Chapter 7

Macroeconomic Equilibrium in the Short Run

Chapter Introduction

In this chapter we start to build a model of the economy and calculate the equilibrium level of output. We use the Keynesian framework to calculate the equilibrium level of output. In this framework, macroeconomic equilibrium takes place when planned aggregate expenditure is equal to the aggregate output.

The Keynesian Cross Diagram

(Closed Economy without Government Expenditure)

We start with a simplifying assumption that the economy is a closed economy. That is, the economy does not trade with the rest of the world, so the net exports are zero. To start with, we also assume that we do not have any government expenditure. That is, $G = 0$. This means that our GDP equation is as follows.

$$GDP = C + I \tag{7.1}$$

Equation 7.1 may look familiar. It is Equation 6.1 from Chapter 6, without the G and the NX parts. Recall from Chapter 6 that NX represents net exports—exports minus imports. Since we are assuming a closed economy, NX is zero, and without any government expenditure G is also equal to zero.

The Aggregate Consumption Function

The first building block in the Keynesian framework is the aggregate consumption function. The aggregate consumption is a positive function of aggregate output or income. That is, as aggregate income increases, aggregate consumption increases, and as aggregate income decreases, aggregate consumption decreases. Recall that in economics, output and income represent the same underlying concept. We represent aggregate consumption by C and aggregate income or output by Y. Saying that the aggregate consumption is a function of aggregate income (or output) means that the aggregate consumption depends upon aggregate output.

The aggregate consumption is the sum of the all the individual consumptions. If we represent the individual consumption with a lowercase c, and individual income with a lowercase y, then we may write the individual consumption function as follows.

$$c = c(y) \tag{7.2}$$

The function in Equation 7.2 is a generic function; it does not say anything about how consumption depends upon income. To give it more structure, we rewrite individual consumption function as follows.

$$c = a + b(y) \tag{7.3}$$

Where $a > 0$, and $0 < b < 1$.

Equation 7.3 states that an individual's consumption is a positive function of an individual's income. As income increases, so does consumption. The increase in consumption due to an increase in income, however, is not one-for-one; it is less than one. Note that b is between zero and one. That is, the slope of the consumption function is between zero and one.

The slope of the consumption function is called marginal propensity to consume (*mpc*). It is the change in consumption due to change in income. That is,

$$mpc = \frac{\Delta c}{\Delta y} \tag{7.4}$$

Using the notation of Equation 7.3, $mpc \equiv b$.

Figure 7.1 presents this function in graphical form.

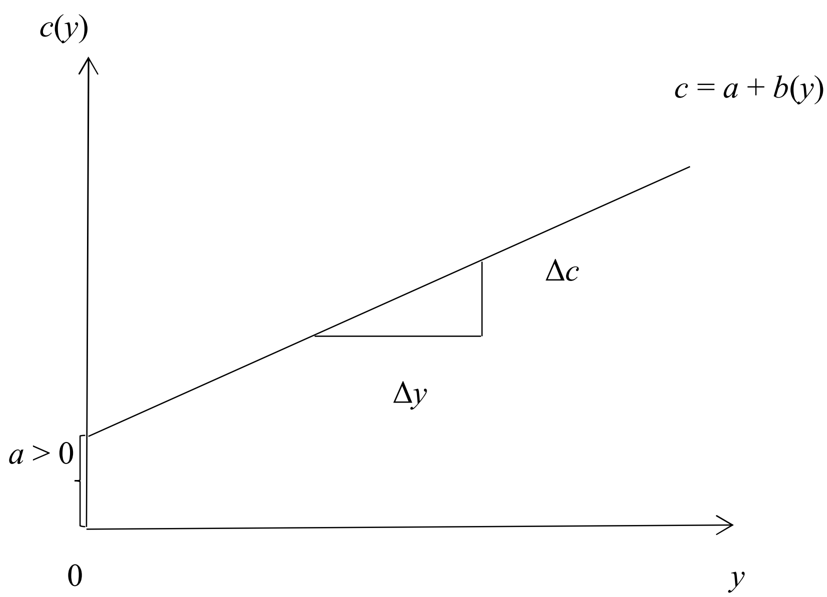

Figure 7.1: Individual Consumption Function

Figure 7.1: On the horizontal axis we have income, y, and on the vertical axis we have consumption, c. The consumption function has a positive slope, indicating that as income increases, so does consumption. And when income decreases, so does consumption. The change in consumption, however, is not one-for-one. That is, the slope of the consumption function, which we call *mpc*, is less than 1. The intercept is represented by a, and it is positive.

Note that in Figure 7.1, curve has a positive slope, indicating that as income increases, so does consumption. And when income decreases, so does consumption. The change in consumption, however, is not one-for-one. That is, the slope of the consumption function, which we call *mpc*, is less than 1. Part of the change is income leads to changes in consumption, and the remainder leads to changes in saving.

Note also that the intercept, a, is greater than zero; even when the income is zero, consumption is positive. This represents the fact that we have positive consumption even when our income is zero. As we will see shortly, some of the consumers whose income is zero, accomplish this by borrowing from those who have saved. Take the example of fulltime students. When we are in school, our income is zero, and we often borrow to meet our consumption needs.

What about normal versus inferior goods, you may ask? We learned in Chapter 3 that when income increases, the demand for inferior goods decreases, and vice versa. And when income increases, the demand for normal goods increases, and vice versa. How come then, in this consumption function, consumption is a positive function of income. The reason is that here we are looking at the consumption of all the goods and services. And since most of the goods and services are normal goods and services, there is a positive relationship between an individual's income and overall consumption by the individual.

Since the aggregate consumption is the sum of all the consumption by individuals, we can write the aggregate consumption function as follows.

$$C = C(Y) \tag{7.5}$$

Where C is the aggregate consumption, and Y is the aggregate income or output. Equation 7.5 states that aggregate consumption is a function of aggregate income. It is the aggregate counterpart of the individual consumption function in Equation 7.2. Just as Equation 7.2, Equation 7.5 does not provide much information, other than stating that aggregate consumption is a function of aggregate income or output. We can add more structure to this function, as we did in the case of the individual consumption function, Equation 7.2, as follows.

$$C = \alpha + \beta(Y) \tag{7.6}$$

Where $\alpha > 0$, and $0 < \beta < 1$.

Equation 7.6 states that the aggregate consumption, C, is a positive function of aggregate income or output, Y. The slope of this consumption function is β, which is greater than zero, but less than one. These are the aggregate counterparts of the individual consumption function in Equation 7.3.

The slope of the consumption function is called the Marginal Propensity to Consume (*MPC*). It is the change in aggregate consumption due to change in aggregate income or output. That is,

$$MPC = \frac{\Delta C}{\Delta Y} \tag{7.7}$$

Using the notation in Equation 7.6, $\beta \equiv MPC$.

Figure 7.2 plots the aggregate consumption function.

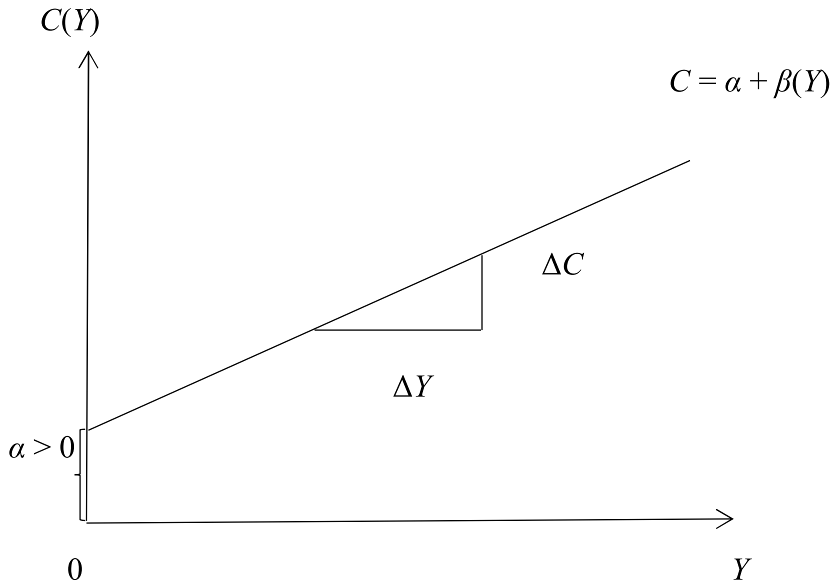

Figure 7.2: Aggregate Consumption Function

Source: M. Ashraf

Figure 7.2: Aggregate income or output, Y, is on the horizontal axis, and aggregate consumption, C, is on the vertical axis. The curve has a positive slope, indicating that as income increases, so does consumption. And when income decreases, so does consumption. This relationship, however, is not one-for-one. That is, the slope of the consumption function, *MPC*, is greater than zero, but less than 1. The intercept is represented by *a*, and it is positive.

In Figure 7.2, curve has a positive slope, indicating that as income increases, so does consumption. And when income decreases, so does consumption. This relationship, however, is not one-for-one. That is, the slope of the consumption function, *MPC*, is greater than zero, but less than 1.

Let us take a numerical example. Suppose that the aggregate consumption function is represented by Equation 7.6, reproduced here.

$$C = \alpha + \beta(Y)$$

Suppose also that $\alpha = 100$, and $\beta = 0.75$. Using these values of α and β, we can rewrite the aggregate consumption function as follows.

$$C = 100 + 0.75(Y)$$

Using this equation, we can find out the value of aggregate consumption (C) for various values of aggregate income or output (Y). Table 7.1 shows data for aggregate consumption—Column [3]—by plugging in aggregate income or output—Column [1].

Table 7.1: Consumption and Income Data

[1]	[2]	[3]	[4]	[5]
Y	Change in Income (ΔY)	Consumption (C)	Change in Consumption (ΔC)	$MPC = \frac{\Delta C}{\Delta Y}$
0		100		
100	100	175	75	0.75
200	100	250	75	0.75
300	100	325	75	0.75
400	100	400	75	0.75
500	100	475	75	0.75
600	100	550	75	0.75
700	100	625	75	0.75
800	100	700	75	0.75

Source: M. Ashraf

Table 7.1 has five columns. Column [1] is the aggregate income (Y), Column [2] is the change in aggregate income (ΔY), Column [3] is the aggregate consumption calculated by plugging the income values into the aggregate consumption function ($C = 100 + 0.75(Y)$), Column [4] calculates the change in aggregate consumption (ΔC), and column [5] calculates the slope of the aggregate consumption function, MPC. These values are the result of dividing the values in Column [4] by the value in Column [2]. That is, $MPC = \frac{\Delta C}{\Delta Y}$.

Figure 7.3 plots the aggregate output data, Column [1], against the aggregate consumption data, Column [3].

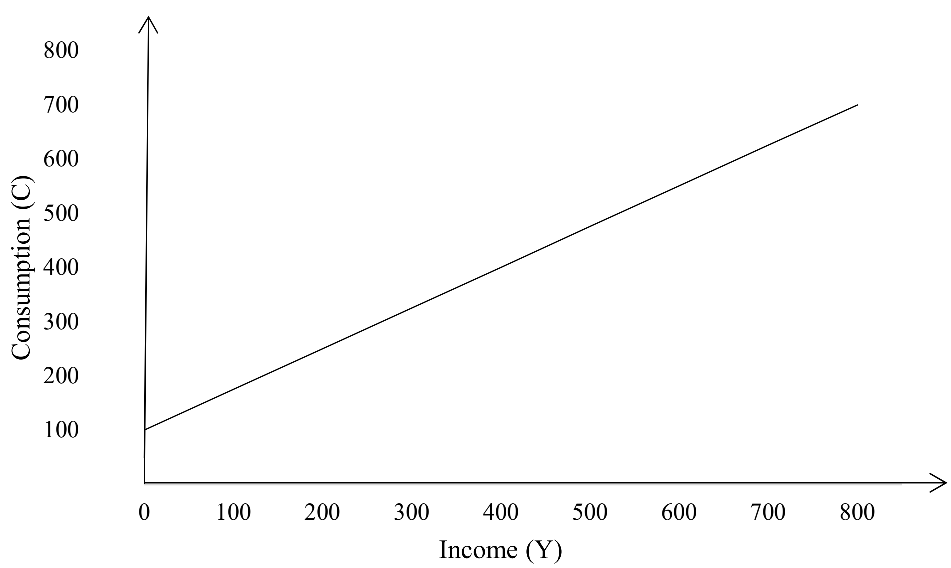

Figure 7.3: Consumption Function ($C = 100 + 0.75(Y)$)

Source: M. Ashraf

Figure 7.3: Income or output, Y, on the horizontal axis, and consumption, C, on the vertical axis. The intercept, a, is 100, and the slope of the consumption function, $MPC = \frac{\Delta C}{\Delta Y} = 0.75$. As income changes by, say, \$1.00, consumption changes by \$0.75.

In Figure 7.3, we have income or output (Y) on the horizontal axis, and consumption (C) on the vertical axis. The intercept is 100, and the slope of the consumption function, $MPC = \frac{\Delta C}{\Delta Y} = 0.75$. As income changes by, say, \$1.00, consumption changes by \$0.75. Note that the slope of the consumption function is constant; it is a linear curve.

Where does the rest of the change in income or output go? The answer: It leads to change in saving.

From Consumption Function to Saving Function

For us to draw a linear curve, all we need is the intercept and the slope. Once we have a consumption function, we can find a corresponding saving function, and vice versa.

Before we move forward, the following relationship between income or output (Y), and consumption (C) and saving (S) is important.

$$Y \equiv C + S \tag{7.8}$$

First note that Equation 7.8 is an identity (≡); the relationship between both sides of the identity is true by definition. Equation 7.8 states that our income is divided into two parts—consumption and saving. We can rewrite Equation 7.8 in change form.

$$\Delta Y \equiv \Delta C + \Delta S \tag{7.9}$$

Where Δ represents change in the variable following the Δ sign. If you are unclear about this notation, I encourage you to review the part of Chapter 1 where we talked about slope.

Divide both sides of Equation 7.9 by ΔY.

$$\frac{\Delta Y}{\Delta Y} \equiv \frac{\Delta C}{\Delta Y} + \frac{\Delta S}{\Delta Y}$$

$$1 \equiv \frac{\Delta C}{\Delta Y} + \frac{\Delta S}{\Delta Y} \tag{7.10}$$

Note that $\frac{\Delta Y}{\Delta Y}$ is equal to 1. One of the other two terms on the right-hand-side of Equation 7.10, $\frac{\Delta C}{\Delta Y}$, should look familiar; it is *MPC*, the slope of the consumption function. It is the change in consumption due to change in income.

The other term on the right-hand-side, $\frac{\Delta S}{\Delta Y}$, is the change in saving due to change in income. It is the slope of the saving function. It is called the marginal propensity to save, *MPS*. We can rewrite Equation 7.10 as follows.

$$1 \equiv MPC + MPS$$

Or

$$MPS \equiv 1 - MPC \tag{7.11}$$

Equation 7.11 states that *MPC* and *MPS* are identically equal to 1; if you have *MPC*, you can get *MPS*, and vice versa. In Table 7.1, we calculated $MPC = 0.75$. Using Equation 7.11, we can get *MPS*. That is,

$$1 \equiv 0.75 + MPS$$

$$MPS \equiv 1 - 0.75 = 0.25 \tag{7.12}$$

So, the slope of the saving function, using these data, is 0.25. The next piece of information we need to draw a linear function, in this case a saving function, is the intercept. Equation 7.8 provides that information. Setting $Y = 0$, and we get,

$$0 \equiv C + S$$

$$S \equiv -C \tag{7.13}$$

That is, when income is zero, saving is equal to the negative of consumption.

Using the data in Table 7.1, we know that when income (Y) is zero, consumption (C) is equal to 100. By Equation 7.13, this means that $S = -100$. Our saving function, corresponding to the above consumption, $C = 100 + 0.75(Y)$, function, then is,

$$S = -100 + 0.25(Y)$$

In general, using the consumption function in Equation 7.6, and the relationship in Equation 7.11, we can write the saving function as follows.

$$S = -\alpha + (1 - \beta)(Y) \tag{7.14}$$

Where $-\alpha$ is the negative of the consumption function intercept, and β is the *MPC* of the of the corresponding consumption function, respectively. That is, $MPS \equiv 1 - \beta$.

Let us expand the Table 7.1 and add three more columns—one for saving (S), one for change in saving (ΔS), and another for *MPS*.

Table 7.2: Income, Consumption, and Saving

[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Y	ΔY	C	ΔC	MPC	S	ΔS	MPS
0		100			-100		
100	100	175	75	0.75	-75	25	0.25
200	100	250	75	0.75	-50	25	0.25
300	100	325	75	0.75	-25	25	0.25
400	100	400	75	0.75	0	25	0.25
500	100	475	75	0.75	25	25	0.25
600	100	550	75	0.75	50	25	0.25
700	100	625	75	0.75	75	25	0.25
800	100	700	75	0.75	100	25	0.25

Source: M. Ashraf.

Note that $S \equiv Y - C$, and $MPS = \frac{\Delta S}{\Delta Y}$. The rest of the variables as defined above.

In Table 7.2, Column [6] provides saving (S), Column [7] provides change in saving (ΔS), and Column [8] provides $MPS = \frac{\Delta S}{\Delta Y}$, the slope of the saving function. Note that consumption (C) is equal to income (Y) when the latter is at 400. This means that saving is zero—Equation 7.8. When income is above 400, saving is positive and when income is below 400, saving is negative. In

Using the data in Table 7.2, we can draw a saving function. Figure 7.4 plots the saving function using data in Table 7.2.

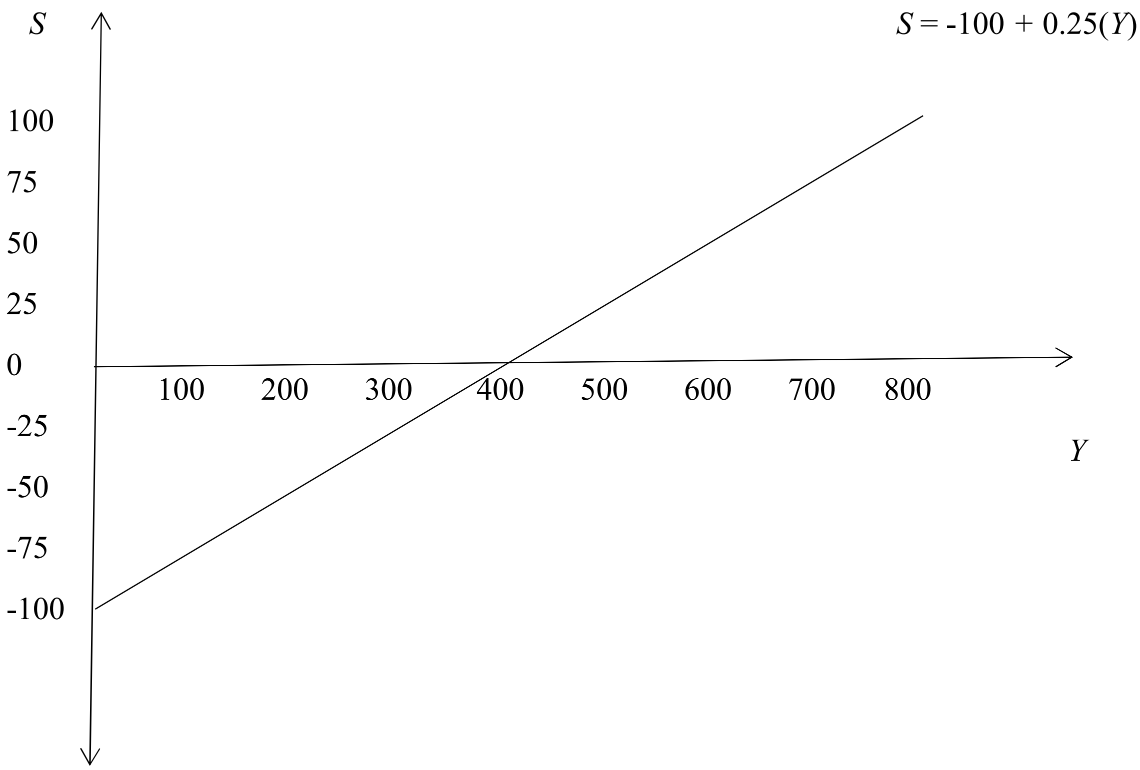

Figure 7.4: Saving Function (S = -100 + 0.25(Y))

Source: M. Ashraf

Figure 7.4: Aggregate income or output, Y, is on the horizontal axis, and aggregate saving, S, is on the vertical axis. The vertical axis extends in both positive and negative directions. We see that the saving curve's intercept is -100, and the slope is 0.25. When Y is equal to 400, the saving is zero, and the curve cross the income axis. When income is above 400, saving is positive and when income is below 400, saving is negative.

In Figure 7.4 note that the vertical axis extends in both positive and negative directions. We see that the saving curve's intercept is -100, and the slope is 0.25. When Y is equal to 400, the saving is zero, and the curve cross the income axis. When income is above 400, saving is positive and when income is below 400, saving is negative. Compare Figure 7.3, the consumption function, with Figure 7.4, the saving function note that when you have a consumption function, you can get the corresponding saving function, and vice versa.

Planned Aggregate Expenditure

The next building block of the Keynesian framework, and the Keynesian Cross diagram, is Planned Aggregate Expenditure (AE). We define planned aggregate expenditure as the sum of aggregate consumption expenditure (C), and planned investment spending (I). Again, we are assuming that it is a closed economy so that NX is zero, and since we are assuming that there isn't any government expenditure, G is also equal to zero. We can express this as follows.

$$AE \equiv C + I \tag{7.15}$$

Note the identity sign (≡); both sides of Equation 7.15 are identically equal.

You may have noticed that Equation 7.15 looks very similar to Equation 7.1, or Equation 6.1 in Chapter 6, where we calculated GDP using the expenditure approach. These two equations are similar, except with one important difference; in Equation 7.1 (or Equation 6.1) we had total investment spending, and we represented it by I. In Equation 7.15 we have planned investment represented by I. We may write total investment spending as the sum of planned investment spending (I_p) and unplanned investment spending (I_u), where the subscript u reminds that this part of the total investment spending is unplanned. That is,

$$I = I_p + I_u$$

While the notation may be confusing, the difference between planned investment spending and total investment spending plays an important role in finding the macroeconomic equilibrium.

You may also ask: How could investment be unplanned?

Recall that investment is addition to the existing stock of capital plus changes in inventory. These changes in inventory may be planned or may be unplanned. The part of inventory investment that is unplanned is the only part of total investment that is unplanned.

Inventory is the difference between what the producers produce and what the producers sell. That is,

$$\text{Inventory} = \text{Production - Sales}$$

Producers may keep inventory to meet unforeseen demand. If the demand for their goods is higher than they have produced, they may meet the higher demand by taking goods out of the inventory. On the other hand, if the demand for their goods is lower than what they have produced, they may add the remainder of the output to the inventory stock. If the producers planned to add to the inventory, then this addition will be the planned investment (I_p) part of the total investment (I). If the producers did not want to add to the inventory stock, but they had to increase inventory stock because the sales were lower than the output, then this is the unplanned inventory investment (I_u) part of the total investment (I).

(H2) Macroeconomic Equilibrium

Now we have all the pieces to define and find macroeconomic equilibrium.

Macroeconomic equilibrium takes place when income (Y) is equal to planned aggregate expenditure (AE). That is,

$$Y = AE \tag{7.16}$$

Using Equation 7.15, we can rewrite Equation 7.16 as,

$$Y = C + I \tag{7.17}$$

Equation 7.18 is the equilibrium condition. It states that equilibrium, in the macroeconomic sense, takes place when output or income is equal to the planned aggregate expenditure. We can modify Table 7.2 by adding planned investment. For the sake of simplicity, I will remove Columns [2], and [4] through [6]. These represent ΔY, ΔC, *MPC*, *S*, ΔS, and *MPS*, respectively. I will add planned investment (I), and planned aggregate expenditure ($AE \equiv C + I$). These data are presented in Table 7.3.

Table 7.3: Macroeconomic Equilibrium

[1]	[2]	[3]	[4]	[5]
Y	*C*	*I*	*AE* (≡ *C* + *I*)	*Change in Inventory*
0	100	25	125	-
100	175	25	200	-
200	250	25	275	-
300	325	25	350	-
400	400	25	425	-
500	475	25	500	0
600	550	25	575	+
700	625	25	650	+
800	700	25	725	+

Source: M. Ashraf

In Table 7.3, Column [1] is income or output (Y), Column [2] is aggregate consumption (C), Column [3] is planned investment (I), and Column [4] is planned aggregate expenditure (AE). It is the sum of Columns [2] and [3]. The data in Columns [1] and [2], Table 7.3, are the same as those in Columns [1] and [3] in Table 7.2. I have added planned investment (I) in Column [3], planned aggregate expenditure (AE) in Column [4], and Column [5] shows whether inventory is decreasing (-), increasing (+), or not changing (0). We are assuming that planned investment spending (I) does not depend upon income (Y). We are assuming that it is determined outside the model. This is why the value of I stays constant for all values of Y. We are setting it equal to 25. When draw the planned investment spending curve in output (Y) and Investment (I) space, it is a horizontal line with an intercept at 25; its slope will be zero. Figure 7.5 shows this curve.

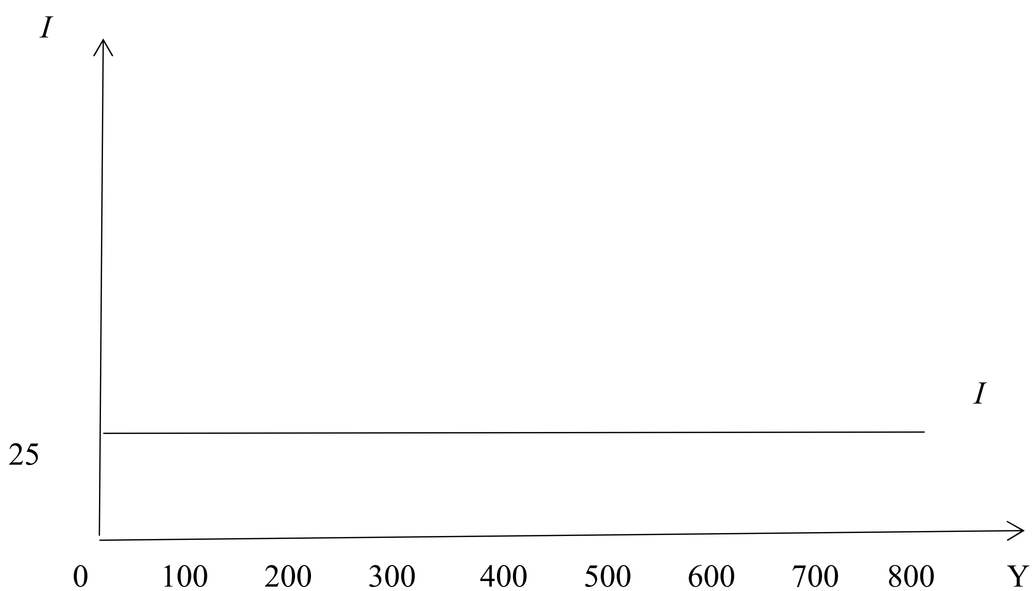

Figure 7.5: Planned Investment Spending

Source: M. Ashraf

Figure 7.5: Aggregate income or output, *Y*, is on the horizontal axis, and planned investment spending, *I*, is on the vertical axis. The curve, *I*, is a horizontal at 25, for all values of *Y*.

In Figure 7.5, because the planned investment spending (*I*) does not depend upon income or output (*Y*), it is a horizontal line with the *I* at 25 for all values of *Y*.

As we learned, macroeconomic equilibrium takes place when income or output (*Y*) is equal to planned aggregate expenditure (*AE*). See Equation 7.18. In Table 7.3, the equilibrium takes place when the level of income is 500. Note that at this point, $Y = AE = 500$. At income levels below 500, $Y < AE$. As a result, change in inventory is negative. That is, inventory investment is negative. And at income levels above 500, $Y > AE$. As a result, change in inventory is positive. That is, inventory investment is positive. These are represented in Column [5] by (-) and (+) sings, respectively. At output level 500, $Y = AE$, and change in inventory is zero.

The data in Table 7.3, are of course, hypothetical. These are presented just to make the concept understandable. Changes in inventory, however, may not be zero, except by chance. Table 7.4 presents actual data from the US National Income and Product Accounts (NIPA). Here I limit the data just for investment.

Table 7.4: Gross Private Domestic Investment from 2018 to 2021 (Billions of US Dollars)

		Year			
Line	Variable	2018	2019	2020	2021
7	Gross private domestic investment	3642.4	3807.1	3642.9	4113.5
8	Fixed investment	3583.3	3734.4	3698.7	4132.6
9	Nonresidential	2784.7	2921.1	2797.9	3025
10	Structures	633.6	674.7	614.4	598.2
11	Equipment	1193.2	1209.8	1077.8	1194
12	Intellectual property products	957.9	1036.6	1105.7	1232.7
13	Residential	798.6	813.2	900.8	1107.6
14	Change in private inventories	59.1	72.8	-55.8	-19.1

Source: M. Ashraf. Data Source: Bureau of Economic Analysis (www.bea.gov) Accessed: December 8, 2022. The data are billions of US dollars (November 30, 2022, revision.) The row numbers are as they appear in NIPA Table 5.1.1.

Note that for 2018 and 2019, the change in inventories is positive, and for 2020 and 2021, the change in inventories is negative. Compare Table 7.4 and Table 6.1, Chapter 6. Table 7.4 provides a subset of data in Table 6.1. Here we limit the data to only "Gross private domestic investment," lines 7 through 14, for years 2018 through 2021.

Also, do not be confused by the difference in variable name—"Gross private domestic investment" and "planned investment spending." These two refer to the same underlying concept. The former is the official variable name used by the Bureau of Economic Analysis, while the latter is used in the macroeconomic literature. You may want to review the details provided in Chapter 6.

We can show this equilibrium using a diagram. First, however, we plot $AE \equiv C + I$ in the income (Y) and planned aggregate expenditure (AE) space. We are combining Figure 7.3 (Consumption Function), and Figure 7.5 (Planned Investment Spending).

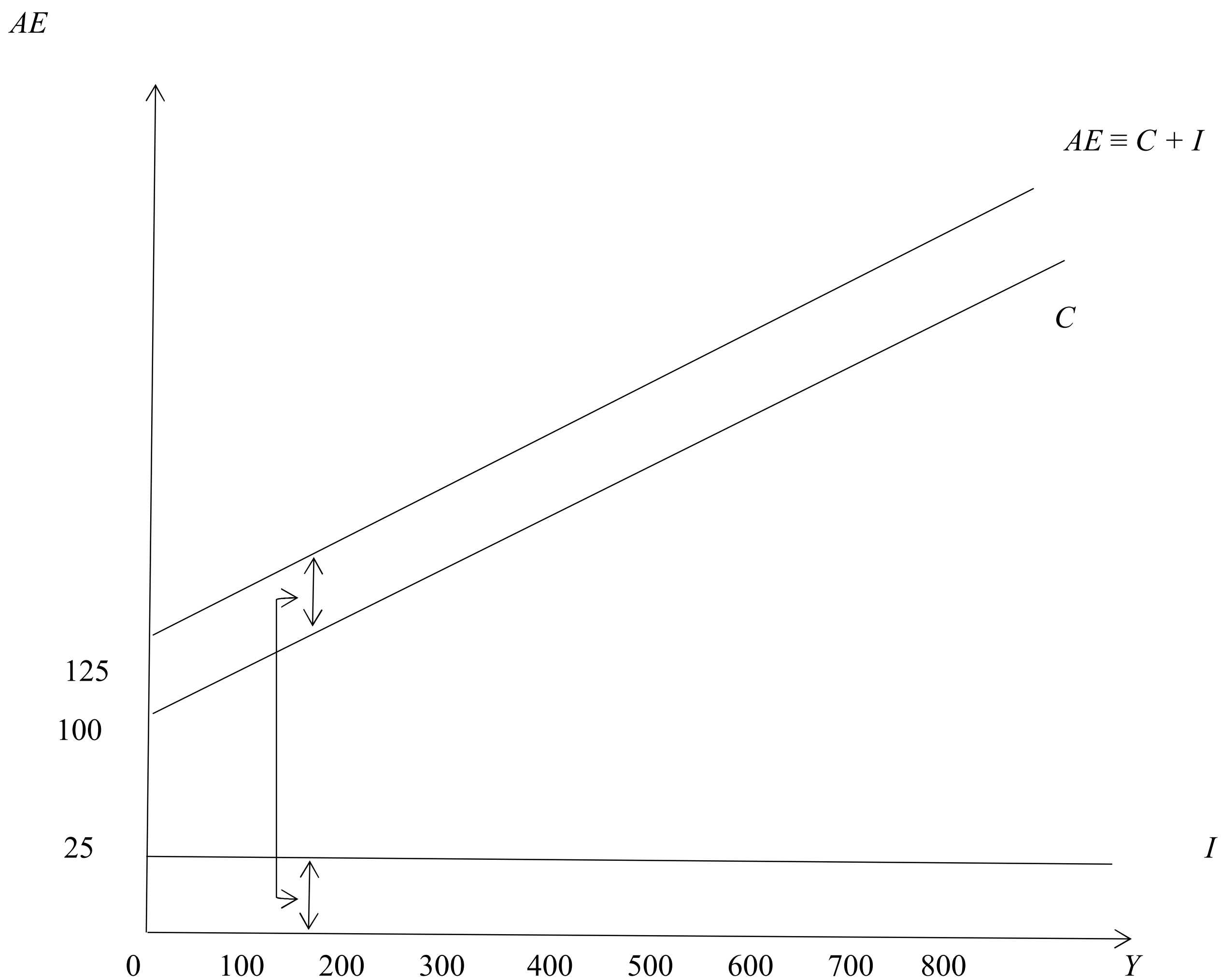

Figure 7.6: The Planned Aggregate Expenditure Curve

Source: M. Ashraf

Figure 7.6: Aggregate output or income, *Y*, is on the horizontal axis, and planned aggregate expenditure, *AE*, is on the vertical axis. Figure 7.6 combines Figure 7.3 and Figure 7.5.

Figure 7.6 combines Figure 7.3 and Figure 7.5.

In Figure 7.6, we combine the consumption function, Figure 7.3, and the planned investment spending, Figure 7.5. We get the $C + I$ curve by plugging in the values of income or output (Y) into the consumption function—$C = 100 + 0.75(Y)$, plotted in Figure 7.3—and adding the value of planned investment spending (I). Note the intercepts of the three curves in Figure 7.6. The planned investment spending (I) curve's intercept is 25. The consumption function's (C) intercept is 100. The planned aggregate expenditure ($C + I$) curve's intercept is the sum of the two—$25 + 100 = 125$.

Note also, that in Figure 7.6, the slope of the planned aggregate expenditure ($AE \equiv C + I$) curve, is the same as that of the consumption function. (Recall that the slope of the consumption function is *MPC*.) The reason is that we are adding the planned investment spending to the consumption function. The planned investment spending (I) curve is a horizontal line; its slope is zero. So, the slope of the $C + I$ curve is the sum of the two, which is equal to *MPC*, the slope of the consumption function. You can think of the $C + I$ curve as the consumption function shifted upward, in parallel fashion, by the amount of the planned investment spending.

Now we have all the building blocks of the Keynesian Cross diagram. We will use data in Table 7.3 to draw this diagram and find the macroeconomic equilibrium.

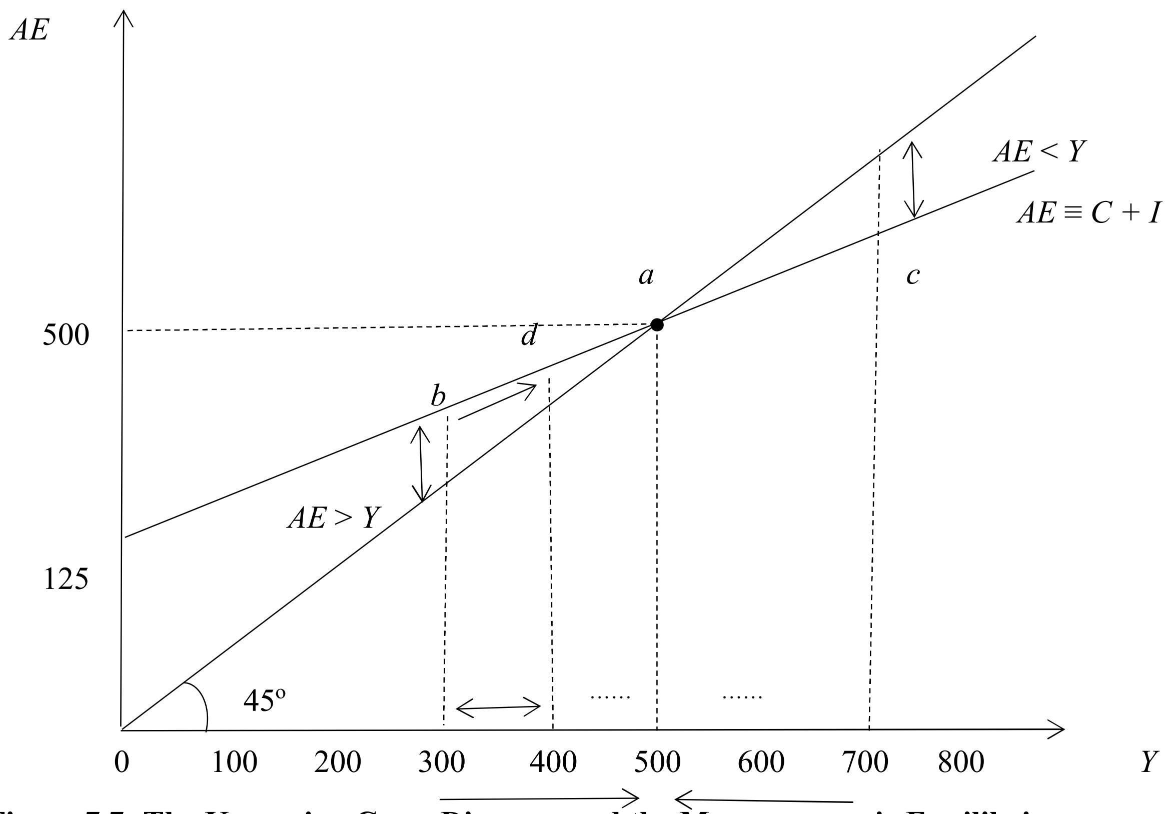

Figure 7.7: The Keynesian Cross Diagram and the Macroeconomic Equilibrium

Source: M. Ashraf

Figure 7.7: Aggregate output or income, Y, is on the horizontal axis, and planned aggregate expenditure, AE, is on the vertical axis. The 45° line is the loci of the points where Y and AE have the same values. It serves as a reference line. At output level 500, both Y and AE are equal. At output levels below 500, planned aggregate expenditure is greater than income or output. At income or output levels above 500, planned aggregate expenditure is less than output.

To make the diagram less cluttered, in Figure 7.7, we plot the planned aggregate expenditure ($C + I$) curve in the AE and Y space, and we add a 45-degree line. The 45-degree line serves as a reference line; it plots the loci of the points where the values of the variable on the vertical axis and the values of the variable on the horizontal axis are the same, in this case, the planned aggregate expenditure (AE), and the income or output (Y). The slope of the 45-degree line, by definition, is equal to 1.

Note that at $Y = 500$, output or income (Y) is equal to planned aggregate expenditure (AE). That is, $Y = C + I$. (See Equation 7.17.) In Figure 7.7, this point is represented by a. Refer, also, to Table 7.3. The values in Columns [1] and Column [4] are equal at this level of output. At output levels below 500, planned aggregate expenditure is greater than output: $AE > Y$. In Figure 7.7, one such level of output is 300, represented by b. The distance between the 45-dgree line and the $C + I$ curve, indicated by the vertical two-headed arrow, shows the difference between the AE and Y; the planned aggregate expenditure curve lies above the 45-degree line.

At output or income levels above 500, planned aggregate expenditure is less than output: $AE < Y$. One such level of output or income is 700, represented by c in Figure 7.7. Again, the distance between the 45-dgree line and the $C + I$ curve, is indicated by the vertical two-headed arrow, shows the difference between the AE and Y; the planned aggregate expenditure curve lies below the 45-degree line.

Reaching the Equilibrium

How do we get to the equilibrium if we happen to be away from the equilibrium? Suppose we are at $Y = 300$, a point represented by b in Figure 7.7. At this level of output, $AE > Y$; producers are selling more than they are producing, and they are meeting the excess demand by depleting their inventories; there is an unplanned reduction in inventories. Producers want to maintain a certain level of inventories. To replenish the inventories, producers increase output. To increase output, producers either ask workers to work longer hours, or hire more workers, or a combination of the two. In either case, this leads to an increase in workers' income. Suppose it increases to 400, a point represented by d in Figure 7.7. At this point, planned aggregate expenditure is still greater than income or output. See also Table 7.3. Why?

As we learned earlier, changes in income led to changes in consumption according to the MPC. In this case, an increase in income leads to an increase in consumption, and we move along the consumption function; in Figure 7.7, we move along the $C + I$ curve. There is still unplanned reduction in inventories. The difference between the levels of planned aggregate expenditure, $C + I$, and output, Y, however, is smaller than it was at output level 300. This is because the MPC is less than 1; workers do not consume all the increase in their incomes. This process continues until we get to the income level 500, where output is equal to planned aggregate expenditure: $Y = C + I$. In Figure, the dots (…) represent this process.

If, on the other hand, we are at $Y = 700$, a point represented by c in Figure 7.7, the process works in the reverse. At $Y = 700$, income or output is greater than planned aggregate expenditure: $Y > C + I$. This leads to an unplanned addition to inventories. Producers cut production either by reducing working hours, or firing some workers, or a combination of the two. In either case, workers' incomes decrease, leading to a decrease in consumption according to *MPC*. Since MPC is less than one, consumption decreases by less than the decrease in income, and the gap between income and planned aggregate expenditure shrinks, until $Y = C + I$. At the base of Figure 7.7, the two arrows point to this pull towards the equilibrium level of income or output, $Y = 500$.

Changes to the Equilibrium Level of Output

What may happen if planned investment spending were to change? Suppose that planned investment spending increases by a certain amount, ΔI. How will this affect the equilibrium level of output? Figure 7.8 shows this change.

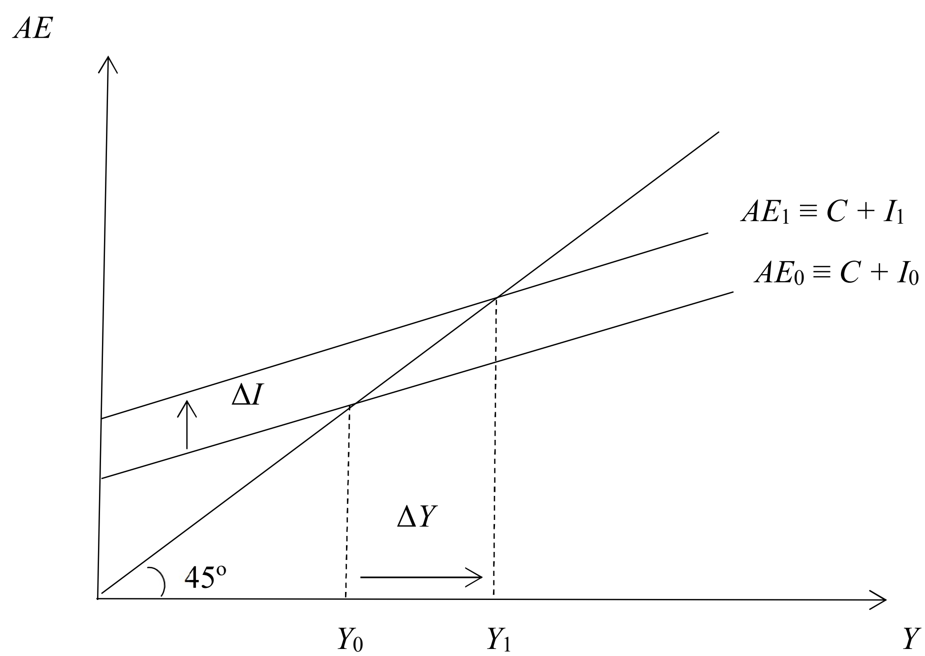

Figure 7.8: Changes to the Equilibrium Level of Output

Source: M. Ashraf

Figure 7.8: Aggregate output or income, Y, is on the horizontal axis, and planned aggregate expenditure, AE, is on the vertical axis. The 45° line is the loci of the points where Y and AE have the same values. It serves as a reference line. As planned investment spending increases, from I_0 to I_1, the planned aggregate expenditure curve shifts up from AE_0 to AE_1. Output increases from Y_0 to Y_1.

In Figure 7.8, I abstract from the details; I do not provide data values. The purpose of this figure is to see how a given change in planned investment spending, ΔI, where $\Delta I = I_1 - I_0$, leads to a change in equilibrium level of output, ΔY, where $\Delta Y = Y_1 - Y_0$. First, note that in this diagram we are showing the effect of an increase in planned investment spending. To show this, we have shifted the planned aggregate expenditure cure up by an amount ΔI. Second, the resulting increase in equilibrium output, ΔY is greater than ΔI. Soon, we will learn why is the change in equilibrium output greater than the change in planned investment spending, and how is the magnitude of this change determined? First, let us put some numbers to this change. Let us modify the data presented in Table 7.3, where the amount of planned investment spending was equal to 25. Let us change it, by 25, to 50. Table 7.4 presents these data, along with the original data presented in Table 7.3.

Table 7.4: Changes to the Macroeconomic Equilibrium

[1]	[2]	[3]	[4]	[5]	[6]
Y	C	I_0	AE_0 ($\equiv C + I_0$)	I'	AE_1 ($\equiv C + I_1$)
0	100	25	125	50	150
100	175	25	200	50	225
200	250	25	275	50	300
300	325	25	350	50	375
400	400	25	425	50	450
500	475	25	500	50	525
600	550	25	575	50	600
700	625	25	650	50	675
800	700	25	725	50	750

Table prepared by the author.

Columns [1] through [4] repeat the data presented in Table 7.3. Because we are changing the planned investment spending from 25 to 50, I represent the original planned investment spending by I_0, and the corresponding planned aggregate expenditure by AE_0, in Columns [3] and [4], respectively. In Column [5], the increased planned investment spending is represented by I_1, and the corresponding planned aggregate expenditure is represented by AE_1 in Column [6].

Note that before the increase in the planned investment spending, at $I = 25$, planned aggregate expenditure was equal to output at output level 500. See Columns [1] and [4]. This is the same equilibrium level of output that we saw in Table 7.3 and Figure 7.7. After the increase in planned investment spending, at $I = 50$, planned aggregate expenditure and output are equal at output level 600. See Columns [1] and [6]. An increase in planned investment spending of 25 lead to an increase in the equilibrium level of output by 100. Why does this happen? As we will see, the answer lies in the *MPC*.

The Planned Investment Spending Multiplier

Let us do a bit of algebra to find out. We will use the consumption function, Equation 7.6, and the equilibrium condition, Equation 7.17. I reproduce here for convenience.

The consumption function is,

$$C = \alpha + \beta(Y) \tag{7.6}$$

And the equilibrium condition is,

$$Y = C + I \tag{7.17}$$

Substitute the consumption function in the equilibrium condition and we get,

$$Y = \alpha + \beta(Y) + I$$

Bring Ys to the left-hand-side, and simplify the equation,

$$Y - \beta(Y) = \alpha + I$$

$$Y(1 - \beta) = \alpha + I$$

$$Y = \left[\frac{1}{1-\beta}\right] \times (\alpha + I) \tag{7.18}$$

Rewrite Equation 7.18 in change form,

$$\Delta Y = \left[\frac{1}{1-\beta}\right] \times (\Delta\alpha + \Delta I) \tag{7.19}$$

Equation 7.19 states, that if you change planned investment spending by a certain amount, ΔI, equilibrium level of output will change, ΔY, by a multiple of the change in planned investment spending, holding all else constant.

The quantity, $\left[\frac{1}{1-\beta}\right]$, is called the investment multiplier, where β is the *MPC*, the slope of the consumption function.

Note that we are not changing the consumption function intercept, α. That is, $\Delta\alpha = 0$. Recall *ceteris paribus*; we change one variable at a time and see what happens to the value of the affected variable.

Let us take a numerical example. Let us plug in data from Table 7.4. We know that $\beta = 0.75$, $\Delta I = 25$, and $\Delta\alpha = 0$. Plugging these values in Equation 7.19, we get,

$$\Delta Y = \left[\frac{1}{1 - 0.75}\right] \times (0 + 25) = 4 \times 25 = 100$$

This calculation says that if the $MPC = 0.75$, the value of the investment multiplier is equal to 4, and a change in planned investment spending, ΔI, of 25, will lead to a change in output or income, ΔY, of 100. Indeed, this is what we saw in Table 7.4; the equilibrium level of output increased from 500 to 600.

Mathematically, we can see that the value of the investment multiplier, $\left[\frac{1}{1-\beta}\right]$, depends upon β; the larger the β, the smaller the denominator, $(1 - \beta)$, and the larger the quantity, $\left[\frac{1}{1-\beta}\right]$, where, as we know β is the $MPC = \frac{\Delta C}{\Delta Y}$, the slope of the consumption function. To understand the economic reason behind this fact, look at Figure 7.7 (and Figure 7.8) again. Note that the larger the slope of the consumption function, the larger the resulting unplanned change in inventories, the larger the difference between the planned aggregate expenditure (*AE*) and the output or income (Y) at each step, and the larger the changes needed in the output to equate with planned aggregate expenditure. This is because at each step, workers whose incomes have changed, will change their consumption by a larger amount.

Changes in the Consumption Function Intercept, α

Suppose now that consumers become more, or less optimistic, and increase, or decrease consumption, respectively, at each level of income. This will lead to a change in the value of the intercept, α. How will this affect the equilibrium level of output? To see the answer graphically, we shift the planned aggregate expenditure curve up or down, depending upon whether consumers become more optimistic or less optimistic, respectively. It is the same procedure that we used to see the changes in planned investment spending in Figure 7.8.

To see the effect of changes in the intercept mathematically, we use Equation 7.19 again. Now, as opposed to changing planned investment spending, we change the intercept. We follow the same process as we did before. Since we are keeping the value of $\beta = 0.75$, you will note that the multiplier is the same, $\left[\frac{1}{1-\beta}\right] = \left[\frac{1}{1-0.75}\right] = 4$.

As an example, suppose that the intercept changes from 100 to 150. That is, $\Delta\alpha = 50$, and planned investment spending does not change, $\Delta I = 0$. Plugging these values in Equation 7.19, we get,

$$\Delta Y = \left[\frac{1}{1-0.75}\right] \times (50+0) = 4 \times 50 = 200$$

Given these values, when the intercept changes by a certain amount, the equilibrium level of output changes by a multiple of $\left[\frac{1}{1-\beta}\right]$.

(H1) Fiscal Policy: Adding Government to the Model

Fiscal policy is related to government spending (G) and taxation (T). The government body that conducts fiscal policy is the US Congress. An increase in government spending and or a decrease in taxes is called expansionary fiscal policy. And a decrease in government spending and or an increase in taxes is called a contractionary fiscal policy. The purpose of these changes in government spending and/or taxes is to affect the output level.

Federal Budget

Before moving on, let us briefly look at the federal budget, which provides details of government expenditure and the sources of government revenue over the course of a fiscal year. A fiscal year starts on October 1st of one calendar year and ends on September 30th of the next calendar year.

There are three main areas of government expenditure.[1]

- Federal agency funding, called discretionary spending—the area Congress sets annually. Discretionary spending typically accounts for around a third of all funding.

[1] Federal budget. https://www.usa.gov/budget?_gl=1*na0osg*_ga*MTg5NTA5NTAzMS4xNjcwOTQzMTQ3*_ga_GXFTMLX26S*MTY3MDk0MzE0Ny4xLjEuMTY3MDk0MzE3Mi4wLjAuMA. (Accessed: December 13, 2022)

- Interest on the debt, which usually uses less than 10 percent of all funding
- Funding for Social Security, Medicare, veterans benefits, and other spending required by law. This is called mandatory spending and typically uses over half of all funding.

The main source of government revenue is taxes. When government expenditure is greater than government revenue, it is called budget deficit.

Budget Deficit: $G > T$

When government expenditure is less than government revenue, it is called budget surplus.

Budget Surplus: $G < T$

A balanced budget is a budget in which government expenditure and government revenue are the same.

Balanced Budget: $G = T$

Note that budget deficit and budget surplus are flow variables; deficit and surplus are measured over a period, a fiscal year. Total federal debt, which is the difference between what the government owns and what the government owes, is a stock variable; it is measure at a point in time.

Let us, now, get back to our model. Once we add G to our model, our planned aggregate expenditure equation, Equation 1.15, changes to,

$$AE \equiv C + I + G \tag{7.20}$$

And our equilibrium condition, Equation 1.17, changes to,

$$Y = C + I + G \tag{7.21}$$

Another important change takes place in our consumption function. Our consumption now is a function of disposable income (Y_d). Disposable income is the income after taxes (T). That is,

$$Y_d \equiv Y - T \tag{7.22}$$

We are assuming that we pay lump sum taxes. In real life, taxes depend upon income; the higher the income, the higher the tax rate, and the higher the amount of taxes paid. We make this assumption for the sake of simplicity. Making this assumption, however, does not change the main message of the model.

With this change our consumption function, Equation 7.6, changes to,

$$C = \alpha + \beta(Y_d) \tag{7.23}$$

Note that when government expenditure changes, as we see in Equation 7.20, this change affects the planned aggregate expenditure directly. When taxes change, the change affects the disposable income, Equation 7.22, which in turn affects consumption, as we see in Equation 7.23. As we will see shortly, this difference in the channels through which fiscal policy variables, *G* and *T*, affect planned aggregate expenditure has implications for the changes in output.

Let us, now modify Table 7.3, and add government spending (*G*) and taxes (*T*) to the table. Table 7.5 presents the modified data.

Table 7.5: Addition of Government Spending and Tax to the Model

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Y	T	$Y_d \equiv Y - T$	$C = 100 + 0.8(Y_d)$	I	G	AE
⋮	⋮	⋮	⋮	⋮	⋮	⋮
1,500	100	1,400	1,220	200	200	1,620
1,600	100	1,500	1,300	200	200	1,700
1,700	100	1,600	1,380	200	200	1,780
1,800	100	1,700	1,460	200	200	1,860
1,900	100	1,800	1,540	200	200	1,940
2,000	100	1,900	1,620	200	200	2,020
2,100	100	2,000	1,700	200	200	2,100
2,200	100	2,100	1,780	200	200	2,180
2,300	100	2,200	1,860	200	200	2,260
2,400	100	2,300	1,940	200	200	2,340
2,500	100	2,400	2,020	200	200	2,420

Table prepared by the author.

In the interest of space, I limit the number of lines presented in Table 7.5; the three dots (⋮) indicate the lines not printed here. I am assuming that the lumpsum taxes (*T*), presented in Column [2], are 100. The disposable income is presented in Column [3]. In this table I am assuming that *MPC* is 0.8, so that out consumption function is $C = 100 + 0.8(Y_d)$. The values are presented in Column [4]. Furthermore, government spending (*G*) and planned investment spending (I), both are 200 each. These data are presented in Columns [5] and [6], respectively. The planned aggregate expenditure (*AE*) is presented in Column [7]. I am making these changes so that the equilibrium values are easier to find, and the data align properly.

After making these changes, the equilibrium level of output is 2,100. At this level of output, $Y = AE$. Output or income levels below this equilibrium level, output or income is less than planned aggregate expenditure, $Y < AE$, and output or income levels above this equilibrium level, output or income is greater than planned aggregate expenditure, $Y > AE$. As we saw earlier, when $Y < AE$, output increases, and when $Y > AE$, output decreases.

We show this equilibrium level of output in Figure 7.9, which is a modified version of Figure 7.7. In Figure 7.9, we add government spending to the model.

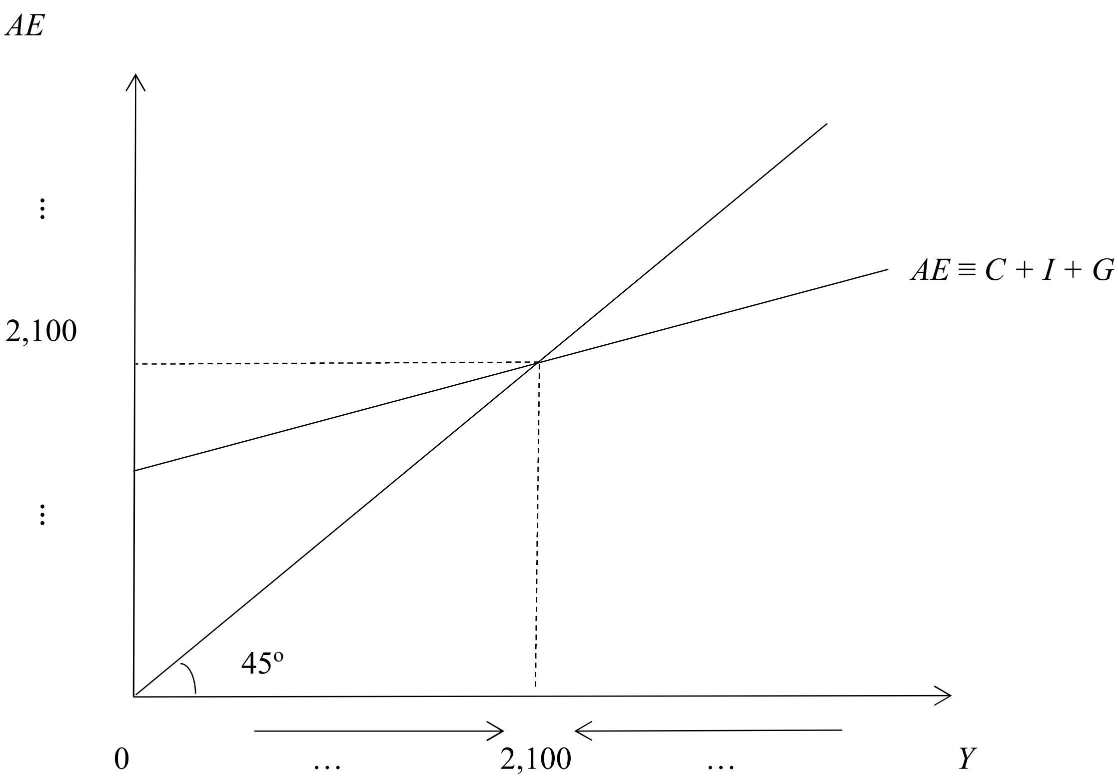

Figure 7.9: Adding Government Spending to the Model

Source: M. Ashraf

Figure 7.9: Aggregate output or income, *Y*, is on the horizontal axis, and planned aggregate expenditure, *AE*, is on the vertical axis. It is equal to $C + I + G$. The 45° line is the loci of the points where *Y* and *AE* have the same values. It serves as a reference line. At $Y = 2{,}100$, $Y = AE$. This represents the macroeconomic equilibrium.

In Figure 7.9, the 45-degree line, as in Figure 7.7, serves as a reference line; it is the loci of the points where the values of the two variables on the horizontal axis and the vertical axis are the same. To keep Figure 7.9 easier to navigate, I am abstracting from a few details; I am not providing all the data values on the two axes. As in Table 7.5, the three dots (⋮), again, represent the omitted data values.

The equilibrium takes place where output or income is equal to planned aggregate expenditure ($Y = C + I + G$). This is shown at $Y = 2{,}100$. At output levels below 2,100, $Y < AE$, and output increases. At output levels above 2,100, $Y > AE$, and output decreases. This is shown by the arrows at the bottom of Figure 7.9. The reasoning behind this movement in output or income is the same as when we discussed Figure 7.7.

Changes to the Equilibrium Level of Output Due to Change in Government Spending

How will a change in government spending lead to change in the equilibrium level of output? In Figure 7.10 we see the effect of an increase in government spending, *G*, on output, *Y*.

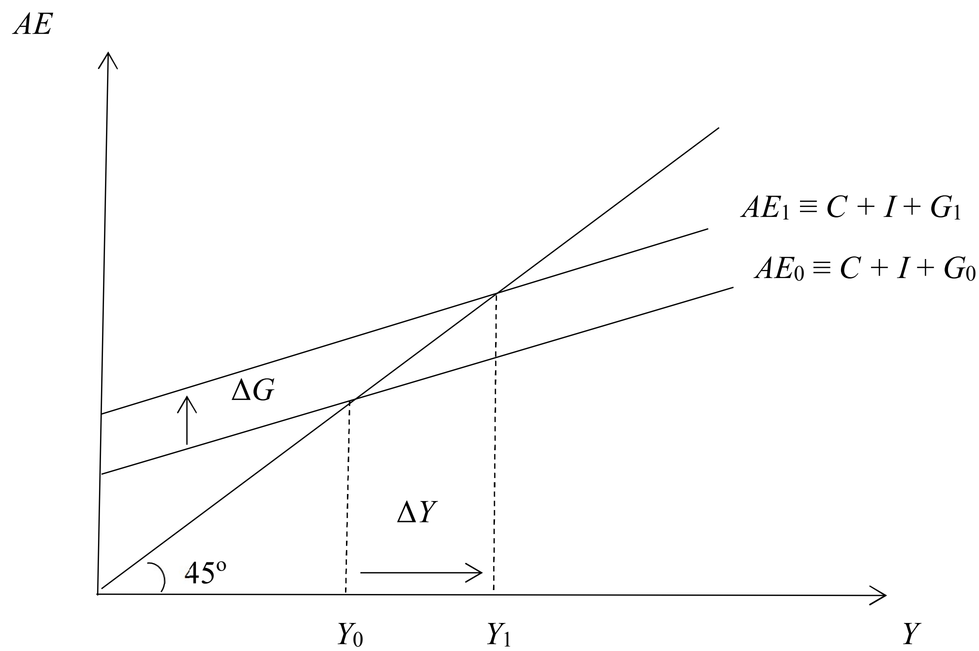

Figure 7.10: Changes to the Equilibrium Level of Output Due to Changes in Government Spending

Source: M. Ashraf

Figure 7.10: Aggregate output or income, Y, is on the horizontal axis, and planned aggregate expenditure, AE, is on the vertical axis. It is equal to $C + I + G$. The 45° line is the loci of the points where Y and AE have the same values. It serves as a reference line. An increase in government spending from G_0 to G_1 shifts the planned aggregate expenditure curve up, from AE_0 to AE_1. As a result, the equilibrium output increases from Y_0 to Y_1.

In Figure 7.10, we see the effect of an increase in government spending by an amount ΔG, where $\Delta G \equiv G_1 - G_0$. This shifts the planned aggregate expenditure curve up, from $C + I + G_0$ to $C + I + G_1$. Note that the other two variables in planned aggregate expenditure, C and I, are not changing. This increase in government spending leads to an increase in the equilibrium level of output by ΔY, where $\Delta Y \equiv Y_1 - Y_0$. Note that the change in equilibrium level of output or income is greater than the change in government spending. This change is similar to the change in planned investment spending in Figure 7.8, and its impact on output. This similarity is no accident. Below we see this using algebra.

Using Equations 7.22 and 7.23, we can rewrite the equilibrium condition, Equation 7.21, as,

$$\mathrm{Y} = \alpha + \beta(Y - T) + \mathrm{I} + \mathrm{G}$$

After some algebra and simplifying, we get,

$$Y = \left[\frac{1}{1-\beta}\right] \times (\alpha - \beta T + I + G) \tag{7.24}$$

As we did in the case of Equation 7.18, we can rewrite Equation 7.24 in change form.

$$\Delta Y = \left[\frac{1}{1-\beta}\right] \times (\Delta\alpha - \beta\Delta T + \Delta I + \Delta G) \quad (7.25)$$

When we compare Equation 7.25 with Equation 7.19, we see that the former has two terms that differ from the latter—$\beta\Delta T$ and ΔG. Let us see what these terms say.

(H2) The Government-Spending Multiplier

Start with ΔG. Equation 7.25 states that if you change government spending (G), by an amount ΔG, the change in output, ΔY, will be a multiple, $\left[\frac{1}{1-\beta}\right]$, of the change in government spending, again, holding other variables constant. That is, $\Delta\alpha = \Delta I = \Delta T = 0$, and $\Delta G \neq 0$.

The quantity, $\left[\frac{1}{1-\beta}\right]$, is called the government-spending multiplier.

Note that the government spending multiplier, Equation 7.25, and the planned investment spending multiplier, Equation 7.19, are the same. This is why the impact of change in planned investment spending on output, Figure 7.8, and the impact of change in government spending on output, Figure 7.10, are the same. For a given value of β, the values of the government spending multiplier and the planned investment spending multiplier are the same.

Let us take an example. Suppose, as before, the *MPC* is 0.75. This means that the value of the government spending multiplier is $\left[\frac{1}{1-\beta}\right] = \left[\frac{1}{1-0.75}\right] = 4$. That is, a given change in government spending will lead to a change in output that is four times the change in government spending. This is the same value that we had in the planned investment spending multiplier. If government spending increases, an expansionary fiscal policy, output will increase four time the increase in government spending. The reverse will happen when government spending decreases, a contractionary fiscal policy.

Tax Multiplier

Next, we look at the impact of changes in taxes on output. According to Equation 7.25, a change in tax by an amount ΔT will lead to a change in output by a multiple of $-\left[\frac{\beta}{1-\beta}\right]$, holding other variables constant. That is, $\Delta\alpha = \Delta I = \Delta G = 0$, and $\Delta T \neq 0$.

The quantity, $-\left[\frac{\beta}{1-\beta}\right]$, is called the tax multiplier. Note the negative sign. It states that when taxes increase, a contractionary fiscal policy, output will decrease, and when taxes decrease, an expansionary fiscal policy, output will increase.

Let us take an example. Again, assume that the *MPC* = 0.75. The value of the tax multiplier is $-\left[\frac{\beta}{1-\beta}\right] = -\left[\frac{0.75}{1-0.75}\right] = -3$.

Note that the absolute value of the tax multiplier is lower than the absolute value of the government spending multiplier. Mathematically, it is easy to see. While the denominator in both multipliers is the same, $1 - \beta$, the tax multiplier has β in the numerator, whereas the government spending multiplier has 1. And since the value of β is less than 1, the numerator in the tax multiplier is smaller than the government spending multiplier.

The economic reason behind this difference lies in the fact that the government spending multiplier, as noted above, affects the planned aggregate expenditure directly, whereas the tax multiplier affects the planned aggregate expenditure through the consumption function via its impact on the disposable income. As tax changes, it changes the disposable income, which changes consumption according to the *MPC*, which is less than 1. This, in turn, affects the planned aggregate expenditure. So, the absolute value of the tax multiplier is smaller than that of the government spending multiplier.

What if we increase government spending and taxes, by the same amount, simultaneously? That is, $\Delta G = \Delta T$. Will the net effect on output be zero? The answer is, no. An increase in government spending financed by an equal increase in taxes will not cancel each other out. The net impact on output or income will be equal to the increase in government spending.

To understand this result, add the government spending multiplier to the tax multiplier, and simplify.

$$\left[\frac{1}{1-\beta}\right] + \left(-\left[\frac{\beta}{1-\beta}\right]\right) = \left[\frac{1-\beta}{1-\beta}\right] = 1$$

Note that the numerator and the denominator are equal and cancel each other out.

This is called balanced budget multiplier. It is equal to 1. It states that when $\Delta G = \Delta T$, the net effect on output is equal to the change in government spending.

Chapter Conclusion

In this chapter we built a model of the economy using the Keynesian framework. We used the Keynesian Cross diagram to find equilibrium output. Then we saw how changes in planned investment spending, autonomous consumption, government spending, and taxes may affect the equilibrium output. We learned that the macroeconomic equilibrium takes place when planned aggregate expenditure is equal to output. For the sake of simplicity, we looked at a closed economy; we did not add net exports to the model. In later chapters we will add net exports to the model and see how this change affect the equilibrium level of output.

A Review of Terms

- Marginal Propensity to Consume (*MPC*): The change in consumption due to change in income. It is the slope of the consumption function, and it is defined as: $\frac{\Delta C}{\Delta Y}$.
- Planned Aggregate Expenditure (*AE*): The sum of all the expenditure. In a closed economy, without government, it is equal to $C + I$. In a closed economy with government, it is equal to $C + I + G$, where C is aggregate consumption, I is planned investment spending, and G is government spending.
- Total investment spending is the sum of planned investment spending and unplanned investment spending. The unplanned investment spending is the unplanned changes in inventories.
- Macroeconomic equilibrium takes place when planned aggregate expenditure is equal to output.
- Government Spending Multiplier: $\left[\frac{1}{1-MPC}\right]$, or $\left[\frac{1}{1-\beta}\right]$.
- Tax Multiplier: $-\left[\frac{MPC}{1-MPC}\right] \equiv -\left[\frac{MPC}{MPS}\right]$, or $-\left[\frac{\beta}{1-\beta}\right]$
- Balanced Budget Multiplier: 1
- Budget Surplus: G < T
- Budget Deficit: G > T
- Balanced Budget: G = T