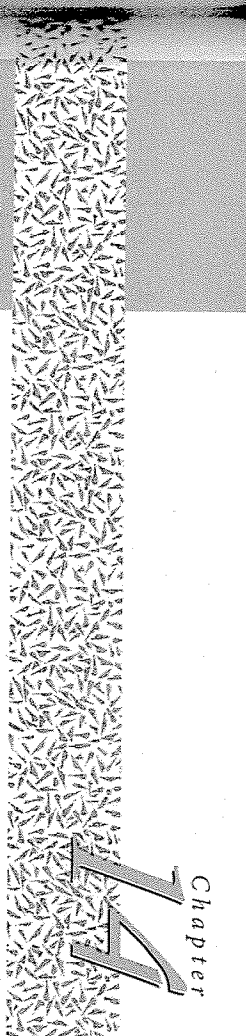


14. Distinguish between the costs of transferring goods from one individual to another and exchange costs. How would you class transportation of goods between producer and consumer? What about the costs of negotiating a contract? Enforcing a contract?

For Further Thought and Discussion

1. Omar Khayyam wrote:
I often wonder what the Vintners buy
One half so precious as the Goods they sell.
Khayyam seems to be suggesting that vintners ought not engage in exchange, because wine is more precious than anything else. Where is the fallacy in his reasoning?
 12. Compare the likely effects of taxes levied upon consumption, upon production, and upon exchange of a commodity.
 13. Suppose Robinson Crusoe is superior to Friday in producing both fish and bananas. For example, it may take Crusoe one hour to catch a fish and two hours to pick a bunch of bananas, whereas it takes Friday four hours to do either. Show that they still can engage in mutually beneficial exchange. (In international trade this is called *the principle of comparative advantage*.)
 14. Imagine an initial Edgeworth-box competitive equilibrium, starting from an endowment position where individual i has all of commodity G (grain) and individual j has all of commodity Y (the *numeraire*). Suppose i 's endowment of grain doubles, everything else remaining unchanged. Can we be sure that i is better off at the new competitive equilibrium? That j is better off? That at least one of them is better off? (*Hint*: Are wheat farmers necessarily better off if the crop is larger? What about consumers of wheat?)
 5. Give examples of markets that have existed historically, but do not now exist. Can you explain their disappearance?
 6. According to the economist Kenneth E. Boulding, a tariff can be regarded as a "negative railroad." Whereas a railroad connects trading communities, a tariff separates them. Is the analogy valid?
 17. The text stated that, in a world of two commodities X and Y , trade would normally lead to greater quantities produced of both goods. Is this necessarily the case? Might there possibly be, say, greater production of X but reduced production of Y ? Explain. (*Hint*: Consider the case where only trader i [John] has productive opportunities, whereas trader j [John] has a fixed endowment.)
 18. Flowers provide bees with nectar, while bees facilitate the pollination of flowers. Is this exchange?
 9. Fresh fruits are cheaper at farm roadstands than in city markets. Does the price difference reflect transfer costs or trading costs, or are there elements of each?
 10. Give examples of exchange costs that are reduced by the existence of money as a medium of exchange. Of money as a store of value.
 11. If rationing is introduced, money is no longer fully effective as a medium of exchange. What types of additional exchange costs emerge in a world where ration coupons and cash are both required in order to effectuate a transaction?
 12. According to elementary textbooks, a commodity selected to serve as money should be portable, divisible, storable, generally recognizable, and homogeneous. In terms of the discussion in this chapter, why are these desirable qualities? Can you think of other desirable qualities? (*Hint*: Think of cigarettes serving as money in a prisoner-of-war camp.)



THE ECONOMICS OF TIME

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14.7 ELEMENTS OF THE ECONOMICS OF TIME

So far we have studied two types of decisions: (1) how to spend income (what consumption goods to purchase) and (2) how to earn income (what amounts of resource services to offer on the market). This chapter examines another economic choice: (3) how to strike a balance between consuming in the present and consuming in the future.

To balance between present and future, people “save” and “invest.” Saving is refraining from current consumption. *Investment* means actually creating new resources that will generate more income in the future. These resources can take the form of physical capital (tangible assets such as factories and machines) or human capital (e.g., a course of training that improves personal skills).

For an isolated Robinson Crusoe, the amounts saved and invested must correspond. Crusoe saves by not eating up all of his current corn crop; he invests by putting the saved corn into the ground as seed for next year. In an exchange economy, however, those who save and those who invest need not be the same people. Savers put money in the bank or purchase corporate securities; the financial system then transfers this purchasing power to investors for building a house, enlarging a factory, or acquiring a college education.¹ However, as will be seen, the aggregate *totals* of saving and investment must correspond.

Why save or invest rather than consume today? Only so you, or someone you designate, or your heirs, can consume more in the future. A person builds a house in order to obtain future shelter; an orchardist plants a tree to harvest fruit in the future. Similarly, it is in order to achieve higher future incomes that businesses construct physical capital and students take courses of training to build up their human capital.

Section 14.1 of this chapter covers the elements of the economics of time. As an extension of standard microeconomics, we will see how the interest rate serves as a kind of price in relation to time. The next two sections cover the logic of choices between present and future. Section 14.4 discusses an important practical topic: the criteria used by business firms and by government agencies for evaluating investment projects. In section 14.5 we will see how *money*, an artificial commodity serving as numeraire, affects investment and interest. Section 14.6 looks in to why interest rates vary as among different financial instruments. For example, the rates on long-term versus short-term bonds. Finally, section 14.7 reexamines the fundamental considerations that cause saving and investment to be large or small and interest rates to be high or low.

¹In ordinary discussions, this distinction between saving and investment is not always carefully maintained. A financial writer may recommend that readers “invest” in stocks or bonds or savings deposits—although, strictly speaking, buying such financial instruments represents saving, not investment.

For simplicity, suppose corn C is the only consumption good. The objects of choice are *dated* quantities of corn: C_0 (this year’s corn), C_1 (corn one year from now), C_2 (corn two years from now), and so on. The corresponding prices will be denoted P_0, P_1, P_2 , and so on. (Note: These are the prices *today* for corn to be delivered at the specified dates.) Let current corn C_0 be the numeraire or basis of pricing, so that $P_0 \equiv 1$.

The economics of time falls easily into place once it is realized that choosing between this year’s corn and next year’s corn (between C_0 and C_1) is completely parallel to the logic previously employed in choosing between this year’s wheat and this year’s manufactures. Just as supply and demand determines the price ratio P_1/P_0 between this year’s corn and next year’s corn.

The *rate of interest* is related to this price ratio. Specifically, the current annual rate of interest r_1 is the *extra* amount of one-year future corn that has to be offered in the market per unit of current corn:

$$\frac{\Delta C_1}{\Delta C_0} \equiv 1 + r_1 \quad (14.1)$$

The minus sign indicates that a person can get more current corn (ΔC_0) only by giving up some future corn (ΔC_1), and vice versa. Furthermore, because in market exchange the values offered and received must be the same, we know that $P_0 \Delta C_0 = P_1 \Delta C_1$. Substituting, and given that C_0 is the numeraire so that $P_0 \equiv 1$, we can write:

$$\frac{1}{1 + r_1} \equiv \frac{P_1}{P_0} \equiv P_1 \quad (14.1')$$

Thus P_1 , the value of one-year future corn, is “discounted” by the factor $1 + r_1$ relative to current corn. Equivalently, r_1 is the “premium” on current corn relative to future corn.

EXERCISE 14.1

- (a) If the interest rate is $r_1 = 10$ percent, what is P_1 , the price today of a one-year future claim to corn? (b) What if $r_1 = 100\%$? (c) If future claims become almost valueless (P_1 approaches zero), what would happen to r_1 ?

Answer: (a) Using equation (14.1'), if $r_1 = 10\%$, then $P_1 \equiv 1/(1 + r_1) = \frac{1}{1.1} = 0.909$, approximately. (b) If $r_1 = 100\%$, then $P_1 = \frac{1}{2} = 0.5$. (c) As P_1 approaches zero, r_1 goes to infinity.

As a check upon understanding, consider the question: Are negative interest rates ($r_1 < 0$) possible? From equation (14.1'), negative interest rates mean that future claims are worth more than current claims in today’s market. Although unusual, this is not impossible. It might come about if people anticipated great scarcities in

the future. However, there is a limit: interest rates less than -100 percent are not possible. If $r < -1$, in equation (14.1') either P_0 or P_1 would have to be negative—contradicting our assumption that current corn and future corn are both goods rather than bads.

So far we have considered only two periods: “now” (date 0) versus “one year from now” (date 1). More generally, individuals will be making choices about corn at various dates C_0, C_1, C_2, \dots in the light of prices P_0, P_1, P_2, \dots —up to some future horizon T . So we need to generalize equations (14.1) and (14.1'). There are two different useful ways of doing this, as illustrated in Table 14.1. First, consider the successive year-to-year price ratios $P_1/P_0, P_2/P_1, \dots, P_T/P_{T-1}$. These can be used to define the one-year short-term interest rates r_1, r_2, \dots, r_T shown in column 1 of the table. Here $1 + r_1$ is the discount factor for transactions between date 0 and date 1, $1 + r_2$ is the discount factor between date 1 and date 2, and so on.

Alternatively, consider the ratios $P_1/P_0, P_2/P_0, \dots, P_T/P_0$ where P_0 appears in all the denominators. In column 2 of Table 14.1 these ratios are used to define the long-term interest rates R_1, R_2, \dots, R_T associated with transactions between date 0 and any future date up to T . Notice that R_2 is a kind of average of r_1 and r_2 . Put an- other way, the worth today of a unit of corn two years off could be found by using either the long-term discounting formula for P_2/P_0 in column 2 of the table or else by successively using the short-term one-year discounting formulas for P_2/P_1 and P_1/P_0 .

Table 14.1 Interest-Rate Equivalents

SHORT-TERM INTEREST RATES		LONG-TERM INTEREST RATES	
$\frac{P_1}{P_0} = \frac{1}{1+r_1}$	$\frac{P_1}{P_0} = \frac{1}{1+R_1}$	$\frac{P_2}{P_0} = \frac{1}{(1+r_1)(1+r_2)}$	$\frac{P_2}{P_0} = \frac{1}{(1+R_2)^2}$
$\frac{P_2}{P_1} = \frac{1}{1+r_2}$	$\frac{P_2}{P_0} = \frac{1}{(1+R_2)^2}$	$\frac{P_T}{P_0} = \frac{1}{(1+r_1)(1+r_2)\dots(1+r_T)}$	$\frac{P_T}{P_0} = \frac{1}{(1+R_T)^T}$

EXERCISE 14.2

- (a) Let $P_0 = 1$, and suppose that $r_1 = 10\%$ and $r_2 = 20\%$. (a) What is the worth at date 1 of a bushel of corn at date 2? (b) What is the worth today of a bushel of corn at date 2? (c) What is the implied long-term interest rate R_2 ?

ANSWER (a) We want to compute P_2/P_1 . Using Table 14.1, when $r_2 = 20\%$ this ratio equals $\frac{1}{1.2} = 0.833$. (b) $P_2/P_0 = (P_2/P_1) \times (P_1/P_0)$, and in the previous exercise we found that $P_1/P_0 = 0.909$ when $r_1 = 10\%$. Thus a bushel two years off is worth $0.833 \times 0.909 = 0.758$ today. (c) Using column 2 of Table 14.1, set $0.758 = 1/(1 + R_2)^2$. The im-

The next two exercises illustrate the power of compound interest.

EXERCISE 14.3

- (a) If $P_0 = 1$ as usual, and supposing that all the short-term interest rates r_1, r_2, \dots are equal to some common value $r = 10\%$, what is the value of a bushel of corn to be received in 5 years? In 10 years? In 20 years? (b) Same questions, if $r = 20\%$?

ANSWER (Questions such as these are most easily answered by reference to the interest tables published in many financial and accounting texts.) (a) At 10% , a payment 5 years in the future is worth 0.683 today, a payment 10 years off is worth 0.386 , and a payment 20 years off is worth 0.149 . (b) At 20% , the corresponding numbers are $0.402, 0.162$, and 0.026 .

So, we see, as the length of the term increases, the force of compound interest more and more drastically erodes the value today of a future payment. Furthermore, the effect becomes disproportionately stronger at higher interest rates.

EXERCISE 14.4

- Suppose you had to plan ahead whether to cut a tree for timber after 10 years or after 20 years. (a) If $r = 5\%$, how much greater would the timber value have to be at the later date to justify letting the tree grow that long? (b) If $r = 10\%$?

ANSWER (a) Using interest tables, at 5 percent a payment 10 years off is worth 0.614 today, whereas a payment 20 years off is worth only 0.377 . To justify not cutting until the later date, the timber value at that date would have to be greater by at least the proportion $\frac{0.614}{0.377} = 1.63$, approximately. (b) At $r = 10\%$ the corresponding ratio is $\frac{0.623}{0.215} = 2.15$.

CONSUMPTION CHOICES OVER TIME: PURE EXCHANGE

The analysis that follows deals with choices between consumption now versus one year from now: between c_0 and c_1 . Using the same kind of simplification as in chapter 13 (section 13.2), we can begin with a hypothetical “pure exchange” economy. In the intertemporal context, pure exchange means that no net investment is taking place. (Productive activities such as building a house or planting a tree are ruled out.) If aggregate investment is zero, then aggregate saving must also equal zero, which means that the saving of some people must be balanced by the “dissaving” of others. (If some are lending, others must be borrowing.) Intertemporal productive opportunities, and their implications for saving and investment, will be covered in the next section.

Borrowing-Lending Equilibrium with Zero Net Investment

Figure 14.1, which pictures choices between consumption this year and consumption next year (between C_0 and C_1), closely resembles the “optimum of the consumer” diagrams in chapter 4. Once again there are indifference curves I^1, I^2, I^3, \dots

