CHAPTER 7 Introduction to Land Rent and Land Use

The trouble with land is that they're not making it anymore.
Will Rogers

This chapter introduces some basic concepts of land rent and land use, setting the stage for the discussion of urban land use in Chapters 8 through 11. This chapter addresses three questions about the land market. First, what determines the price of land? Second, who benefits from public policies that increase the fertility or accessibility of land? Third, does the land market allocate land efficiently?

It will be useful to define two terms, *land rent* and *market value*. Like other assets, land yields a stream of marketable services and thus a stream of income. For example, agricultural land yields a stream of agricultural output (bushels of corn), generating a stream of income for the farmer. Similarly, a parking lot in the city yields a stream of parking services, generating a stream of income for the parking firm. When a landowner grants the rights to use his land to another individual or a firm, he charges **land rent.** If a farmer is granted the right to grow corn on a plot of land, the rent might be $1,000 per acre per year. If a firm is granted the right to operate a parking lot on a plot of land, the rent might be $5,000 per acre per year.

What determines the market value of land? The **market value** of land equals the **present value** of the stream of rental income generated by the land. To explain the concept of present value, consider an asset that generates R of income each year and is expected to generate this income for n years. If the market interest rate is i, the present value of the stream of earnings from the asset is

$$PV = \sum_{t=0}^{n} \frac{R}{(1 + i)^t} \qquad (7\text{–}1)$$

For example, if an asset is expected to generate $20 of net income per year, starting today and lasting for a total of five years, and the interest rate is 10%, the present value of the asset is

$$PV = 20 + \frac{20}{1.10} + \frac{20}{1.21} + \frac{20}{1.33} + \frac{20}{1.46} \quad (7\text{–}2)$$

$$PV = 20 + 18.18 + 16.53 + 15.04 + 13.70 = \$83.45 \quad (7\text{–}3)$$

If the stream of earnings lasts forever, the equation for present value simplifies to

$$PV = \frac{R}{i} = \frac{20}{0.10} = 200 \quad (7\text{–}4)$$

For example, if the $20 annual income lasts forever, the present value of the asset is $200.

The present value is the maximum amount that an investor is willing to pay for an asset, given an alternative investment that yields *i* percent per year. Suppose that the alternative is a savings account that yields 10 percent per year. The investor can either invest in an asset that yields $20 per year forever or invest in a savings account that yields 10 percent per year. At a purchase price of $200, the investor is indifferent between spending $200 on the asset and investing the same amount in a savings account: in both cases, the annual income is $20. At a purchase price less than $200, the investor prefers the asset to the savings account. For example, if the price is $100, the investor can make $20 per year by investing $100 in the asset, compared to $10 per year by investing the same amount in a savings account. Similarly, for a purchase price exceeding $200, the savings account is more lucrative than the asset.

The market value of land is the present value of the annual rental payments from the land. Land used for residential, commercial, and industrial activities can, in principle, yield a constant stream of rental income. In contrast with agricultural land, which can deteriorate with use, developed land does not deteriorate. Therefore, the market value equals the annual rent divided by the interest rate. For example, if the annual rent on a plot of land is $5,000 per acre and the market interest rate is 10 percent, the market value of land is $50,000 per acre. The market value of land equals the present value because the present value makes an investor indifferent between buying the land (spending $50,000 to earn $5,000 per year in land rent forever) and putting the $50,000 in a bank account with a 10 percent interest rate (earnings of $5,000 per year).

This book uses land rent—not market value—as the **price of land**. Most of the other relevant economic variables are defined as streams of revenue or costs. For example, a household earns an annual income, and a firm computes its annual profits as its annual revenue less its annual cost. To be consistent, the *price of land* is defined as the annual payment in exchange for the right to use the land: the *price of land* is synonymous with *land rent*. Given the simple relationship between rent and value, it's easy to make the translation from land rent to market value: just divide the annual rent by the market interest rate.

Land Rent and Fertility

David Ricardo (1821) is credited with the idea that the price of agricultural land is determined by its fertility. The more productive the land, the more a tenant farmer is willing to pay to use the land. Fertility analysis demonstrates some of the most important concepts of land rent in a simple and compelling way.

Consider an agricultural county where tenant farmers use land of varying fertility to grow corn. The characteristics of the local economy are as follows:

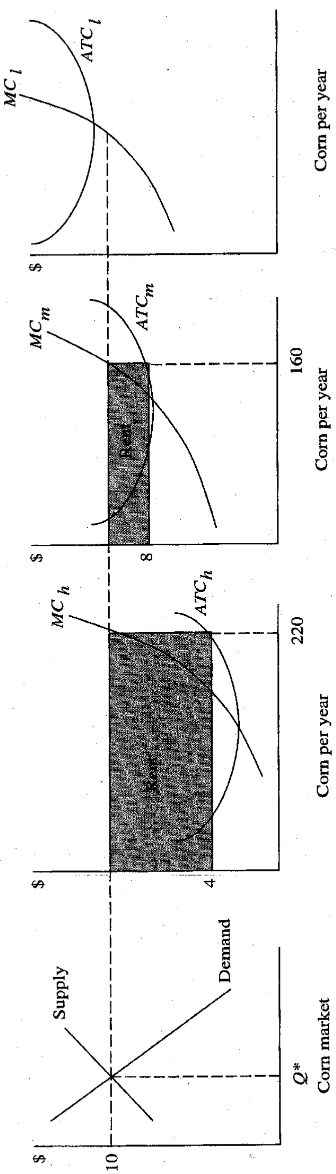
1. **Fixed prices.** The prices of the output (corn) and inputs (labor, seed, fertilizer, capital) are determined in national markets, so local farmers take the prices as given. The prices are the same at all locations in the county.
2. **Zero economic profit.** There is free entry into farming, so all farmers make zero economic profits (normal accounting profits).
3. **Fertility of land.** There are three types of land: *h* (high fertility), *m* (medium fertility), and *l* (low fertility).
4. **Land to highest bidder.** Landowners rent their land to the highest bidder.
5. **Zero transport costs.** Transport costs are assumed to be so small that they can be ignored. Later in the chapter, this assumption will be relaxed.

Figure 7–1 shows the conventional cost curves for one-acre plots of the three types of land. The marginal-cost curves (MC) are positively sloped, and pass through the U-shaped average total-cost curves (ATC) at the minimum points of average cost curves. The cost curves include all the nonland costs of production, including the costs of raw materials (seeds and fertilizer), capital (tractors), and labor. They also include the opportunity cost of being a farmer, for example, the money the farmer gives up by being a farmer instead of a steelworker.

The positions of the cost curves depend on the fertility of the land. A farmer on relatively fertile land can produce the same amount of corn with smaller quantities of the nonland inputs. Because the farmer spends less money on seeds, fertilizer, tractors, and labor, his average cost curves are lower. In general, the higher the fertility, the lower the cost curves.

How much are farmers willing to pay for the three types of land? In Figure 7–1, the national corn market generates an equilibrium price of $10: supply intersects demand at a price of $10. Farmers are price takers and maximize profit where price equals marginal cost. The profit-maximizing output on the high-fertility land is 220 bushels per acre, generating profit equal to the shaded area. In this example, profit equals $1,320 per acre per year (total revenue of $2,200 less a total cost of $880). A farmer would be willing to pay up to $1,320 per year to use one acre of the high-fertility land. Similarly, a farmer would be willing to pay up to $320 per year for the medium-fertility land. For the low-fertility land, production costs are so high that corn production is not profitable at a price of $10, so a corn farmer would not be willing to pay anything for the low-fertility land.

FIGURE 7–1 Fertility and Land Rent



The equilibrium price of corn is $10 per bushel. Competition for land forces farmers to pay their surplus (total revenue less total nonland cost) to landowners. The high-fertility land has lower production costs and higher pre-rent profit, so farmers are willing to pay more rent. The medium-fertility land earns less rent because it has higher production costs. The low-fertility land generates no profits, so its rent is zero.

Competition and Land Rent

Competition among prospective farmers bids up the price of land to the point at which economic profit is zero (accounting profit is normal). Farmers are willing to pay up to $1,320 for the high-fertility land, and are forced by competition to do so: at any rent less than $1,320 per acre, the landowner will be able to find another farmer willing to pay slightly more to use the land. Similarly, the equilibrium rent on the medium-fertility land is $320. Because the equilibrium land rents make economic profits equal to zero, farmers are indifferent between different plots of land. Although the high-fertility land has lower production costs, the savings in production costs are offset by higher land costs.

In equilibrium, land rent equals the excess of total revenue over nonland costs. This is the **leftover principle**: because of competition among farmers for land, the landowner gets the leftovers. This principle assumes that individual plots of land have unique characteristics, but farmers are all the same. Competition among a large number of farmers, each of whom has the same cost curves, bids up the price of high-fertility land to the point at which economic profit is zero. If the farmer on the high-fertility land pays less than the excess of total revenue over nonland cost, the farmer would be evicted and replaced with another farmer willing to pay the leftovers (total revenue less nonland cost) for the opportunity to earn normal accounting profits.

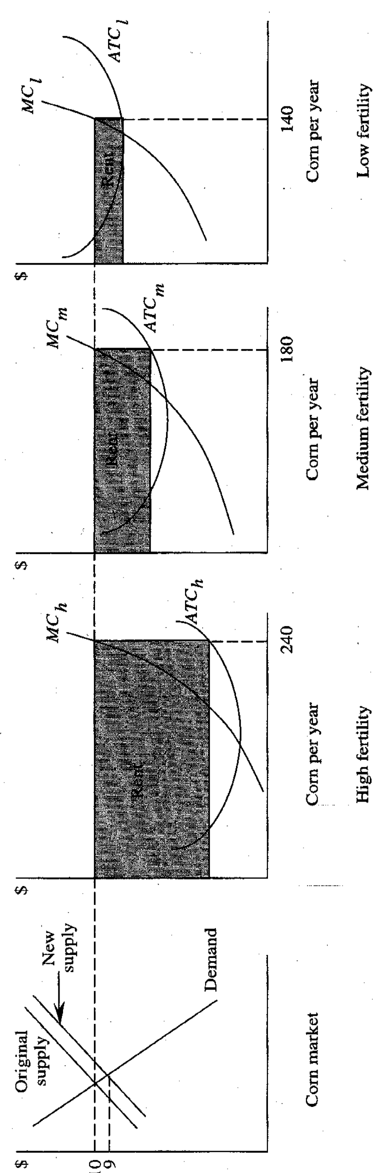
The leftover principle does not hold if there are restrictions on entry and competition. One restriction on entry comes from patents. If farmer Tom holds the patent for a particular farming technique, he has lower production costs than all other farmers. For example, suppose that Tom can produce an acre's worth of corn for a pre-rent profit of $2,000, and other farmers, using inferior techniques, generate a pre-rent profit of only $500. The landlord is unable to charge Tom a rent of $2,000 because the threat of eviction is a hollow one: there are no other farmers with the same production costs, so there are no farmers willing to pay $2,000 per acre. Instead, Tom pays only $500, allowing him to make an economic profit of $1,500. The landowner does not get the leftovers because the patent restricts competition. Once the patent expires and all farmers have access to the same technology, the landowner can increase land rent and convert the economic profit into increased land rent.

Land Rent and Public Policy

Fertility analysis can be used to predict the effects of public policy on land rent. Suppose that an agricultural county builds an aqueduct and provides free irrigation to farmers. Who benefits from the irrigation project?

Consider first the possibility that the irrigation project does not affect the equilibrium price of corn. The irrigation project decreases farmers' production costs, shifting the cost curves downward, as shown in Figure 7–2. For all three types of land, pre-rent profits increase: high-fertility land and medium-fertility land become more profitable, and low-fertility land now generates a positive profit. As profit increases, competition among farmers bids up land rent to the point at which economic profit is zero. The savings in production costs are paid to landowners in the form of higher rent, so the benefits of the irrigation project go to landowners.

FIGURE 7–2 Effects of Irrigation Project on Land Rent and Corn Price



An irrigation project decreases production costs for all three types of land. If the price of corn stays at $10, the shaded areas show the land rent on the three types of land. The supply of corn will increase because land is used more intensively (output increases on the high-fertility and medium-fertility land) and marginal (low-fertility) land is brought into production. The increase in supply decreases the equilibrium price of corn, so the rent on each plot of land is actually less than the shaded area.

Will the price of corn be affected by the irrigation project? The project increases the supply of corn for two reasons. First, the project shifts the marginal-cost curves downward, increasing the profit-maximizing outputs of the high-fertility and medium-fertility farms. Second, marginal land (low-fertility land) is brought into production. For these two reasons, the supply curve shifts to the right, decreasing the equilibrium price of corn. Therefore, corn consumers benefit from the irrigation project. As the price of corn decreases, the pre-rent profits of farmers decrease, decreasing land rent. In other words, consumers gain at the expense of landowners.

What determines the distribution of benefits between landowners and corn consumers? The general rule is that the smaller the geographical area covered by the irrigation program, the larger the share of the benefits that go to landowners. Consider first an irrigation project that decreases the production costs of a single 50-acre plot of land. The project causes a trivial increase in supply and virtually no change in the price of corn. Therefore, all the benefits go to the landowner. Consider next a national irrigation project that decreases the production costs of all corn farmers. The project causes a large increase in supply (existing land is cultivated more intensively and more land is brought under production), so it decreases corn prices significantly. In this case, a large share of the benefits goes to consumers.

The benefits of the irrigation project are **capitalized** into the market value of land. Since the project increases the annual rent, it increases the present value of the stream of earnings from land, increasing its market value. For example, suppose that the annual rent on high-fertility land increases from $1,320 per acre per year to $1,500. If the market interest rate is 10 percent, equation (7–4) suggests that the market value of land rises from $13,200 per acre to $15,000 per acre.

Land Rent and Accessibility

This section uses a model developed by Von Thunen (in 1826) to explain why land rent increases with the accessibility of land. In the Von Thunen model, accessibility replaces fertility as the determinant of land rent. The Von Thunen approach will be used in Chapter 8 (Land Use in the Monocentric City) to discuss urban land rent and land use.

Consider a county where all land is used to grow carrots. The characteristics of the economy are as follows:

1. **Fixed prices.** The prices of the output (carrots) and inputs (labor, seed, fertilizer, capital) are determined in national markets, so farmers take the prices as given. The prices are the same at all locations.
2. **Marketplace.** All carrots are transported from farms to a central marketplace at a cost of t per ton per mile.
3. **Competitive markets.** There is free entry into carrot farming. In equilibrium, all farmers make zero economic profits (normal accounting profits).
4. **Fertility of land.** All land is equally fertile, so production costs are the same at all locations.

Linear Land-Rent Function

Suppose that carrots are produced with fixed factor proportions. In other words, farmers do not engage in factor substitution as the relative prices of inputs change. The typical farmer occupies one acre of land and produces Q tons of carrots, which are sold at a price of P per ton. If the unit transport cost is t per ton per mile, total transport cost for a farm located u miles from the marketplace is

$$TC = t \cdot Q \cdot u \tag{7–5}$$

For example, if unit transport cost (t) is \$4 per ton per mile and the farmer produces 20 tons per acre, transport cost is \$80 for a farm one mile from the market, \$160 for a farm two miles from the market, and so on. If the farmer spends C on nonland production costs (labor, raw materials, and the opportunity cost of farming time) and land rent is R, the profit per acre is

$$\pi = P \cdot Q - C - t \cdot Q \cdot u - R \tag{7–6}$$

For zero economic profit, the bid rent for land is

$$R = P \cdot Q - C - t \cdot Q \cdot u \tag{7–7}$$

Because land near the marketplace (u) has relatively low transport costs, the farmer is willing to pay more for this land.

Figure 7–3 shows the **bid-rent function** of the typical farmer. The numerical assumptions are listed below the graph. Total revenue per acre (shown by the horizontal line) is the same at all locations because price and quantity do not vary across space. Total cost is the sum of nonland cost per acre and transport costs. The total-cost curve is positively sloped because transport costs increase with distance to the market; the slope of the cost curve is ($t \cdot Q$). The farmer's bid rent for a particular location is total revenue less total cost, so the bid-rent function is negatively sloped. The bid rent is \$250 at the marketplace and falls by \$80 per mile.

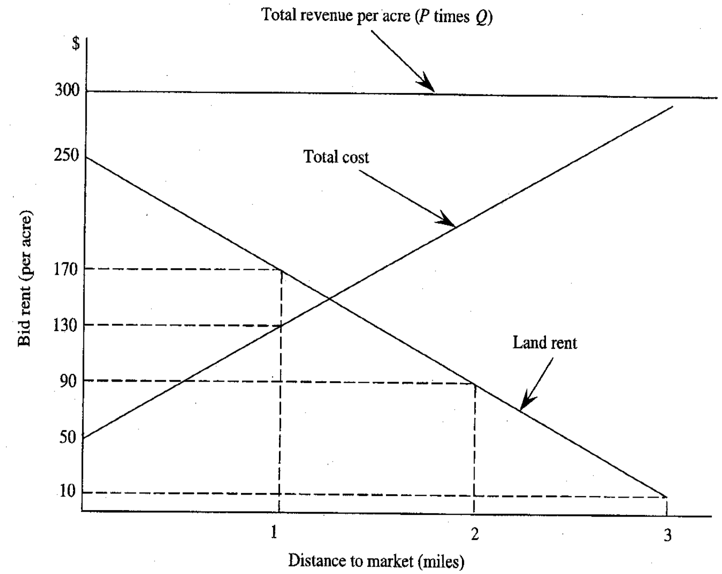
The **land-rent function** shows the equilibrium land rent for different locations. Farmers compete for land, bidding up land rent to the point at which economic profit is zero at every location. If all farmers are identical (they all have the same production costs and transport costs), the land-rent function is the same as the bid-rent function of the typical farmer. The land-rent function makes farmers indifferent among all land in the county: as the farmer approaches the market, the savings in transport costs are exactly offset by increases in land rent.

Factor Substitution: Convex Land-Rent Function

The bid-rent function in Figure 7–3 is linear because the farmer is assumed to be inflexible. The farmer produces 20 tons of carrots with one acre of land and \$50 worth of nonland inputs, regardless of the relative price of land. This section shows that if farmers engage in factor substitution, the bid-rent function is convex instead of linear.

Consider a flexible farmer, defined as one who changes input proportions as the relative price of land changes. If the farmer moves to relatively expensive land, she

FIGURE 7–3 Revenue, Cost, and Bid Rent for the Carrot Farmer



Land rent equals total revenue less nonland costs and transport costs. The farmer's total revenue is \$300 and nonland cost is \$50. Transport cost increases by \$80 for every mile from the marketplace, so the slope of the bid-rent function is \$80.

substitutes nonland inputs (capital, labor, raw materials) for land, so she can produce 20 tons of carrots on a smaller plot of land. The farmer's production isoquant, mapped in Figure 7–4, shows the different input combinations that produce 20 tons of carrots: the possibilities include points B (0.80 acres of land and \$60 of nonland inputs) and C (0.60 acres and \$80 of nonland inputs).

Table 7–1 shows how to compute the farmer's bid-rent function. If the farmer uses T acres of land, the new expression for profit is

$$\pi = P \cdot Q - C - t \cdot Q \cdot u - R \cdot T \tag{7–8}$$

Economic profit is zero if the total payment for land is

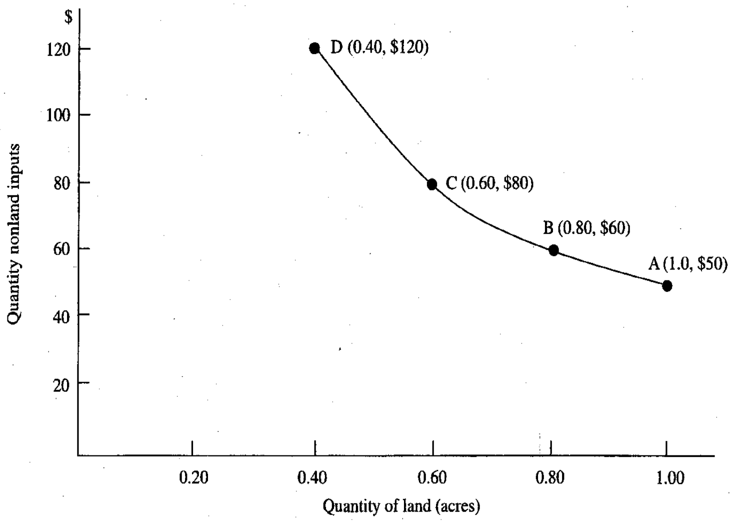
$$R \cdot T = P \cdot Q - C - t \cdot Q \cdot u \tag{7–9}$$

Dividing each side by T gives the bid rent per acre:

$$R = \frac{P \cdot Q - C - t \cdot Q \cdot u}{T} \tag{7–10}$$

At a location three miles from the market, the flexible farmer uses the same input combinations as the inflexible farmer (one acre of land and \$50 worth of nonland inputs), and is willing to pay the same amount in land rent (\$10). As the farmer moves toward the marketplace, the price of land increases, causing movement up

FIGURE 7–4 Isoquant for 20 Tons of Carrots



The isoquant shows the different combinations of land and nonland inputs needed to produce 20 tons of carrots. As the farmer moves toward the market, the price of land increases, so the farmer moves up the isoquant, substituting nonland inputs for land.

the isoquant, from point B (two miles), to C (one mile), to D. For each location, the pre-rent profit is total revenue less nonland costs and transport costs [the right-hand side of equation (7–9)]. The bid rent per acre equals the pre-rent profit divided by the size of the farm (in acres). For a farm two miles from the market, pre-rent profit is $80 on 0.80 acres of land, so the farmer is willing to pay $100 per acre ($80/0.80).

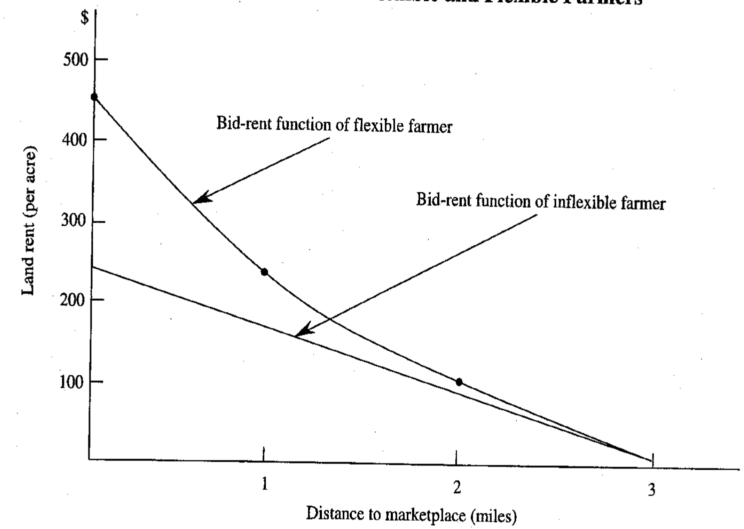
TABLE 7–1 Costs and Land Rent for the Flexible Farmer

Distance to Market (miles)	*Farm Size (acres)*	*Total Revenue*	*Nonland Costs*	*Transport Costs*	*Pre-Rent Profit*	*Rent per Acre*
0	0.4	$300	$120	$ 0	$180	$450
1	0.6	300	80	80	140	233
2	0.8	300	60	160	80	100
3	1.0	300	50	240	10	10

Assumptions
Output = 20 tons
Price = $15
Transport cost = $4 per ton per mile
Pre-rent profit = Total revenue − Nonland costs − Transport cost

$$\text{Rent} = \frac{\text{Pre-rent profit}}{\text{Farm size}}$$

FIGURE 7–5 Bid-Rent Functions of Inflexible and Flexible Farmers



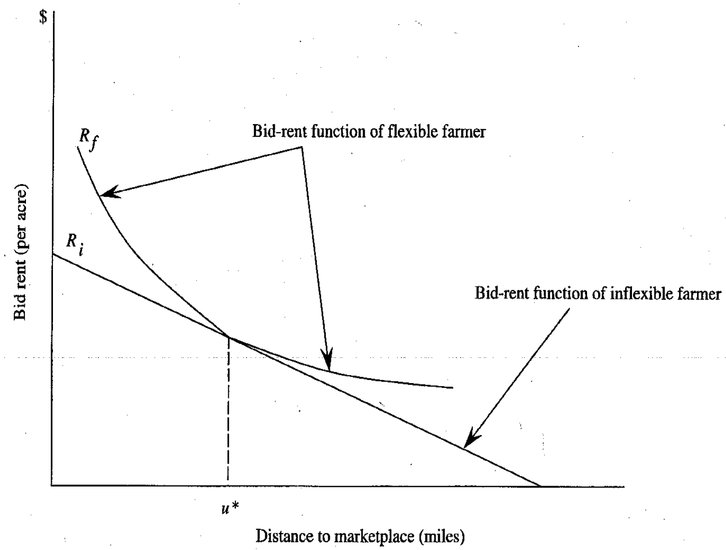
The bid-rent function of the inflexible farmer is linear because carrots are produced with fixed factor proportions. In contrast, the flexible farmer is more efficient, so the farmer has lower production costs and can pay more rent.

The bid rent increases as the farmer approaches the market, rising to $450 for a farm close to the marketplace.

Figure 7–5 shows the bid-rent functions of the flexible and inflexible farmers. The flexible bid-rent function lies above the inflexible one for all locations except $u = 3$, that is, the flexible farmer outbids the inflexible one for all land except at $u = 3$. To explain the ability of the flexible farmer to outbid the inflexible one, suppose that both farmers start at $u = 3$. At $u = 3$, both farmers have the same bid rent ($10) because they use the same input combination (1 acre of land and $50 of nonland inputs). Suppose that each farmer considers a one-mile move toward the marketplace, which would decrease transport costs by $80. Since the inflexible farmer does not change his input combinations, his bid rent would increase by $80. In contrast, the flexible farmer would substitute nonland inputs for the relatively expensive land (moving up the isoquant from point A to B in Figure 7–4). Given the higher price of land at $u = 2$, point B is more efficient than point A, so the flexible farmer has lower production costs. The decrease in production costs from factor substitution increases the bid rent for land, so the flexible farmer can outbid the inflexible farmer.

Figure 7–6 shows the general shape of the bid-rent functions of flexible and inflexible farmers. Because the inflexible farmer uses the same input combination at all locations, the bid-rent function simply reflects differences in transport costs: the bid-rent function is linear, with a slope equal to transport cost per mile. In contrast, the flexible farmer engages in factor substitution, generating savings in both transportation costs and production costs as the farmer moves toward the marketplace. As a result, the flexible bid-rent function is convex, as shown by R_f. The two bid-rent

FIGURE 7–6 Flexible versus Inflexible Bid-Rent Functions



The flexible farmer is more efficient than the inflexible one, and is therefore able to pay more for land. The rent functions are tangent at the point at which the inflexible farmer is lucky enough to choose the efficient input combination.

functions are tangent at the point at which the two farmers choose the same input combination (u^*).

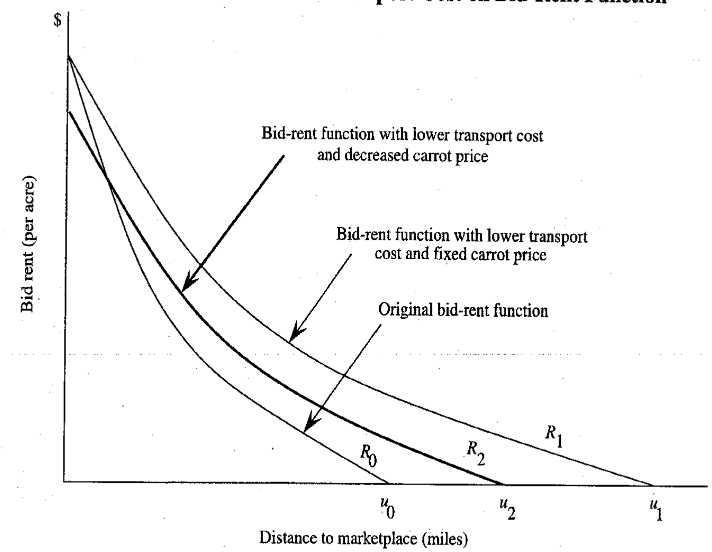
Will landowners rent land to inflexible farmers? For most plots of land, flexible farmers outbid inflexible farmers. The inflexible farmer will get land only if the farmer is lucky enough to choose the efficient input combination. In general, inflexibility means inefficiency, so the competition for land eliminates inefficient farmers.

Decrease in Transport Costs and Land Rent

How does a decrease in transport costs affect the bid-rent function? In Figure 7–7, the original bid-rent function is R_0 and the radius of the carrot farming district is u_0 miles. For land beyond u_0, transport costs are so high that carrot farmers are not willing to pay anything for land. Suppose that a new highway is built, decreasing the cost of transporting carrots to the market. The decrease in transport costs per mile decreases the slope of the bid-rent function. If the price of carrots is fixed, the bid-rent function shifts from R_0 to R_1, so the radius of the carrot district increases from u_0 miles to u_1 miles. In this case, the benefits of decreased transport costs go to landowners: land within the original farm district commands a higher rent, and marginal land (between u_0 and u_1) now commands a positive rent.

The decrease in transport costs increases the supply of carrots for two reasons. First, land in the original carrot district is used more intensively. As land rent rises,

FIGURE 7–7 Effect of Decreased Transport Cost on Bid-Rent Function



A decrease in transport costs decreases the slope of the bid-rent function. If the price of carrots is fixed, the function shifts from R_0 to R_1. If the supply of carrots increases and the market price drops, the bid-rent function shifts downward from R_1 to R_2.

farmers economize on land by substituting nonland factors for land. As farmers move up their isoquants, output per acre increases. Second, marginal land (between u_0 and u_1) is brought into production, increasing the total acreage of carrot production.

What are the implications of the increased carrot supply for the bid-rent function? If the increase in supply is large enough to decrease the equilibrium price of carrots, total revenue per acre decreases, decreasing the amount farmers are willing to pay for land. As shown in Figure 7–7, the decrease in the price of carrots shifts the bid-rent function downward from R_1 to R_2. The downward shift of the bid-rent function decreases the radius of the carrot district from u_1 to u_2.

The benefits of the highway are shared by landowners and consumers. Landowners can charge a higher rent because their land is more accessible, and carrot consumers face lower prices because there is a greater supply of carrots. As explained earlier for the irrigation project, the distribution of benefits between landowners and consumers depends on the geographical extent of the public works program. If a single county improves its road to increase the accessibility of its carrot-growing land, the supply of carrots will increase by a trivial amount and the price will decrease by a trivial amount. Therefore, most of the benefits of the highway go to landowners. In contrast, a national highway program is likely to increase supply and decrease price by relatively large amounts. Therefore, some of the benefits of new highways go to consumers.

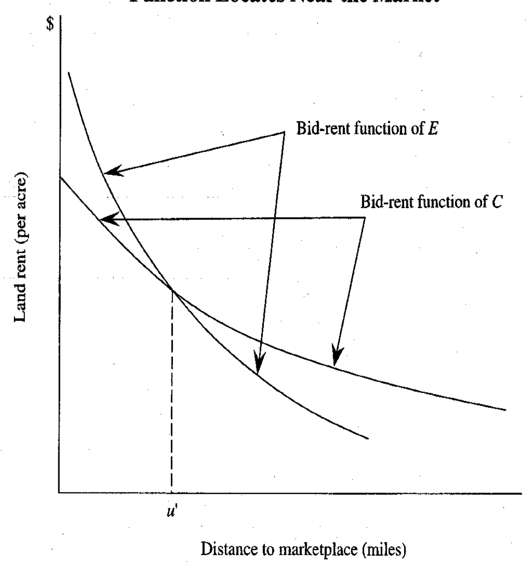
Two Land Uses

Figure 7–8 shows how land is allocated between two competing users. Because land is allocated to the highest bidder, land within u' miles of the market is occupied by activity E, and land beyond u' is occupied by C. The equilibrium land-rent function (the thick line in Figure 7–8) shows the market rent for different locations. For u less than u', E outbids C, so the land-rent function is the same as E's bid-rent function. For u greater than u', the land-rent function is the same as C's bid-rent function.

Activity E occupies the land closest to the market because it has a relatively steep bid-rent function. The bid-rent function is negatively sloped because of transport costs, so the higher the transport costs, the steeper the bid-rent function. Transport costs are relatively high if the output is relatively heavy or costly to ship.

1. **More output per acre: eggplant and cotton.** Because eggplant farmers produce more tons per acre than cotton farmers, they have higher transport costs and a steeper bid-rent function (everything else being equal).
2. **Higher unit transport costs: eggs and carrots.** Although carrots can be thrown in the back of a truck, eggs must be placed in egg cartons. A ton of eggs takes up more space than a ton of carrots, so eggs have a higher unit transport cost. Egg producers have higher total transport costs and thus a steeper bid-rent function (everything else being equal).

FIGURE 7–8 The Activity with the Steeper Bid-Rent Function Locates Near the Market



Because activity E's bid-rent function is steeper than C's, E occupies land closer to the marketplace. E has a relatively steep bid-rent function because it has relatively high transport costs, a result of either higher unit transport costs (eggs versus carrots) or more tons per acre (eggplant versus cotton). The equilibrium land-rent function is the thick line (the E bid-rent function for $u < u'$, and the C bid-rent function for $u > u'$). Land is allocated to its "highest and best use."

In general, the activity with higher transport costs (higher transport rate or greater weight) occupies the central land.

Does the land market allocate land efficiently? The market allocates central land to the activity with the highest transport costs, that is, the activity with the most to gain from proximity to the market. To explain, suppose that an eggplant farmer starts at a location one mile from the market and then swaps locations with a cotton farmer three miles from the market. Since the eggplant farmer has higher transport costs per acre of production, the land swap increases eggplant transportation costs by more than it decreases cotton transport costs, so total transport costs increase. In general, because the market allocates central land to the activity with relatively large transport costs, it minimizes total transportation costs. In the terms used by land developers, land is allocated to its "highest and best use."

The conclusion that the land market allocates land efficiently rests on the assumption that there are no externalities in land use. If there are externalities, the market allocation is inefficient, and government intervention can be justified on efficiency grounds. The issue of land-use externalities will be examined in detail in later chapters.

Market Interactions

The demand for land is derived from the demand for outputs (corn, carrots, housing, retail goods, manufactured goods). This section examines the interactions between the land market and the output market. The discussion addresses a sort of chicken-and-egg question about the land market: is the price of land high because the price of output is high, or is the price of output high because the price of land is high?

The Corn Laws Debate

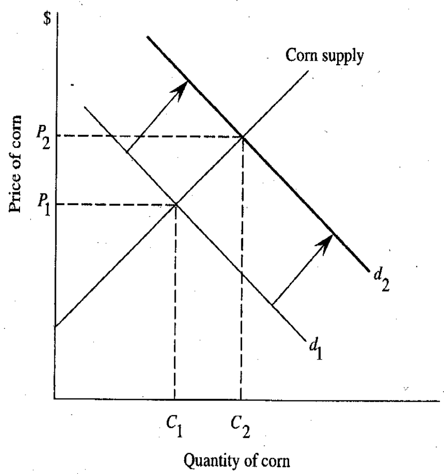
The British Corn Laws of the 1800s restricted grain imports to Britain. The decrease in the supply of imported grain increased the demand for domestically produced corn. Figure 7–9 shows the effects of the Corn Laws on the corn market and the land market.

1. **Corn market.** The Corn Laws shifted the demand curve from d_1 to d_2. The price of domestic corn increased from P_1 to P_2, and the quantity of corn produced increased from C_1 to C_2.
2. **Land market.** As domestic corn production increased, the demand for land increased. In Figure 7–9, the increase in corn production shifted the demand curve for land from D_1 to D_2. Because the supply curve is perfectly inelastic (they aren't making land any more), the increase in demand increased the price of land from R_1 to R_2.

FIGURE 7–9 The Corn Laws Debate

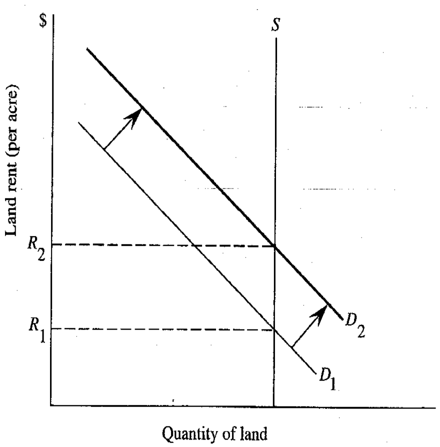
(A)

Corn market



(B)

Land market



The Corn Laws restricted grain imports, increasing the demand for domestic corn and its price. Corn production increased from C_1 to C_2, increasing the demand for land from D_1 to D_2. The price of land increased from R_1 to R_2. The price of land is high because the price of corn (and the production of corn) is high.

To summarize, the price of land is high because the price of corn is high. The Corn Laws increased the price of corn, which stimulated the production of corn and the demand for corn-growing land. Landowners responded by increasing the price of land to allocate the fixed resource among competing land uses. The lesson is that high land prices are the result of high corn prices, not the reason for high corn prices.

Housing Prices and Land Prices

The lesson from the Corn Laws debate is applicable to the urban housing market. Consider the following statement: "Greedy landowners in the San Francisco Bay Area have increased the price of land, increasing the price of housing." In fact, the price of land is high because the demand for housing (and the demand for land on which to build housing) is high. As the demand for housing increases, the price of housing increases, causing builders to buy more land to build more houses. The increase in the demand for land increases the price of land. Or consider the following: "The price of land in Boston is so high that few people can afford to live there." In fact, the price of land in Boston is high because so many people *can* afford to live there. The large demand for housing generates a large demand for land, which causes a relatively high price of land. The high price of land is the result—not the cause—of high housing prices.

The Single Tax

In 1880, Henry George proposed a 100 percent tax on rental income. The proposed tax was dubbed the "single tax" because it would have generated enough revenue to support all levels of government at the time. The spirit of the single tax is best expressed by George himself. The following is from an interview with David Dudley Field (in the *North American Review* in 1885):

> *Field:* Then suppose A to be the proprietor of a thousand acres on the Hudson, chiefly farming land, but at the same time having on it houses, barns, cattle, horses, carriages, furniture; how is he to be dealt with under your theory?
> *George:* He would be taxed on the value of his land, and not on the value of his improvements and stock.... The effect of our present system, which taxes a man for values created by his labor and capital, is to put a fine upon industry, and repress improvement. The more houses, the more crops, the more buildings in the country, the better for us all, and we are doing ourselves an injury by imposing taxes upon the production of such things.
> *Field:* Then you would tax the farmer whose farm is worth $1,000 as heavily as you would tax the adjoining proprietor, who, with the same quantity of land, has added improvements worth $100,000; is that your idea?
> *George:* It is. The improvements made by the capitalist would do no harm to the farmer, and would benefit the whole community, and I would do nothing to discourage them.

Field: A large landlord in New York owns a hundred houses, each worth, say, $25,000 (scattered in different parts of the city); at what rate of valuation would you tax him?
George: On his houses, nothing. I would tax him on the value of the lots.
Field: As vacant lots?
George: As if each particular lot were vacant, surrounding improvements remaining the same.
Field: Well, what do you contemplate as the ending of such a scheme?
George: The taking of the full annual value of land for the benefit of the whole people. I hold that land belongs equally to all, that land values arise from the presence of all, and should be shared among all.

George proposed the single tax for both equity and efficiency reasons. On the equity issue, George argued that land rent is determined by nature and society, not by the efforts of landowners. As discussed earlier in the chapter, agricultural land rent is determined by the fertility of the soil and its accessibility to markets. Similarly, the urban land rent is determined by its accessibility to other activities. In George's time, cities were growing rapidly, causing rapid increases in land rent and value. George argued that landowners did nothing to deserve the increases in property value, so that any windfall gains from urban growth should be taxed away.

On the efficiency issue, George argued that the land tax would eliminate the need for taxes on improvements. The elimination of improvement taxes would stimulate investment in houses, crops, and buildings. The land tax would not affect the supply of land because the supply of land is fixed. The replacement of the improvement tax with the land tax would increase the total wealth of society.

The single tax has been criticized for three reasons. First, the single tax would decrease the net return to the landowner (net land rent) to zero, making the market value of land zero. In other words, the government would essentially confiscate the land. This strikes many people as inequitable. Second, if the net return on land is zero, landowners will abandon their land, leaving government bureaucrats to decide who uses the land. Unlike the private owner, who receives more income if the land is used efficiently, the bureaucrat has nothing to gain from the efficient use of land. Therefore, the government land market is less likely to allocate land to its highest and best use. The third criticism is that it is difficult to measure land rent (and the appropriate tax). Most land has structures or other improvements, and it is difficult to separate the value generated by the raw land from the value generated by the improvements.

An alternative to the single tax is a **partial land tax**. Under a partial tax, land is taxed at less than 100 percent of its value. A partial land tax would be less confiscatory than the single tax: like conventional taxes on labor and capital, the partial tax would confiscate only a portion of the taxpayer's resources. In addition, because a partial tax leaves landowners with a positive net return, the land market will continue to be run by those who have a private interest in allocating land to its highest bidder.

Another alternative to a pure land tax is the **two-rate tax,** or the **split tax**. Under the conventional property tax, land and improvements are taxed at the same rate.

A 3 percent property tax is actually a 3 percent tax on land and a 3 percent tax on improvements. Under a split tax, the tax rate on land may be 9 percent, while the tax rate on improvements may be 1 percent. The split tax is widely used in Australia and New Zealand. It is also used in some cities in Pennsylvania: Pittsburgh implemented a split tax in 1913, and six other cities, including Scranton and Harrisburg, have adopted the split tax in recent years.

The replacement of the conventional property tax with the split tax would stimulate capital investment. The switch to the split tax would decrease the tax rate on capital, encouraging capital improvements. Suppose, for example, that Rhonda would like to add a recreation room to her house. The new room would increase the assessed value of her house by $20,000. Under a conventional 3 percent property tax, her tax liabilities would increase by $600 per year. Under a split tax with a 1 percent rate on improvements, her tax liabilities would increase by only $200 per year. The tax penalty from the home improvement would be lower under the split tax, so Rhonda would be more likely to improve her house.

The same argument applies to investment in commercial and industrial property. Under the split tax, the tax liability of the property owner is only 1 percent of market value, so investments that increase the market value of the property have smaller tax penalties. The owner of an apartment building is more likely to install a new roof if the roof (and the associated increase in assessed value) increases his tax liability by a relatively small amount.

Summary

1. According to the leftover principle, the bid rent for land equals the difference between total revenue and total cost. Competition for land ensures that the landowner gets the excess of total revenue over total cost.
2. Land that is relatively fertile has relatively low production costs, so it commands a higher rent.
3. A policy that increases fertility (e.g., an irrigation project) generates benefits for both landowners and consumers.
   a. The project decreases production costs, increasing land rent.
   b. If the supply of the agricultural good increases, the price decreases, generating benefits for consumers.
   c. The distribution of benefits between landowners and consumers depends on the geographical extent of the program: the smaller the geographical area affected by the project, the smaller the price decrease and the larger the rent increase.
4. The benefits of an irrigation project are capitalized into the market value of land: the increase in rent increases the present value of rental income, increasing the market value of land.
5. The bid-rent function shows how much a firm is willing to pay for land at different distances from the market. The function is negatively sloped:

transportation costs are lower near the market, so rent is higher. The rent function is convex—not linear—if firms substitute nonland inputs for land as the price of land increases.

6. A decrease in transport costs decreases the slope of the bid-rent function. If the resulting increase in supply of agricultural goods decreases agricultural prices, the bid-rent function shifts downward. The benefits of increased accessibility are shared by consumers and landowners.
7. If there are two land uses, the activity with the higher transport costs has a relatively steep bid-rent function and occupies the land closest to the market.
   a. The bid-rent function is relatively steep if (1) output per acre is relatively large or (2) unit transport costs are relatively high.
   b. The market allocates central land to the activity with the most to gain from proximity.
8. The demand for land is derived from the demand for output (e.g., corn, housing). The price of land is high because the demand for output is high. Expensive land is the result—not the cause—of expensive output.
9. Henry George proposed the single tax, a 100 percent tax on rental income.

Exercises and Discussion Questions

1. In the state of California, rice growers burn their field stubble to sanitize their fields. The field burning causes serious air pollution. The alternative sanitizing method costs $150 per acre. Consider a county where rice farmers are currently willing to pay $500 per acre for land, and corn farmers (who do not sanitize their fields) are willing to pay $300 per acre. The total output of the county is small enough that the prices of rice and corn are unaffected by events in the county. Suppose that field burning is outlawed in the county, forcing rice farmers to switch to the alternative sanitizing method.
   a. How does the field-burning law affect rice consumers, corn consumers, farmers, and landowners? In other words, who bears the cost of the pollution-control program?
   b. How would your answer to (*a*) change if the cost of the alternative method is $250 per acre?
   c. How would your answer to (*b*) change if field burning is outlawed in the entire state of California?
2. Critically appraise the following statement:

   I would like to clear the air with some facts about rice straw burning. Burning is the only economical way to prevent stem rot in rice. This disease would drastically reduce the yield of rice grown on the same land the next year. The California Department of Agriculture estimates the cheapest alternative to rice straw burning, which involves baling and hauling it elsewhere, would cost about $150 per acre. The opponents of straw burning suggest the savings ($150 per acre) go straight into the pockets of growers. Actually, straw burning decreases the prices of Rice Krispies and other rice products, so the savings go to consumers.

3. Consider an agricultural economy with the following characteristics:
   i. All the land in the region is initially used by tenant farmers to grow indigo.
   ii. The price of indigo is determined in international markets.
   iii. The tenant initially pays the landowner 30 percent of the indigo harvest as rent.
   iv. Output per acre is 1,000 units per year and the price of indigo is $2 per unit.
   v. The interest rate is 10 percent per year.
   a. Compute (1) nonland cost per acre per year and (2) the market value of land.
   b. Suppose that the price of indigo drops to $1.90. Assuming that the tenant continues to grow indigo on the land, compute the equilibrium rent (1) in dollars, (2) in units of indigo, and (3) as a percent of the indigo harvest.
   c. By how much does the market value of land drop as a result of the decrease in the price of indigo (assuming the tenant grows indigo)?
   d. How would your answer to (*c*) change if there is an alternative crop with the same nonland costs and output per acre?
4. Suppose that Mr. Greengenes, a farmer and genetic engineer, develops a new method for growing corn that decreases the cost of growing corn by $300 per acre. Greengenes's landlord rejoices, saying, "According to the leftover principle, you will pay me $300 more in rent." Is the landlord correct? If not, is he applying the leftover principle incorrectly, or is the principle wrong?
5. Consider a county where farmers produce with fixed factor proportions and truck their output to a central marketplace. Draw the land-rent function under the following circumstances:
   a. Unit transport cost is a constant t per ton per mile.
   b. Unit transport cost increases as the farmer approaches the marketplace (a result of traffic congestion).
   c. Unit transport cost decreases as the farmer approaches the marketplace, a result of better roads closer to the market.
6. Using the information in Table 7–1, recompute the land-rent function for the following events. Assume that the farm size at each location is fixed (0.4 acres at $u = 0$, 0.6 acres at $u = 1$, and so on).
   a. A herd of rabbits invades the county, stealing $50 worth of carrots per acre.
   b. The unit cost of transport increases from $4 to $5.
   c. The price of carrots increases from $15 to $40.
   d. Is the assumption of a fixed farm size at each location realistic? If not, how would your answer to (*c*) change if farm sizes could change?

7. Consider a flexible carrot farmer. Complete the following table, assuming that (1) the farmer produces 10 tons of carrots, (2) the price of carrots is $40 per ton, and (3) transport cost per ton per mile is $5.

Distance to Market (miles)	*Farm Size (acres)*	*Total Revenue*	*Nonland Costs*	*Transport Costs*	*Pre-Rent Profit*	*Rent per Acre*
0	0.70		$66			
1	0.80		52			
2	0.90		40			
3	1.00		30			

8. Consider the input combinations listed in Table 7–1. As the price of land increases, the farmer substitutes nonland inputs for land. As the farmer uses less and less land, the trade-off between land and nonland inputs becomes less favorable.
   a. In what sense does the trade-off become less favorable?
   b. Why does the trade-off become less favorable?
9. Suppose that two activities, F and R, compete for land. Activity R produces a good that requires fixed factors of proportion. Factor substitution is impossible. Activity F engages in factor substitution: as the relative price of land increases, the firm substitutes nonland inputs for land.
   a. Draw a pair of bid-rent functions showing F occupying the land closest to the market. In what sense is it efficient for F to occupy central land?
   b. Draw another pair of bid-rent functions showing F occupying land close to the market and far from the market, and R occupying the intermediate land. In what sense is it efficient for F to occupy land close to and far from the market?
10. Pick the word in parentheses that makes the following statement correct: "As a firm's isoquant gradually changes in shape from a straight line to an L-shaped curve, the firm's bid-rent function becomes (*less, more*) curved." Note: *Less curved* means closer to a straight line.
11. Consider Euphoric County, where a large share of the arable land is used to grow M. The production of M is illegal: there are severe penalties imposed on M growers, but no penalties imposed on M consumers. Suppose that M is a competitive industry, with equilibrium profits equal to zero: total revenue equals total costs. Included in the costs are the costs associated with engaging in illegal activities (the opportunity cost of time spent in jail, legal costs, concealment costs). Suppose that Euphoric County legalizes the production of M.
   a. Depict graphically the effects of legalization on the equilibrium price and quantity of M. Explain your graph.

   b. Depict graphically the effects of legalization on the price of land in Euphoric County. Explain your graph.
12. The residents of mobile home parks own their dwellings, and rent land from absentee landowners. Consider a city in which all land is currently occupied by mobile home parks. Suppose the city imposes a 50 percent tax on land, to be paid (in legal terms) by the person who occupies the land (the tenant, either a mobile home owner or some other user). Who actually pays the tax?
13. What would be the effect of a partial land tax ($100 per acre) on land rent, land values, and corn prices?
14. As the flexible farmer approaches the marketplace, the farmer substitutes nonland inputs for land. As a result, the land-rent function of the flexible farmer is steeper than the land-rent function of the inflexible farmer. What happens as the flexible farmer moves *away* from the marketplace? Is the flexible land-rent function steeper or flatter than the inflexible function? Explain.

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