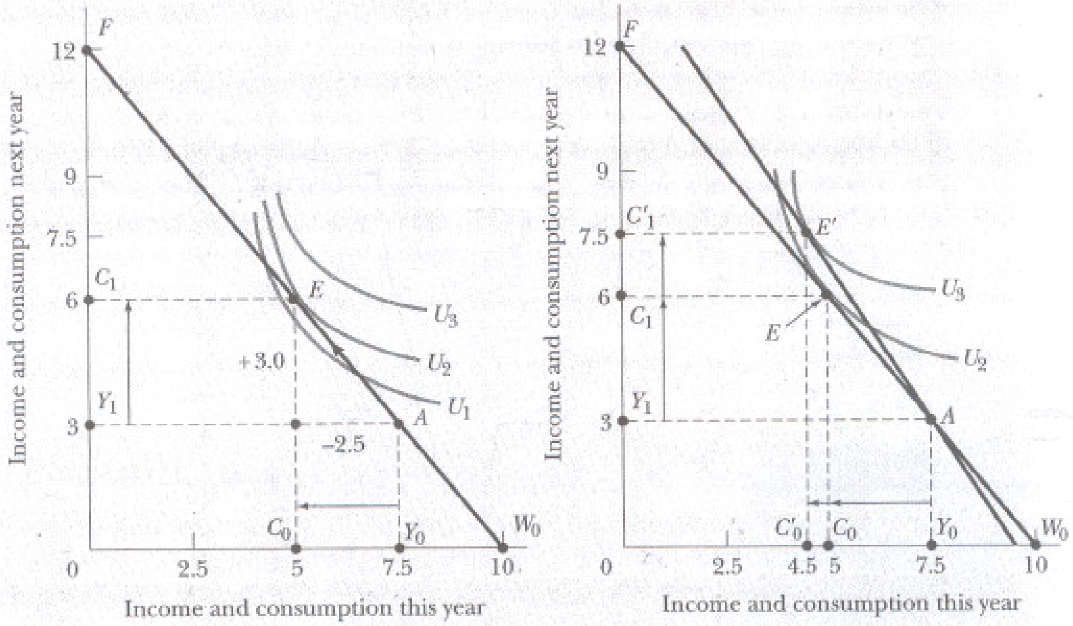
FIGURE 15.1 LENDING

Starting from endowment A ($Y_0 = 7.5$ and $Y_1 = 3$), the consumer maximizes satisfaction at point E, where the budget line FW_0 is tangent to indifference curve U_2 in the left panel. The consumer reaches point E by lending $Y_0 - C_0 = 2.5$ units from this year's endowment and receiving 3 additional units next year. Thus, the slope of the budget line is $3/(-2.5) = -1.2$ or $-1(1 + 0.2)$ and the interest rate $r = 0.2$ or 20%. At $r = 50\%$, the optimal point is E' (in the right panel), where the steeper budget line through point A is tangent to indifference curve U_3. Point E' is reached by lending 3 units (instead of 2.5).



this year's corn or borrow against next year's corn. the question is how should the consumer distribute consumption between this year and next so as to maximize the total or joint satisfaction over the two periods? this is analogous to the consumer's choice between hamburgers (commodity X) and soft drinks (commodity Y) examined in Chapter 3.5 and Figure 3.8. The only difference is that here the choice is between the consumption of corn this year or consumption the next.

In the left panel of Figure 15.1, the consumer's tastes between consumption this year and next are given by indifference curves U_1, U_2, and U_3. The consumer also faces budget line FW_0. The latter shows the various combinations of present and future income and consumption available to the consumer. Starting from endowment position A ($Y_0 = 7.5$ and $Y_1 = 3$), the consumer can lend part of this year's corn endowment so that he or she will consume less this year and more next year. This is represented by an upward movement from point A along budget line FW_0. On the other hand, the consumer could increase consumption this year by borrowing against next year's endowment or income by moving downward from point A along FW_0.

The consumer maximizes satisfaction by reaching the highest indifference curve possible with his or her budget line. The optimal choice is given by point E, where budget line FW_0 is tangent to indifference curve U_2. At point E, the individual consumes $C_0 = 5$ units of corn this year and $C_1 = 6$ units next year (see the left panel of Figure 15.1). The consumer reaches point E by lending $Y_0 - C_0 = 2.5$ units of corn out of this year's endowment or output and by receiving 3 additional units next year.

The slope of the budget line gives the premium or the rate of interest that the lender receives. For example, the movement from point A to point E indicates that the consumer receives 3 units of the commodity next year by lending 2.5 units this year. Thus, the slope of the budget line is $3/(-2.5) = -1.2$ or $-1(1 + 0.2)$, so that the interest rate $r = 0.2$ or 20%. That is,

$$\frac{C_1 - Y_1}{C_0 - Y_0} = -(1 + r) = -(1 + 0.2) \qquad [15.1]$$

The negative sign reflects the downward-to-the-right inclination of the budget line. This simply means that for the consumer to be able to consume more next year, he or she will have to consume less this year. In this case, the consumer lends (i.e., reduces consumption by) 2.5 units this year and gets $2.5(1 + 0.2) = 3$ next year. If the consumer lends all of this year's income or endowment of $Y_0 = 7.5$ units at 20% interest, he or she will receive $7.5(1 + 0.2) = 9$ additional units next year (and reach point F on budget line FW_0). The consumer could do this, but does not, because he or she would not be maximizing satisfaction.

Returning to the slope of the budget line, we can say more generally that the **rate of interest (r)** is the premium received by an individual next year by lending \$1.00 today. Another way of stating this is that the rate of interest is the excess in the price next year (P_1) of \$1.00 this year (P_0). That is,

$$P_1 = P_0(1 + r) \qquad [15.2]$$

The individual receives (\$1)$(1 + r)$ next year (P_1) by lending \$1.00 this year (P_0). If the interest rate r is 0.2 or 20%, the individual receives (\$1)(1 + 0.2) = \$1.20 next year by lending \$1.00 this year. Of course, the person who borrows \$1.00 today must repay \$1.20 next year if the rate of interest is 20%. Thus, the interest rate can be viewed as the excess in the price next year of \$1.00 lent or borrowed this year.

If the interest rate rises (i.e., if the budget line becomes steeper), lenders will usually lend more. For example, starting with endowment position A in the right panel of Figure 15.1, if the interest rate rises to 50% so that the slope of the budget line becomes $-(1 + 0.5)$, the optimal choice of the consumer is at point E', where the new steeper budget line through point A is tangent to higher indifference curve U_3. The consumer can reach point E' by lending $Y_0 - C_0' = 3$ units (instead of 2.5), for which he or she receives $C_1' - Y_1 = 4.5$ units next year. That is, by lending 3 units at

50% interest, the consumer receives $3(1 + 0.5) = 4.5$ units next year. Thus, the increase in the rate of interest from 20% to 50% leads this individual (the lender) to increase lending from 2.5 to 3 units.[2]

Borrowing

We will now show that if the endowment position of the consumer in the left panel of Figure 15.1 had been to the left of point E on budget line FW_0 (rather than at point A), the consumer would have been a borrower rather than a lender. This is shown in the left panel of Figure 15.2. Specifically, suppose the endowment position of the consumer had been at point B ($Y_0 = 2.5$ and $Y_1 = 9$) on budget line FW_0. The consumer would maximize satisfaction at point E ($C_0 = 5$ and $C_1 = 6$), where budget line FW_0 is tangent to indifference curve U_2 (the highest the consumer can reach with budget line FW_0). To reach point E, the consumer would have to borrow $C_0 - Y_0 = 2.5$ units of the commodity this year and repay $Y_1 - C_1 = 3$ units next year.

Since $3/2.5 = 1.2$, the rate of interest $r = 0.2$ or 20%, as in the lending example. This means that in order to borrow 2.5 units this year, the individual must repay 3 units next year if the market rate of interest is 20%. That is, $2.5 = 3/(1 + 0.2)$. The reason for this is that 2.5 units this year will grow to 3 units next year at $r = 0.2$ or 20%. More generally, we can say that the price of \$1.00 today (P_0) is equal to \$1.00 next year (P_1) divided by $(1 + r)$. That is,

$$P_0 = P_1/(1 + r) \qquad [15.3]$$

This is obtained by dividing both sides of equation [15.2] by $(1 + r)$. For example, at $r = 20\%$, \$1.00 next year is equivalent to $\$1/(1 + 0.2) = \$0.83$ this year, because \$0.83 lent this year at 20% will grow to \$1.00 next year.

If the individual borrowed all of next year's income of $Y_1 = 9$, he or she could increase consumption this year by $\$9/(1 + 0.2) = 7.5$ and be at point $W_0 = 10$. Point $W_0 = 10$ gives the **wealth** of the individual. This is equal to the individual's income or endowment this year plus the present value of next year's income or endowment. That is, the consumer's wealth is given by

$$W_0 = Y_0 + [Y_1/(1 + r)] \qquad [15.4]$$

In our example, the income this year is $Y_0 = 2.5$ and the present value of next year's income is $Y_1/(1 + r) = 9/(1 + 0.2) = 7.5$, resulting in the individual's

[2] The increase in the rate of interest will usually, but not always, increase the amount of lending. The reason is that (as in the case of an increase in the wage rate), an increase in the rate of interest gives rise to a substitution effect and an income effect. According to the substitution effect, the increase in the rate of interest leads the individual to lend more. However, by increasing the future income of the individual, the increase in the rate of interest also gives rise to an income effect, which leads the individual to lend less. At a sufficiently high rate of interest, the negative income effect exceeds the positive substitution effect and the individual's supply curve of loans bends backward. This is examined in Problem 5(a), with the answer at the end of the text.

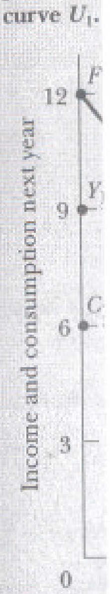
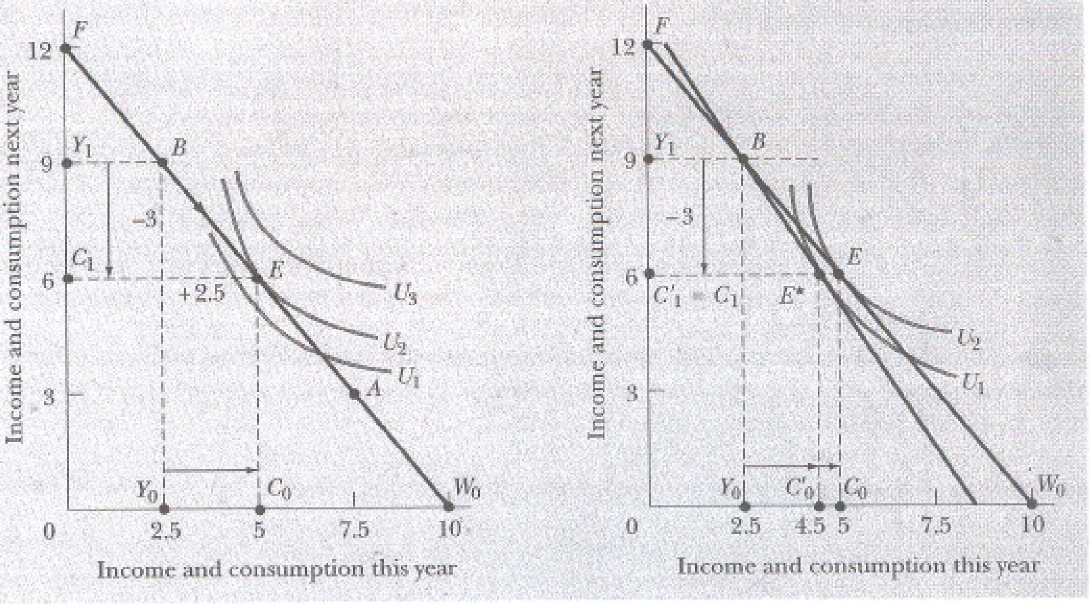


FIGURE 15.2 BORROWING

Starting from endowment B ($Y_0 = 2.5$ and $Y_1 = 9$), the consumer maximizes satisfaction at point E, where budget line FW_0 is tangent to indifference curve U_2 in the left panel. The consumer reaches point E by borrowing $C_0 - Y_0 = 2.5$ and repaying $Y_1 - C_1 = 3$ next year. Thus, the slope of the budget line is $3/(-2.5) = -1.2$ or $-1(1 + 0.2)$ and the interest rate $r = 0.2$ or 20%. At $r = 50\%$, the optimal point is E^* in the right panel, where the steeper budget line through point B is tangent to indifference curve U_1. Point E^* is reached by borrowing 2 units (instead of 2.5).



wealth of 10. Graphically, the wealth of the individual or consumer is given by the intersection of the budget line with the horizontal axis. Thus, wealth plays the same role in intertemporal choice as the consumer's income plays in the consumer's choice between two commodities during the same year. An increase in wealth, like an increase in income, will shift the consumer's budget line outward and allows the consumer to purchase more of every normal good or to consume more, both this year and next.

An increase in the rate of interest leads to a reduction in the amount the individual wants to borrow. Since present consumption becomes more expensive in terms of the future consumption that must be given up, the borrower will borrow less. This is shown in the right panel of Figure 15.2. Starting once again with endowment position B in the right panel of Figure 15.2, an increase in the rate of interest to 50% will result in a new budget line with a slope of $-(1 + 0.5)$. The optimal choice of the consumer is then at point E^*, where the steeper budget line through point B is tangent to lower indifference curve U_1. Indifference curve U_1 is the highest that the consumer can reach with his or her initial endowment

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...Lending

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the other with endowment A (the lender) on FW_0. We also a...
both individuals have the same tastes or time preferences for p...
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...nal choice of individual A is to move from point A to point
...W_0 by lending 2.5 units of the commodity this year at the
...r 20% (so that he or she will receive an additional
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A and B are the only two individuals in the
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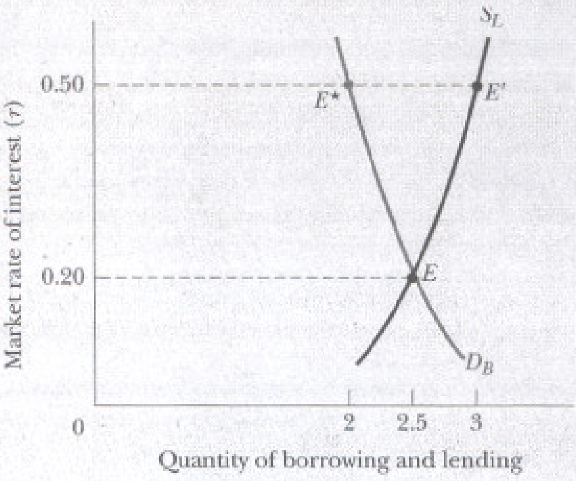
FIGURE 15.3 BORROWING-LENDING EQUILIBRIUM

Borrowing-lending equilibrium occurs at point *E*, where the demand curve for borrowing (D_B) intersects the supply curve for lending (S_L). Point *E* shows that $r = 20\%$ and 2.5 units are borrowed and lent. At $r = 50\%$, the quantity supplied of lending of 3 units (point E') exceeds the quantity demanded of borrowing of 2 units (point E^*) and the interest rate falls to 20% (point *E*). The opposite is true at *r* lower than 20%.



from the right panel of Figure 15.1). The resulting excess in the quantity supplied over the quantity demanded of loans of 1 unit (E^*E') at $r = 50\%$ causes the rate of interest to fall to the equilibrium level of $r = 20\%$ (point *E*).

In the above analysis, we have assumed for simplicity that there are only two individuals, A and B, in the market and that both have identical tastes or time preferences.[4] In the real world, however, there are many individuals with different tastes. Yet, the process by which the equilibrium market rate of interest is determined is basically the same. That is, the equilibrium market rate of interest is the one at which the total or aggregate quantity demanded of borrowing matches the aggregate quantity supplied of lending. At a market rate of interest above the equilibrium rate, the supply of lending exceeds the demand for borrowing and the interest rate falls. On the other hand, at a market rate of interest below the equilibrium rate, the demand for borrowing exceeds the supply of lending and the market rate of interest rises toward equilibrium. Only at the equilibrium market rate of interest does the quantity demanded match the quantity supplied and there is no tendency for the interest rate to change.

[4] The determination of the market rate of interest when consumers have different time preferences is examined in Problem 4 (with the answer at the end of the text).

EXAMPLE 1
PERSONAL SAVINGS IN THE UNITED STATES

Table 15.1 shows the total aggregate amount of personal savings (PS) and the level of disposable (i.e., after tax) personal income (DPI) in 1987 prices, and PS as a percentage of DPI in the United States for 1960, 1970, 1980, 1985, and 1990 through 1994. Personal savings ranged from $75 billion in 1960 to $158 billion in 1994, or from 5.7% of disposable personal income in 1960 to 4.1% in 1994.

Prior to the establishment of Social Security in 1935, individuals provided for their retirement by voluntarily saving a portion of their earnings during their working years. Social Security provided retirement income through a forced savings (Social Security tax) program, thus reducing the need for personal savings. If the government had saved the Social Security taxes it levied, net savings (personal plus government) would have been more or less unchanged. Because the government chose not to "fund" the system, but to use Social Security taxes for current expenditures and pay future Social Security benefits out of future taxes, the nation's level of aggregate savings declined. Michael Darby estimated that the Social Security program has reduced the nation's savings by 5% to 20%.

SOURCE: Michael R. Darby, *The Effects of Social Security on Income and Capital Stock* (Washington, D.C.: American Enterprise Institute, 1979).

TABLE 15.1 Personal Savings and Disposable Personal Income (in billions of 1987 dollars)

YEAR	PS	DPI	PS AS A PERCENTAGE OF DPI
1960	$ 75.0	$1,313.0	5.7
1970	161.3	2,025.3	8.0
1980	215.3	2,733.6	7.9
1985	203.4	3,162.1	6.4
1990	147.9	3,524.5	4.2
1991	176.7	3,538.5	15.0
1992	200.7	3,684.1	5.4
1993	152.2	3,704.1	4.1
1994	157.9	3,835.4	4.1

SOURCE: Council of Economic Advisors, *Economic Report of the President* (Washington, D.C.: U.S. Government Printing Office, 1995), pp. 307–308.

15.2 SAVING-INVESTMENT EQUILIBRIUM

In section 15.1 we analyzed borrowing-lending equilibrium. For simplicity, we assumed that no part of the current endowment or output was invested to increase future productive capacity. In this section, we begin with the opposite situation and examine saving-investment equilibrium without borrowing or lending. That is, we begin by examining the case in which an isolated individual (a Robinson Crusoe) consumes less than he or she produces in this period (saves) in order to have more seeds, or to produce a piece of equipment, to increase production in the next period (invests). Next, we relax the assumption that the individual is isolated and that he or she cannot borrow or lend and examine saving-investment equilibrium with borrowing and lending. Finally, we show how the equilibrium rate of interest is determined with saving and investment and with borrowing and lending.

Saving-Investment Equilibrium without Borrowing and Lending

Suppose that an individual lives alone on an island and produces and consumes a single commodity. This Robinson Crusoe has no possibility to borrow or lend (or trade) the commodity and can only consume what he produces. Suppose that under present conditions he can count on producing $Y_0 = 7.5$ units of the commodity during this year and $Y_1 = 3$ units next year. This is shown by point *A* on the production-possibilities curve *FQ* in Figure 15.4.

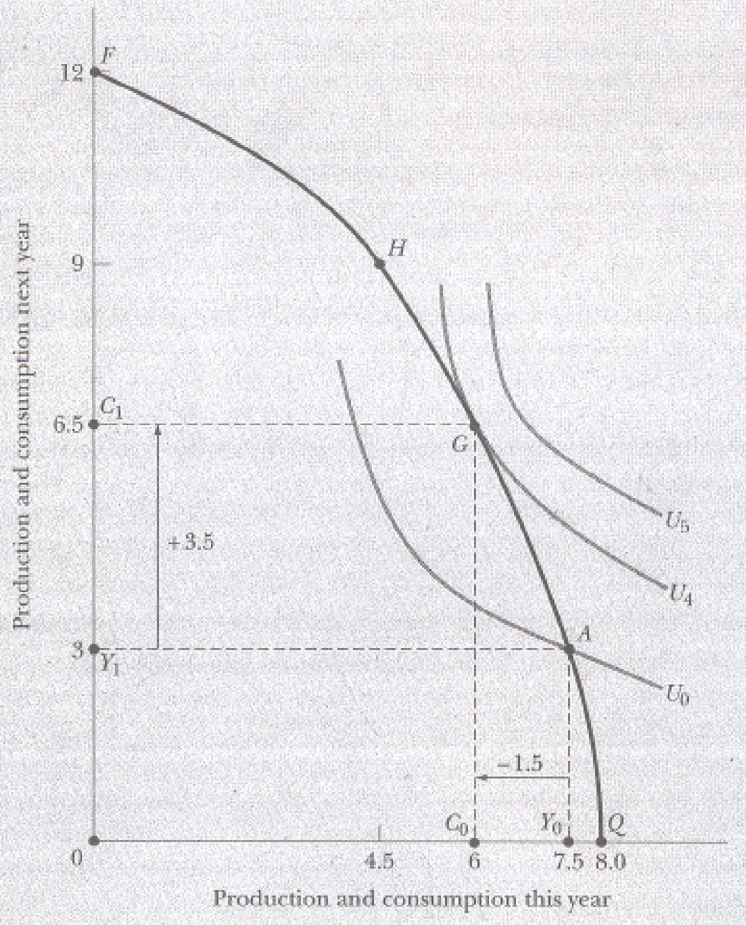
Production-possibilities curve *FQ* shows how much Crusoe can produce and consume next year by saving part of this year's output and investing it to increase next year's output. **Saving** refers to the act of refraining from present consumption. **Investment** refers to the formation of new capital assets. For example, Crusoe may use part of the year to construct a rudimentary net rather than catch fish with a spear. Since he is not catching fish while he is building the net, he is refraining from present consumption (saving). The net is an investment that will allow him to catch more fish in the future. In this case, the saving and the investment are done by the same person, and are one and the same thing.

Disregarding for the moment the indifference curves in Figure 15.4, we see that the *FQ* curve shows that if the individual consumes $C_0 = 6$ units of the commodity this year, he can produce and consume $C_1 = 6.5$ units of the commodity next year (point *G* on *FQ*). Starting from point *A*, this means that by saving and investing $Y_0 - C_0 = 7.5 - 6 = 1.5$ units of the commodity this year, the individual can increase output by $C_1 - Y_1 = 6.5 - 3 = 3.5$ units next year. Thus, the average yield or return on investment (in terms of next year's output) is $3.5/1.5 = 2.33 = (1 + 1.33)$ or 133%. Should the individual save and invest 3 units of the commodity this year, his output will increase by 6 units next year (the movement from point *A* to point *H* on *FQ*), so that the average yield or rate of return would be $6/3 = 2 = (1 + 1)$ or 100%. Note that the larger the amount invested, the lower the rate of return (because of the operation of the law of diminishing returns).

Starting at point *A* on production-possibilities curve *FQ*, the question is, "What is the optimal amount of saving and investment for this individual?" The answer is 1.5 units. The reason is that this will permit the individual to reach

FIGURE 15.4 SAVING-INVESTMENT EQUILIBRIUM WITHOUT BORROWING OR LENDING

Production-possibilities curve FQ shows how much an isolated individual can produce and consume next year by saving and investing part of this year's output. Starting at point A on FQ, the optimal level of saving and investment is 1.5 units. This level allows the individual to reach point G on the highest indifference curve possible (U_4). Saving and investing 1.5 units this year allows the individual to produce and consume 3.5 more units next year. Thus, the average yield on investment is 133%.



point G on indifference curve U_4. Indifference curve U_4 is the highest that Crusoe can reach with his production-possibilities curve. Note that indifference curves here show the trade-off or time preference between consumption this year and next. Thus, starting from point A, Crusoe should save and invest 1.5 units of this year's output so as to reach point G next year and maximize his total or joint utility or satisfaction over the two years.

Saving-Investment Equilibrium with Borrowing and Lending

Suppose that more people get stranded on Crusoe's island, and they also start producing and consuming the commodity. Now, borrowing and lending become possible. The optimal choice for Crusoe is now to save and invest, borrow or lend, so as to reach the highest indifference curve possible (higher than U_4).

To show this, we must realize that from every point of the production-possibilities curve there is a **market line,** the slope of which shows the rate at which the individual (Crusoe) can borrow or lend in the market. For example, starting at point A on the FQ curve in Figure 15.5, the individual can borrow or lend along market line FAW_0 at the rate of interest of $r = 20\%$ (as in the left panel of Figures 15.1 and 15.2). If starting from point A the individual only borrows or lends (or does neither), his wealth is $W_0 = 10$ (given by the intersection of market line FAW_0 with the horizontal axis).

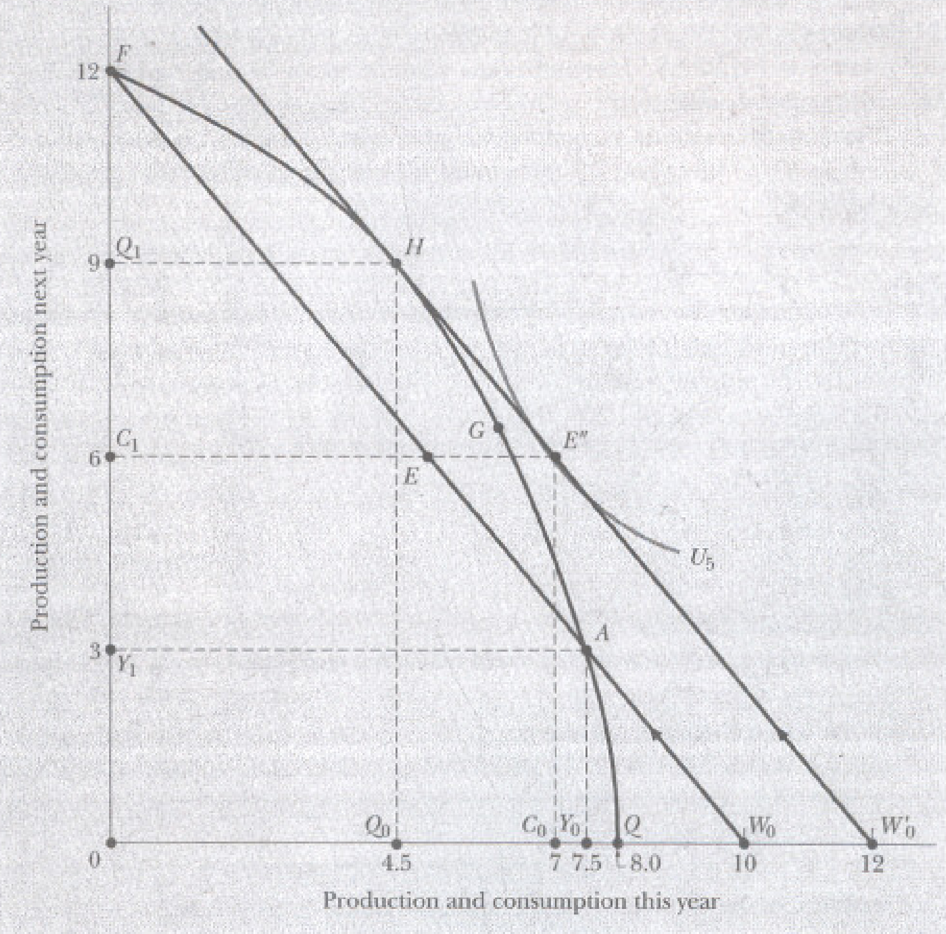
However, with the possibility of saving and investment, and borrowing or lending now open, the optimal choice for Crusoe is to invest first (so as to maximize wealth) and then to borrow (so as to reach the highest indifference curve possible). Wealth is maximized by reaching the highest market line (with slope reflecting the market rate of interest) that is possible with the FQ curve. This is given by market line $HE''W_0'$, which is parallel to market line FAW_0 (so that $r = 20\%$) and tangent to production-possibilities curve FQ at point H. Market line $HE''W_0'$ shows that the maximum attainable wealth is $W_0' = 12$. Starting from point A on the FQ curve, the individual can attain market line $HE''W'_0$ and maximize wealth by investing $Y_0 - Q_0 = 3$ units of this year's output. This allows him to reach point H on this production-possibilities curve and produce $Q_1 = 9$ units of the commodity next year.

Having attained the highest wealth possible by investing 3 units of the commodity (point H on market line $HE''W_0'$), the individual can then borrow $C_0 - Q_0 = 2.5$ units (i.e., move to the right of point H on market line $HE''W_0'$) and reach point E'' on U_5. This is the highest indifference curve that the individual can reach with optimal investment and borrowing. Point E'' on indifference curve U_5 is superior to point A on U_0 (see Figure 15.4) without borrowing or investing, it is superior to borrowing alone (to the right of point A along budget line FEW_0), and it is superior to point G on U_4 (see Figure 15.4) with saving equal to investment and no borrowing.

To summarize, the optimal choice of the individual is to invest $Y_0 - Q_0 = 3$ units (i.e., to move from point A to point H on the FQ curve) in order to maximize wealth (at $W_0' = 12$) and to borrow $C_0 - Q_0 = 2.5$ units (the movement from point H to point E'' on indifference curve U_5) to maximize total or joint satisfaction or utility over both years. Of the total amount of $Y_0 - Q_0 = 3$ invested, the individual borrows $C_0 - Q_0 = 2.5$ and saves $Y_0 - C_0 = 0.5$. That is, the individual is saving a portion of his current output, but not enough to "finance" all of his investment. Therefore, other individuals must be saving 2.5 units of the commodity more than they invest in order to lend this amount to our individual.

FIGURE 15.5 SAVING-INVESTMENT EQUILIBRIUM WITH BORROWING AND LENDING

Starting from point A, the individual maximizes wealth (at $W'_0 = 12$ units) by investing 3 units of the commodity and reaching point H, where market line $HE''W'_0$ (with slope reflecting the market rate of interest) is tangent to production-possibilities curve FQ. The individual then borrows 2.5 units (i.e., moves to the right of point H on market line $HE''W'_0$) and reaches point E'' on U_5 (the highest indifference curve possible). The individual invests 3 units, borrows 2.5, and saves 0.5.



If the market rate of interest rises above $r = 20\%$, the market line becomes steeper and tangent to production-possibilities curve FQ to the right of point H, and the individual will invest less (see Figure 15.6 and Problem 6). If the individual borrows more than he invests, he will be dissaving (see Problem 7). If indifference curve U_5 had been tangent to market line HW'_0 to the left of point H in Figure 15.5, the individual would have been investing and lending (rather than investing and borrowing) so that his saving would equal the sum of the two (see Problem 8).

The Market Rate of Interest with Saving and Investment, Borrowing and Lending

We now examine how the equilibrium rate of interest is determined in the market with saving and, investment and borrowing and lending. For simplicity, we assume that only our individual borrows and invests while all other individuals collectively only want to lend 2.5 units of the commodity at the rate of interest of $r = 20\%$. The equilibrium rate of interest is then 20% and is shown in Figure 15.6 in two different ways: (1) by point E, where the demand curve of borrowing of our individual (D_B) intersects the supply curve of lending of all other individuals (S_L) as in Figure 15.3, or equivalently, (2) by point E'', where the demand curve for investment of our individual (D_I) intersects the total supply curve of savings of this and other individuals (S_S).

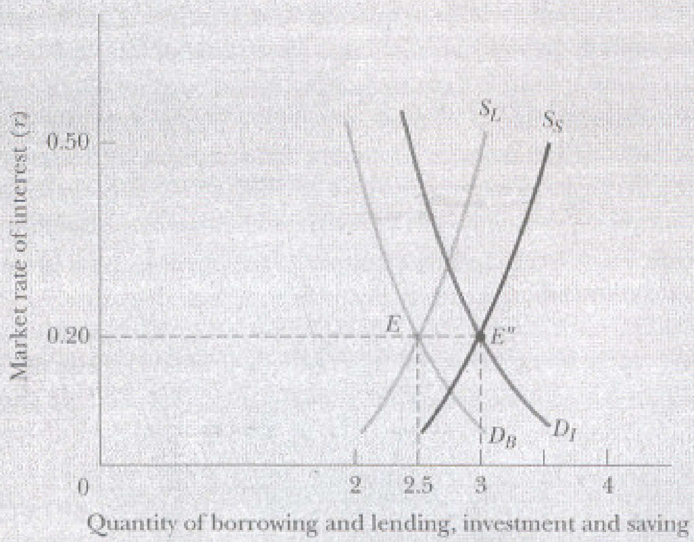
At the equilibrium market rate of interest of $r = 20\%$, the quantity of desired borrowing of 2.5 units (done exclusively by our individual) equals the quantity of desired lending of 2.5 units (supplied by all other individuals). In addition, at $r = 20\%$, the total amount of desired savings of 3 units (2.5 units by other individuals and 0.5 units by our individual) matches the desired level of investment of 3 units (undertaken exclusively by our individual). That is, at equilibrium, desired borrowing equals desired lending (point E) and desired savings equals desired investment (point E''). Note that the excess between the saving-investment equilibrium and the borrowing-lending equilibrium refers to the amount of investment that is self-financed from the investor's own savings rather than from borrowing in the market.[5]

At a rate of interest above equilibrium, there will be (1) an excess in the quantity supplied of lending over the quantity demanded of borrowing, and (2) an excess in the total quantity supplied of savings over the total quantity demanded of investment (see Figure 15.6). As a result, the interest rate will fall to the equilibrium level. The opposite is true at rates of interest below equilibrium. Of course, in the real world, there are many borrowers and many lenders, and many savers and investors, but the principles by which the equilibrium rate of interest is determined are the same (when capital markets are perfectly competitive). That is, at equilibrium, aggregate desired borrowing equals aggregate desired lending, and aggregate desired investment equals aggregate desired saving.

[5]Just as some people can borrow more than they invest so that they dissave, so some individuals can consume more than the sum of what they produce, borrow, and invest. Such individuals would be *disinvesting* or failing to maintain (i.e., not replacing depreciated) capital stock. To some extent, these individuals are "living off their capital." This may also be true for society as a whole during periods of war or natural disaster, or when it borrows abroad to increase present consumption.

FIGURE 15.6 RATE OF INTEREST WITH BORROWING AND LENDING, INVESTMENT AND SAVING

The equilibrium rate of interest is 20% and is shown (1) by point E, where the demand curve for borrowing (D_B) intersects the supply curve of lending (S_L), and (2) by point E'', where the demand curve for investment (D_I) intersects the total supply curve of savings (S_s). At $r > 20\%$, desired lending exceeds desired borrowing, and desired savings exceeds desired investments, and r falls. The opposite is true at $r < 20\%$.



EXAMPLE 2
PERSONAL AND BUSINESS SAVINGS, AND GROSS AND NET PRIVATE DOMESTIC INVESTMENT IN THE UNITED STATES

Table 15.2 presents the total or aggregate amount of personal savings (PS), business savings (BS), gross private domestic investment (GPDI), and net private domestic investment (NPDI) in the United States in terms of 1987 prices for the years 1960, 1970, 1980, 1985, and 1990 through 1994. NPDI equals GPDI minus capital consumption allowances or depreciation resulting from the production of the given year's output. Table 15.2 also shows the level of real net national product (NNP) and NPDI as a percentage of NNP during the same years. Note the very low values of the ratio of NPDI to NNP during the 1991–1992 recession years.

Business savings are from two to four times larger than personal savings. Net private domestic investment is the net addition to society's capital stock and is an important contributor to the growth of the economy and standards of living. Personal and business savings are required to provide for the replacement of the capital consumed during the course of producing current output and for the net additions to the capital stock of the country. Not included in the table are government savings and investments and foreign investments. As indicated in the previous example, Michael Darby estimated that the establishment of Social Security in 1935 reduced the nation's savings by 5% to 20%. He also estimated that this reduction in saving decreased the level of national income by 2% to 7%.

SOURCE: Michael R. Darby, *The Effects of Social Security on Income and Capital Stock* (Washington, D.C.: American Enterprise Institute, 1979).

TABLE 15.2 Personal and Business Savings, and Gross and Net Private Domestic Investment in the United States (in billions of 1987 dollars)

YEAR	PS	BS	GPDI	NPDI	NNP	NPDI AS A PERCENTAGE OF NNP
1960	$ 75.0	$221.8	$290.8	$117.1	$1,712.5	6.8
1970	161.3	303.5	429.7	171.7	2,604.0	6.6
1980	215.3	483.9	594.4	193.7	3,401.7	5.7
1985	203.4	587.1	745.9	274.4	3,867.0	7.1
1990	147.9	601.4	746.8	192.0	4,320.3	4.4
1991	176.7	606.1	683.8	113.8	4,271.6	2.7
1992	200.7	593.3	725.3	129.5	4,345.6	3.0
1993	152.2	639.8	819.9	220.4	4,240.2	5.2
1994	157.9	657.7	955.5	326.9	4,649.1	7.0

SOURCE: Council of Economic Advisors, *Economic Report of the President* (Washington, D.C.: U.S. Government Printing Office, 1995), pp. 295, 300, 307–308.

EXAMPLE 3
NET SAVINGS AND GROWTH IN THE LEADING INDUSTRIAL COUNTRIES

Table 15.3 shows the average rate of growth of real GDP in the leading industrial countries from 1960 to 1993 as well as net savings as a percentage of GDP, arranged from the highest to the lowest growth rate of real GDP. The table shows a very strong positive or direct correlation (association) between the average rate of growth of real GDP and net savings as a percentage of GDP for these nations. That is, nations with a higher percentage of net savings to GDP had a higher growth of real GDP. The only exception is Canada, which had the second highest growth rate but only the fifth highest rate of net savings. Thus, higher savings and investment rates seems to be strongly associated with higher growth rates, even though growth also depends on other important factors such as education, health, technological change, and economic structure.

TABLE 15.3 Average Growth of Real GDP and Net Savings as a Percentage of GDP in the Leading Industrial Countries, 1960–1993

COUNTRY	GROWTH OF REAL GDP	NET SAVINGS AS A PERCENTAGE OF GDP
Japan	5.9	20.5
Canada	3.8	8.9
Italy	3.6	13.2
France	3.4	12.9
Germany	3.0	12.8
United States	3.0	7.0
United Kingdom	2.2	6.8

SOURCE: Organization for Economic Cooperation and Development (OECD), *Economic Outlook* (OECD: Paris, various issues).

15.3 INVESTMENT DECISIONS

The previous discussion has important practical applications and is the basis for very valuable decision rules used by firms and government agencies in determining which investment project to undertake. For example, a bank may have to decide whether to purchase or rent a large computer, a government agency whether to build a dam, and a manufacturing firm whether it should purchase a more expensive machine that lasts longer or a cheaper one that lasts a shorter period of time. The decision rule to answer these questions and to rank various investment projects is called **capital budgeting.** Our discussion of capital budgeting begins by considering a two-period time framework. We then extend and generalize the discussion to a multiperiod time horizon.

Net Present Value Rule for Investment Decisions: The Two-Period Case

An investment project involves a cost (to purchase the machinery, build the factory, acquire a skill, and so on) and a return in the form of an increase in output or income in the future. In a two-period framework, the cost is usually incurred in the current year and the return or benefit comes the following year. However, since one unit of a commodity or a dollar next year is worth less than a unit of the