increases and \( r^* \) increases. As \( T \) increases, \( Y^* \) decreases and \( r^* \) decreases.

The above equation shows that an increase in \( G \) by one unit will cause \( Y^* \) to increase by \( \frac{1}{2-m} \) units. Thus here \( \frac{1}{1-m} \) is the government-purchases multiplier.

Note that since \( M < 1 \), now the government-purchases multiplier is less than one.
Example 3(classwork) Suppose $G = 10, \ T = 10$. $C(Y - T) = 0.5(Y - T), \ I(r) = 100 - 10r$. Suppose $M^s = 100, \ P = 1$ and $L(r, Y) = Y - 10r$. Suppose now the Fed decides to cut interest rate by one percentage point, should the Fed increase money supply by how many units? Will GDP increase or decrease? By how many percentage points?