>>Chapter 12 Appendix: Taxes and the Multiplier

In the chapter, we described how taxes reduce the size of the multiplier and act as an automatic stabilizer for the economy. Let's look a little more closely at the mathematics of how this works.

Specifically, let's assume that the government "captures" a fraction t of any increase in GDP in the form of taxes, where t, the tax rate, is a number between 0 and 1. And let's repeat the exercise we carried out in Chapter 10, where we consider the effects of a \$50 billion increase in investment spending.

The \$50 billion increase in investment spending initially raises GDP by \$50 billion (the first round). In the absence of taxes, disposable income would rise by \$50 billion. But because part of the rise in GDP is collected in the form of taxes, disposable income only rises by $(1 - t) \times \$50$ billion. The second-round increase in consumer spending, which is equal to the marginal propensity to consume *(MPC)* multiplied by the rise in disposable income, is $MPC \times (1 - t) \times \$50$ billion. This leads to a third-round increase in consumer spending of $(MPC \times (1 - t)) \times (MPC \times (1 - t)) \times \$50$ billion, and so on. So the total effect on GDP is

$$\begin{gathered}
\$50 \text{ billion (Increase in investment spending)} \\
+ (\text{MPC} \times (1 - t)) \times \$50 \text{ billion (Second-round increase in consumer spending)} \\
+ (\text{MPC} \times (1 - t)) \times (MPC \times (1 - t)) \times \$50 \text{ billion} = (MPC \times (1 - t))^2 \\
\times \$50 \text{ billion (Third-round increase in consumer spending)} \\
+ (\text{MPC} \times (1 - t)) \times (MPC \times (1 - t)) \times (MPC \times (1 - t)) \times \$50 \text{ billion} \\
= (MPC \times (1 - t))^3 \times \$50 \text{ billion (Fourth-round increase in consumer spending)} \\
+ \ldots
\end{gathered}$$

As we pointed out in Chapter 10, a series of the form $1 + x + x^2 + \ldots$, with $0 < x < 1$, is equal to $1/(1 - x)$. In this example, $x = (MPC \times (1 - t))$. So the total effect of a \$50 billion increase in government purchases of goods and services, taking into account all the subsequent increases in consumer spending, is to raise GDP by

$$\$50 \text{ billion} \times \frac{1}{1 - (MPC \times (1 - t))}$$

When we calculated the multiplier assuming away the effect of taxes, we found that it was $1/(1 - MPC)$. But when we assume that a fraction t of any change in GDP is collected in the form of taxes, the multiplier is

$$\text{Multiplier} = \frac{1}{1 - (MPC \times (1 - t))}$$

This is always a smaller number. Suppose, for example, that $MPC = 0.6$. In the absence of taxes, this implies a multiplier of $1/(1 - 0.6) = 1/0.4 = 2.5$. But now let's assume that $t = 1/3$, that is, that 1/3 of any increase in GDP is collected by the government. Then the multiplier is

$$\frac{1}{1 - (0.6 \times (1 - 1/3))} = \frac{1}{1 - (0.6 \times 2/3)} = \frac{1}{1 - 0.4} = \frac{1}{0.6} = 1.667$$

PROBLEMS

1. An economy has a marginal propensity to consume of 0.6, real GDP equals $500 billion, and the government collects 20% of GDP in taxes. If planned investment spending increases by $10 billion, show the rounds of increased spending that take place by completing the accompanying table. The first and second rows are filled in for you. In the first row, the increase in planned investment spending of $10 billion raises real GDP by $10 billion, taxes increase by $2 billion, and *YD* increases by $8 billion; in the second row, the increase in *YD* of $8 billion increases consumer spending by $4.80 billion (*MPC* × change in disposable income).

Rounds	Change in $I_{Planned}$ or C	Change in real GDP (billions of dollars)	Change in taxes	Change in *YD*
1	$\Delta I_{Planned}$ = $10.00	$10.00	$2.00	$8.00
2	ΔC = $4.80	4.80	0.96	3.84
3	ΔC =			
4	ΔC =			
5	ΔC =			
6	ΔC =			
7	ΔC =			
8	ΔC =			
9	ΔC =			
10	ΔC =			

a. What is the total change in real GDP after the 10 rounds? What is the value of the multiplier? What would you expect the total change in real GDP to be, based on the multiplier formula? How do your two answers compare?

b. Redo the table above, assuming the marginal propensity to consume is 0.75 and the government collects 10% of the rise in real GDP in taxes. What is the total change in real GDP after 10 rounds? What is the value of the multiplier? As the marginal propensity to consume increases, what happens to the value of the multiplier?

2. Calculate the change in government purchases of goods and services necessary to close the recessionary or inflationary gaps in the following cases.

a. Real GDP equals $100 billion, potential output equals $160 billion, the government collects 20% of any increase in real GDP in the form of taxes, and the marginal propensity to consume is 0.75.

b. Real GDP equals $250 billion, potential output equals $200 billion, the government collects 10% of any increase in real GDP in the form of taxes, and the marginal propensity to consume is 0.5.

c. Real GDP equals $180 billion, potential output equals $100 billion, the government collects 25% of any increase in real GDP in the form of taxes, and the marginal propensity to consume is 0.8.

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