Chapter 11

Numerical Problems

1. The following table shows the real wage (w), the effort level (E), and the effort per unit of real wages (E / w).

<table>
<thead>
<tr>
<th>w</th>
<th>E</th>
<th>E/w</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>7</td>
<td>0.875</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>1.00</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td>1.25</td>
</tr>
<tr>
<td>14</td>
<td>17</td>
<td>1.21</td>
</tr>
<tr>
<td>16</td>
<td>19</td>
<td>1.19</td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td>1.11</td>
</tr>
</tbody>
</table>

The firm will pay a wage of 12, since that wage provides the maximum effort per unit of the real wage (E / w = 1.25).
The firm will employ 88 workers, since that is the number of workers for which w = MPN.
As long as the supply of labor exceeds the demand for labor, labor supply has no effect on the firm's decision.

2.
   a. The IS curve is found from the equation \( Y = C_d + P + G = 130 + 0.5(Y - 100) - 500r + 100 - 500r + 100 \), or \( 0.5Y = 280 - 1000r \), or \( Y = 560 - 2000r \).

   The LM curve comes from the equation \( M / P = L \), which in this case is \( 1320 / P = 0.5Y - 1000r \), or \( Y = (2640 / P) + 2000r \).

   b. At full employment, \( Y = 500 \).

   Using this in the IS curve gives \( 500 = 560 - 2000r \), which has the solution \( r = 0.03 \).

   Plugging the values for \( Y \) and \( r \) in the LM curve gives \( 500 = (2640 / P) + (2000 x 0.03) \), or \( 440 = 2640 / P \), which has the solution \( P = 6 \).

   Then consumption is \( C = 130 + 0.5(Y - 100) - 500r = 130 + 0.5(500 - 100) - (500 x 0.03) = 315 \).

   Investment is \( I = 100 - (500 x 0.03) = 85 \).

   c. If desired investment increases to 200 - 500r, the IS curve shifts from IS1 to IS2 in Fig. 2.

   This can be seen in the equation \( Y = C_d + I_d + G = 130 + 0.5(Y - 100) - 500r + 200 - 500r + 100 \), or \( 0.5Y = 380 - 1000r \), or \( Y = 760 - 2000r \).

   In the short run, the price level remains fixed at 6, so the LM curve remains at LM1.

   With the price level equal to 6, the LM curve has the equation \( Y = (2640 / P) + 2000r = 440 + 2000r \).

   The IS and LM curves intersect where \( 760 - 2000r = 440 + 2000r \), or \( 320 = 4000r \), which has the solution \( r = 0.08 \).

   At \( r = 0.08 \), Output is given from the IS curve as \( Y = 760 - 2000r = 760 - (2000 x 0.08) = 600 \).

   Then consumption is \( C = 130 + 0.5(Y - 100) - 500r = 130 + 0.5(600 - 100) - (500 x 0.08) = 340 \).
Investment is $I = 200 - 500r = 200 - (500 \times 0.08) = 160$.

In the long run, the price level rises to shift the LM curve from LM1 to LM2 to restore equilibrium.

The IS curve is given by the equation $Y = 760 - 2000r$.

At full employment, $Y = 500$, so the IS curve is $500 = 760 - 2000r$, or $2000r = 260$, which has the solution $r = 0.13$.

The LM curve is given by the equation $Y = \frac{2640}{P} + 2000r$, or $500 = \frac{2640}{P} + (2000 \times 0.13)$, or $240 = \frac{2640}{P}$, which has the solution $P = 11$.

Then consumption is $C = 130 + 0.5(500 - 100) - (500 \times 0.13) = 265$.

Investment is $I = 200 - 500r = 200 - (500 \times 0.13) = 135$.

3. The IS curve is $Y = C^d + I^d + G = [600 + 0.8(Y - 1000) - 500r] + [400 - 500r] + 1000$, so $0.2Y = 1200 - 1000r$. This is plotted in Figure 11.13.

Since $\delta^e = 0$, the nominal interest rate ($i$) equals the real interest rate ($r$).

a. Can the economy reach full employment? Since full-employment output is $Y = 8000$, for the economy to be on the IS curve, $0.2Y = 1200 - 1000r$, so $(0.2 \times 8000) = 1200 - 1000r$, or $1000r = -400$, so $r = i = -0.4$. But since the nominal interest rate can't be negative, this isn't possible. Thus, the requirement that $i$ be non-negative means that there's no way to satisfy the goods market equilibrium condition at full employment. Assuming that the result is that $i = 0$ and that output is determined along the IS curve means that $0.2Y = 1200 - (1000 \times 0)$, so $Y = 6000$. Note that this is the best result possible, no matter what the money supply is, so monetary policy can't restore full employment.

b. To restore full employment while the nominal interest rate is zero clearly requires a shift in the IS curve. If we return to the original derivation and put $G$ in the equation instead of using the original value of $G = 1000$, we get: $Y = C^d + I^d + G = [600 + 0.8(Y - 1000) - 500r] + [400 - 500r] + G$, so $0.2Y = 200 + G - 1000r$. To get $Y = 8000$ and $r = 0$, we have $0.2 \times 8000 = 200 + G - (1000 \times 0)$, so $G = 1400$. Then the IS curve is $0.2Y = 1600 - 1000r$. This is plotted in Figure 11.14 as $IS^2$, while the original IS curve is $IS^1$.

Thus, raising $G$ to 1400 can generate full employment, if the money supply is chosen so that the LM curve intersects the IS curve at the right point. Note that taxes are 1000, so the government must run a large budget deficit.

What must the money supply be? Since $P = 2$, we need money supply ($M/P$) = money demand ($L$), so $M/2 = 0.5Y - 200i = (0.5 \times 8000) - (200 \times 0) = 4000$, so $M = 8000$.

This situation is quite similar to the situation in Japan in the 1990s and suggests that to get out of the liquidity trap, Japan will need to use expansionary monetary policy, along with expansionary fiscal policy.

4. a.
The IS curve is given by \( Y = C_d + I_d + G = 300 + 0.5(Y - 100) - 300r + 100 - l00r + 100 = 450 + 0.5Y - 400r. \) 
This can be rewritten as \( 0.5Y = 450 - 400r, \) or \( Y = 900 - 800r. \) The LM curve is \( M/P = L, \) or \( 6300/P = 0.5Y - 200r. \) 
To find the aggregate demand curve, substitute the LM curve into the IS curve to eliminate \( r. \) 
To do this, multiply both sides of the LM curve by 4 to get \( 25,200/P = 2Y - 800r, \) or \( 800r = 2Y - (25,200/P). \) Then substitute this in the IS curve: \( Y = 900 - 800r = 900 - [2Y - (25,200/P)]. \) 
This can be rewritten \( 3Y = 900 + (25,200/P), \) or \( Y = 300 + (8400/P). \)

b. 
With \( P = 15, \) the AD curve is \( Y = 300 + (8400/15) 860. \) 
From the IS curve, \( 860 = 900 - 800r, \) which has the solution \( r = 0.05. \) 
Consumption is \( C = 300 + 0.5(860 - 100) - (300 \times 0.05) = 665. \) 
Investment is \( I = 100 - (100 \times 0.05) = 95. \) 
In the long run, \( Y = 700. \) 
From the IS equation, \( 700 = 900 - 800r, \) which has the solution \( r = 0.25. \) 
The LM curve then is \( 6300/P = (0.5 \times 700) - (200 \times 0.25) = 300, \) which has the solution \( P = 21. \) 
Consumption is \( C = 300 + 0.5(700 - 100) - (300 \times 0.25) = 525. \) 
Investment is \( I = 100 - (100 \times 0.25) = 75. \)

5. 

a. 
Setting \( w = MPN, w = 10/\sqrt{N}. \) This is the labor demand curve

b. 
At \( W = 20, w = W/P = 20/P. \) Since labor demand is given by \( w = 10/\sqrt{N}, \) then \( 20/P = 10/\sqrt{N}, \) then \( 20/P = 10/\sqrt{N} \) or \( 2 \sqrt{N} = P. \) 
c. 
\( Y = 10 \sqrt{N} = 10P, \) or \( P = (1/10)Y, \) as shown in Fig. 5 by the SRAS curve.

d. 
The IS curve is \( Y = 120 - 500r. \) 
The LM curve is \( M/P = 0.5Y - 500r, \) which can be rewritten as \( 500r = 0.5Y - (M/P). \) 
Plugging the LM curve into the IS curve to eliminate \( r \) gives \( Y = 120 - 500r = 120 - [0.5Y - (M/P)]. \) 
This can be rewritten as \( 1.5Y = 120 + (M/P). \) This is the AD curve.

With \( M = 300, \) the AD curve is \( 1.5Y = 120 + (300/P), \) or \( Y = 80 + (200/P). \) The AD curve is shown in Fig. 5.

e. 
To find the intersection of the SRAS curve \( (Y = 10P) \) and the AD curve \[ Y = 80 + (200/P), \] find the price level such that \( 10P = 80 + (200/P). \) 
This can be rewritten as \( 10P^2 - 80P - 200 = 0, \) or as \( P^2 - 8P - 20 = 0. \) 
This can be factored as \( (P - 10)(P + 2) = 0. \)
The nonnegative root is $P = 10$.

At $P = 10$, from the SRAS curve, $Y = 10P = 10 \times 10 = 100$.

On the IS curve, $100 = 120 - 500r$, or $r = 0.04$.

Since $P = 2^{\sqrt{N}}$, or $10 = 2^{\sqrt{N}}$, then $\sqrt{N} = 5$, or $N = 25$.

The real wage is $w = 20/P = 20/10 = 2$.

f.

When the money supply falls to 135, the AD curve becomes $1.5Y = 120 + (135/P)$, or $Y = 80 + (90/P)$.

The AD curve intersects the SRAS curve where $10P = 80 + (90/P)$. This can be rewritten as $10P^2 - 80P - 90 = 0$, or $P^2 - 8P - 9 = 0$. This can be factored as $(P - 9)(P + 1) = 0$, which has the nonnegative solution $P = 9$.

From the SRAS curve, $Y = 10P = 10 \times 9 = 90$. From the IS curve $90 = 120 - 500r$, which has the solution $r = 0.06$.

Since $P = 2^{\sqrt{N}}$, $N = (P/2)^2 = 4.5^2 = 20.25$.

The real wage is $w = W/P = 20/9 = 2 \frac{2}{9}$.

6.

a. $Y = C + I + G = [325 + 0.5(1000 - 150) - 500r] + [200 - 500r] + 150$, so $1000r = 100$, so $r = 0.10$.

$M/P = L$, so $6000/P = 0.5Y - 1000r = (0.5 \times 1000) - (1000 \times 0.10) = 400$, so $P = 15$.

$C = 325 + 0.5(Y - T) - 500r = 325 + 0.5(1000 - 150) - (500 \times .10) = 700$.

$I = 200 - 500r = 200 - (500 \times .10) = 150$.

b. \[ \hat{a}_{IS} = \frac{c_0 + i_0 + G - c_Yt_0}{c_r + i_r} = \frac{[325 + 200 + 150 - (0.5 \times 150)]}{500 + 500} = 0.6. \]

\[ \hat{a}_{IS} = \frac{[1 - (1 - t)c_Y]}{c_r + i_r} = \frac{[1 - (1 - 0) 0.5]}{500 + 500} = .0005. \]

\[ \hat{a}_{LM} = \frac{L}{L} = 0/1000 - 0 = 0. \]

\[ \hat{a}_{LM} = \frac{1/1000}{0.5/1000} = .0005. \]

$L = 1000$.

c. Since $P = 15$ at full employment, then $Y = 1000$ and $r = 0.10$.

d. \[ \hat{a}_{IS} = \frac{c_0 + i_0 + G - c_Yt_0}{c_r + i_r} = \frac{[325 + 200 + 250 - (0.5 \times 150)]}{500 + 500} = 0.7. \]

$M/P = 6000/15 = 400$.

$Y = [\hat{a}_{IS} - \hat{a}_{LM} + (1/L)(M/P)]/[\hat{a}_{IS} + \hat{a}_{LM}] = [0.7 - 0 + (400/1000)]/(0.0005 + 0.0005) = 1.1/0.001 = 1100$.

e. \[ \hat{A}Y/\hat{A}G = 1/[c_r + i_r(\hat{a}_{IS} + \hat{a}_{LM})] = 1/[500 + 500(0.0005 + 0.0005)] = 1. \]
The result is the same as in part (d). In part (d), $\ddot{\text{Y}} = 100$ when $\ddot{G} = 100$, so $\ddot{\text{Y}}/\ddot{G} = 1$. 
Analytical Problems

Draw the figures for the answers. Name the different points in the curves that you will be referring to and state their meaning. Ex: point A is the starting point, point B shows the short-run equilibrium after the change, and point C shows the long-run equilibrium after the change.

1. a. The increase in tax incentives increases investment, shifting the IS curve to the right, and shifting the AD curve up. The short-run equilibrium is at the interception between the new IS curve and the LM curve and between the new AD curve and the short-run AS curve (horizontal line at the initial price level). Output increases, the real interest rate increases, employment increases, and the price level is unchanged.

To restore long-run equilibrium, the price level rises, shifting the LM curve up and the short-run aggregate supply curve also up. The long-run equilibrium is at the interception between the new IS curve, the FE line and the new LM curve and between the new AD curve and the long-run AS line. Compared to the starting point, output is the same, the real interest rate is higher, employment is the same, and the price level is higher.

b. The increase in tax incentives increases saving-shifting the IS curve down, and shifting the AD curve also down. The short-run equilibrium is at the interception between the new IS curve and the LM curve and between the new AD curve and the short-run AS curve. Output decreases, the real interest rate decreases, employment decreases, and the price level is unchanged.

To restore long-run equilibrium, the price level declines, shifting the LM curve down and the short run aggregate supply curve also down. Compared to the starting point, in the long-run equilibrium, output is the same, the real interest rate is lower, employment is the same, and the price level is lower.

c. A wave of investor pessimism reduces investment. This shifts the IS and AD curves to the left, having the same result as in problem part (b).

d. An increase in consumer confidence increases consumption spending, shifting the IS curve and the AD curve to the right, with the same result as in problem part (a).

4. An increase in government purchases shifts the IS and AD curves to the right to return the economy to full employment, instead of waiting for the price level to fall to get there. The advantage of doing so, according to Keynesians, is that full employment is restored quickly, whereas if the price level must adjust, it may take a long time for full employment to be restored. In the short run, the fiscal expansion does not affect the real wage, since it is an efficiency wage. However, it increases employment and it increases current and future taxes to pay for the higher government spending. The effect on
consumption is ambiguous, with the rise in output raising consumption, while the rise in taxes reduces consumption. In
the long run, at full employment, the lasting effects of the fiscal expansion are to decrease consumption, because of the
higher real interest rate and the higher taxes, with more of the economy's output devoted to government purchases and
less to the private sector.
Whether a program of fiscal stimulus in response to a recession is worthwhile depends on the benefits of the government
purchases and on how long it takes the economy to return to a full-employment equilibrium by a change in the price
level. The more beneficial are government purchases, the more likely such a program is to increase economic welfare.
The longer the free market takes to restore equilibrium, the more likely such a program is to increase economic welfare.

5.

a. In response to expansionary monetary policy, aggregate demand increases, increasing output and labor demand. This
causes the labor demand curve to shift to the right in the primary labor market. The result is an increase in employment
and output with no change in the real wage in the primary labor market. Since more workers are now in the primary
labor market, the labor supply in the secondary labor market decreases. This causes an increase in the real wage, a
decrease in employment, and a decrease in output in the secondary labor market.

b. Increased immigration has no effect in the primary labor market, since labor supply changes in general have no effect. In
the secondary labor market, the immigration shifts the labor supply curve to the right, causing a reduction in the real
wage, increased employment, and increased output. However, to some extent these effects may be mitigated by the fact
that increased immigration leads to increased aggregate demand, increasing labor demand in both the primary and
secondary markets.

c. If there is a shift in the effort curve, the efficiency wage rises in the primary labor market. Since effort exerted at the
higher wage is the same as before the change, the shift in the effort curve has no impact on the marginal product of
labor, so there is no shift in the labor demand curve. So the effect of the higher real (efficiency) wage is to reduce
employment and thus output in the primary labor market. This means that labor supply in the secondary labor market
increases, shifting the labor supply curve to the right. The real wage falls, employment rises, and output rises in the
secondary labor market.

d. The productivity improvement shifts the labor demand curve to the right, so at the fixed real (efficiency) wage, firms
demand more labor. Employment increases, so output increases in the primary labor market. The increase in
employment in the primary labor market reduces the labor supply in the secondary labor market, shifting the labor
supply curve to the left. This increases the real wage, and reduces employment and output in the secondary labor
market.

e. The productivity improvement in the secondary labor market has no effect on the primary labor market. In the
secondary labor market, increased productivity increases the marginal product of labor so that labor demand increases.
The result is a higher real wage, higher employment, and increased output.