b. $M = 3600$, so $M / P = 1800$. Setting money supply equal to money demand: $1800 = 1000 + 0.2Y - 20{,}000r$

$20{,}000r = -800 + 0.2Y$
$r = -0.04 + (Y / 100{,}000)$.
When $Y = 5000$, $r = 0.01$.
When $Y = 6000$, $r = 0.02$.

The LM curve is shifted down from LM^a to LM^b in Fig. 9.20, since the same level of Y gives a lower r at equilibrium

c. $M^d / P = 2000 + 0.2Y - 20{,}000(r + \pi^e)$

$= 2000 + 0.2Y - 20{,}000r - (20{,}000 \times .04)$
$= 1200 + 0.2Y - 20{,}000r$.
Setting money supply equal to money demand:
$1500 = 1200 + 0.2Y - 20{,}000r$
$20{,}000r = -300 + 0.2Y$
$r = -0.015 + (Y/100{,}000)$.
When $Y = 5000$, $r = 0{,}035$.
When $Y = 6000$, $r = 0.045$.

The LM curve is shifted up from LM^a to LM^C in Fig. 9.20, since there is a higher real interest rate for every given level of output.

3. a. First, we'll find the IS curve.
$S^d = Y - C^d - G = Y - [200 + 0.8(Y - T) - 500r] - G = Y - [200 + (0.6Y - 16) - 500r] - G$
$= -184 + 0.4Y + 500r - G$.
Setting $S^d = I^d$ gives $-184 + 0.4Y + 500r - G = 200 - 500r$.
Solving this for Y in terms of r gives $Y = (960 + 2.5G) - 2500r$.
When $G = 196$, this is $Y = 1450 - 2500r$.

Next, we'll find the LM curve. Setting money demand equal to money supply gives $9890/P = 0.5Y - 250r - 25$, which can be solved for $Y = 19{,}780/P + 50 + 500r$.

With full-employment output of 1000, using this in the IS curve and solving for r gives $r = 0.18$. Using $Y = 1000$ and $r = 0.18$ in the LM curve and solving for P gives $P = 23$. Plugging these results into the consumption and investment equations gives $C = 694$ and $I = 110$.

b. With $G = 216$, the IS curve becomes $Y = 1500 - 2500r$. With $Y = 1000$, the IS curve gives $r = .20$, the LM curve gives $P = 23.27$, the consumption equation gives $C = 684$, and the investment equation gives $I = 100$.

4. a. First, look at labour market equilibrium.

Labour supply is $NS = 55 + 10(1 - t)w$. Labour demand comes from the equation $w = 5A - 0.005A\ ND$. Substituting the latter equation into the former, and equating labour supply and labour demand gives

$N = 100$. Using this in either the labour supply or labour demand equation then gives $w = 9$. Using N in the production function gives $Y = 950$.

b. Next, look at goods market equilibrium and the IS curve.

$S^d - Y - C^d - G = Y - [300 - 0.8(Y - T) - 200r] - G = Y - [300 - (0.4Y - 16) - 200r] - G$
$= -284 - 0.6Y - 200r - G$.
Setting $S^d = I^d$ gives $-284 + 0.6Y + 200r - G = 258.5 - 250r$.
Solving this for r in terms of Y gives $r = (542.5 - G)/450 - 0.004/3\ Y$.
When $G = 50$, this is $r = 1.31666... -0.004/3\ Y$.
With full-employment output of 950, using this in the IS curve and solving for r gives $r = 0.05$.
Plugging these results into the consumption and investment equation gives $C = 654$ and $I = 246$.

c. Next, look at asset market equilibrium and the LM curve.

Setting money demand equal to money supply gives $9150/P = 0.5Y - 250(r - 0.02)$, which can be solved for $r = [0.5Y - (5 - 9150/P)]/250$. With $Y = 950$ and $r = 0.05$. solving for P gives $P = 20$.

d. With $G = 72.5$, the IS curve becomes $r = 1.3666... -0.004/3\ Y$. With $Y = 950$. the IS curve gives $r = .10$, the LM curve gives $P = 20.56$, the consumption equation gives $C = 644$. and the investment equation gives $I = 233.5$. The real wage, employment, and output are unaffected by the change.

5. The IS curve is found by setting desired saving equal to desired investment. Desired saving is $Sd = Y - Cd - G = Y - [1275 - 0.5(Y - T) - 200r] - G$. Setting $Sd = Id$ gives $Y - [1275 - 0.5(Y - 200r] - G = 900 - 200r$, or $Y = 4350 - 800r + 2G - T$. The LM curve is $M / P = L = 0.5Y - 200i = 0.5Y - 200(r + \pi) - 0.5Y - 200r$.

a. $T = G = 450$, $M = 9000$. The IS curve gives $Y = 4350 - 800r - 2G - T = 4350 - 800r + (2 \times 450) - 450 = 4800 - 800r$. The LM curve gives $9000 / P = 0.5Y - 200r$. To find the aggregate demand curve, eliminate r in the two equations by multiplying the LM curve through by 4 and rearrange the resulting equation and the IS curve.

LM: $9000 / P = 0.5Y - 200r$. Multiplying by 4 gives $36{,}000 / P = 2Y - 800r$. Rearranging gives $800r = 2Y - 36{,}000 / P$. IS: $Y = 4800 - 800r$. Rearranging gives $800r = 4800 - Y$. Setting the right-hand sides of these two equations to each other (since both equal $800r$) gives: $2Y - (36.000 / P) = 4800 - Y$, or $3Y = 4800 + (36{,}000 / P)$, or $Y = 1600 - (12{,}000 / P)$; this is the AD curve. With $Y = 4600$ at full employment, the AD curve gives $4600 = 1600 + (12{,}000 / P)$, or $P = 4$. From the IS curve $Y = 4800 - 800r$, so $4600 = 4800 - 800r$, or $800r = 200$, so $r = 0.25$. Consumption is $C = 1275 + 0.5(Y - T) - 200r = 1275 + 0.5(4600 - 450) - (200 \times 0.25) = 3300$. Investment is $I = 900 - 200r = 900 - (200 \times 0.25) = 850$.

a. $T = G = 450$, $M = 9000$. The *IS* curve gives $Y = 4350 - 800r + 2G - T = 4350 - 800r + (2 \times 450) - 450 = 4800 - 800r$. The *LM* curve gives $9000/P = 0.5Y - 200r$. To find the aggregate demand curve, eliminate r in the two equations by multiplying the *LM* curve through by 4 and subtracting the *IS* curve from it.

LM: $9000 / P = 0.5Y - 200r$. Multiplying by 4 gives $36{,}000 / P = 2Y - 800r$.

IS: $Y = 4800 - 800r$.

$LM - IS = AD$: $(36{,}000 / P) - Y = 2Y - 800r - 4800 + 800r$, or $(36{,}000 / P) + 4800 = 3Y$, or $Y - 1600 + (12{,}000 / P)$

With $Y = 4600$ at full employment, the *AD* curve gives $4600 = 1600 + (12{,}000 / P)$, or $P = 4$. From the *IS* curve $Y = 4800 - 800r$, so $4600 = 4800 - 800r$, or $800r = 200$, so $r = 0.25$. Consumption is $C = 1275 + 0.5(Y - T) - 200r = 1275 + 0.5(4600 - 450) - (200 \times 0.25) = 3300$. Investment is $I = 900 - 200r = 900 - (200 \times 0.25) = 850$.

b. Following the same steps as above, with $M = 4500$ instead of 9000, gives the aggregate demand curve *AD*. $Y = 1600 + (6000 / P)$. With $Y = 4600$, this gives $P = 2$. Nothing has changed in the *IS* equation, so it still gives $r = 0.25$. And nothing has changed in either the consumption or investment equations, so we still get $C = 3300$ and $I = 850$. Money is neutral here, as no real variables are affected and the price level changes in proportion to the money supply.

c. $T = G = 330$, $M = 9000$. The *IS* curve is $Y = 4350 = 800r + 2G - T = 4350 - 800r + (2 \times 330) - 330 = 4680 - 800r$

LM: $36{,}000 / P = 2Y - 800r$

IS: $Y = 4680 - 800r$

$LM - IS = AD$: $(36{,}000 / P) - Y = 2Y - 800r - 4680 + 800r$, or $(36{,}000 / P) + 4680 = 3Y$, or $Y = 1560 + (12{,}000 / P)$

With $Y = 4600$ at full employment, the *AD* curve gives $4600 = 1560 - (12.000 / P)$, or $P - 3.95$. From the *IS* curve, $Y = 4680 - 800r$, so $4600 = 4680 - 800r$, or $800r = 80$. so $r = 0.10$. Consumption is $C = 1275 - 0.5(Y - T) - 200r = 1275 - 0.5(4600 - 330) - (200 \times 0.10) = 3390$. Investment is $I = 900 - 200r = 900 - (200 \times 0.10) + 880$.

4. *AD*: $Y = 300 + 30(M / P)$, AS: $Y = 500 + 10(P - P^e)$ $M = 400$.

a. $P^e = 60$. Setting $AD = AS$ to eliminate Y, we get $300 + 30(M / P) = 500 + 10(P - P^e)$. Plugging the values of *M* and P^e gives $300 + (30 \times 400 / P) = 500 + 10(P - 60)$, or $300 + (12{,}000 / P) = 500 + 10P - 600$, or $400 + (12{,}000 / P) = 10P$. Multiplying this equation through by $P / 10$ gives $40P + 1200 = P^e$, or $P^e - 40P - 1200 = 0$. This can be factored into $(P - 60)(P + 20) = 0$, *P* can't be negative, so the only solution to this equation is $P = 60$. At this equilibrium $P = P^e$, so $Y = 500$, and the economy is at full-employment output.

b. With an unanticipated increase in the money supply to $M = 700$; the expected price level is unchanged at $P^e = 60$. The aggregate demand curve is $Y = 300 + 30(M / P) = 300 + (30 \times 700 / P) = 300 + (21{,}000 / P)$. The aggregate supply curve is $Y = 500 + 10(P - P^e) = 500 + 10(P - 60) = 10P - 100$. Setting $AD = AS$ to eliminate Y gives $300 + (21.000 / P) = 10P - 100$, or $400 - (21{,}000 / P) = 10P$, or $P - 40 - (2100 / P) = 0$. Multiplying through by P gives $P^e - 40P - 2100 = 0$. This can be factored as $(P - 70)(P - 30) = 0$, which has the positive solution $P = 70$. From the AD curve, $Y = 300 - (21{,}000 / P) = 300\ (21{,}000 / 70) = 600$.

c. When M − 700 and is anticipated $P = P^e$. Then the AD curve is $Y = 300 + (21{,}000 / P)$ and the AS curve is $Y = 500$. Setting $AD = AS$ gives $500 = 300 + (21{,}000 / P$, which has the solution $P = 105$.

5. a. To find the Solow residual, use the equation for the production function, dividing through to solve for A: $A = Y / K^{0.3}N^{0.7}$. Assuming there's no change in utilization rates, this is the measured Solow residual. Given that equation, plugging in the values for Y, K, and N, gives the Solow residual as 1.435 in 2000 and 1.507 in 2001. The growth rate of the Solow residual is [(1.507/1.435) - 1] x 100% = 5.0%.

b. With no change in utilization rates, the growth rate of the Solow residual equals the growth rate of productivity (A), 5.0%.

c. With a change in utilization rates, the production function is modified, as shown in Eq. (10.2). Now productivity is measured as $A = Y / (u_K K)^{0.3}(u_N N)^{0.7}$ but the Solow residual is still measured as in part (a). Setting $u_N = 1$ in year 2000 and 1.03 in year 2001, we calculate the value of A as 1.435 in 2000 (as in part *a*), and 1.476 in 2001.

This is an increase in productivity of [(1.476/1.435)-1] x100% = 2.9%, significantly less than the 5.0% increase in the Solow residual.

d. Setting $u_N = 1$ in year 2000 and 1.03 in year 2001, and $u_K = 1$ in year 2000 and 1.03 in year 2001, we calculate the value of A as 1.435 in 2000 (as in part *a*), and 1.463 in 2001. This is an increase in productivity of [(1.463/1.435) - 1] x 100% = 2.0%, again significantly less than the 5.0% increase in the Solow residual.

This problem illustrates the idea that the measured Solow residual grows faster than productivity when the utilization rates of capital and labor increase.

6. An example is shown in Figure 11.5. There are several long cycles in output.

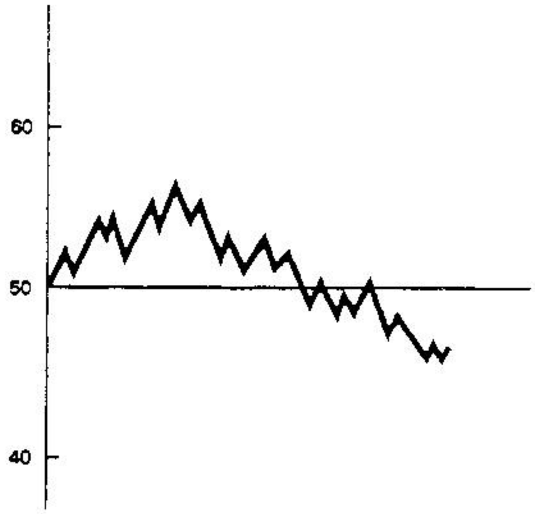

Figure 11.5

Analytical Problems

1. a. The increase in MPK^f leaves aggregate supply unchanged, since expected future labour income and expected future wages are unchanged. But aggregate demand increases, because firms increase investment, shifting the *IS* curve up. There is no shift in either the *LM* curve or the *FE* line.

   Figure 11.6(a) shows that the increase in aggregate demand causes no change in output, since the *AS* curve is vertical, but the price level increases. Figure 11.6(b) shows the shift to the right in the *IS* curve from IS^1 to IS^2. To get the economy to equilibrium, the price level rises so that the *LM* curve shifts from LM^1 to LM^2. The real interest rate increases as a result. In the labour market, there is no change in labour demand or supply, so employment and output are unchanged. Since the real interest rate rises, saving increases and consumption declines. Since investment equals saving, investment also rises.

   b. The misperceptions theory gets a different result. As shown in Fig. 11.7. the shift in the aggregate demand curve from AD^1 to AD^2 increases both output and the price level as the economy moves along the short-run aggregate supply curve *SRAS*. The difference in this result compared to the result in part (a) comes from producers misperceiving the change in the price level as a change in relative prices, and increasing their labour demand and output.

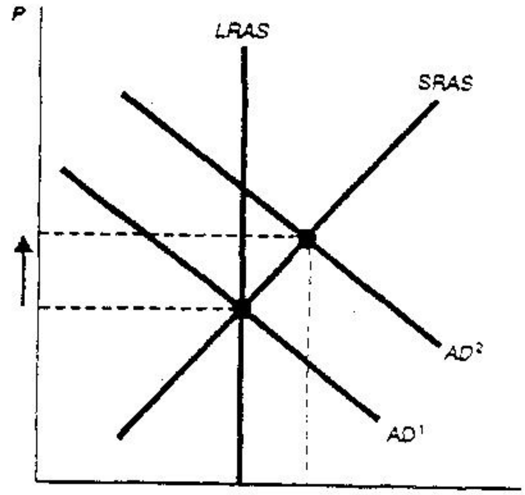

Figure 11.7

2. In the case of a permanent increase in government purchases, the income effect on labour supply, which arises because the present value of taxes increases to pay for the added government spending, is much higher than in the case of a temporary increase in government spending. So workers increase their labour supply more when the government spending change is permanent than when it is temporary.

   b. Desired national saving is unaffected by the change in government spending if the change in consumption is just equal to the change in taxes, so there is no shift in the saving curve. If investment is also unaffected by the change in government spending, then the *IS* curve does not shift.

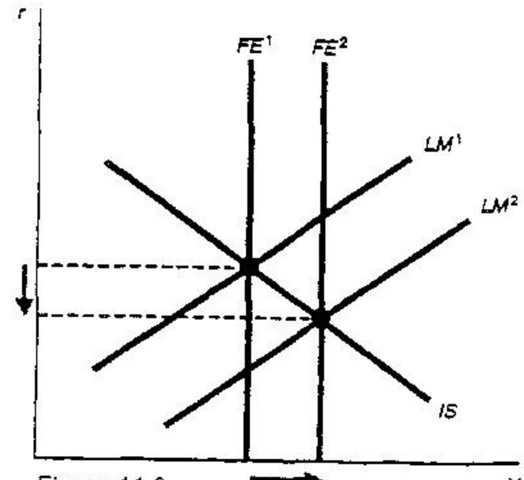

Figure 11.8

   c. Figure 11.8 shows the effect of the increase in government purchases on the economy. The *FE* line shifts to the right from FE^1 to FE^2 due to the increase in labour supply. To restore equilibrium, the price level must decline to shift the *LM* curve from LM^1 to LM^2. So output rises and the real interest rate declines.

If consumption falls less than the increase in government purchases, the *IS* curve shifts up from IS^1 to IS^2 in Fig. 11.9. As a result of the shift in the *IS* curve, the real interest rate and the price level will fall by less than in the case in which current consumption falls by 100, and in fact, the real interest rate and the price level may even rise if the *IS* curve shifts by a lot, as shown in the figure.

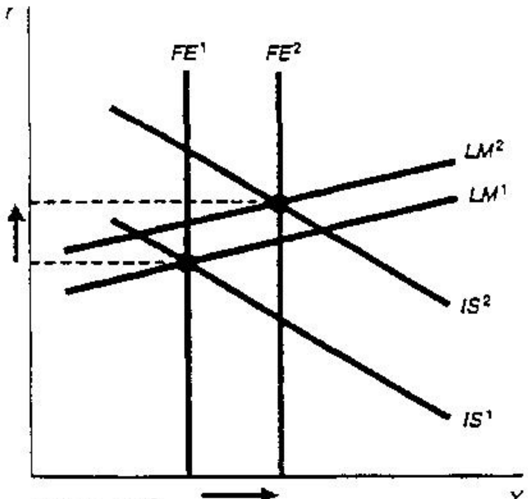

Figure 11.9

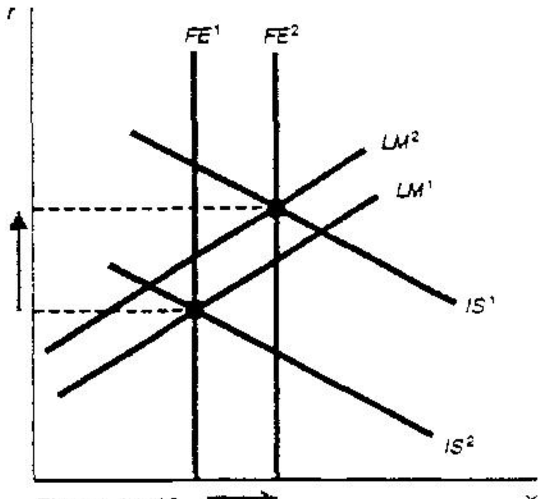

Figure 11.10

3. The temporary increase in government purchases causes an income effect that increases workers' labour supply. This results in an increase in the full-employment level of output from FE^1 to FE^2 in Fig. 11.10. The increase in government purchases also shifts the *IS* curve up and to the right from IS^1 to IS^2, as it reduces national saving. Assuming that the shift to the right in the *IS* curve is larger than the shift to the right in the *FE* line, the price level must rise to get back to equilibrium at full employment, by shifting the *LM* curve up and to the left from LM^1 to LM^2. The result is an increase in output and the real interest rate.

Figure 11.11 shows the impact on the labour market. Labour supply shifts from *NS*~ to NS2, leading to a decline in the real wage and a rise in employment. Average labour productivity declines, since employment rises while capital is fixed. Investment declines, since the real interest rate rises.

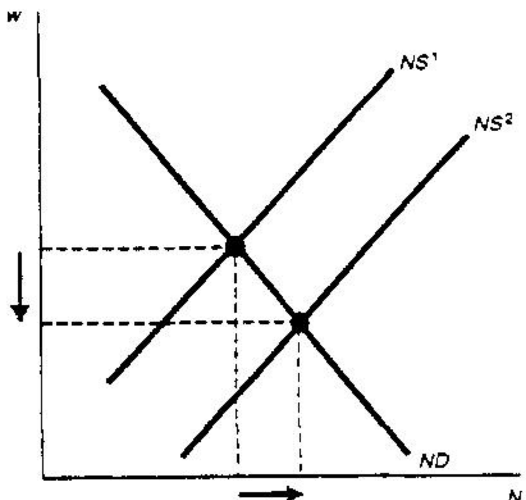

Figure 11.11