

Here are the answers to the problems at the back of Chapters 17-20 and 22. Please be advised that I did not emphasize all of the material in these chapters and that not all of these problems concern material that will be tested.

Chapter 17 Answers to Problems

1. Slowing population growth and an increased share of retired people both imply slower growth in the number of people employed. If average labor productivity (output per employed worker) continues to grow at earlier rates, total output will still grow more slowly than before, because of slower growth in the number of workers. If average labor productivity stagnates, then total output will grow very slowly or even decline.

Living standards depend not on total output but on output divided by the total population. Slowing population growth reduces total output but also the number of people who share that output. So slower population growth in itself should not affect living standards. However, a reduced share of the population that is working, all else equal, will reduce output per person, lowering living standards. Slower productivity growth will only worsen this problem.

2. It's possible, if the decline in average labor productivity (output per worker) is offset by an increased share of the population that is employed. For a simple example, suppose an economy has two people, one of whom is working. The one worker produces 10 units of output, so average labor productivity is 10. Output per person ($10/2$) is 5. Now suppose that average labor productivity drops to 8 but both people are working. Then total output is 16 and output per person is 8, so average living standards (output per person) rise even though average labor productivity (output per employed worker) has fallen.
3. The answer depends on the latest economic statistics.
4.
 - a. Positive (a statement about what is likely to happen).
 - b. Normative (a statement about what the Fed *should* do).
 - c. Positive.
 - d. Positive.
 - e. Normative (depends on views about the fairness of the tax code).
5.
 - a. Microeconomist (operations of an individual firm).
 - b. Microeconomist (behavior of an individual market).
 - c. Macroeconomist (behavior of economy as a whole; uses aggregation to study a broad trend)
 - d. Macroeconomist (behavior of the economy as a whole)
 - e. Macroeconomist (behavior of a broad macroeconomic aggregate, consumer spending)

Chapter 18 Answers to Problems

1. The market value of production is $(300 \text{ fish} \times 1 \text{ clamshell each}) + (5 \text{ boars} \times 10 \text{ clamshells each}) + (200 \text{ bunches of bananas} \times 5 \text{ clamshells each}) = 300 + 50 + 1000 = 1350$. Al's digging bait represents an intermediate service, which is not counted in GDP, nor is the purchase of an existing asset (mature banana trees) counted in GDP. So the GDP of the island is 1350 clamshells.

2a. Government purchase of a service; GDP increases by \$1 billion.

b. Transfer payment; GDP does not change.

c. Government purchase of a good; GDP increases by \$1 billion.

d. Government interest payment; GDP does not change.

e. Government purchase of goods of \$1 billion is exactly offset by net exports of -\$1 billion (the oil is imported); GDP does not change. This makes sense, since no additional production occurred within the United States.

3. Value added by each firm is as follows:

Intelligence Inc.: $100 \text{ chips} \times \$200 = \$20,000$

Microsoft: $100 \text{ software packages} \times \$50 = \$5,000$

Bell: $100 \text{ computers} \times \$800 \text{ minus purchased inputs } (\$20,000 \text{ in chips and } \$5,000 \text{ in software}) = \$80,000 - \$25,000 = \$55,000$

PC Charlie's: $100 \text{ computers} \times \$1000 \text{ minus purchased inputs } (\$80,000 \text{ in computers at wholesale}) = \$100,000 - \$80,000 = \$20,000$

Sum of value added: $\$20,000 + \$5,000 + \$55,000 + \$20,000 = \$100,000$

This is the same result we get by summing up the market values of final goods and services (the 100 computers sold by PC Charlie's at \$1,000 each equals \$100,000).

4a. U.S. GDP and consumption both rise by the value of the new car.

b. Consumption rises by the value of the car, net exports fall by the value of the car (as imports rise). No change in U.S. GDP.

c. U.S. GDP and investment both rise by the value of the car (purchase of the car by a business counts as investment).

d. Investment rises by the value of the car, net exports fall by the value of the car. No change in U.S. GDP.

e. U.S. GDP and government purchases both rise by the value of the car.

5. We find the four components of expenditure:

Consumption expenditures are 600. These already include household purchases of durable goods, so those would not be counted again.

Investment expenditures equal residential construction (100) plus business fixed investment (100) plus inventory investment (change in stocks over the year, or 25), for a total of 225. Sales of existing homes and apartments are not counted in investment or GDP.

Government purchases are 200. Government payments to retirees are transfers and are not counted.

Net exports are exports (75) minus imports (50), or 25.

GDP is the sum of the four components: $600 + 225 + 200 + 25 = 1050$.

6. For the year 2000

Nominal GDP = $(100 \times \$5) + (300 \times \$20) + (100 \times \$20) = \8500

Real GDP (using prices from 2000) = $(100 \times \$5) + (300 \times \$20) + (100 \times \$20) = \8500 .

Notice that nominal GDP and real GDP are the same for the base year.

For the year 2005

Nominal GDP = $(125 \times \$7) + (250 \times \$20) + (110 \times \$25) = \8625

Real GDP (using prices from 2000) = $(125 \times \$5) + (250 \times \$20) + (110 \times \$20) = \7825

So real GDP actually declined between 2000 and 2005.

7. It would not be correct to decide against the policy because it is projected to reduce real GDP. Rather, the costs and benefits of the policy should be compared. The reduction (if any) in real GDP is relevant when measuring the cost of the proposed policy, as it captures the loss in output. However, the benefits of the policy, in terms of cleaner air, are not captured in GDP and must be assessed in some other way (for example, by trying to value the health benefits of cleaner air). Economists would recommend implementing the policy only if its benefits exceed its costs.

8. Of the 65 people, the 10 children under age sixteen, the 10 retired people, the 5 full-time homemakers, the 5 full-time students, and the 2 disabled people are not in the labor force. Of the remaining 33 people, 30 people are employed (either part-time or full-time). So three people do not have jobs but would like one. However, one of these three people has not looked for work for three months and so is counted as not in the labor force rather than unemployed; the other two people are unemployed.

In summary, of 65 people, 33 are not in the labor force. So the labor force is 32 people. The participation rate is the share of the population in the labor force, equal to $32/65 = 49\%$. Of those in the labor force, 30 are employed, 2 are unemployed. The unemployment rate, the share of the labor force that is unemployed, is $2/32$, or 6.25%.

9. As the participation rate is 62.5%, we know that 62.5% of the working-age population is in the labor force and the remaining 37.5% is not in the labor force. Sixty million people are not in the labor force, so the total working-age population must be 160 million (60 million is 37.5% of 160 million). The labor force is 62.5% of 160 million, or 100 million people. The unemployment rate is 5.0%, so 5.0% of the 100 million people in the labor force are unemployed, or 5 million people.

To summarize, the labor force is 100 million, the working age population is 160 million, and 5 million workers are unemployed.

10a. In Sawyer, 100/1200 of the labor force, or 8.3% was unemployed. In Thatcher, each worker is unemployed one-twelfth of the time, so the average unemployment rate is also 8.3%. (Notice that both Thatcher and Sawyer experience 100 person-years of unemployment and 1100 person-years of employment.)

b. Sawyer has 100 unemployment spells, each lasting a year, so the average duration of unemployment in Sawyer is one year. Thatcher has 1200 unemployment spells, each lasting a month, so the average duration of unemployment is one month.

c. Because spells are shorter in Thatcher, the costs of unemployment (particularly the psychological and social costs) are likely to be smaller.

Chapter 19 Answers to Problems

1.a. The cost of the basket in the base year is $\$200 + \$600 + \$100 + \50 , or $\$950$. In the subsequent year the same basket of goods costs $\$220 + \$640 + \$120 + \40 , or $\$1020$. The CPI in the subsequent year equals the cost of the basket in that year relative to the base year: $\$1020/\$950 = 1.074$. Since the CPI in the base year is 1.000, the rate of inflation (equal to the percentage increase in the CPI) between the base year and the subsequent year is 7.4%.

b. The family's nominal income rose by 5%, less than the increase in the cost of living. So the family is worse off, in terms of real purchasing power.

2. Inflation rates for the years 1991 through 2001 are presented below.

Year	CPI	Inflation Rate (%)
1990	130.7	
1991	136.2	4.2
1992	140.3	3.0
1993	144.5	3.0
1994	148.2	2.6
1995	152.4	2.8
1996	156.9	3.0
1997	160.5	2.3
1998	163	1.6
1999	166.6	2.2
2000	172.2	3.4
2001	177.1	2.8

Inflation rates were relatively low throughout the 1990s, but lower at the end of the decade than at the beginning. By 2000 the inflation rate began to rise again, but only mildly.

3. The real median income for each year is given in the table below. The real median income is determined by dividing the nominal income by the CPI for the given year and multiplying the result by 100.

Year	Nominal Income	CPI	Real Income
1980	\$24,332.00	82.4	\$29,529.13
1985	\$32,777.00	107.6	\$30,461.90
1990	\$41,451.00	130.7	\$31,714.61
2000	\$62,228.00	172.2	\$36,137.05

Based on the information in the table, real family income has been rising. If the Boskin Report is correct, that true inflation is being overstated, then the growth in real income would be even greater than found here. (If inflation is overstated, then prices have not risen as much as the CPI suggests, and real purchasing power has grown relatively more.)

4. Using CPI data from Problem 2, the real entry wage in 1997 was $\$13.65/1.605 = \8.50 (using 1982-84 as the base period). Let W_{1990} be the nominal entry wage in 1990. Since the CPI in 1990 was 1.307, the real wage in 1990 was $W_{1990}/1.307$. The real wage in 1997 was 92% of this, or $\$8.50 = W_{1990}/1.307$. Solving, we get $W_{1990} = \$11.11$.

5. The rate of inflation between 2002 and 2004 (the percentage increase in the price level) is $(185 - 175)/175 = 5.7\%$ (approximately). To keep tax brackets at the same points in terms of real income, the nominal income categories should each be increased by 5.7%. The year-2004 tax schedule is

Family income	Tax rate
<\$21,140	10%
\$21,141 - \$31,710	12%
\$31,711 - \$52,850	15%
\$52,851 - \$84,560	20%
>\$84,561	25%

If you found the inflation rate to more decimal points, your answers will be slightly different from those above.

6a. The cost of the basket in 2000 is $\$90 + \$60 + \$80$, or $\$230$. In 2001, the cost is $\$150 + \$70 + \$80$, or $\$300$. The official “cost of eating” has increased by $(\$300 - \$230)/\$230$ or 30.4% between 2000 and 2001.

b. Since two chickens now cost more than one ham, people will switch from 30 chickens to 15 hams, for a total ham consumption of 25. The cost of the food basket is now 25 hams at $\$7.00$ plus 10 steaks at $\$8.00$, or $\$255$. The true increase in the cost of eating is $(\$255 - \$230)/\$230$, or 10.9%, much lower than the official estimate of 30.4%. The overestimate of inflation in the cost of eating reflects substitution bias.

7. The first column below shows the real or relative price of gasoline (the nominal price of gasoline divided by the CPI). The second column shows the year-to-year percentage change in the relative price of gasoline, and the third column shows the inflation rate (the year-to-year percentage change in the CPI).

Year	Relative price of gasoline	Change in relative price of gasoline	Inflation
1978	1.017	---	---
1979	1.241	22.0%	11.3%
1980	1.540	24.1	13.5
1981	1.530	- 0.6	10.3
1982	1.356	-11.4	6.2
1983	1.282	- 5.5	3.2
1984	1.183	- 7.3	4.3
1985	1.153	- 2.5	3.6
1986	0.841	-27.1	5.6

The table shows that a large part of the fluctuations in oil prices reflected changes in the relative price of gas, rather than general inflation. Most striking, the relative price of gas fell 27% in 1986, even as the general inflation rate was positive.

8. Woodrow has two options (Example 19.8). First, he can go to the bank once per week; in this case his average cash holding at the beginning of the day is \$15,000, and the cost of his trips to the bank is \$200 (\$4 per trip times 50 trips per year). Second, he can go to the bank every day, reducing his average cash holding to \$5,000 but increasing his cost of trips to the bank to \$1,000 (\$4 per trip times 250 trips).

a. Woodrow's benefit from going to the bank each day (relative to his previous practice of weekly trips) is that his average cash holdings are reduced by \$10,000, so that he loses less purchasing power to inflation. If inflation is 5%, the real benefit of reducing cash holdings by \$10,000 is 5% times \$10,000, or \$500. The cost of going to the bank every day is \$800 more than the cost of going once a week. Since the extra cost of going to the bank more often (\$800) exceeds the extra benefit (\$500), Woodrow will continue to go to the bank once a week. In this case there are no additional shoe leather costs (relative to the original situation).

b. If trips to the bank cost \$2 each, the extra cost of going to the bank daily is \$400, which is less than the benefit, which is still \$500 as in part (a). So now Woodrow will go to the bank every day. The extra costs incurred from visiting the bank more often (\$400) are shoe-leather costs.

c. If Woodrow needs \$10,000 rather than \$5,000 per day to transact with customers, then the amount of cash he holds under each scenario is doubled. Specifically, if he goes to the bank once a week his average cash holding at the beginning of the day is \$30,000; and if he goes to the bank daily his average cash holding at the beginning of the day is \$10,000. At 10% inflation, Woodrow's loss of purchasing power is \$3,000 a year if he goes to the bank once a week and \$1,000 a year if he goes to the bank daily. Since the extra cost of going to the bank daily (at \$4 per trip) is \$800, and the benefit to Woodrow is \$2,000 a year, Woodrow will choose to go to the bank every day. Shoe leather costs, the costs of trip to the bank, are once again \$800 more than the situation in which Woodrow goes to the bank once a week. Notice that, from Woodrow's

point of view, more frequent trips to the bank make good economic sense, because they allow him to avoid a larger loss in purchasing power of his cash holdings. From society's point of view, however, all the extra trips to the bank are just a waste of real resources.

9. First, calculate inflation for each year. For 2000, inflation is the percentage increase in the CPI over that year, equal to $(105-100)/100 = 5\%$. For 2001, inflation is $(110-105)/105 = 4.8\%$. For 2002, inflation is $(118-110)/110 = 7.3\%$. Real return equals the nominal interest rate minus the inflation rate. Subtracting the inflation rate for each year from the nominal interest rate (6% in each year) gives real returns of 1% in 2000, 1.2% in 2001, and -2.3% in 2002.

Now consider the three-year period as a whole. At the end of one year, Albert's \$1000 is worth \$1060. Assuming that interest is re-invested, at the end of two years he has $\$1060 * 1.06 = \1123.60 , and at the end of three years he has $\$1123.60 * 1.06 = \1191.02 , for a total gain of 19.1%. As the price level has risen by 18% over the three years, Albert's total real return over the three years is $19.1\% - 18\% = 1.1\%$.

10a. Inflation is expected to be $(110-100)/100 = 10\%$ in the first year and $(121-110)/110 = 10\%$ in the second year. If Frank charges Sarah a 12% nominal interest rate, he will earn a real return of 2% per year (12% nominal interest rate - 10% inflation rate).

b. To ensure a 2% annual return on the loan, Frank and Sarah should agree that Sara will pay an interest rate in each year equal to 2% plus whatever the inflation rate turns out to be. For example, if inflation turns out to be 8% during the first year and 10% during the second year, Sarah should pay 10% nominal interest in the first year and 12% in the second year.

11. A consumer who spent \$100 in the base year would spend \$17.80 on food and beverages, \$42.80 on housing, \$6.30 on apparel and upkeep, and so on. To buy the goods and services this year, which cost \$100 in the base year, the consumer would have to increase his spending on food and beverages from \$17.80 to \$19.58 (a 10% rise), on housing from \$42.80 to \$44.94, and on medical care from \$5.70 to \$6.27. Other expenditures would be the same as in the base year. The total cost of the basket can be found to be \$104.49, so the CPI for the current year is 1.0449 or (multiplying by 100), 104.49.

Chapter 20 Answers to Problems

1. After one year, Richland's real GDP per person equal $10,000*(1.01)$, after two years it equals $10,000*(1.01)*(1.01) = 10,000*(1.01)^2$, and so on. After ten years, Richland's GDP per person equal $10,000*(1.01)^{10} = 11,046$, and after twenty years it equals $10,000*(1.01)^{20} = 12,202$.

Poorland's GDP per person after ten years is $5,000*(1.03)^{10} = 6720$, and after twenty years it equals $5000*(1.03)^{20} = 9031$. So after twenty years Poorland has gone from half the level of income of Richland to about three-quarters the level.

Suppose that GDP per person in Richland and Poorland are equal after t years; our objective is to find t . After t years Poorland's GDP per person is $5000*(1.03)^t$, and Richland's GDP per person is $10,000*(1.01)^t$. Setting these two expressions equal, and dividing both sides by 5000, we get

$$(1.03)^t = 2*(1.01)^t$$

By solving the above equation for t (algebraically, graphically, or by trial and error), we find that Poorland catches up in between 35 and 36 years.

2. From Table 20.3, U.S. average productivity grew by 2.3% per year during 1960-73, 0.6% per year in 1973-79, and 1.7% per year over 1979-2000.

Let x be U.S. average labor productivity in 1973. If average labor productivity had grown at 2.3% per year over the 27-year period from 1973 to 2000, in 2000 it would have equaled $x*(1.023)^{27}$, or $1.848*x$. We'd like to compare that with actual U.S. productivity in 2000.

To determine actual U.S. labor productivity using only the information in Table 20.3, recall first that productivity grew by 0.6% per year during 1973-79. So if productivity in 1973 equaled x , in 1979 productivity equaled $x*(1.006)^6$. Over the next 21 years productivity increased at 1.7%, so productivity in 2000 equaled $[x*(1.006)^6]*(1.017)^{21} = 1.477*x$. Dividing $1.848*x$ by $1.477*x$ (and noting that the initial level of productivity, x , cancels out), we get the answer 1.251. In short, if average labor productivity had continued to grow at its 1960-73 rate until 2000, in the latter year output per worker in the U.S. economy would have been 25.1% higher than was actually the case, quite a significant difference.

3. Real GDP per person is average labor productivity times the share of the population that is employed. Hence, in 2000 real GDP per person was $\$66,588*0.489$, or $\$32,562$.

What will real GDP per person be in 2038 if productivity grows by the same amount as in 1960-2000 but the share of the population that is employed falls to the 1960 level? Between 1960 and 2000 average labor productivity grew from $\$35,836$ to $\$66,588$, a gain of 85.8%. If productivity grows by the same amount over the period 2000-2040, in 2040 it would equal $(1.858)*\$66,588$, or $\$123,721$. To find real GDP per person in 2040, multiply this number by the share of the population that is employed, which we assume will be 0.364, the same as in 1960. Doing this multiplication we find real GDP per person in 2040 to be $\$45034$, about 38.3% higher than in

2000. So in this scenario output per person will be higher in 2040, relative to 2000, but by much less than implied by the increase in labor productivity. The projected decline in the share of the population that is working implies that output per person will grow more slowly than average labor productivity.

4. From the relationship $\text{real GDP per person} = \text{average labor productivity} \times \text{share of the population employed}$, we know that average labor productivity equals real GDP per person divided by the share of the population employed. Calculating average labor productivity for the three countries, we get

	1979	2000
Canada	\$46,442	\$57,835
Germany	\$52,982	\$70,445
Japan	\$35,955	\$48,573

Virtually all of the increases in output per person in Canada and Germany result from increased labor productivity, as the ratio of employment to population barely changed in either country. In Japan increased employment played some role: Over this period the ratio of employment to population increased 8.5% in Japan. However, average labor productivity in Japan increased by 35.1%, so in Japan as well the bulk of the gains were from productivity increases.

5a. If Joanne goes to work, she will earn \$20,000 per year for the next five years. After living expenses she will save \$5,000 per year, so at the end of the five years she will have savings of \$25,000 (assuming zero interest earnings). If she goes to junior college, she'll earn \$38,000 a year in years 3-5, for a total of \$114,000. Subtracting five years' living expenses (\$75,000) and student loan repayments (\$12,000), she will be left with \$27,000 in savings at the end of the five years. So she should go to junior college. Note that Joanne's objective of maximizing her savings after five years takes no account of what is perhaps an even stronger economic incentive for further education, which is that after 5 years she will have a \$38,000 per year job rather than a \$20,000 per year job.

b. If Joanne can earn \$23,000 per year with a high school degree, she will be able to save \$8,000 per year, leaving her \$40,000 at the end of five years. Her savings after five years if she goes to junior college are \$27,000, as we found in part a. So in this case she should not make the investment of furthering her education. Economically speaking, her opportunity cost of two years in junior college is higher when she can earn \$23,000 rather than \$20,000 by going directly to work.

c. If tuition and books cost \$8,000 per year, Joanne will have to repay \$16,000 in student loans rather than \$12,000, and her savings at the end of five years will be $(\$114,000 - \$75,000 - \$16,000) = \$23,000$, less than the \$25,000 in savings she will have if she goes directly to work. A higher cost of obtaining an education makes doing so less economically attractive.

d. If she goes directly to work, Joanne will add \$5,000 to her savings at the end of each year, years 1 to 5. Let's find her total savings, including interest, at the end of year 5. At the end of year 5, the \$5,000 Joanne deposits at the end of year 1 will be worth

$$\$5,000*(1.10)*(1.10)*(1.10)*(1.10) = \$5,000*(1.10)^4 = \$7321$$

Similarly, at the end of year 5 the \$5,000 she deposits at the end of year 2 will be worth $\$5,000*(1.10)^3 = \6655 ; her deposit at the end of year 3 will be worth $\$5,000*(1.10)^2 = \6050 ; her deposit at the end of year 4 will be worth $\$5,000*(1.10) = \5500 ; and her last deposit will be worth \$5,000. Adding these five amounts yields total saving at the end of year 5 of \$30,526.

If Joanne goes to college, at the end of year 1 she will have a debt of \$21,000 (living expenses plus tuition and books). At 10% interest, at the end of year 5 this debt will have grown to $\$21,000*(1.10)^4 = \$30,746$. Another debt of \$21,000 at the end of year 2 will have grown to $\$21,000*(1.10)^3 = \$27,951$ by the end of year 5. In years 3 - 5 Joanne will earn \$38,000 and spend \$15,000 on living expenses, saving \$23,000 each year. At the end of 5 years the value of these savings will be

$$(\$23,000)*(1.10)^2 + (\$23,000)*(1.10) + \$23,000 = \$27,830 + \$25,300 + \$23,000 = \$76,130.$$

Subtracting Joanne's debts of \$30,746 and \$27,951 from her saving yields \$17,433 in assets at the end of five years, less than if she skips junior college. So, on purely economic grounds, Joanne should go directly to work. This example illustrates that a higher interest rate reduces the value of activities that involve incurring costs now in exchange for higher benefits later.

- 6a. With four employees and two lanes, both lanes have a checker and a bagger. Total output is 80 customers per hour. Average labor productivity is $80/4 = 20$ customers per hour per worker.
- b. A bagger increases output by 15 customers per hour (the difference between the 40 customers serviced by a checker and a bagger and the 25 customers served by a checker only. If there is an empty lane available, a checker increases output by of 25 customers. So the best strategy is to take one of the baggers and make him or her a checker in the new lane. Total output is $40 + 25 + 25 = 90$ customers per hour, and average labor productivity is 22.5 customers per hour. Note that adding capital (the extra lane) increases both total output and average labor productivity.
- c. With four lanes, all four employees become checkers. Total output is 100 customers and average labor productivity is 25 customers per hour. Because there are only four employees, a fifth lane adds no output (average labor productivity remains 25 customers per hour).

We do observe diminishing returns to capital, at least for the fifth lane: Adding a third lane increased output by 10 customers per hour, as did adding a fourth lane. However, adding a fifth lane does not increase output further.

- 7a. As a team, the three painters can paint 280 square feet in 3 painter-hours. So productivity is $280/3 = 93.3$ square feet per painter hour.
- b. The first roller should be given to Fred, as it increases his production by the largest amount. The second and third rollers should be given to Harrison and Carla (in either order). There is no one to use the fourth roller. With this information we can calculate total output for the team per hour and total output per painter-hour as follows:

No. of rollers	Output by team	Output per painter-hour
0	280	$280/3 = 93.3$
1	400	$400/3 = 133.3$
2	500	$500/3 = 167.7$
3	600	$600/3 = 200.0$
4	600	$600/3 = 200.0$

The first roller increases the team's output by 120, the second increases it by 100, the third by 100, and the fourth by zero. Since the extra output produced by an extra roller declines with more rollers (except for the third roller, which has the same addition to output as the second), we observe diminishing returns to capital.

c. With the technological improvement, the table in part b becomes

No. of rollers	Output by team	Output per painter-hour
0	336	$336/3 = 112$
1	480	$480/3 = 160$
2	600	$600/3 = 200$
3	720	$720/3 = 240$
4	720	$720/3 = 240$

After the technological improvement, the first roller increases the team's output by 144, the second by 120, the third by 120, and the fourth by zero. So we still observe diminishing returns to capital. However the economic value of additional rollers has increased, since each roller adds more output than before.

8a. Zero, as that will allow her stock of fish to double by next year.

b. Maximizing the growth of her stock of fish has the disadvantage that it allows Hester no current income to spend. In other words, Hester can have the benefit of a very high income and consumption next year only at the cost of starving herself this year. Analogously, the more a country is willing to "starve itself" this year, by saving and investing its resources in new capital goods rather than consuming, the faster it will grow.

c. To maximize her current income Hester should sell all her fish this year, realizing \$5000. The problem with this strategy is that it leaves no source of income for the future.

d. If Hester harvests none of her fish this year, she has no income this year; and if she harvests all of her fish this year, she has no income next year. Having very low or zero income in either year is very unpleasant for Hester. A better choice is to sell some fish this year, allowing for a reasonable level of current income and consumption, while leaving enough fish in the hatchery to provide for reasonable income in the future as well. In the same way, a country should choose a rate of economic growth that balances the cost of sacrificing consumption today against the benefits of higher income and consumption in the future.

9. The chapter argues that this statement is true. One way to see this point is to compare rich and poor countries in the world today. In principle, at a given time all countries have access to the same basic scientific information. But poor countries do not benefit from existing scientific

knowledge to the same degree rich countries do, because they lack the resources to apply the knowledge widely. Thus, medical knowledge is of limited help without hospitals, medicines, and trained personnel (not to mention adequate nutrition and sanitation). Similarly, new developments in communications and computing can be utilized only when there are sufficient resources to support an infrastructure of communications equipment, computers, and the like.

10. No answer given. A good answer will cite some statistics from the U.S and other countries on such issues as saving rates, public capital formation, and spending on research and development.

Chapter 22 Answers to Problems

1a. Corey's balance sheet is as follows:

ASSETS		LIABILITIES	
Bike	\$300	Credit card debt	\$150
Cash	200	Electric bill due	250
Baseball card	400		
Checking acct. balance	1200		
<hr/>		<hr/>	
TOTAL	2100		400

Net worth 1700

Corey's assets have value of \$2100, his liabilities are \$400, so his net worth is \$2100 - \$400, or \$1700.

b. The card is worth zero rather than \$400. Assets decline to \$1700, liabilities are unchanged, net worth falls by \$400 to \$1300. This is an example of a capital loss; no saving (positive or negative) has occurred.

c. Liabilities are reduced by \$150, assets are unchanged, net worth increases by \$150 to \$1850 (corrected). Note that paying off a debt out of current income is a form of saving.

d. Assets decline by \$150, as the checking account balance falls from \$1200 to \$1050. Liabilities also decline by \$150, as the credit card debt falls to zero. Net worth (assets minus liabilities) is unchanged. No saving has been done in this case, rather an existing asset was set off against an existing liability.

2a. Flow. GDP represents production per unit of time, such as a year or a quarter.

b. Flow. National saving is measured per unit of time, analogous to individual saving.

c. Stock. This value is measured at a point in time.

d. Stock. Again, the value is measured at a point in time.

e. Flow. The deficit is the government's spending less its receipts. Spending and receipts are measured per unit of time, such as a year or quarter.

f. Stock. The quantity of government debt outstanding is measured at a point in time.

- 3a. For life-cycle reasons (anticipation of future child-care expenses, tuitions), Ellie and Vince will probably increase their current saving. There is also the possibility that in the future one or both parents may work less in order to be at home; to prepare for the possibility of reduced income in the future the couple should save more today.
- b. Vince's risk of layoff has increased, so the couple should increase their saving for precautionary reasons.
- c. More saving is needed to meet a life-cycle objective.
- d. More saving is needed for a life-cycle objective; as the couple faces both a reduction in their income and tuition expenses in a few years, they need to save more now.
- e. Less saving is needed to meet the life-cycle objective of retirement.
- f. For bequest reasons, the couple should save more.

4a. Suppose Greg deposits the \$10,000 in his IRA. At 5% interest, the \$10,000 bonus is worth $\$10,000(1.05)$ in one year, $\$10,000(1.05)(1.05) = \$10,000(1.05)^2$ in two years, up to five years when it is worth $\$10,000(1.05)^5 = \$12,763$. After Greg withdraws he must pay 30% in taxes, leaving him with $0.7\$12,763 = \8934 after taxes.

If Greg does not use the IRA, he will have to pay a 30% tax on the bonus in the year that he receives it, leaving him \$7,000 to invest. He must also pay 30% of his interest income in taxes each year, so that the actual interest he will receive will be 70% of 5%, or 3.5% after taxes. In five years his investment will be worth $\$7,000(1.035)^5 = \8314 . He owes no further taxes on withdrawal. On net, Greg ends up with \$8934 after taxes if he deposits his bonus in his IRA, and \$8314 if he does not. So the IRA is a good deal for Greg.

b. The IRA effectively increases the interest rate that Greg can earn on his saving. As discussed in the chapter, a higher interest rate increases the reward to saving (which tends to increase saving) but also makes it easier to achieve a given savings target (which tends to reduce saving). Empirically, a higher real return seems to increase saving modestly, suggesting that on this count, the availability of IRAs has a positive (if small) effect on saving.

From a psychological perspective, the fact that funds cannot be withdrawn from an IRA prior to retirement (except at substantial penalty) may make it easier for people to exert self-control. On this count also, IRAs tend to raise saving.

5a. Public saving = government budget surplus
 $= \text{tax collections} - \text{government purchases} - \text{transfers and interest payments}$
 $= 150 - 100 - 100 = -50$

Private saving = Household saving + business saving
 $= 200 + 400 = 600$

National saving = Private saving + public saving
 $= 600 - 50 = 550.$

National saving rate = National saving/GDP = $550/2200 = 25\%$.

b. Public saving = Government budget surplus = 100

If we knew G , government purchases, we could find national saving, $Y - C - G$. To find G , note that the government budget surplus equals tax collections less government purchases (G) less government transfers and interest payments. Since the budget surplus is 100, tax collections are 1200, and transfers and interest payments are 400, government purchases must equal 700 ($100 = 1200 - 700 - 400$). Now we can find national saving, equal to GDP less consumption expenditures less government purchases ($Y - C - G$), equal to $6000 - 4500 - 700 = 800$.

As national saving is 800 and public saving is 100, private saving must be 700 (since national saving is the sum of private and public saving). The national saving rate, national saving divided by GDP, equals $800/6000$ or 13.3%.

c. Using the relationship $Y = C + I + G + NX$, the gross domestic product (Y) equals $4000 + 1000 + 1000 + 0$, or 6000. National saving is $Y - C - G = 6000 - 4000 - 1000 = 1000$. The national saving rate is $1000/6000 = 16.7\%$.

To find public saving, note that public saving equals the government budget surplus, equal to tax collections less government purchases less transfers and interest payments, or $1500 - 1000 - 500 = 0$. So public saving is zero. Since public saving plus private saving add to national saving, private saving must be 1000.

6. Consult sections 1 (National Product and Income), 3 (Government Current Receipts and Expenditures), and 5 (Saving and Investment) of the *Survey of Current Business* for the most recent figures. Compare your answers to Example 22.4.

7a. Ellie and Vince's ownership costs equal their general expenses (maintenance, taxes, and insurance) plus their mortgage interest costs. General expenses are 4% of \$200,000 = \$8,000 per year, and interest expenses are 6% of \$200,000 = \$12,000 per year, so the total ownership cost is \$20,000 per year. This exceeds the cost of renting (\$1500 per month for 12 months, or \$18,000), so Ellie and Vince should rent rather than buy.

b. If Ellie and Vince are willing to pay \$2,000 per month, or \$24,000 per year, to rent, then they are better off buying (the cost of buying is lower than the cost of renting an equivalent house).

c. If the real interest rate is 4%, then interest costs are 4% of \$200,000 = \$8,000, and total ownership costs are \$16,000, less than the \$18,000 Ellie and Vince are willing to pay in part a. They should buy the house.

d. If the value of the house is \$150,000, then general expenses are 4% of \$150,000 = \$6,000 and interest costs are 6% of \$150,000 = \$9,000, so total ownership costs are \$15,000. As Vince and Ellie would be willing to pay \$18,000 to rent a comparable house, now they should be willing to buy.

e. Higher real interest rates make people less willing to buy houses (compare part a to part c). If they are going to sell homes at all, homebuilders can do so only at a reduced price (compare part a to part d).

8a.	Number of screens	Marginal product	Value of marginal product
	1	40,000	\$80,000
	2	35,000	70,000
	3	30,000	60,000
	4	25,000	50,000
	5	20,000	40,000

The marginal products decline as screens are added, illustrating diminishing returns to capital.

b. The interest cost of each screen is $5.5\% \times \$1,000,000$, or \$55,000. There are no other costs mentioned. The value of marginal product exceeds \$55,000 for 3 screens but not 4. So 3 screens should be built.

c. The value of marginal product exceeds the interest cost (7.5% of \$1,000,000, or \$75,000) for only the first screen. One screen will be built.

d. At 10% interest the interest cost of a screen is \$100,000, more than the value of the marginal product of even the first screen. No screens will be built. Parts b through d illustrate that capital investment (and, consequently, the demand for saving) falls as the real interest rate rises.

e. The value of the marginal product of the fifth screen is \$40,000. At an interest rate of 5.5%, building five screens is profitable only if 5.5% times the per-screen construction cost is no greater than \$40,000. Since $5.5\% \times \$727,273 = \$40,000$, the construction cost would have to fall to \$727,273 per screen to make the five-screen complex profitable.

9a. The investment tax credit effectively lowers the price of new capital goods to the firm by 10%. Firms' willingness to invest increases, raising the demand for saving (I). The real interest rate, investment, and national saving rise as the demand for saving (I) curve shifts to the right.

b. Increased public saving raises national saving. The supply of saving (S) curve shifts right. The real interest rate falls, national saving and investment rise.

c. Increased productivity of new capital goods makes investment more profitable. The demand for saving (I) curve shifts to the right, raising the real interest rate, investment, and national saving.

d. The increased tax on corporate profits reduces the after-tax return to capital investments (a greater share of the income earned by capital goes to the government). Firms become less willing to invest, so that the demand for saving (I) shifts leftward. Public saving is unchanged by assumption, so the supply of saving curve (S) does not shift. The real interest rate, investment, and national saving all decline.

e. Increased precautionary saving raises national saving. The supply of saving (S) curve shifts right. The real interest rate falls, national saving and investment rise.

f. Increased cost of capital decreases a firms willingness to invest, lowering the demand for saving (I). The real interest rate, investment, and national saving fall as the demand for saving (I) curve shifts to the left.