Intermediate Macroeconomics

4. Introduction to the Equilibrium Model

Contents

One of the dominant puzzles in macroeconomics is why an economy will go through recurrent cycles of booms and busts in economic growth (as well as unemployment and inflation). Puzzles such as the enduring nature of business cycles are studied using macroeconomic models that attempt to capture the complex interactions between the many different sectors of the economy in as parsimonious (simple) a manner as possible.

In your Introduction to Macroeconomics you studied the relationships between market sectors (e.g., the goods and money markets) and aggregate economic outcomes (e.g., total output, unemployment and inflation) using graphical analysis techniques. In this course we will address many of the same issues but use mathematical techniques, particularly algebra and some very limited calculus.

The reasons for using mathematical techniques are several:

- It is the method of advanced economics. The macroeconomic modeling techniques used in this course are very similar to those currently used by firms and government agencies to analyze economic events and produce economic market forecasts.
- Mathematical techniques are not limited in the dimensions of analysis in the way graphs are. For example, a simple graph with a horizontal and vertical axis is limited to two dimensions: X is a function of Y. Equations have no such limitation.
- The simplifying assumptions underlying the model become more obvious. A graph of aggregate demand may not clearly illustrate the assumed components of that demand and in what ways they are variable. An equation, on the other hand, can quickly reveal its true nature.

1. The Parsimonious Model

One important characteristic of useful models is that they should be simple and as easy to apply as possible. This is the principle of ***Occam's Razor*** -- cut away all the complicating details that do not significantly contribute to the reliability or

validity of a model. A model should be simple because reality is too complex to understand in its entirety. Perhaps you know it as KISS - Keep It Simple Stupid.

There are two underlying principles to Occam's Razor:

1. Do not include variables or complications that do not change the implications or predictions of the model. The position of the stars may influence the behavior of some individuals; but since it doesn't influence macroeconomic outcomes, we can fortunately leave this (and many other variables) out of our macroeconomic models.
2. Isolate and hold constant extraneous variables that, while they may significantly impact the economy, are not the principle interest of the theory being developed. This is often expressed by economists through the Latin phrase ***ceteris paribus***, meaning "other things being equal." For example, in microeconomic demand theory, changes in population may significantly affect product demand, but we can simplify the model by assuming that population remains constant.

> "And as a man without a culture or society, he was uniquely free to apply Occam's razor, or, if you like, the Law of Parsimony, to virtually any situation, to wit: The simplest explanation of a phenomenon is, nine times out of ten, say, truer than a really fancy one."
>
> Kurt Vonnegut, *Timequake* (1998).

In the models we will develop in this course we will make many strong assumptions in order to simplify our models. There are two issues here:

1. We explicitly identify any simplifying assumptions we make.
2. We consider the implications if the assumption is violated. We describe a model as "robust" if the implications of the model do not significantly change when we consider a more complex model that does not include the simplifying assumption.

> "The object of our analysis is not to provide a machine or method of blind manipulation, which will furnish an infallible answer, but to provide ourselves with an organized and orderly method of thinking out particular problems; and, after we have reached a provisional conclusion by isolating the complicating factors one by one, we then have to go back on ourselves and allow, as well as we can, for the probable interactions of the factors amongst themselves. This is the nature of economic thinking."
>
> John Maynard Keynes, *General Theory of Employment Interest and Money* (1936).

We can identify several simplifying assumptions that will apply to all the short-run equilibrium models in this course. These assumptions relate directly to the accounting of National Income and GDP presented in Chapter 2 as Table 2-3 and Table 2-4.

1. We assume aggregate output is equivalent to national income. This is equivalent to saying that gross domestic product is equal to national income. Specifically, we ignore the difference between GNP and GDP. While this is a relatively safe assumption for the U.S. economy because of the historically small difference between the two, it may be more significant for other economies that are more dependent on foreign investment or residents working abroad. More important, we ignore depreciation. While depreciation is a significant variable in long-run growth models, in our short-run equilibrium models we are more interested in total spending (i.e., gross investment rather than net investment).

   Also, we assume that indirect business taxes (e.g., sales, excise, and property taxes) are a component of National Income. This treats indirect business taxes the same way as income tax. An income is received for a good or service and a sales and/or income tax is then paid to the government. This assumption is of no consequence to our models.

2. We also ignore the difference between National Income and Personal Income. Essentially we are humanizing corporations. In other words, corporations are collections of shareholders and the actions of corporations

represent the income and expenditures of individuals. Again, we are interested in total spending or income and are unconcerned what bank accounts the money flows out of or into.

With these two assumptions we can refer to aggregate output and total income interchangeably. However, will will make a distinction between total income and personal *disposable* income in this and later chapters. Think of it as the difference between your gross pay before taxes and you take-home pay after taxes are deducted.

2. What Is An Equilibrium Model?

Equilibrium is defined as a state of balance. In economics, equilibrium represents the condition in which each individual agent (persons and firms) is doing the best it can for itself (maximizing utility or profits) given the actions of all other agents in the economy and the institutional constraints on behavior. In a microeconomic equilibrium no individual has an incentive to change his or her behavior. In a macroeconomy, where the actions of all individuals are added up, the aggregate outcomes are also presumed to be stable in an equilibrium.

While our two assumptions above imply that aggregate output is equivalent to national income, it doesn't necessarily hold that aggregate output (or national income) is equal to aggregate demand. The truly critical assumption in our macroeconomic models is that in equilibrium aggregate output (or national income) equals aggregate demand.

Assumed Equilibrium Condition: Aggregate Output (or National Income), Y = Aggregate Demand, AD

Note that our equilibrium condition is an *assumed* one. This is what makes a theory rather than a simple accounting identity. What happens when a macroeconomy is not in equilibrium? What process occurs to bring the economy back into equilibrium?

When aggregate output (or national income) is not equal to aggregate demand we have either undesired inventory accumulation or undesired inventory draw (decline). In equilibrium aggregate output equals aggregate demand and inventories are stable, neither increasing or decreasing.

Undesired Inventory Accumulation - a symptom of disequilibrium where aggregate output > aggregate demand

Undesired Inventory Draw - a symptom of disequilibrium where aggregate output < aggregate demand

We can give a simplified story of what happens to return an economy to equilibrium. When aggregate output is greater than aggregate demand there is more being produced in an economy than is being consumed. Supply is greater than demand. Unsold production starts to accumulate. Firms respond by cutting prices to stimulate demand. Lower prices also means that firms will produce less. Aggregate output declines and aggregate demand rises until the desired level of inventory is attained and equilibrium is restored.

When aggregate output is less than aggregate demand the opposite happens. Supply is less than demand and inventories decline below the desired level. This is a signal for firms to raise prices. With higher prices aggregate output increases and aggregate demand declines until the economy returns to equilibrium.

We could complicate the story by considering the interest rate, foreign exchange rates, income tax, and so on. But adding complexity to this model will not change the general observations we make, only the magnitudes of the outcomes.

3. Equilibrium Model Solution Method

The typical short-run macroeconomic model in this course represents an economy that is defined by one or more equations. The individual equations must be solved simultaneously. For our purposes that usually means creating a single equation by combining the individual equations and applying the required macroeconomic equilibrium condition (Y = AD), where Y is national income and AD represents aggregate demand. For example, in this chapter and the next we will typically execute the following steps:

1. Combine the given equations and solve for AD (aggregate demand).

2. State the assumed equilibrium condition:

$$Y = AD \tag{1}$$

3. Substitute the derived equation for AD from step 1 into the right-hand side of the equilibrium condition.

4. Simplify the equation. This often means solving for income (Y), since Y should appear on both the left- and right-hand sides of the equation in step 3.

While this method is convenient for solving the small models that we will present in this course it's not the best method. A better approach is to use matrix algebra but teaching this mathematical technique is beyond the scope of this course. In practice you would let a computer program solve a set of simultaneous equations for you. For the computer program to be able to come up with a proper solution the equations must be properly specified. We hope this course will show you how the equations should be defined, how they interact, and what solutions you should be looking for.

4. Simple Equilibrium Model in Action

Our first equilibrium model is of a public open economy. A "public" economy is one in which the government sector is modelled. The government sector includes government spending, taxes, and transfer payments (e.g., social security). Some macroeconomic models are of *closed* economies in which the government is ignored. A model of a closed economy is appropriate in a parsimonious model in which the implications of the model are not significantly affected by government spending, taxes, or deficits. In our simple model below we are particularly interested in seeing how government deficits affect consumption and investment spending and the balance of foreign trade.

Our model is also an "open" economy. An open economy includes foreign trade, i.e., the balance between imports and exports of goods and services. Some macroeconomic models are of *closed* economies where the balance of trade does not significantly affect the analysis. But we are interested in the trade balance and if government deficits can contribute to a country importing more than in exports.

A. Describing the Economy

We start with a definition for aggregate demand, which is equivalent to equation for gross domestic product presented in Chapter 2. Aggregate demand is equal to consumption plus investment plus government spending plus net exports as shown in equation (2):

$$AD = C + I + G + NX \tag{2}$$

where,

AD = Aggregate demand
C = Consumption
I = *Desired* level of investment

G = government spending
NX = net exports (exports - imports)

In an equilibrium model we assume that national income equals aggregate demand. So, our next step is to define national income. In following chapters this will be more straight forward but for the model in this chapter we will have to workup to it. First we define disposable income.

The disposable income (net pay after taxes) a household receives can be disposed of in one of two ways: consumption or savings:

$$YD = C + S \tag{3}$$

where,
YD = disposable income
C = Consumption
S = Savings

Having defined disposable income we must relate disposable income to national income. Disposable income represents national income plus transfer payments from government like social security and unemployment benefits less taxes paid on national income and government transfers:

$$YD = Y + TR - TA \tag{4}$$

where,
Y = national income,
TR = government transfers (e.g., social security)
TA = taxes paid

Note that we specify investment in equation (2) as the ***desired*** level of investment and not the actual level of investment. This is consistent with our assumed equilibrium condition that aggregate output equals aggregate demand. When our equilibrium condition is violated aggregate output does not equal aggregate demand and actual investment does not equal the desired level of investment. In a disequilibrium condition there is undesired inventory build or draw.

B. Solving the Model

Step 1. Solve for aggregate demand (AD). Note that disposable income (YD) appears in both equations (3) and (4). Eliminate the disposable income term by setting equation (3) equal to equation (4):

$$YD \text{ (equation 3)} = YD \text{ (equation 4)}$$

or,

$$C + S = Y + TR - TA \tag{5}$$

Now we have consumption that appears in both equation (2) and equation (5). Solve for consumption (C) in equation (5):

$$C = Y - S + TR - TA \tag{6}$$

Then substitute the solution for C from equation (6) into the aggregate demand equation (2). This gives us our final representation for aggregate demand as shown in equation (7).

$$\begin{aligned} AD &= C + I + G + NX \\ &= Y - S + TR - TA + I + G + NX \end{aligned} \tag{7}$$

The substitutions we just went through are probably not intuitively obvious to you. Don't worry about that now. The process will become clearer in the following chapters when we present the Keynesian model. For now you should just recognize that the objective of Step 1 was to combine the given equations into the definition of aggregate demand.

Step 2. State the assumed equilibrium condition:

$$Y = AD \qquad (8)$$

Step 3. Substitute solution for AD in equation (7) from step 1 into the right-hand side of the equilibrium condition equation (8) in step 2:

$$Y = Y - S + TR - TA + I + G + NX \qquad (9)$$

Step 4. Simplify equation (9) by rearranging. Here we can't solve for Y since the left- and right-hand side Y's cancel each other out. But we do get the result:

$$S - I - NX = G + TR - TA \qquad (10)$$

Again, this particular manipulation of equation (9) probably was not intuitively obvious to you. You would have to know beforehand that our objective in this model is to look at the government budget balance (G + TR - TA) and see how it affects savings, investment, and net exports. How does an increase or decrease in the governments budget deficit affect the economy?

C. Implications of the Model

We will look at three possible outcomes arising from an increase in the government deficit (G + TR - TA) that are implied by equation (10). A change in the government deficit can affect three variables: savings, investment, or net exports. In our three cases we will hold two of the three variables constant and see what happens to the third.

1. Crowding Out

Assume:

- Increase in government deficit through an increase in government spending (G), an increase in transfer payments (TR), and/or a decrease in taxes (TA). With any one of these events the government's budget deficit (G + TR - TA) increases.
- Savings (S) and net exports (NX) are constant.

Result:

- From our equilibrium solution in equation (10) there must be a decrease in investment (I).

Government borrows money to finance the deficit. Government borrowing reduces money available for investment. Government spending ***crowds out*** investment. We could quantify this crowding out effect by adding the interest rate to our model. Government borrowing would increase the interest rate, which would reduce planned investment spending. This would complicate our model but not change the general relationships between macroeconomic variables that we are trying to identify.

Crowding Out - government deficit spending reduces private investment spending

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2. Ricardian Equivalence

Assume:

- Increase in government deficit. (G + TR - TA) increases.
- Investment (I) and net exports (NX) constant.

Result:

- From our equilibrium solution in equation (10) there must be an increase in savings (S)

Ricardian equivalence, named after the 19th century economist David Ricardo, suggests that households and firms are forward looking. Economic agents base their current spending not only on current income but also future expected income. A government budget deficit today means higher taxes in the future to pay off the debt. Current savings increase in the expectation they will be needed to pay the future increase in taxes.

If the government deficit increases through more government spending, the increase in government spending represents an increase in income to households. Households save the income increase because they expect higher future taxes to reduce the deficit. If the government deficit increases because of a tax cut, households again put the extra income in the bank to cover the future tax increase to pay off the deficit.

Ricardian Equivalence - government deficits do not affect the overall level of demand in an economy. Taxpayers expect that any increase in the deficit now must be repaid later and increase their savings in anticipation.

What actually happens is probably a little bit of both and something more. Consumers may not expect the government to pay off the accumulated debt, at least not soon. Then the increase in government spending or cut in taxes would lead to a real increase in national income and aggregate demand in the short term. We can enjoy the windfall today and let the next generation(s) deal with the consequences.

The foreign trade balance introduces a new means of financing a government deficit. The government can borrow money from other countries. But sooner or later those countries will want those dollars back. The implicit (unstated) assumption here is that there is an international equilibrium in the demand for dollars. What we will see is that the dollars the government borrows will be replaced by dollars spent by U.S. residents on foreign goods.

3. Twin Deficits

Assume:

- Increase in government deficit through an increase in government spending (G), increase in transfer payments (TR), and/or decrease in taxes. (G + TR - TA) increases.
- Savings (S) and investment (I) constant.

Results:

- From our equilibrium solution in equation (10) there must be a decrease in NX, i.e. decline in exports and/or increase in imports

Assume the government borrows money to finance a deficit. Since U.S. savings (S) and investment (I) is fixed, the government borrows money from foreign countries. The foreign countries now have less U.S. currency than they did before the government initially borrowed money. The foreign currency exchange rate adjusts so that it is now cheaper for U.S. residents to purchase foreign goods and imports increase, returning the U.S. currency to

foreign shores. As the government deficit increases so does the foreign trade deficit (i.e., we import more than we export). We now have ***twin deficits*** in the government budget and foreign trade.

Twin Deficits - an increase in government debt is accompanied by an increase in the foreign trade deficit (imports exceeds exports).

The twin deficits was particularly relevant during the 1980s. Early in the decade, the U.S. government budget deficit increased because of higher defense spending and tax cuts. Private saving and investment did not change very much. Consequently, our negative foreign trade balance grew significantly.

4. Summary

We can summarize the crowding out, Ricardian equivalence, and twin deficit results by applying some hypothetical numbers to equation (10) from Step 4 of our last model. Assume in an initial equilibrium that savings = $1,000, investment = $1,000, and the government budget deficit and trade deficit equal zero. If there is a $100 increase in the government budget deficit we could have any one or a combination of the results shown in Table 4-1.

Table 4-1. The Effect of a Budget Deficit on Savings, Investment, and Net Exports

	Budget Deficit G + TR - TA	Savings S	Investment I	Net Exports NX
Initial conditions	0	1,000	1,000	0
Crowding out	100	1,000	***900***	0
Ricardian equivalence	100	***1,100***	1,000	0
Twin deficits	100	1,000	1,000	***- 100***

While we have presented the impacts of government deficits on savings, investment and the trade balance separately, in reality we get some of each. All three macroeconomic variable adjust to accommodate the government deficit. Now you know why economists dislike government budget deficits.

With our simple model all we can really do is indicate the possible relationships between macroeconomic variables without specifying the magnitudes. Do we get a lot of one (e.g., crowding out) and a little of the others (e.g., Ricardian equivalence and twin deficits) or something else. We can begin to consider the question of magnitudes by introducing behavioral equations that define the desires or intentions of economic agents. For example, one behavioral equation is the relationship between interest rates and investment. As we introduce behavioral equations later on in this course we can attempt to identify how the economy will react.

File last modified: August 1, 2004