Introduction to Land Rent

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This chapter, drawn from the Fifth Edition of *Urban Economics* (McGraw-Hill/Irwin, 2003) introduces some basic concepts of land rent and land use. We'll address 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

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

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 percent, the present value of the asset is

$$PV = 20 + \frac{20}{1.10} + \frac{20}{1.21} + \frac{20}{1.33} + \frac{20}{1.45}$$
$$PV = 20 + 18.18 + 16.53 + 15.04 + 13.70 = \$83.45$$

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

$$PV = \frac{R}{i} = \frac{20}{0.10} = \$200$$

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).

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*. 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. 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).

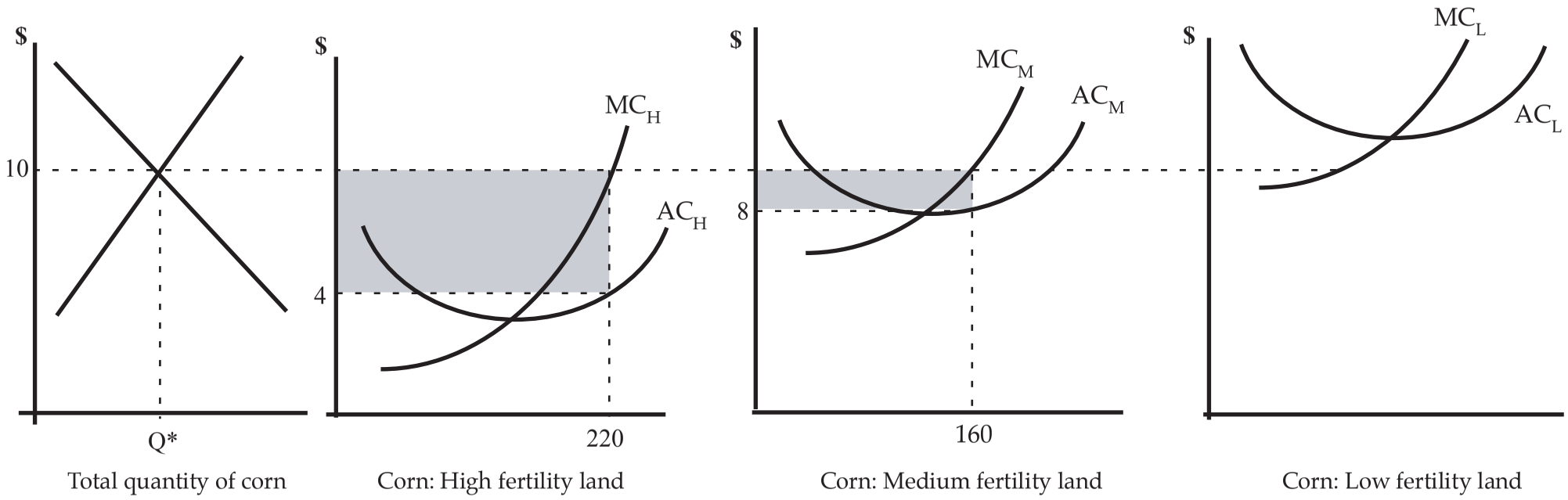
4. **Land to highest bidder.** Landowners rent their land to the highest bidder.

5. **Zero transport costs.** Transport costs are assumed to be so small that they can be ignored.

Figure 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 (*AC*) 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

Figure 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.

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 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, total revenue is $2,200 (equal to $10 times 220), total cost is $880 (equal to an average cost of $4 times 220), so the profit equals $1,320 per acre per year ($2,200 - $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.

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 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.

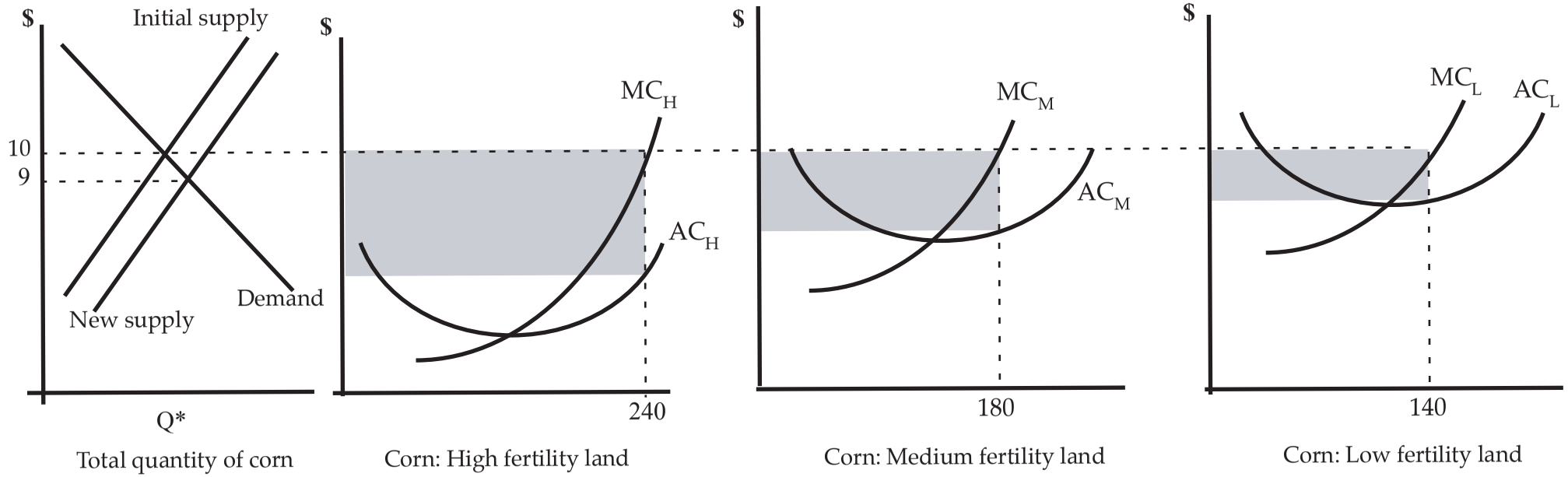
Land Rent and Public Policy

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 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.

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

Figure 2 Effects of Irrigation Project on Land Rent and the Price of Corn



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.

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 the 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, the equation showing the relationship between rent and value suggests that the market value of the land will increase from $13,200 per acre to $15,000 per acre.

MARKET INTERACTIONS

The demand for land is derived from the demand for outputs (e.g., 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 3 shows the effects of the Corn Laws on the corn market and the land market.

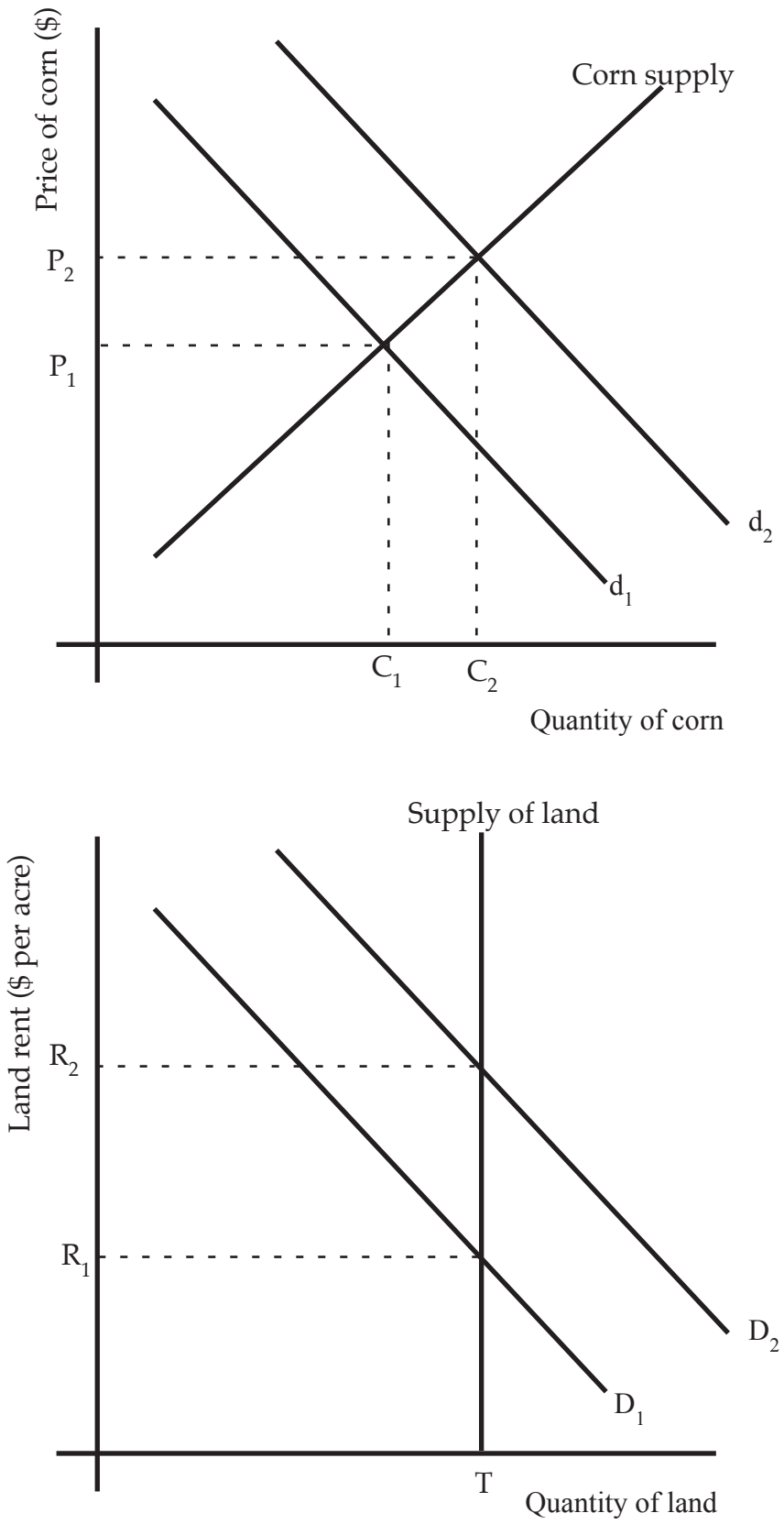
- **Corn market.** The Corn Laws shifted the demand curve from d_1 to d_2. The price of domestic corn increased from P_1 to P_2, and the quantity of corn produced increased from C_1 to C_2.
- **Land market.** As domestic corn production increased, the demand for land increased. In Figure 3, the increase 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.

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

Figure 3 The Corn Laws Debate



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.

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.

LAND TAXATION

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 were zero, landowners would 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.

Alternatives to the Single Tax

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 investments 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.

Urban Land Taxation in Pittsburgh

Many cities in Pennsylvania have a graded property-tax system under which land is taxed at twice the rate as improvements. In the 1980s, Pittsburgh increased the tax rate on land and decreased the rate on improvements, thus moving its graded system in the direction of George's single tax. By 1991, the tax rate on land was more than five times the rate on improvements. In the 1980s Pittsburgh experienced a boom in commercial building with most of the new construction involving office buildings in the central business district. Is there a connection between Pittsburgh's tax reform and its building boom? Oates and Schwab (1992) explore the effects of Pittsburgh's tax reform on building activity in the city. They conclude that the tilting of the graded-tax system in the direction of higher land taxes stimulated building activity in the city. The higher tax rate on land generated revenue that allowed the city to reduce the tax rate on improvements. The decrease in the improvement tax decreased the penalty on new construction and thus encouraged development. Although other factors played a role in the city's commercial

building boom of the 1980s, the tilting of the graded-tax system toward lower taxes on improvements was an important factor.

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.

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 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.

6. 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 were $250 per acre?

c. How would your answer to (**b**) change if field burning were 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 nonland cost per acre per year and 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 in dollars, in units of indigo, and 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 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.

6. 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?

7. What would be the effect of a partial land tax ($100 per acre) on land rent, land values, and corn prices?

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