services such as air traffic control. All of these activities are part of GDP. Transfer ments are government payments to individuals that are not in exchange for goo services. They are the opposite of taxes: taxes reduce household disposable in whereas transfer payments increase it. Examples of transfer payments include S Security payments to the elderly, unemployment insurance, and veterans' benefits

7. Consumption, investment, and government purchases determine demand for the e my's output, whereas the factors of production and the production function dete the supply of output. The real interest rate adjusts to ensure that the demand fo economy's goods equals the supply. At the equilibrium interest rate, the demar goods and services equals the supply.

8. When the government increases taxes, disposable income falls, and therefore cons tion falls as well. The decrease in consumption equals the amount that taxes in multiplied by the marginal propensity to consume (*MPC*). The higher the *MPC* i greater is the negative effect of the tax increase on consumption. Because out fixed by the factors of production and the production technology, and governmen chases have not changed, the decrease in consumption must be offset by an incre investment. For investment to rise, the real interest rate must fall. Therefore, increase leads to a decrease in consumption, an increase in investment, and a fall real interest rate.

Problems and Applications

Chpt 3

1. a. According to the neoclassical theory of distribution, the real wage equals th ginal product of labor. Because of diminishing returns to labor, an increase labor force causes the marginal product of labor to fall. Hence, the real wage

   b. The real rental price equals the marginal product of capital. If an earth destroys some of the capital stock (yet miraculously does not kill anyone and the labor force), the marginal product of capital rises and, hence, the real price rises.

   c. If a technological advance improves the production function, this is lik increase the marginal products of both capital and labor. Hence, the real wa the real rental price both increase.

2. A production function has decreasing returns to scale if an equal percentage incr all factors of production leads to a smaller percentage increase in output. For ex if we double the amounts of capital and labor, and output less than doubles, th production function has decreasing returns to capital and labor. This may ha there is a fixed factor such as land in the production function, and this fixed becomes scarce as the economy grows larger.

   A production function has increasing returns to scale if an equal perc increase in all factors of production leads to a larger percentage increase in outp example, if doubling inputs of capital and labor more than doubles output, then t duction function has increasing returns to scale. This may happen if specializa labor becomes greater as population grows. For example, if one worker builds then it takes him a long time because he has to learn many different skills, must constantly change tasks and tools; all of this is fairly slow. But if many v build a car, then each one can specialize in a particular task and become very fas

3. a. A Cobb–Douglas production function has the form $Y = AK^{\alpha}L^{1-\alpha}$. The text that the marginal products for the Cobb–Douglas production function are:

$$MPL = (1 - \alpha)Y/L.$$

$$MPK = \alpha Y/K.$$

Competitive profit-maximizing firms hire labor until its marginal product equals the real wage, and hire capital until its marginal product equals the real rental rate. Using these facts and the above marginal products for the Cobb–Douglas production function, we find:

$$W/P = MPL = (1-\alpha)Y/L.$$

$$R/P = MPK = \alpha Y/K.$$

Rewriting this:

$$(W/P)L = MPL \times L = (1-\alpha)Y.$$

$$(R/P)K = MPK \times K = \alpha Y.$$

Note that the terms $(W/P)L$ and $(R/P)K$ are the wage bill and total return to capital, respectively. Given that the value of $\alpha = 0.3$, then the above formulas indicate that labor receives 70 percent of total output, which is $(1 - 0.3)$, and capital receives 30 percent of total output.

b. To determine what happens to total output when the labor force increases by 10 percent, consider the formula for the Cobb–Douglas production function:

$$Y = AK^{\alpha}L^{1-\alpha}.$$

Let Y_1 equal the initial value of output and Y_2 equal final output. We know that $\alpha = 0.3$. We also know that labor L increases by 10 percent:

$$Y_1 = AK^{0.3}L^{0.7}.$$

$$Y_2 = AK^{0.3}(1.1L)^{0.7}.$$

Note that we multiplied L by 1.1 to reflect the 10-percent increase in the labor force.

To calculate the percentage change in output, divide Y_2 by Y_1:

$$\frac{Y_2}{Y_1} = \frac{AK^{0.3}(1.1L)^{0.7}}{AK^{0.3}L^{0.7}}$$

$$= (1.1)^{0.7}$$

$$= 1.069.$$

That is, output increases by 6.9 percent.

To determine how the increase in the labor force affects the rental price of capital, consider the formula for the real rental price of capital R/P:

$$R/P = MPK = \alpha AK^{\alpha-1}L^{1-\alpha}.$$

We know that $\alpha = 0.3$. We also know that labor (L) increases by 10 percent. Let $(R/P)_1$ equal the initial value of the rental price of capital, and $(R/P)_2$ equal the final rental price of capital after the labor force increases by 10 percent. To find $(R/P)_2$, multiply L by 1.1 to reflect the 10-percent increase in the labor force:

$$(R/P)_1 = 0.3AK^{-0.7}L^{0.7}.$$

$$(R/P)_2 = 0.3AK^{-0.7}(1.1L)^{0.7}.$$

The rental price increases by the ratio

$$\frac{(R/P)_2}{(R/P)_1} = \frac{0.3AK^{-0.7}(1.1L)^{0.7}}{0.3AK^{-0.7}L^{0.7}}$$

$$= (1.1)^{0.7}$$

$$= 1.069.$$

So the rental price increases by 6.9 percent.

To determine how the increase in the labor force affects the real wage, consider the formula for the real wage W/P:

$$W/P = MPL = (1 - \alpha)AK^{\alpha}L^{-\alpha}.$$

We know that $\alpha = 0.3$. We also know that labor (L) increases by 10 percent. Let $(W/P)_1$ equal the initial value of the real wage and $(W/P)_2$ equal the final value of the real wage. To find $(W/P)_2$, multiply L by 1.1 to reflect the 10-percent increase in the labor force:

$$(W/P)_1 = (1 - 0.3)AK^{0.3}L^{-0.3}.$$
$$(W/P)_2 = (1 - 0.3)AK^{0.3}(1.1L)^{-0.3}.$$

To calculate the percentage change in the real wage, divide $(W/P)_2$ by $(W/P)_1$:

$$\frac{(W/P)_2}{(W/P)_1} = \frac{(1-0.3)AK^{0.3}(1.1L)^{-0.3}}{(1-0.3)AK^{0.3}L^{-0.3}}$$

$$= (1.1)^{-0.3}$$
$$= 0.972.$$

That is, the real wage falls by 2.8 percent.

c. We can use the same logic as (b) to set

$$Y_1 = AK^{0.3}L^{0.7}.$$
$$Y_2 = A(1.1K)^{0.3}L^{0.7}.$$

Therefore, we have:

$$\frac{Y_2}{Y_1} = \frac{A(1.1K)^{0.3}L^{1.7}}{AK^{0.3}L^{0.7}}$$
$$= (1.1)^{0.3}$$
$$= 1.029.$$

This equation shows that output increases by about 3 percent. Notice that $\alpha < 0.5$ means that proportional increases to capital will increase output by less than the same proportional increase to labor.

Again using the same logic as (b) for the change in the real rental price of capital:

$$\frac{(R/P)_2}{(R/P)_1} = \frac{0.3A(1.1K)^{-0.7}L^{0.7}}{0.3AK^{-0.7}L^{0.7}}$$
$$= (1.1)^{-0.7}$$
$$= 0.935.$$

The real rental price of capital falls by 6.5 percent because there are diminishing returns to capital; that is, when capital increases, its marginal product falls.

Finally, the change in the real wage is:

$$\frac{(W/P)_2}{(W/P)_1} = \frac{0.7A(1.1K)^{-0.7}L^{0.7}}{0.7AK^{-0.7}L^{0.7}}$$
$$(1.1)^{0.3}$$
$$= 1.029.$$

Hence, real wages increase by 2.9 percent because the added capital increases the marginal productivity of the existing workers. (Notice that the wage and output have both increased by the same amount, leaving the labor share unchanged—a feature of Cobb–Douglas technologies.)

d. Using the same formula, we find that the change in output is:

$$\frac{Y_2}{Y_1} = \frac{(1.1A)K^{0.3}L^{0.7}}{AK^{0.3}L^{0.7}}$$
$$= 1.1.$$

This equation shows that output increases by 10 percent. Similarly, the rental price of capital and the real wage also increase by 10 percent:

$$\frac{(R/P)_2}{(R/P)_1} = \frac{0.3(1.1A)K^{-0.7}L^{0.7}}{0.3AK^{-0.7}L^{0.7}}$$
$$= 1.1.$$

$$\frac{(W/P)_2}{(W/P)_1} = \frac{0.7(1.1A)K^{0.3}L^{-0.3}}{0.7AK^{0.3}L^{-0.3}}$$
$$= 1.1.$$

4. Labor's share is WL/PY. If this ratio is about constant at, say, a value of 0.7, then it must be the case that $W/P = 0.7*Y/L$. This means that the real wage is roughly proportional to labor productivity. Hency, any trend in labor productivity must be matched by an equal trend in real wages—otherwise, labor's share would deviate from 0.7. Thus, the first fact (a constant labor share) implies the second fact (the trend in real wages closely tracks the trend in labor productivity)

5. a. According to the neoclassical theory, technical progress that increases the marginal product of farmers causes their real wage to rise.

b. The real wage in (a) is measured in terms of farm goods. That is, if the nominal wage is in dollars, then the real wage is W/PF, where PF is the dollar price of farm goods.

c. If the marginal productivity of barbers is unchanged, then their real wage is unchanged.

d. The real wage in (c) is measured in terms of haircuts. That is, if the nominal wage is in dollars, then the real wage is W/PH, where PH is the dollar price of a haircut.

e. If workers can move freely between being farmers and being barbers, then they must be paid the same wage W in each sector.

f. If the nominal wage W is the same in both sectors, but the real wage in terms of farm goods is greater than the real wage in terms of haircuts, then the price of haircuts must have risen relative to the price of farm goods.

g. Both groups benefit from technological progress in farming.

6. a. The marginal product of labor MPL is found by differentiating the production function with respect to labor:

$$MPL = \frac{dY}{dL}$$
$$= \frac{1}{3}K^{1/3}H^{1/3}L^{-2/3}.$$

This equation is increasing in human capital because more human capital makes all the existing labor more productive.

b. The marginal product of human capital MPH is found by differentiating the production function with respect to human capital:

$$MPH = \frac{dY}{dH}$$
$$= \frac{1}{3}K^{1/3}L^{1/3}H^{-2/3}.$$

2. a. National saving is the amount of output that is not purchased for current consumption by households or the government. We know output and government spending, and the consumption function allows us to solve for consumption. Hence, national saving is given by:

$$S = Y - C - G$$
$$= 5{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) - 1{,}000$$
$$= 750.$$

Investment depends negatively on the interest rate, which equals the world rate r^* of 5. Thus,

$$I = 1{,}000 - 50 \times 5$$
$$= 750.$$

Net exports equals the difference between saving and investment. Thus,

$$NX = S - I$$
$$= 750 - 750$$
$$= 0.$$

Having solved for net exports, we can now find the exchange rate that clears the foreign-exchange market:

$$NX = 500 - 500 \times \varepsilon$$
$$0 = 500 - 500 \times \varepsilon$$
$$\varepsilon = 1.$$

b. Doing the same analysis with the new value of government spending we find:

$$S = Y - C - G$$
$$= 5{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) - 1{,}250$$
$$= 500$$

$$I = 1{,}000 - 50 \times 5$$
$$= 750$$

$$NX = S - I$$
$$= 500 - 750$$
$$= -250$$

$$NX = 500 - 500 \times \varepsilon$$

$$-250 = 500 - 500 \times \varepsilon$$

$$\varepsilon = 1.5.$$

The increase in government spending reduces national saving, but with an unchanged world real interest rate, investment remains the same. Therefore, domestic investment now exceeds domestic saving, so some of this investment must be financed by borrowing from abroad. This capital inflow is accomplished by reducing net exports, which requires that the currency appreciate.

c. Repeating the same steps with the new interest rate,

$$S = Y - C - G$$
$$= 5{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) - 1{,}000$$
$$= 750$$

$$I = 1{,}000 - 50 \times 10$$
$$= 500$$

$$NX = S - I$$
$$= 750 - 500$$
$$= 250$$

$$NX = 500 - 500 \times \varepsilon$$

$$250 = 500 - 500 \times \varepsilon$$

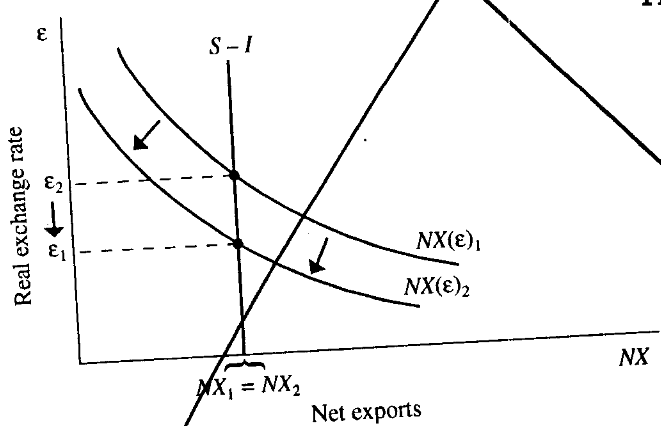
$$\varepsilon = 0.5.$$

Saving is unchanged from part (a), but the higher world interest rate lowers investment. This capital outflow is accomplished by running a trade surplus, which requires that the currency depreciate.

3. a. When Leverett's exports become less popular, its domestic saving $Y - C - G$ does not change. This is because we assume that Y is determined by the amount of capital and labor, consumption depends only on disposable income, and government spending is a fixed exogenous variable. Investment also does not change, since investment depends on the interest rate, and Leverett is a small open economy that takes the world interest rate as given. Because neither saving nor investment changes, net exports, which equal $S - I$, do not change either. This is shown in Figure 5–6 as the unmoving $S - I$ curve.

The decreased popularity of Leverett's exports leads to a shift inward of the net exports curve, as shown in Figure 5–6. At the new equilibrium, net exports are unchanged but the currency has depreciated.

Figure 5–6



Even though Leverett's exports are less popular, its trade balance has remained the same. The reason for this is that the depreciated currency provides a stimulus to net exports, which overcomes the unpopularity of its exports by making them cheaper.