CHAPTER 3 National Income: Where It Comes From and Where It Goes

Questions for Review

1. The factors of production and the production technology determine the amount of output an economy can produce. The factors of production are the inputs used to produce goods and services: the most important factors are capital and labor. The production technology determines how much output can be produced from any given amounts of these inputs. An increase in one of the factors of production or an improvement in technology leads to an increase in the economy's output.

2. When a firm decides how much of a factor of production to hire or demand, it considers how this decision affects profits. For example, hiring an extra unit of labor increases output and therefore increases revenue; the firm compares this additional revenue to the additional cost from the higher wage bill. The additional revenue the firm receives depends on the marginal product of labor (*MPL*) and the price of the good produced (*P*). An additional unit of labor produces *MPL* units of additional output, which sells for *P* dollars per unit. Therefore, the additional revenue to the firm is $P \times MPL$. The cost of hiring the additional unit of labor is the wage *W*. Thus, this hiring decision has the following effect on profits:

$$\begin{aligned}\Delta\text{Profit} &= \Delta\text{Revenue} - \Delta\text{Cost} \\ &= (P \times MPL) - W.\end{aligned}$$

   If the additional revenue, $P \times MPL$, exceeds the cost (*W*) of hiring the additional unit of labor, then profit increases. The firm will hire labor until it is no longer profitable to do so—that is, until the *MPL* falls to the point where the change in profit is zero. In the equation above, the firm hires labor until $\Delta\text{profit} = 0$, which is when $(P \times MPL) = W$.

   This condition can be rewritten as:

$$MPL = W/P.$$

   Therefore, a competitive profit-maximizing firm hires labor until the marginal product of labor equals the real wage. The same logic applies to the firm's decision regarding how much capital to hire: the firm will hire capital until the marginal product of capital equals the real rental price.

3. A production function has constant returns to scale if an equal percentage increase in all factors of production causes an increase in output of the same percentage. For example, if a firm increases its use of capital and labor by 50 percent, and output increases by 50 percent, then the production function has constant returns to scale.

   If the production function has constant returns to scale, then total income (or equivalently, total output) in an economy of competitive profit-maximizing firms is divided between the return to labor, $MPL \times L$, and the return to capital, $MPK \times K$. That is, under constant returns to scale, economic profit is zero.

4. A Cobb-Douglas production function function has the form $F(K,L) = AK^{\alpha}L^{1-\alpha}$. The text showed that the parameter α gives capital's share of income. (Since income equals output for the overall economy, it is also capital's share of output.) So if capital earns one-fourth of total income, then $\alpha = 0.25$. Hence, $F(K,L) = AK^{0.25}L^{0.75}$.

5. Consumption depends positively on disposable income—the amount of income after all taxes have been paid. The higher disposable income is, the greater consumption is.

   The quantity of investment goods demanded depends negatively on the real interest rate. For an investment to be profitable, its return must be greater than its cost. Because the real interest rate measures the cost of funds, a higher real interest rate makes it more costly to invest, so the demand for investment goods falls.

6. Government purchases are a measure of the dollar value of goods and services purchased directly by the government. For example, the government buys missiles and tanks, builds roads, and provides services such as air traffic control. All of these activities are part of GDP. Transfer payments are government payments to individuals that are not in exchange for goods or services. They are the opposite of taxes: taxes reduce household disposable income, whereas transfer payments increase it. Examples of transfer payments include Social Security payments to the elderly, unemployment insurance, and veterans' benefits.
7. Consumption, investment, and government purchases determine demand for the economy's output, whereas the factors of production and the production function determine the supply of output. The real interest rate adjusts to ensure that the demand for the economy's goods equals the supply. At the equilibrium interest rate, the demand for goods and services equals the supply.
8. When the government increases taxes, disposable income falls, and therefore consumption falls as well. The decrease in consumption equals the amount that taxes increase multiplied by the marginal propensity to consume (*MPC*). The higher the *MPC* is, the greater is the negative effect of the tax increase on consumption. Because output is fixed by the factors of production and the production technology, and government purchases have not changed, the decrease in consumption must be offset by an increase in investment. For investment to rise, the real interest rate must fall. Therefore, a tax increase leads to a decrease in consumption, an increase in investment, and a fall in the real interest rate.

Problems and Applications

1. a. According to the neoclassical theory of distribution, the real wage equals the marginal product of labor. Because of diminishing returns to labor, an increase in the labor force causes the marginal product of labor to fall. Hence, the real wage falls.
   b. The real rental price equals the marginal product of capital. If an earthquake destroys some of the capital stock (yet miraculously does not kill anyone and lower the labor force), the marginal product of capital rises and, hence, the real rental price rises.
   c. If a technological advance improves the production function, this is likely to increase the marginal products of both capital and labor. Hence, the real wage and the real rental price both increase.
2. A production function has decreasing returns to scale if an equal percentage increase in all factors of production leads to a smaller percentage increase in output. For example, if we double the amounts of capital and labor, and output less than doubles, then the production function has decreasing returns to scale. This may happen if there is a fixed factor such as land in the production function, and this fixed factor becomes scarce as the economy grows larger.

   A production function has increasing returns to scale if an equal percentage increase in all factors of production leads to a larger percentage increase in output. For example, if doubling inputs of capital and labor more than doubles output, then the production function has increasing returns to scale. This may happen if specialization of labor becomes greater as the population grows. For example, if only one worker builds a car, then it takes him a long time because he has to learn many different skills, and he must constantly change tasks and tools. But if many workers build a car, then each one can specialize in a particular task and become very fast at it.
3. a. A Cobb–Douglas production function has the form $Y = AK^{\alpha}L^{1-\alpha}$. The text showed that the marginal products for the Cobb–Douglas production function are:

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

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

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

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

An increase in human capital will increase the marginal product of labor 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:

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

An increase in human capital will decrease the marginal product of human capital because there are diminishing returns.

c. The labor share of output is the proportion of output that goes to labor. The total amount of output that goes to labor is the real wage (which, under perfect competition, equals the marginal product of labor) times the quantity of labor. This quantity is divided by the total amount of output to compute the labor share:

$$\text{Labor Share} = \frac{(\frac{1}{3} K^{1/3} H^{1/3} L^{2/3}) L}{K^{1/3} H^{1/3} L^{1/3}} = \frac{1}{3}.$$

We can use the same logic to find the human capital share:

$$\text{Human Capital Share} = \frac{\left(\frac{1}{3} K^{1/3} L^{1/3} H^{-2/3}\right) H}{K^{1/3} H^{1/3} L^{1/3}} = \frac{1}{3},$$

so labor gets one-third of the output, and human capital gets one-third of the output. Since workers own their human capital (we hope!), it will appear that labor gets two-thirds of output.

d. The ratio of the skilled wage to the unskilled wage is:

$$\frac{W_{\text{skilled}}}{W_{\text{unskilled}}} = \frac{MPL + MPH}{MPL} = \frac{\frac{1}{3} K^{1/3} L^{-2/3} H^{1/3} + \frac{1}{3} K^{1/3} L^{1/3} H^{-2/3}}{\frac{1}{3} K^{1/3} L^{-2/3} H^{1/3}} = 1 + \frac{L}{H}.$$

Notice that the ratio is always greater than 1 because skilled workers get paid more than unskilled workers. Also, when H increases this ratio falls because the diminishing returns to human capital lower its return, while at the same time increasing the marginal product of unskilled workers.

e. If more college scholarships increase H, then it does lead to a more egalitarian society. The policy lowers the returns to education, decreasing the gap between the wages of more and less educated workers. More importantly, the policy even raises the absolute wage of unskilled workers because their marginal product rises when the number of skilled workers rises.

8. If consumers increase the amount that they consume today, then private saving and, therefore, national saving will fall. We know this from the definition of national saving:

$$\begin{aligned}\text{National Saving} &= [\text{Private Saving}] + [\text{Public Saving}] \\ &= [Y - T - C(Y - T)] + [T - G].\end{aligned}$$

An increase in consumption decreases private saving, so national saving falls.

Figure 3–2 illustrates saving and investment as a function of the real interest rate. If national saving decreases, the supply curve for loanable funds shifts to the left, thereby raising the real interest rate and reducing investment.

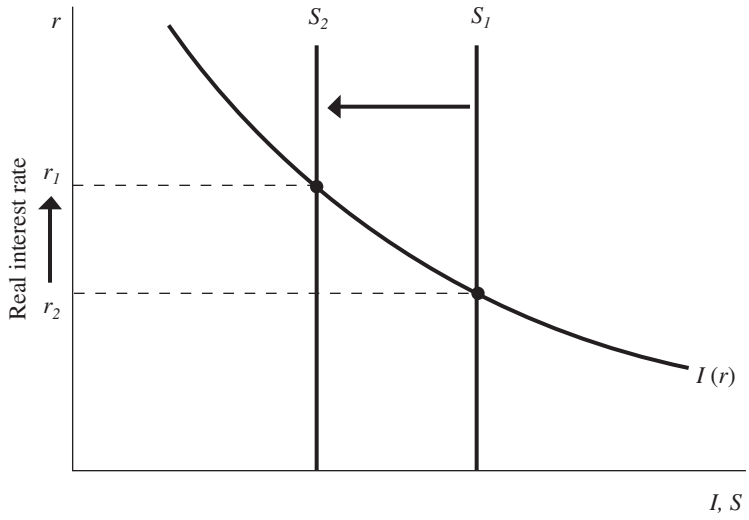


Figure 3–2

9. a. Private saving is the amount of disposable income, $Y - T$, that is not consumed:

$$\begin{aligned}S^{\text{private}} &= Y - T - C \\ &= 5{,}000 - 1{,}000 - (250 + 0.75(5{,}000 - 1{,}000)) \\ &= 750.\end{aligned}$$

Public saving is the amount of taxes the government has left over after it makes its purchases:

$$\begin{aligned}S^{\text{public}} &= T - G \\ &= 1{,}000 - 1{,}000 \\ &= 0.\end{aligned}$$

Total saving is the sum of private saving and public saving:

$$\begin{aligned}S &= S^{\text{private}} + S^{\text{public}} \\ &= 750 + 0 \\ &= 750.\end{aligned}$$

b. The equilibrium interest rate is the value of r that clears the market for loanable funds. We already know that national saving is 750, so we just need to set it equal to investment:

$$\begin{aligned}S &= I \\ 750 &= 1{,}000 - 50r\end{aligned}$$

Solving this equation for r, we find:

$$r = 5\%.$$

c. When the government increases its spending, private saving remains the same as before (notice that G does not appear in the S^{private} above) while government saving decreases. Putting the new G into the equations above:

$$S^{\text{private}} = 750$$

$$\begin{aligned} S^{\text{public}} &= T - G \\ &= 1{,}000 - 1{,}250 \\ &= -250. \end{aligned}$$

Thus,

$$\begin{aligned} S &= S^{\text{private}} + S^{\text{public}} \\ &= 750 + (-250) \\ &= 500. \end{aligned}$$

d. Once again the equilibrium interest rate clears the market for loanable funds:

$$\begin{aligned} S &= I \\ 500 &= 1{,}000 - 50r \end{aligned}$$

Solving this equation for r, we find:

$$r = 10\%.$$

10. To determine the effect on investment of an equal increase in both taxes and government spending, consider the national income accounts identity for national saving:

$$\begin{aligned} \text{National Saving} &= [\text{Private Saving}] + [\text{Public Saving}] \\ &= [Y - T - C(Y - T)] + [T - G]. \end{aligned}$$

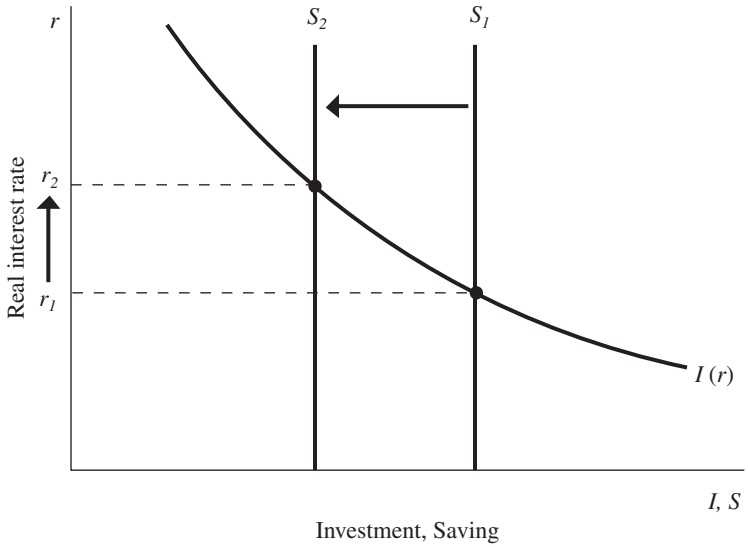
We know that Y is fixed by the factors of production. We also know that the change in consumption equals the marginal propensity to consume (MPC) times the change in disposable income. This tells us that

$$\begin{aligned} \Delta\text{National Saving} &= [-\Delta T - (MPC \times (-\Delta T))] + [\Delta T - \Delta G] \\ &= [-\Delta T + (MPC \times \Delta T)] + 0 \\ &= (MPC - 1)\,\Delta T. \end{aligned}$$

The above expression tells us that the impact on saving of an equal increase in T and G depends on the size of the marginal propensity to consume. The closer the MPC is to 1, the smaller is the fall in saving. For example, if the MPC equals 1, then the fall in consumption equals the rise in government purchases, so national saving $[Y - C(Y - T) - G]$ is unchanged. The closer the MPC is to 0 (and therefore the larger is the amount saved rather than spent for a one-dollar change in disposable income), the greater is the impact on saving. Because we assume that the MPC is less than 1, we expect that national saving falls in response to an equal increase in taxes and government spending.

The reduction in saving means that the supply of loanable funds curve shifts to the left in Figure 3–3. The real interest rate rises, and investment falls.

Figure 3–3



CHAPTER 4 Money and Inflation

Questions for Review

1. Money has three functions: it is a store of value, a unit of account, and a medium of exchange. As a store of value, money provides a way to transfer purchasing power from the present to the future. As a unit of account, money provides the terms in which prices are quoted and debts are recorded. As a medium of exchange, money is what we use to buy goods and services.
2. Fiat money is established as money by the government but has no intrinsic value. For example, a U.S. dollar bill is fiat money. Commodity money is money that is based on a commodity with some intrinsic value. Gold, when used as money, is an example of commodity money.
3. In many countries, a central bank controls the money supply. In the United States, the central bank is the Federal Reserve—often called the Fed. The control of the money supply is called *monetary policy*.

   The primary way that the Fed controls the money supply is through open-market operations, which involve the purchase or sale of government bonds. To increase the money supply, the Fed uses dollars to buy government bonds from the public, putting more dollars into the hands of the public. To decrease the money supply, the Fed sells some of its government bonds, taking dollars out of the hands of the public.
4. The quantity equation is an identity that expresses the link between the number of transactions that people make and how much money they hold. We write it as

   $$\text{Money} \times \text{Velocity} = \text{Price} \times \text{Transactions}$$
   $$M \times V = P \times T.$$

   The right-hand side of the quantity equation tells us about the total number of transactions that occur during a given period of time, say, a year. T represents the total number of transactions. P represents the price of a typical transaction. Hence, the product $P \times T$ represents the number of dollars exchanged in a year.

   The left-hand side of the quantity equation tells us about the money used to make these transactions. M represents the quantity of money in the economy. V represents the transactions velocity of money—the rate at which money circulates in the economy.

   Because the number of transactions is difficult to measure, economists usually use a slightly different version of the quantity equation, in which the total output of the economy Y replaces the number of transactions T:

   $$\text{Money} \times \text{Velocity} = \text{Price} \times \text{Output}$$
   $$M \times V = P \times Y.$$

   P now represents the price of one unit of output, so that $P \times Y$ is the dollar value of output—nominal GDP. V represents the income velocity of money—the number of times a dollar bill becomes a part of someone's income.
5. If we assume that velocity in the quantity equation is constant, then we can view the quantity equation as a theory of nominal GDP. The quantity equation with fixed velocity states that

   $$MV = PY.$$

   If velocity V is constant, then a change in the quantity of money (M) causes a proportionate change in nominal GDP (PY). If we assume further that output is fixed by the factors of production and the production technology, then we can conclude that the quantity of money determines the price level. This is called the *quantity theory of money*.

6. The holders of money pay the inflation tax. As prices rise, the real value of the money that people hold falls—that is, a given amount of money buys fewer goods and services since prices are higher.

7. The Fisher equation expresses the relationship between nominal and real interest rates. It says that the nominal interest rate i equals the real interest rate r plus the inflation rate π:

$$i = r + \pi.$$

This tells us that the nominal interest rate can change either because the real interest rate changes or the inflation rate changes. The real interest rate is assumed to be unaffected by inflation; as discussed in Chapter 3, it adjusts to equilibrate saving and investment. There is thus a one-to-one relationship between the inflation rate and the nominal interest rate: if inflation increases by 1 percent, then the nominal interest rate also increases by 1 percent. This one-to-one relationship is called the **Fisher effect**.

If inflation increases from 6 to 8 percent, then the Fisher effect implies that the nominal interest rate increases by 2 percentage points, while the real interest rate remains constant.

8. The costs of expected inflation include the following:
   a. **Shoeleather costs.** Higher inflation means higher nominal interest rates, which mean that people want to hold lower real money balances. If people hold lower money balances, they must make more frequent trips to the bank to withdraw money. This is inconvenient (and it causes shoes to wear out more quickly).
   b. **Menu costs.** Higher inflation induces firms to change their posted prices more often. This may be costly if they must reprint their menus and catalogs.
   c. **Greater variability in relative prices**. If firms change their prices infrequently, then inflation causes greater variability in relative prices. Since free-market economies rely on relative prices to allocate resources efficiently, inflation leads to microeconomic inefficiencies.
   d. **Altered tax liabilities.** Many provisions of the tax code do not take into account the effect of inflation. Hence, inflation can alter individuals' and firms' tax liabilities, often in ways that lawmakers did not intend.
   e. **The inconvenience of a changing price level.** It is inconvenient to live in a world with a changing price level. Money is the yardstick with which we measure economic transactions. Money is a less useful measure when its value is always changing.

   There is an additional cost to unexpected inflation:

   f. **Arbitrary redistributions of wealth.** Unexpected inflation arbitrarily redistributes wealth among individuals. For example, if inflation is higher than expected, debtors gain and creditors lose. Also, people with fixed pensions are hurt because their dollars buy fewer goods.

9. Hyperinflation is always a reflection of monetary policy. That is, the price level cannot grow rapidly unless the supply of money also grows rapidly; and hyperinflations do not end unless the government drastically reduces money growth. This explanation, however, begs a central question: Why does the government start and then stop printing lots of money? The answer almost always lies in fiscal policy: When the government has a large budget deficit (possibly due to a recent war or some other major event) that it cannot fund by borrowing, it resorts to printing money to pay its bills. And only when this fiscal problem is alleviated—by reducing government spending and collecting more taxes—can the government hope to slow its rate of money growth.

10. *Real variables* are measured in physical units, and *nominal variables* are measured in terms of money. Real variables have been adjusted for inflation and are often measured in terms of constant dollars, while nominal variables are measured in terms of current dollars. For example, real GDP is measured in terms of constant base-year dollars, while nominal GDP is measured in current dollars. An increase in real GDP means we

have produced a larger total quantity of goods and services, valued in base-year dollars. As another example, the real interest rate measures the increase in your purchasing power, the quantity of goods and services you can buy with your dollars, while the nominal interest rate measures the increase in the amount of current dollars you possess. The interest rate you are quoted by your bank, say 3 percent, is a nominal rate. If the inflation rate is 3 percent, then the real interest rate is 5 percent, meaning your purchasing power has only increased by 5 percent and not 8 percent. The quantity of dollars you possess has increased by 8 percent but you can only afford to buy 5 percent more goods and services with these dollars.

Problems and Applications

1. Money functions as a store of value, a medium of exchange, and a unit of account.
   a. A credit card can serve as a medium of exchange because it is accepted in exchange for goods and services. A credit card is, arguably, a (negative) store of value because you can accumulate debt with it. A credit card is not a unit of account—a car, for example, does not cost 5 VISA cards.
   b. A Rembrandt painting is a store of value only.
   c. A subway token, within the subway system, satisfies all three functions of money. Yet outside the subway system, it is not widely used as a unit of account or a medium of exchange, so it is not a form of money.
2. The real interest rate is the difference between the nominal interest rate and the inflation rate. The nominal interest rate is 11 percent, but we need to solve for the inflation rate. We do this with the quantity equation expressed in percentage-change form:

   $$\%\text{ Change in } M + \%\text{ Change in } V = \%\text{ Change in } P + \%\text{ Change in } Y.$$

   Rearranging this equation tells us that the inflation rate is given by:

   $$\%\text{ Change in } P = \%\text{ Change in } M + \%\text{ Change in } V - \%\text{ Change in } Y.$$

   Substituting the numbers given in the problem, we thus find:

   $$\%\text{ Change in } P = 14\% + 0\% - 5\%$$

   $$= 9\%.$$

   Thus, the real interest rate is 2 percent: the nominal interest rate of 11 percent minus the inflation rate of 9 percent.
3. a. Legislators wish to ensure that the real value of Social Security and other benefits stays constant over time. This is achieved by indexing benefits to the cost of living as measured by the consumer price index. With indexing, nominal benefits change at the same rate as prices.
   b. Assuming the inflation rate is measured correctly (see Chapter 2 for more on this issue), senior citizens are unaffected by the lower rate of inflation. Although they get less money from the government, the goods they purchase are cheaper; their purchasing power is exactly the same as it was with the higher inflation rate.
4. The money demand function is given as

   $$\left(\frac{M}{P}\right)^d = kY.$$

   a. To find the average inflation rate the money demand function can be expressed in terms of growth rates:

   $$\%\text{ growth } M^d - \%\text{ growth } P = \%\text{ growth } Y.$$

   The parameter k is a constant, so it can be ignored. The percentage change in nominal money demand M^d is the same as the growth in the money supply because nominal money demand has to equal nominal money supply. If nominal money demand grows 12 percent and real income (Y) grows 4 percent then the growth of the price level is 8 percent.

b. From the answer to part (a), it follows that an increase in real income growth will result in a lower average inflation rate. For example, if real income grows at 6 percent and money supply growth remains at 12 percent, then inflation falls to 6 percent. In this case, a larger money supply is required to support a higher level of GDP, resulting in lower inflation.

c. If velocity growth is positive, then all else the same inflation will be higher. From the quantity equation we know that:

$$\%\text{ growth } M + \%\text{ growth } V = \%\text{ growth } P + \%\text{ growth } Y.$$

Suppose that the money supply grows by 12 percent and real income grows by 4 percent. When velocity growth is zero, inflation is 8 percent. Suppose now that velocity grows 2 percent: this will cause prices to grow by 10 percent. Inflation increases because the same quantity of money is being used more often to chase the same amount of goods. In this case, the money supply should grow more slowly to compensate for the positive growth in velocity.

5. The major benefit of having a national money is seigniorage—the ability of the government to raise revenue by printing money. The major cost is the possibility of inflation, or even hyperinflation, if the government relies too heavily on seigniorage. The benefits and costs of using a foreign money are exactly the reverse: the benefit of foreign money is that inflation is no longer under domestic political control, but the cost is that the domestic government loses its ability to raise revenue through seigniorage. (There is also a subjective cost to having pictures of foreign leaders on your currency.)

   The foreign country's political stability is a key factor. The primary reason for using another nation's money is to gain stability. If the foreign country is unstable, then the home country is definitely better off using its own currency—the home economy remains more stable, and it keeps the seigniorage.

6. A paper weapon might have been effective for all the reasons that hyperinflation is bad. For example, a large increase in the money supply increases shoeleather and menu costs; it makes relative prices more variable; it alters tax liabilities in arbitrary ways; it increases variability in relative prices; it makes the unit of account less useful; and finally, it increases uncertainty and causes arbitrary redistributions of wealth. If the hyperinflation is sufficiently extreme, it can undermine the public's confidence in the economy and economic policy.

   Note that if foreign airplanes dropped the money, then the government would not receive seigniorage revenue from the resulting inflation, so this benefit usually associated with inflation is lost.

7. The money demand function is given as

$$\left(\frac{M}{P}\right)^d = L(i, Y) = \frac{Y}{5i}.$$

   a. If output Y grows at rate g, then real money balances $(M/P)^d$ must also grow at rate g, given that the nominal interest rate i is a constant.

   b. To find the velocity of money, start with the quantity equation $MV = PY$ and rewrite the equation as $V = (PY)/M = (P/M)Y$. Now, note that P/M is the inverse of the real money supply, which is equal to real money demand. Therefore, the velocity of money is $V = (5i/Y) \times Y$, or $V = 5i$.

   c. If the nominal interest rate is constant, then the velocity of money must be constant.

   d. A one-time increase in the nominal interest rate will cause a one-time increase in the velocity of money. There will be no further changes in the velocity of money.

8. One way to understand Coolidge's statement is to think of a government that is a net debtor in nominal terms to the private sector. Let B denote the government's outstanding debt measured in U.S. dollars. The debt in real terms equals B/P, where P is the price level. By increasing inflation, the government raises the price level and reduces in