I. Measurement of Price Changes.

In Merryland, there are only 3 goods: popcorn, movie shows, and diet drinks. The following table shows the prices and quantities produced of these goods in 1980, 1990, and 1991:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>Q</td>
<td>P</td>
</tr>
<tr>
<td>Popcorn</td>
<td>1.00</td>
<td>500</td>
<td>1.00</td>
</tr>
<tr>
<td>Movie Shows</td>
<td>5.00</td>
<td>300</td>
<td>10.00</td>
</tr>
<tr>
<td>Diet Drinks</td>
<td>0.70</td>
<td>300</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Note: The quantities (Q) in the table above are not used in answering the questions below. These would be used, however, to calculate both GDP and the GDP deflator. (The GDP deflator is the price index associated with GDP, where the bundle of goods under consideration is the aggregate output of the economy. It is used to convert between nominal and real GDP.)

a) A "market bundle" for a typical family is deemed to be 5 popcorn, 3 movie shows, and 3 diet drinks. Compute the consumer price index (CPI) for each of the three years, using 1980 as the base year.

The consumer price index for 1980 is 100. This is easily seen:

\[
CPI_{1980} = \frac{\text{cost of buying the market bundle in 1980}}{\text{cost of buying the market bundle in 1980}} \times 100
\]

\[
= \frac{(5 \times 1.00) + (3 \times 5.00) + (3 \times 0.70)}{(5 \times 1.00) + (3 \times 5.00) + (3 \times 0.70)} \times 100
\]

\[
= 100
\]

The consumer price index for 1990 and 1991, respectively, is:
\[
CPI_{90} = \frac{\text{cost of buying the market bundle in 1990}}{\text{cost of buying the market bundle in 1980}} \times 100
= \frac{(5 \times 1.00) + (3 \times 10.00) + (3 \times 0.80)}{(5 \times 1.00) + (3 \times 5.00) + (3 \times 0.70)} \times 100
= 169.2
\]
\[
CPI_{91} = \frac{\text{cost of buying the market bundle in 1991}}{\text{cost of buying the market bundle in 1980}} \times 100
= \frac{(5 \times 1.05) + (3 \times 10.50) + (3 \times 0.75)}{(5 \times 1.00) + (3 \times 5.00) + (3 \times 0.70)} \times 100
= 176.5
\]

b) What was the rate of inflation from 1990 to 1991, using the CPI you calculated in (a)?

The rate of inflation equals the percentage change in the price index from 1990 to 1991. This is:

\[
\frac{\text{CPI}_{91} - \text{CPI}_{90}}{\text{CPI}_{90}} \times 100 = \frac{176.5 - 169.2}{169.2} \times 100 = 4.3\%
\]

c) Now compute the CPI for each of the three years, using 1990 as the base year instead of 1980 but using the same "market bundle."

Using 1990 as the base year, the CPI for 1980, 1990, and 1991, respectively, is:

\[
CPI_{80} = \frac{\text{cost of buying the market bundle in 1980}}{\text{cost of buying the market bundle in 1990}} \times 100
= \frac{(5 \times 1.00) + (3 \times 5.00) + (3 \times 0.70)}{(5 \times 1.00) + (3 \times 10.00) + (3 \times 0.80)} \times 100
= 59.1
\]
\[
CPI_{90} = \frac{\text{cost of buying the market bundle in 1990}}{\text{cost of buying the market bundle in 1990}} \times 100
= \frac{(5 \times 1.00) + (3 \times 10.00) + (3 \times 0.80)}{(5 \times 1.00) + (3 \times 10.00) + (3 \times 0.80)} \times 100
= 100
\]
\[
CPI_{91} = \frac{\text{cost of buying the market bundle in 1991}}{\text{cost of buying the market bundle in 1990}} \times 100
= \frac{(5 \times 1.05) + (3 \times 10.50) + (3 \times 0.75)}{(5 \times 1.00) + (3 \times 10.00) + (3 \times 0.80)} \times 100
= 104.3
\]
d) What was the rate of inflation from 1990 to 1991, using the CPI you calculated in (c)? Is it the same as your answer to (b)?

As before, we want the percentage change in the CPI from 1990 to 1991:

\[
\frac{\text{CPI}_{91} - \text{CPI}_{90}}{\text{CPI}_{90}} \times 100 = \frac{104.3 - 100}{100} \times 100 = 4.3\% 
\]

This is the same inflation rate we calculated in (d)! This should make sense to you – the percentage increase in prices for a certain bundle of goods between any two years should not depend on the base year chosen for our index. That is, the base year does not affect the inflation rate, it is chosen only for convenience. Indeed, we can calculate the inflation rate for any specific bundle of goods without using any base year, simply by calculating the percent change in the cost of buying this bundle:

\[
\frac{(\text{cost of bundle in 1991}) - (\text{cost of bundle in 1990})}{\text{cost of bundle in 1991}} \times 100 = \frac{39.0 - 37.4}{37.4} \times 100 = 4.3\% 
\]

e) Now suppose that a new market bundle is defined; the "market bundle" is now 6 popcorn, 2 movie shows, and 4 diet drinks. Compute the CPI for the three years, using this "market bundle" and using 1980 as the base year.

These calculations are below. (Notice that the CPI for our base year always equals 100.)

\[
\text{CPI}_{80} = \frac{\text{cost of buying the market bundle in 1980}}{\text{cost of buying the market bundle in 1980}} \times 100 \\
= \frac{(6 \times 1.00) + (2 \times 5.00) + (4 \times 0.70)}{(6 \times 1.00) + (2 \times 5.00) + (4 \times 0.70)} \times 100 \\
= 100
\]

\[
\text{CPI}_{90} = \frac{\text{cost of buying the market bundle in 1990}}{\text{cost of buying the market bundle in 1980}} \times 100 \\
= \frac{(6 \times 1.00) + (2 \times 10.00) + (4 \times 0.80)}{(6 \times 1.00) + (2 \times 5.00) + (4 \times 0.70)} \times 100 \\
= 155.3
\]

\[
\text{CPI}_{91} = \frac{\text{cost of buying the market bundle in 1991}}{\text{cost of buying the market bundle in 1980}} \times 100 \\
= \frac{(6 \times 1.05) + (2 \times 10.50) + (4 \times 0.75)}{(6 \times 1.00) + (2 \times 5.00) + (4 \times 0.70)} \times 100 \\
= 161.2
\]
f) What was the rate of inflation from 1990 to 1991, using the CPI you calculated in (e)? Explain why it is different from your answer to (b)?

Once again, we want the percentage change in the CPI from 1990 to 1991, except this time we use the CPI calculated from the new market bundle:

\[
\frac{\text{CPI}_{91} - \text{CPI}_{90}}{\text{CPI}_{90}} \times 100 = \frac{161.2 - 155.3}{155.3} \times 100 = 3.8\% 
\]

This differs from the inflation rate calculated in (b) because the "market bundle" is different. The rate of inflation is the percentage increase in the cost of buying a specific bundle of goods. Therefore it may be different for different bundles.

Why might we want to change the bundle of goods used to calculate the CPI? Consider movie shows, which have experienced a price increase. Consumers respond to this price increase by consuming fewer movie shows -- this is called the substitution effect. As a result, inflation measured by the new "market bundle" (the one with fewer movies) is lower than inflation measured by the old market bundle. In other words, the original CPI would overstate inflation by not accounting for the substitution effect. Many economists believe that the standard CPI used by the U.S. government similarly overstates inflation by not sufficiently accounting for the substitution effect.

II. Determination of Aggregate Output

1. The effect of an increase in planned investment can be shown graphically as follows:

An increase in I leads to an increase in equilibrium Y.

Using the same kind of graphical analysis, show the effect of each of the following:

a) Consumption drops because consumers are saving more.
b) Government spending increases, without any change in taxes.

The AE curve shifts up, increasing equilibrium output.

The AE curve shifts down, decreasing the level of equilibrium output.

c) Taxes rise, without any change in government spending.

The AE curve shifts down because consumption is lower as a result of the tax increase. Equilibrium output is reduced.
2. Consider an economy with no government, imports, or exports, and with fixed prices and interest rates. Let $C = 150 + 0.60Y$ and $I = 50$.

a) What is the equilibrium output?

Equilibrium output occurs where aggregate expenditure ($C + I$) equals aggregate output ($Y$). That is,

$$C + I = Y$$

$$\Rightarrow (150 + 0.6Y) + 50 = Y$$

$$\Rightarrow 200 + 0.6Y = Y$$

$$\Rightarrow 200 = 0.4Y$$

$$\Rightarrow 500 = Y$$

Therefore equilibrium output equals 500.

b) What is the value of the marginal propensity to consume?

The marginal propensity to consume (MPC) is the fraction of an increase in income that is consumed. In this economy, the MPC is 0.6.

c) What is the value of the multiplier?

The multiplier is the factor by which equilibrium output changes in response to a change in an autonomous variable (such as investment). It is calculated as follows:

$$\text{multiplier} = \frac{1}{1 - \text{MPC}} = \frac{1}{1 - 0.6} = 2.5$$

d) Suppose planned investment rises by 10 to $I = 60$. Calculate the new equilibrium output in two ways. First, calculate the new equilibrium output using the multiplier from (c).
Second, calculate the new equilibrium output using the same procedure as you did for (a), but with I = 60 instead of I = 50. Your answer should be the same under both methods.

- **Using the multiplier, we simply multiply the increase in investment by the value of the multiplier to find the increase in output:**

  \[
  \text{(change in investment)} \times \text{(multiplier)} = \text{change in output}
  \]
  \[
  10 \times 2.5 = 25
  \]

  Therefore equilibrium output is now 525.

- **By the procedure from (a) we have:**

  \[
  C + I = Y
  \]
  \[
  \Rightarrow (150 + 0.6Y) + 60 = Y \quad \text{(Notice that I is now 60, not 50.)}
  \]
  \[
  \Rightarrow 210 + 0.6Y = Y
  \]
  \[
  \Rightarrow 210 = 0.4Y
  \]
  \[
  \Rightarrow 525 = Y
  \]

  Therefore equilibrium output now equals 525.

3. A government is added to the original (I = 50) economy from part (2). The government spends 100 and receives taxes of 100 (such that the government budget is balanced with no deficit.) The economy is now described by:

\[
C = 150 + 0.60(Y-T)
\]
\[
= 150 + 0.60(Y-100)
\]
\[
I = 50
\]
\[
G = 100
\]

a) What is the equilibrium output?

**As before, equilibrium output occurs where aggregate expenditure (which is now C + I + G) equals aggregate output (Y). Aggregate expenditure is:**

\[
AE = C + I + G
\]
\[
= [150 + 0.6(Y-100)] + 50 + 100
\]
\[
= [150 + 0.6Y - 60] + 150
\]
\[
= 240 + 0.6Y
\]

Since equilibrium requires \( AE = Y \), we find equilibrium output by solving the equation:

\[
AE = Y
\]
\[
\Rightarrow 240 + 0.6Y = Y
\]
\[
\Rightarrow 240 = 0.4Y
\]
\[
\Rightarrow 600 = Y
\]

Therefore equilibrium output is 600.
b) As explained in lecture and in the text, the balanced budget multiplier equals 1. Explain how your answers to (2a) and (3a) confirm that the balanced budget multiplier is indeed 1.

Observe that government spending (and taxes) increased by 100 (from 0 to 100), and that the increase in equilibrium output is also 100. This is what it means for the balanced budget multiplier to equal 1.

c) Full employment output in this economy is 800. Suppose government spending is raised to attain this level of income, but taxes are not changed. What level of government spending will result in an equilibrium output of 800? How large will the deficit be? What will be the level of consumption?

- To find the level of government spending which results in an equilibrium output of 800 we must find the level of government spending that makes aggregate expenditure equal to 800 when aggregate output is 800.

\[ AE = 150 + 0.6(Y-100) + 50 + G \]

\[ 800 = 150 + 0.6(800-100) + 50 + G \]  \hspace{1em} \text{(Imposing AE=800 and Y=800.)}

\[ 800 = 620 + G \]

\[ G = 180 \]

So government spending of 180 is needed to attain full employment output. Alternatively, we can find the full employment level of G by using the multiplier. We know:

\[ \text{(multiplier)} \times \Delta G = \Delta Y \]

Therefore,

\[ \Delta G = \frac{\Delta Y}{\text{(multiplier)}} \]

Since we want to increase output by 200 (from 600 to 800), we need to increase government spending by

\[ \Delta G = 200/2.5 = 80 \]

Since we started with government spending at 100, the full employment level of G is 100 + \( \Delta G = 180 \).

- The deficit is easy to calculate: \( G - T \) = (180 - 100) = 80.

- The level of consumption when output (and income) is 800 will be:

\[ C = 150 + 0.6(800-100) \]

\[ = 150 + 420 \]

\[ = 570 \]

d) Suppose instead that government spending and taxes are raised simultaneously, such that the budget remains balanced. What level of government spending and taxes are needed to attain full employment output (Y=800)? What will be the level of consumption?
• To attain full employment equilibrium output of 800 we must find the level of government spending and taxes that makes aggregate expenditure equal to 800 when aggregate output is 800. (Notice that G=T since we have a balanced budget.)

\[ AE = 150 + 0.6(Y-100) + 50 + G \]
\[ 800 = 150 + 0.6(800-T) + 50 + G \] (Imposing AE=800 and Y=800.)
\[ ⇒ 800 = 200 + 480 - 0.6T + G \]
\[ ⇒ 800 = 680 - 0.6G + G \] (Recognizing G=T.)
\[ ⇒ 120 = 0.4G \]
\[ ⇒ 300 = G (=T) \]

So both taxes and government spending should be 300 in order to attain full employment output with a balanced budget. As before, we could have used the multiplier to calculate the change in taxes and spending needed to raise output by 200. Since the balanced-budget multiplier equals 1, in order to raise equilibrium output by 200 we need to increase both G and T by 200 (from 100 to 300).

• The level of consumption will be:

\[ C = 150 + 0.6(800-300) \]
\[ = 150 + 300 \]
\[ = 450 \]

Notice that consumption is lower when full employment is achieved with a balanced budget than when it is achieved by increasing G alone. But, nevertheless, consumption under full employment attained with a balanced budget is the same as consumption at less than full employment [i.e., in (3a)]. Therefore, as long as government spending brings some benefits, under a balanced budget it is better to be at full employment than at less than full employment. That is, increasing the scale of government (both G and T) to attain full employment is better than staying at less than full employment.

III. Determination of Interest Rate.

Using supply and demand curves for money, illustrate the impact of the following events on the equilibrium interest rate.

a) The general price level for goods increases. The money demand curve shifts to the right. The equilibrium interest rate increases from \( i_0 \) to \( i_1 \).
b) Aggregate output rises.  

The effects are the same as the price level rise from part (a). The money demand curve shifts to the right. The equilibrium interest rate increases from $i_0$ to $i_1$.

\[ M \]

\[ M \]

\[ M \]

\[ M \]

\[ M \]

\[ M \]

c) The Fed sells government securities (bonds) in the open market.  

The sale of government bonds decreases the money supply. The money supply curve shifts left, and the interest rate increases.

\[ M \]

\[ M \]

\[ M \]

\[ M \]

d) The Fed decreases the minimum reserve requirement of banks.

This increases the money supply. The money supply curve shifts right, and the interest rate decreases.

\[ M \]

\[ M \]

\[ M \]

\[ M \]