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# LAND POLICIES AND THEIR OUTCOMES

Edited by Gregory K. Ingram and Yu-Hung Hong

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*Gregory K. Ingram and Yu-Hung Hong*

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# *The Economics of Conservation Easements*

Andrew J. Plantinga

An easement is a right or privilege that one person has with respect to another person's land. With conservation easements, the holder of the easement places use restrictions on the landowner to ensure that the land continues to produce environmental benefits. In a typical arrangement, a private conservation group or government agency purchases the development rights from the property owner. The owner retains title to the property, but is limited to undeveloped uses of the land such as farming and forestry. Often, easements are permanent, and future owners of the property are subject to the same restrictions.

Conservation easements are employed for a variety of purposes. Easements that place restrictions on development are often used to preserve farmland, forestland, and other types of open space. Other, more specific uses include easements for the protection of wetlands, grasslands, scenic view sheds, wildlife habitat, streams and rivers, trails, coastlines, groundwater quality, and historical and cultural sites. Conservation easements are acquired by a variety of organizations, including private land trusts operating at the local and regional levels, and local, state, and national government agencies. Government agencies often provide a share of the funds used by private organizations to purchase easements.

The Farmland Protection Policy Act of 1981 was the first legislation to give the federal government a role in preventing the conversion of land out of agriculture. Later farm bills in 1990, 1996, and 2002 provided federal funds to purchase agricultural conservation easements, and the 2002 bill allows the transfer of federal funds to nongovernmental organizations for the purchase of easements (American

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Farmland Trust 2005). The major federal programs are the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), Grassland Reserve Program (GRP), Forest Legacy Program (FLP), and Farm and Ranch Lands Protection Program (FRPP). The CRP, WRP, and GRP allow the purchase of cultivation rights for specified periods of time. Under the CRP, for example, owners of environmentally sensitive cropland are paid to not cultivate their land for a period of either 10 or 15 years. Participants are required to establish an alternative vegetative cover on the land such as grass or trees. The WRP targets former wetlands that are now under cultivation. Cultivation and development rights are purchased, and cost sharing is provided for the restoration of wetlands. The FLP and FRPP establish permanent easements on agricultural and forestland to ensure that the land remains in its current use.

The CRP is the largest of the federal programs; some 35 million acres are enrolled. The other programs are substantially smaller: WRP, 1.6 million acres; FLP, 1 million acres; and GRP, 900,000 acres. Although only about 500,000 agricultural acres have been directly enrolled under the FRPP, it provides many state-level farmland protection programs with the funds for easement purchases. For example, using FRPP funds and matching state and private funds, six states (Connecticut, Delaware, Maine, Maryland, New Jersey, and Vermont) in the northeastern United States have purchased agricultural conservation easements covering between 10 and 19 percent of total farmland acres (American Farmland Trust 2005).

Over the past decade, the public has strongly supported land conservation programs operated by state, county, and municipal governments. Between 1994 and 2005, U.S. voters were asked to consider 1,630 ballot measures providing funds for land conservation (table 5.1), and they approved a large majority (77 percent)

**Table 5.1**
U.S. State, County, and Municipal Ballot Measures Providing Funds for Land Conservation: 1994–2005

| Year | Number of Measures | Measures Approved | Approval Rate (percent) | Land Conservation Funds Approved ($ billions) |
|---|---|---|---|---|
| 1994 | 48 | 33 | 69% | $0.6 |
| 1995 | 39 | 30 | 77 | 1.1 |
| 1996 | 96 | 74 | 77 | 1.2 |
| 1997 | 71 | 59 | 83 | 0.7 |
| 1998 | 178 | 145 | 81 | 6.4 |
| 1999 | 105 | 93 | 89 | 2.2 |
| 2000 | 212 | 173 | 82 | 4.8 |
| 2001 | 201 | 141 | 70 | 1.6 |
| 2002 | 194 | 143 | 74 | 5.5 |
| 2003 | 133 | 99 | 74 | 1.2 |
| 2004 | 219 | 164 | 75 | 4.1 |
| 2005 | 134 | 106 | 79 | 1.7 |
| Total | 1,630 | 1,260 | 77 | 31.1 |

Source: The Trust for Public Land, http://www.tpl.org/tier3_cdl.cfm?content_item_id=15266&folder_id=2607.

**Table 5.2**
U.S. State, County, and Municipal Ballot Measures Providing Funds for Land Conservation, by Region: 1994–2005

| Region | Number of Measures | Measures Approved | Approval Rate (percent) | Land Conservation Funds Approved ($ billions) |
|---|---|---|---|---|
| New England | 337 | 259 | 77% | $0.9 |
| Mid-Atlantic | 561 | 471 | 84 | 9.0 |
| Southeast | 150 | 116 | 77 | 3.8 |
| Midwest | 210 | 149 | 71 | 3.4 |
| Southwest | 101 | 93 | 92 | 2.7 |
| Rocky Mountain | 147 | 110 | 75 | 2.4 |
| West | 121 | 58 | 48 | 8.6 |

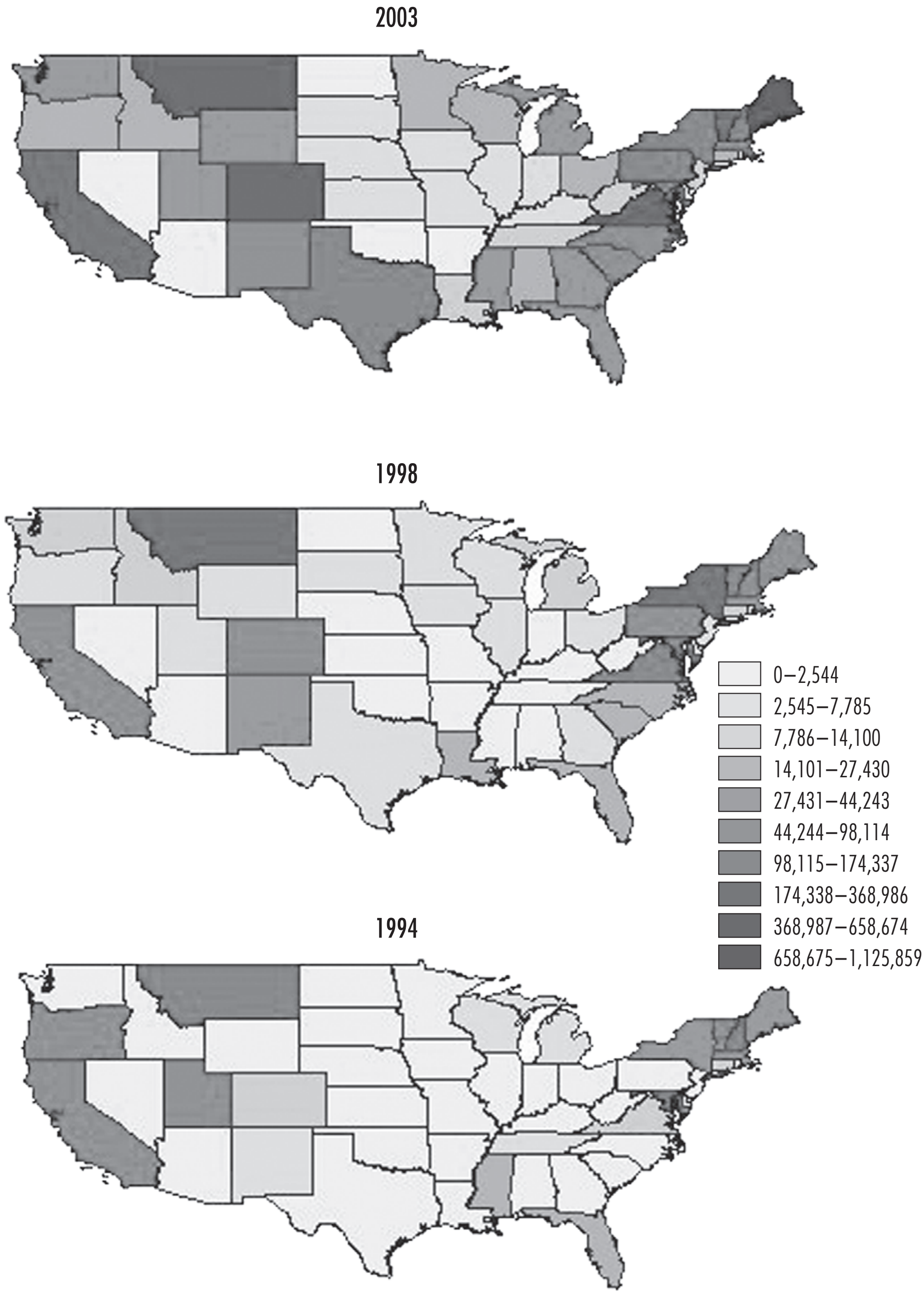
Source: The Trust for Public Land, http://www.tpl.org/tier3_cdl.cfm?content_item_id=15266&folder_id=2607.

of these measures, which provided $31.1 billion in funding. The number of measures proposed increased greatly in 1998 and remained relatively constant over time (table 5.1). Moreover, the approval rate remained relatively constant at between 69 and 89 percent. Over the same period, the most measures were approved in the New England and Mid-Atlantic states, but the most funds were approved in the Mid-Atlantic and western states (table 5.2). Banzhaf et al. (2006) point out that to understand the factors underlying referenda results, one has to acknowledge a geographical selection effect—that is, land conservation initiatives are more likely to be proposed in places where they are likely to be approved. They suggest that the demographic characteristics of communities, such as age, education, and income, and local factors, such as the rate of farmland loss and the presence of ecologically sensitive landscapes, are plausible determinants of conservation referenda.

Although federal and state governments have operated easement programs over the past several decades, only in the past decade have private land trusts begun to make extensive use of conservation easements. In 1988 private land trusts held easements on about 290,000 acres of land in the United States (Land Trust Alliance 2004). By 2003 this figure had grown to over 5 million acres. Figure 5.1 shows by state the acreage under easements held by private land trusts for the years 1994, 1998, and 2003. Between 1994 and 2003, the acreage under privately held easements increased in almost every state. In absolute terms, the largest increases occurred in Colorado, Maine, Montana, Vermont, and Virginia. About 1,500 private land trusts operated in the United States in 2003, of which 39 percent listed preservation of habitat for plants and animals as a primary purpose and 36 percent listed open space conservation. Other objectives included preservation of working farms and ranches (21 percent), of working forests (13 percent), and of historic or cultural resources (13 percent).

This chapter examines selected economics issues arising from conservation easements designed to prevent development of land for urban uses. These easements are of particular interest because they can directly affect local land markets by limiting the supply of developable land in specific locations. By contrast, easements that

**Figure 5.1**
Land Under Conservation Easements Held by Private Land Trusts, by State: 1994, 1998, and 2003 (acres)




Source: Land Trust Alliance (2004).

restrict cultivation rights affect land markets only indirectly through commodity prices.[1] The next section of this chapter reviews the economics literature on conservation easements. Important questions that emerge from this review are how do conservation easements affect the markets for developed land, and what are their implications for property taxes and the provision of public services? These questions have been addressed in a handful of empirical studies, but a solid theoretical basis for understanding these issues has not been developed. The section that follows presents an urban spatial model with conservation easements and then uses it to analyze how easements affect property prices, the size of cities, and property tax revenues. The penultimate section considers the valuation of conservation easements and proposes a theoretical basis for easement valuation, discusses alternative valuation approaches, and presents estimates of easement values for U.S. counties. The final section is devoted to conclusions.

## Literature Review

This review of the economics literature on conservation easements focuses on three issues: (1) motivations for the use of conservation easements, (2) the effects of conservation easements on property values, and (3) the effects of conservation easements on property tax revenues.

### MOTIVATIONS FOR THE USE OF CONSERVATION EASEMENTS

Conservation easements provide benefits to those concerned with environmental amenities that might otherwise be lost when the land is developed. The magnitude of these benefits is considered in various contingent valuation studies that estimate willingness to pay (WTP) to prevent development of farmland (Bergstrom, Dillman, and Stoll 1985; Bowker and Didychuk 1994; Krieger 1999). In a study of residents of Greenville County, South Carolina, Bergstrom, Dillman, and Stoll find a household WTP to prevent development of agricultural land of only $0.06 for each additional thousand acres (1981–1982 dollars). Bowker and Didychuk, in a study in eastern Canada, find that the WTP for an additional thousand acres of protected farmland ranges from $0.28 to $1.14 (early 1990s dollars), depending on the total number of acres protected. A much higher WTP is found by Krieger in a study of residents of suburban Chicago. The mean WTP to protect 20,000 acres of farmland is $484 per year (mid-1990s dollars) for five years, or $24 per year for 1,000 acres.

The contingent valuation studies identify factors that explain differences in willingness to pay among individuals in the sample. For example, Bergstrom, Dillman, and Stoll (1985) find that WTP rises with income, age, and education. Kline and Wichelns (1994) study the results of referenda in Rhode Island and Pennsylvania and find that support for purchasing development rights is higher in counties and towns with rapidly growing populations and property values. Similarly, Kline (2006) uses national referendum data to link growing public support for preserving local open space to the growing scarcity of open space lands. The relative scarcity

1. Wu (2000) finds that for every 100 acres of cropland conserved under the CRP, 20 acres of noncropland is converted to crops.

of open space may explain the differences in the contingent valuation results just reported. In the counties examined in the Krieger study, farmland is under intense pressure for development, and it provides the majority of open space.

What are the advantages of conservation easements from the landowner's perspective? Donations of conservation easement can reduce federal and state income taxes, capital gains taxes, estate taxes, and property taxes. Wright (1993) suggests that tax savings is the most common motivation for landowners to donate easements. However, it seems unlikely that the donation of a conservation easement could ever be in the best interest of a landowner from a purely financial standpoint. If not, then other considerations such as environmental benefits or personal ties to the land in its current use would be needed to induce landowners to donate easements.

The Tax Reform Act of 1976 (and subsequent amendments) enabled taxpayers to claim deductions for charitable contributions of conservation easements to government agencies or qualifying nonprofit organizations (Wiebe, Tegene, and Kuhn 1996). The federal tax code allows owners to deduct the full market value of a perpetually conveyed conservation easement. The tax savings, which depends on a donor's income, is limited to 30 percent of the adjusted gross income. If the easement value exceeds the 30 percent limit, the donor may carry over the unused deduction for up to five years until the full value of the easement has been deducted from taxable income. This income tax deduction is particularly significant for income from capital gains. On undeveloped land that has been held for a long time in proximity to a growing urban area, the increase in land value because of development pressure may be substantial, thereby creating large capital gains that the owner must claim on their tax forms (Wiebe, Tegene, and Kuhn 1996).

Savings on estate taxes also plays an important role in the incentive to sell or donate conservation easements. The Taxpayer Relief Act of 1997 made it possible to exclude from a taxable estate 40 percent of the value of any land subject to a qualified conservation easement, and a charitable deduction is allowed for both estate tax purposes and income tax purposes for charitable contributions of permanent conservation easement property (Englebrecht 1999). The donation of a conservation easement by the original owner could reduce the value of an estate and make it possible for the heirs to retain title, especially when the heirs are cash-poor but land-rich (Wright 1994).

Conservation easements that restrict future development of land reduce the value of the land (this point is discussed later in this chapter). If property taxes are assessed on fair market value, then conservation easements provide a means for landowners to reduce their tax obligations. In practice, however, property tax savings is often a limited incentive for conservation easements, because all 50 states have use-value assessment programs for farmland (and many have similar programs for forestland). For participating landowners, assessment is already based on the restricted use of the land, and conveyance of a conservation easement would likely have no further effect on their property tax assessment (Wiebe, Tegene, and Kuhn 1996).

## EFFECTS OF CONSERVATION EASEMENTS ON PROPERTY VALUES

In theory, conservation easements should reduce the value of the property to which they are applied. Taff (2004), who analyzes 380 recent sales of agricultural land in Minnesota (156 had short-term restrictions and 34 had permanent restrictions), finds that both short-term and permanent restrictions are negatively and significantly associated with per acre sales prices. Specifically, Taft finds that values for land enrolled in the Conservation Reserve Program, which restricts cropping rights for 10 or 15 years are lower by 18 percent when compared with similar unencumbered land. The value of agricultural land enrolled in a state program with permanent restrictions is lower by an average of 32 percent. Similarly, Shultz and Taff (2004) find significant reductions in property values associated with wetland easements in North Dakota. Hedonic price analyses have been conducted to test for the effects of easements on farmland values, but in these studies the evidence that easements lower property values is less conclusive (Anderson and Weinhold 2005). In their study of 458 farmland transactions in New York, Vitaliano and Hill (1994) find that enrollment in the state's agricultural district farmland preservation program has no effect on farmland prices. This voluntary program combines use-value assessment with some development restrictions. The authors suggest that self-selection may explain the lack of a significant effect. Landowners may be more likely to enroll in the program if they do not have profitable opportunities to develop their land.

Nickerson and Lynch (2001) examine 224 sales transactions of farm parcels in three Maryland counties. Twenty-four of the parcels are enrolled in a state purchase-of-development-rights program. The average price per acre is \$8,998 for unencumbered parcels and \$3,761 for encumbered parcels. However, in a hedonic regression that controls for parcel size, soil characteristics, distance to a major metropolitan area, and sample selection, the coefficient on preservation status is not significantly different from zero. Nickerson and Lynch provide some possible explanations for this result. Buyers may expect the development restrictions to be relaxed in the future. Or a significant number of buyers may be primarily interested in the amenities to be gained from living on a farm near an urban area rather than the income from agriculture. Although the authors net out the value of structures to obtain the property price used in the hedonic analysis, significant value may be attached to the right to live in the existing home.

Anderson and Weinhold (2005) use similar data on farm properties in Wisconsin—131 unencumbered properties and 19 encumbered properties. When the authors use the complete data set, they obtain results similar to those of Nickerson and Lynch (2001): the effect of the development easement is negative but not statistically different from zero. However, when they restrict the data set to include only vacant land parcels, thus omitting farm properties with houses, they find that easements have a negative and statistically significant effect on property values. Specifically, easements are found to reduce property values by 50 percent. The authors explain this result by noting that "city people looking for a retreat will be put off by the fact that they cannot stay there, regardless how lovely" (Anderson and Weinhold 2005, 15).

Farmland, forest, and other open space may have positive spillover effects on neighboring property values (Irwin and Bockstael 2001; Lutzenhiser and Netusil 2001; Irwin 2002; Geoghegan, Lynch, and Bucholtz 2003; Ready and Abdalla 2003; Roe, Irwin, and Morrow-Jones 2004). Some of these studies distinguish between public open space and private open space with and without conservation easements. Irwin and Bockstael (2001) and Irwin (2002) find larger positive effects on the property values of neighboring private open space with easements compared with private open space without easements. This result makes sense, because the easements guarantee that the open space amenities will be provided in perpetuity. These authors also find larger effects from permanent private open space compared with permanent public open space, a finding they attribute to the nuisance effects, such as crowds, associated with the public lands. The findings of Geoghegan, Lynch, and Bucholtz (2003) are largely in agreement, although in some instances they find that private open space without easements reduces neighboring property values. Ready and Abdalla (2003) find larger effects from private farmland with easements than without if the farmland is located within 400–1,600 meters (437–1,749 yards). If it is located within 400 meters (437 yards), the reverse is true. An explanation suggested by the authors is that farmland with easements may be more intensively managed, thus negatively affecting neighboring property values.

**EFFECTS OF CONSERVATION EASEMENTS ON PROPERTY TAX REVENUES**

Conservation easements may lower assessed property values with the result that the property tax base of a town or city shrinks. Because the negative tax implications of conservation easements and land conservation have been a concern in New York and Montana, legislation was introduced in 2003 in these states to allow the taxation of idle land owned by nonprofits and mandate local approval of any new permanent easement (King and Anderson 2004). But King and Anderson suggest that the negative effects of easements on the tax base may be only a short-term phenomenon. In the longer term, the preservation of open space may increase tax revenues as higher amenity levels attract new residents who bid up property values and increase the tax base.

The impact of easements on property tax revenues has been analyzed by Haight (1999), Geoghegan, Lynch, and Bucholtz (2003), and King and Anderson (2004). King and Anderson consider the effects of easements on marginal property tax rates in Vermont towns. The property tax rate is measured as the cost of services divided by the property tax base, assuming assessment at fair market value. They estimate the effects on the current property tax rates of lagged acres conserved and find that recently conserved land (one or two years prior) has a positive effect on tax rates, whereas land conserved earlier (six, seven, and eight years prior) has a negative effect.[2] Thus, their results are consistent with the negative short-term and positive long-term effects of conservation easements on the tax base described earlier in this chapter. Geoghegan, Lynch, and Bucholtz (2003) consider whether easements can be self-financing. They use the results of a hedonic analysis to determine the effects of easements on the value of neighboring properties and compare the corresponding increase in tax revenues with the cost of the easements. They find that about 60 percent of the cost is recovered through higher taxes on neighboring properties.

2. The authors also control for the town budget and town demographics and policies in their regression model.

## *Effects of Conservation Easements on Property Values, Tax Revenues, and Public Services*

Conservation easements are often established in urbanizing areas to preserve undeveloped land that would, otherwise, be used for residential housing. This section examines how conservation easements affect land prices within a city, the size of the city, and the property tax base. Several empirical studies described earlier examine this issue empirically. This section provides a theoretical foundation for understanding these issues. The framework is an urban spatial model in the Mills-Muth-Alonso tradition that has a fixed population (closed city) and fixed lot sizes. Static spatial market equilibria with and without conservation easements are compared. The model is then generalized in two ways: first, allowing for variable lot sizes while maintaining the assumption of a fixed population, and, second, reverting to the assumption of fixed lot sizes but allowing for a variable population size (open city). In the open city model, conservation easements may provide the city's residents with utility-increasing amenities. Earlier theoretical studies considered how open space affects markets for developed land (Lee and Fujita 1997; Yang and Fujita 1983; Wu and Plantinga 2003). The analysis presented in the following sections emphasizes the effects of open space on property taxes and public services.

### CLOSED CITY WITH FIXED LOT SIZES

The city is populated by a fixed number of identical households $N$ that commute to work to a central business district (CBD). Following Capozza and Helsley (1989), households have utility $u(X, \overline{L})$, where $X$ is a numeraire good and $\overline{L}$ is fixed land consumption per household. Households earn income $y$, which they allocate to the numeraire good, land for housing, and commuting costs to yield

$$(1) \qquad y = X + R(1 + t)\overline{L} + Tz,$$

where $R$ is the rental price of land, $t$ is the rate of an ad valorem property tax, $z$ is the distance of the household to the CBD, and $T$ is the marginal cost of commuting.

Assuming the utility function is homogeneous of degree 1, it can be rewritten as $U(X / \overline{L}) = u(X/\overline{L},1)$. In spatial market equilibrium, households will have exhausted all gains from moving, and utility is constant across locations in the city. Denoting the equilibrium utility level $V$, the utility function can be inverted to obtain $X / \overline{L} = U^{-1}(V)$. Using this result, the budget constraint (1) can be rearranged as

$$(2) \qquad R(z) = \frac{1}{\overline{L}(1 + t)}(y - Tz) - \frac{U^{-1}(V)}{(1 + t)}.$$

Equation (2) yields the well-known result that land rents for housing decline in distance to the CBD to compensate households for higher commuting costs.

To close the model, two conditions are imposed on the boundary of the city, denoted $z_0$. First, the $N$ households must fit between the CBD and $z_0$. It is thus assumed that the residents of the city live along a line between the CBD and $z_0$.[3] The condition is then

$$(3) \qquad N = \int_0^{z_0} \frac{1}{\overline{L}} dz,$$

where $\overline{L}^{-1}$ is the number of households per unit area. Solving the integral yields $z_0 = \overline{L}N$. The second condition is that the rental price of land for development equals the rental price of land in its alternative use. The alternative use is assumed to be agriculture, and the exogenous rental price is denoted $R_A$. The condition is then

$$(4) \qquad R(z_0) = \frac{1}{\overline{L}(1 + t)} (y - T\overline{L}N) - \frac{U^{-1}(V)}{(1 + t)} = R_A.$$

Equation (4) is solved for $U^{-1}(V)$, which is substituted into (2) to obtain

$$(5) \qquad R_0(z) = \frac{T}{(1 + t)} \left(N - \frac{z}{\overline{L}}\right) + R_A.$$

The "0" subscript in (5) indicates that the rent function corresponds to a city with boundary $z_0$.

The size of the city is $z_0$, and the revenues collected through taxes on property within the city are given by

$$(6) \qquad PT_0 = \int_0^{z_0} tR_0(z)dz = t\overline{L}N\left(\frac{T}{2(1 + t)} + R_A\right).$$

Property tax revenues are used to pay for public infrastructure such as roads and other public services for residents of the city. The ratio of property taxes to city size provides a normalized measure of public services provision—specifically, the amount of public expenditures per unit of land in the city. This measure is denoted $PTA_0$ and in the present case is given by

$$(7) \qquad PTA_0 = t\left(\frac{TN}{2(1 + t)} + R_A\right).$$

Holding other factors constant, $PTA_0$ rises with the property tax rate $t$, population $N$, the commuting cost $T$, and the agricultural rent $R_A$. An increase in $t$ lowers development rents (from equation (5)), but has a positive net effect on total property taxes collected. Increases in population raise land rents and increase the city size. The net effect on $PTA_0$ is positive, because a population increase affects the city size only at the boundary—$z_0$ increases by $\overline{L}$ for each new household. However, developed land rents—and property taxes—increase throughout the city. Because the rent on the parcel at the new boundary must equal $R_A$, rents for all parcels closer to the CBD will be bid up above their original value. For increases in $T$ and $R_A$,

3. It is customary in urban spatial models to analyze a circular city. A line city is considered here, however, because it simplifies considerably the first boundary condition and the analysis that follows.

population and lot sizes are fixed, and the size of the city does not change. Thus, developed land rents are bid up to compensate residents for higher commuting costs and to attract land away from agricultural use. In both cases, property tax revenues rise, and the value of $PTA_0$ increases.

At this point, a conservation easement is introduced to the city, and the new spatial market equilibrium is evaluated. The conservation easement is placed inside the boundary of the original city between $\alpha z_0$ and $z_0$, where $0 < \alpha < 1$. No housing development is permitted on the land with the conservation easement. With fixed population and fixed lot size, $z_0 - \alpha z_0$ units of land will have to be developed beyond $z_0$, and the new boundary of the city will be given by $z_1 = N\bar{L}(2 - \alpha)$. The developed land rent must equal $R_A$ at $z_1$, implying that rents are bid up above their original values between zero and $\alpha z_0$. Rents for land within the city are given by

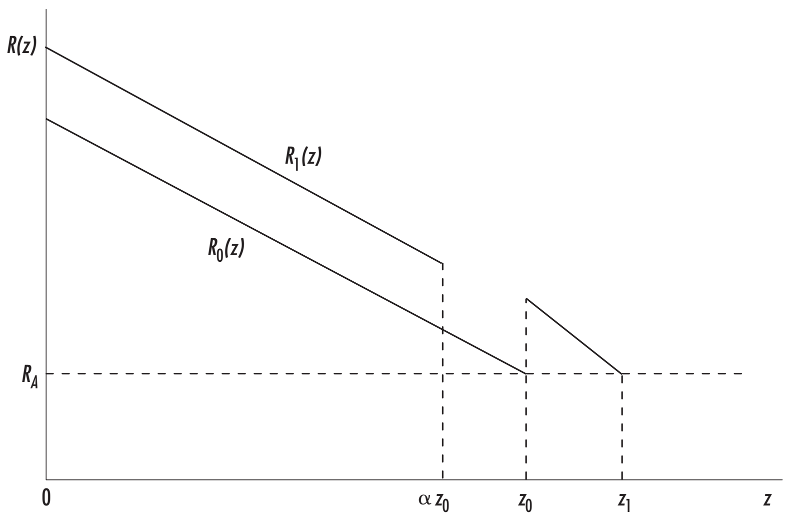
$$(8) \qquad R_1(z) = \begin{cases} \dfrac{TN(2-\alpha)}{(1+t)} - \dfrac{T}{\bar{L}(1+t)} z + R_A & 0 \le z \le \alpha z_0,\ z_0 \le z \le z_1 \\ R_A & \alpha z_0 < z < z_0 \end{cases}.$$

Figure 5.2 illustrates the result in (8).

For the city with a conservation easement, there is more than one way to measure the ratio of property tax to city size. If the land occupied by the conservation easement is thought to neither contribute to the city's tax base nor require public services, the city size is unchanged ($\alpha z_0 + z_1 - z_0 = \bar{L}N$), and total property taxes are

$$(9) \qquad PT_{1,1} = t\bar{L}N\left(\frac{TN}{(1+t)}(0.5 + \alpha - \alpha^2) + R_A\right).$$

**Figure 5.2**
Rents in a City with Conservation Easements: Closed City Model with Fixed Lot Sizes



Comparing (6) and (9), and noting that $\alpha - \alpha^2 > 0$ for $0 < \alpha < 1$, reveals that the conservation easement has increased total property taxes. Thus, public expenditures per unit of land, given by

$$(10) \qquad PTA_{1,1} = t\left(\frac{TN}{(1+t)}(0.5 + \alpha - \alpha^2) + R_A\right),$$

are higher as well. $PTA_{1,1}$ is equal to $PTA_0$ at $\alpha = 1$ and $\alpha = 0$, and is greatest at $\alpha = 0.5$. When $\alpha = 1$, there is no conservation easement, and when $\alpha = 0$ the conservation easement occupies the entire area of the original city. In the latter case, the negative effect of distance to the CBD on developed land rents exactly offsets the rent increases induced by the conservation easement. For example, note that when $\alpha = 0$, the developed land rent at $z_0$, $R_1(z_0)$, equals the rent in the CBD in the city with no conservation easement. Property taxes are largest at the intermediate value of $\alpha = 0.5$.

Alternatively, it can be assumed that the land with the conservation easement makes use of public services and is taxed accordingly. In this case, the size of the city is $z_1$, and property taxes are given by $PT_{1,2} = PT_{1,1} + tR_A z_0(1 - \alpha)$. The second term on the right-hand side measures the taxes collected on the land with the conservation easement. The public expenditures per unit of land are now

$$(11) \qquad PTA_{1,2} = t\left(\frac{TN}{(2-\alpha)(1+t)}(0.5 + \alpha - \alpha^2) + R_A\right).$$

$PTA_{1,2}$ is less than $PTA_{1,1}$ because of the addition of $z_0(1 - \alpha)$ units of land that generate lower property taxes than the lands included in the $PTA_{1,1}$ measure. Comparing $PTA_{1,2}$ with $PTA_0$ reveals that $PTA_{1,2} \geq PTA_0$, if $f(\alpha) = -2\alpha^2 + 3\alpha - 1 \geq 0$. Here $f(\alpha)$ is positive for values of $\alpha$ between 0.5 and 1.0 and negative for values of $\alpha$ less than 0.5. As long as the conservation easement is relatively small ($\alpha$ near 1.0), the additional property taxes generated by the easement outweigh the increase in public services, and $PTA_{1,2} > PTA_0$. However, as the easement increases in size property taxes begin to fall while the requirements for public services are increasing. Thus, for sufficiently large easements $PTA_0 > PTA_{1,2}$.

## CLOSED CITY WITH VARIABLE LOT SIZES

In the next version of the model, the assumption of fixed lot sizes is relaxed, and land consumption becomes a choice variable for households. For analytical tractability, households are assigned the Cobb-Douglas utility function $u(X,L) = X^{\beta}L^{1-\beta}$, where $0 < \beta < 1$. The utility maximization problem is written as

$$(12) \qquad \max_{X,L} X^{\beta}L^{1-\beta} \;\; s.t. \;\; y = X + R(1+t)L + Tz,$$

and solving the constrained optimization problem in (12) yields the optimal demands

$$(13) \qquad X^* = \beta(y - Tz),\; L^* = \frac{(1-\beta)(y - Tz)}{R(1+t)}.$$

Substituting the demands in (13) into the utility function, imposing the spatial equilibrium condition $V = X^{*\beta}L^{*1-\beta}$, and solving for the developed land rent yield

$$(14)\qquad R(z) = \frac{\beta^{\beta/(1-\beta)}(1-\beta)}{(1+t)}\left(\frac{y - Tz}{V}\right)^{1/(1-\beta)}.$$

Two conditions are now imposed—the city's population must fit between the CBD and the boundary $z_0$, and the developed land rent must equal the agricultural rent at $z_0$—to obtain the equilibrium land rent function.[4]

$$(15)\qquad R_0(z) = \frac{NT + R_A(1+t)}{(1+t)\,y^{1/(1-\beta)}}(y - Tz)^{1/(1-\beta)}.$$

Evaluating (15) at the city's boundary, $z_0$, and rearranging yield

$$(16)\qquad z_0 = \frac{y}{T}\left[1 - \left(\frac{R_A(1+t)}{NT + R_A(1+t)}\right)^{1-\beta}\right].$$

When a conservation easement is introduced at $z_0 - \alpha z_0$, the land rent function becomes

$$(17)\qquad R_1(z) = \begin{cases} \dfrac{NT + R_A(1+t)}{(1+t)\,[y^{1/(1-\beta)} + \phi]}(y - Tz)^{1/(1-\beta)} & 0 \le z \le \alpha z_0,\ z_0 \le z \le z_1 \\ R_A & \alpha z_0 < z < z_0 \end{cases},$$

where $\phi = (y - Tz_0)^{1/(1-\beta)} - (y - T\alpha z_0)^{1/(1-\beta)}$. Here $\phi$ is less than zero, and so $R_1(z) > R_0(z)$. Evaluating (17) at the boundary $z_1$ defines

$$(18)\qquad z_1 = \frac{y}{T} - \frac{1}{T}\left(\frac{R_A(1+t)(y^{1/(1-\beta)} + \phi)}{NT + R_A(1+t)}\right)^{1-\beta}.$$

Inspection of (16) and (18) reveals that $z_1 > z_0$. Thus, the conservation easement increases the city size by displacing some of the city's residents. Because the rent of the parcel at the new boundary equals $R_A$, developed land rents are bid up throughout the rest of the city.

It is now possible to show that the increase in city size $(z_1 - z_0)$ is less than the size of the conservation easement $(z_0 - \alpha z_0)$. First, by differentiating (18) with respect to $\alpha$ one finds that $z_1$, and thus $z_1 - z_0$, is monotonically decreasing on the interval $\alpha \in [0,1]$. Second, evaluating (18) at $\alpha = 0$ reveals that $z_1 < 2z_0$, implying that $z_1 - z_0 < z_0 - \alpha z_0$ at $\alpha = 0$. Finally, differentiating (18) with respect to $\alpha$ and

4. The first condition requires that $N$ equal $\int_0^{z_0} L^*(z)^{-1}dz$, where $L^*(z)$ is given in (13). Substituting $R(z)$ from (14) into $L^*(z)$ and solving the integral. This yields an expression for the equilibrium utility level $V$ in terms of $\bar{z}_0$. The second condition is imposed by evaluating (14) at $\bar{z}_0$ and setting $R(\bar{z}_0)$ equal to $R_A$. This formulation yields a second expression for $V$ in terms of $\bar{z}_0$. The two expressions are combined to produce a reduced-form equation for $V$. Substitution of $V$ back into (14) yields (15).

evaluating at $\alpha = 1$ yields $dz_1 / d\alpha > z_0$, implying that $d(z_1 - z_0) / d\alpha - d(z_0 - \alpha z_0) / d\alpha$ at $\alpha = 1$. Together, the three results imply that $z_1 - z_0 < z_0 - \alpha z_0$ on the interval $\alpha \in [0,1]$. As noted earlier, the conservation easement increases developed land rents between the CBD and $z_0 - \alpha z_0$. Because lot sizes are variable, households reduce their land consumption in response to higher rents—see equation (13), implying that the number of households residing between the CBD and $z_0 - \alpha z_0$ has increased. As a result, the city does not need to expand much beyond $z_0$ to accommodate the fixed population. Figure 5.3 illustrates the rent schedules with and without the conservation easement.

The public expenditures per unit of land in the city are computed following the approach described earlier. The expressions for total property taxes are

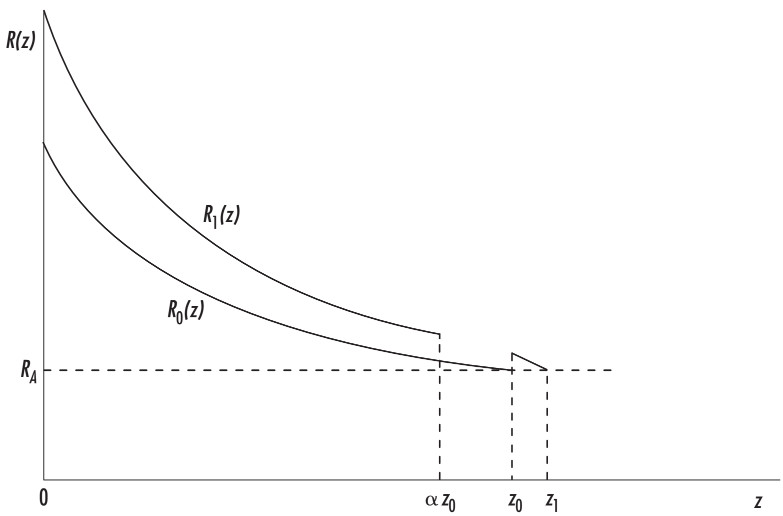
$$PT_0 = \Theta \frac{y^{\lambda} - (y - Tz_0)^{\lambda}}{y^{1/(1-\beta)}}$$

(19) $$PT_{1,1} = \Theta \frac{y^{\lambda} - (y - T\alpha z_0)^{\lambda} + (y - Tz_0)^{\lambda} - (y - Tz_1)^{\lambda}}{y^{1/(1-\beta)} - (y - T\alpha z_0)^{1/(1-\beta)} + (y - Tz_0)^{1/(1-\beta)}},$$

$$PT_{1,2} = PT_{1,1} + tR_A (z_0 - \alpha z_0)$$

where $\theta = t(NT + R_A(1 + t))(1 - \beta) / T(1 + t)(2 - \beta)$ and $\lambda = (2 - \beta) / (1 - \beta)$. In general, the relative magnitudes of the expressions cannot be determined. Consider, for example, $PT_0$ and $PT_{1,1}$. Because the expansion in the city is smaller than the conservation easement, it is unclear whether the taxes lost over the interval $z_0 - \alpha z_0$ are offset by the additional taxes gained between the CBD and $\alpha z_0$ and over the interval $z_1 - z_0$. More formally, note that $f(x) = x^{\lambda}$ is an increasing convex

**Figure 5.3**
Rents in a City with Conservation Easements: Closed City Model with Variable Lot Sizes



function and that $(y - T\alpha z_0) - (y - Tz_0) > (y - Tz_0) - (y - Tz_1)$. These results imply that the numerator of $PT_0$ exceeds the numerator of $PT_{1,1}$. Because the denominator of $PT_0$ also exceeds the denominator of $PT_{1,1}$, it is impossible to tell which of the two expressions is larger. It follows, then, that the relative magnitudes of $PTA_0$, $PTA_{1,1}$, and $PTA_{1,2}$ cannot be determined.

The solution to the model can be better understood by means of a numerical analysis using the parameter values listed in table 5.3. For the baseline set of parameters, $\alpha$ is set equal to 0.8, implying that the conservation easement occupies 20 percent of the land at the boundary of the original city (see table 5.4 for the results). With no conservation easement, the length of the city is 40.78; developed land rents vary from \$10,524 at the CBD to \$1,000 at the city's boundary; and land consumption varies from 2.26 units at the CBD to 10.87 units at the boundary. The property taxes per unit of land in the city are $PTA_0 = \$237$.

When the conservation easement is introduced, most of the adjustment in the land market is in the form of higher densities between the CBD and $\alpha z_0$. Only one additional unit of land is developed beyond the original city boundary. The increase in land rents (\$982, for example, in the CBD), together with the small expansion in the city boundary, result in an increase in property taxes per unit area ($PTA_{1,1} =$ \$1,064 and $PTA_{1,2} = \$243$). Holding the size of the conservation easement constant, the ranking $PTA_{1,1} > PTA_{1,2} > PTA_0$ is maintained for a wide range of parameter values. However, for a large enough conservation easement ($\alpha < 0.175$), $PTA_0$ is larger than the other two measures. The first version of the model produced a similar result. As the easement increases in size, property taxes eventually fall,

**Table 5.3**
Baseline Parameter Values Used in the Numerical Analysis

| Parameter | Value |
|---|---|
| *Closed city model* | |
| $y$ | 75,000 |
| $T$ | 1,000 |
| $t$ | 0.05 |
| $\beta$ | 0.67 |
| $R_A$ | 1,000 |
| $N$ | 10 |
| $\alpha$ | 0.80 |
| *Open city model* | |
| $y$ | 75,000 |
| $T$ | 1,000 |
| $t$ | 0.05 |
| $\beta$ | 0.67 |
| $R_A$ | 1,000 |
| $\gamma$ | 0.5 |
| $\bar{V}$ | 1,782 |
| $\alpha$ | 0.80 |

**Table 5.4**
Numerical Solution for the Closed City Model with Variable Lot Sizes

| Computed Variable | Value |
|---|---|
| *No conservation easement* | |
| $z_0$ | 40.78 |
| $R_0(0)$ | 10,524 |
| $R_0(z_0)$ | 1,000 |
| $X^*(0)$ | 50,000 |
| $X^*(z_0)$ | 22,816 |
| $L^*(0)$ | 2.26 |
| $L^*(z_0)$ | 10.87 |
| $PTA_0$ | 231 |
| *With conservation easement* | |
| $z_1$ | 41.78 |
| $z_0 - \alpha z_0$ | 8.16 |
| $z_1 - z_0$ | 1.00 |
| $R_1(0)$ | 11,506 |
| $R_1(z_0)$ | 1,093 |
| $R_1(z_1)$ | 1,000 |
| $PTA_{1,1}$ | 1,064 |
| $PTA_{1,2}$ | 243 |

because higher commuting distances diminish developed land rents. With variable lot sizes, part of the adjustment to the conservation easement is to increase densities near the CBD, reducing the need to expand the city beyond $z_0$. As a result, property taxes do not fall as quickly as the conservation easement increases in size. Thus, $PTA_{1,2} > PTA_0$ for $\alpha > 0.175$, compared with $\alpha > 0.5$ with fixed lot sizes.

## OPEN CITY WITH FIXED LOT SIZES

The final version of the model once again assumes fixed lot sizes, but it allows for costless migration between cities. Residents are assumed to relocate as long as there is a utility gain from doing so. In equilibrium, the utility level is constant among and within cities and, if there is a large number of cities, exogenous from the standpoint of a single city. In an open city model, a conservation easement will simply cause residents to move to other cities, unless it has a direct effect on utility. It is assumed that the conservation easement provides amenities such as open space or recreation to residents, and utility is specified as $U(X, \overline{L}, z_0 - \alpha z_0) = X^{\beta}\overline{L}^{1-\beta}(1 + z_0 - \alpha z_0)^{\gamma}$, where $\gamma$ is greater than zero. When there is no conservation easement ($\alpha = 1$), the utility function simplifies to $U = X^{\beta}\overline{L}^{1-\beta}$. Utility increases as $\alpha$ falls and the size of the easement increases.

Solving the utility maximization problem, as in equation (12), and using the constraint to solve for $\overline{L}$, yield

$$(20) \qquad X^* = \beta(y - Tz), \quad \bar{L} = \frac{(y - Tz)(1 - \beta)}{R(1 + t)}.$$

Substituting (20) into the utility function, setting the result equal to the exogenous utility level $\overline{V}$, and solving for $R$ yield

$$(21) \qquad R_1(z) = \begin{cases} \dfrac{\beta^{\beta/(1-\beta)}(1-\beta)(1+z_0-\alpha z_0)^{\gamma/(1-\beta)}}{(1+t)V^{1/(1-\beta)}}(y - Tz)^{1/(1-\beta)} & 0 \le z \le \alpha z_0, z_0 \le z \le z_1 \\ R_A & \alpha z_0 < z < z_0 \end{cases}.$$

Setting $R_1(z_1) = R_A$ and solving for $z_1$ give

$$(22) \qquad z_1 = \frac{y}{T} - \frac{1}{T}\left(\frac{R_A \overline{V}^{1/(1-\beta)}(1+t)}{\beta^{\beta/(1-\beta)}(1-\beta)(1+z_0-\alpha z_0)^{\gamma/(1-\beta)}}\right)^{1-\beta}.$$

The expressions in (21) and (22) then reduce to

$$(23) \qquad R_0(z) = \frac{\beta^{\beta/(1-\beta)}(1-\beta)}{(1+t)V^{1/(1-\beta)}}(y - Tz)^{1/(1-\beta)}$$

and

$$(24) \qquad z_0 = \frac{y}{T} - \frac{1}{T}\left(\frac{R_A \overline{V}^{1/(1-\beta)}(1+t)}{\beta^{\beta/(1-\beta)}(1-\beta)}\right)^{1-\beta}$$

when there is no conservation easement ($\alpha = 1$). A comparison of these expressions reveals that the conservation easement increases development rents between the CBD and $\alpha z_0$ and expands the city's boundary.

In contrast to the results in earlier versions of the model, the conservation easement has an ambiguous effect on the size of the city—that is, the expansion in the city $(z_1 - z_0)$ may be greater or less than the size of the conservation easement $(z_0 - \alpha z_0)$. One can see this by defining $S = z_0 - \alpha z_0$ and substituting in (22) to obtain

$$(25) \qquad z_1 - z_0 = \frac{y}{T} - \frac{1}{T}\left(\frac{R_A \overline{V}^{1/(1-\beta)}(1+t)}{\beta^{\beta/(1-\beta)}(1-\beta)}\right)^{1-\beta}\frac{1}{(1+S)^{\gamma}} - z_0.$$

Differentiating (25) with respect to $S$ yields $d(z_1 - z_0) / dS > 0$ and $d^2(z_1 - z_0) / dS^2 < 0$. Because $z_0 - \alpha z_0$ is a linear function of $S$ with slope 1 and $z_1 - z_0$ equals $z_0 - \alpha z_0$ at zero, there will be at most one strictly positive value at which $z_1 - z_0 = z_0 - \alpha z_0$. Thus, if the expansion in the city exceeds the size of the conservation easement, it will tend to do so for a relatively small conservation easement. The city may expand by more than the conservation easement if the response to the additional amenities is strong enough. Indeed, it can be shown that the marginal effect of $S$ on $z_1 - z_0$ is an increasing function of $\gamma$.

Because the effect of the conservation easement on the city size is ambiguous, the relative magnitudes of $PTA_0$, $PTA_{1,1}$, and $PTA_{1,2}$ cannot be determined in general. Thus, as earlier, additional insights into the solution can be gained using a numerical analysis. Table 5.3 lists the parameter values, and table 5.5 presents the results. The open city model is parameterized so that it yields a solution identical to that for the closed city model (table 5.4) when there is no conservation easement. For the baseline parameters, $\alpha = 0.8$ and $\gamma = 0.5$. In this case, the introduction of the conservation easement causes the city to expand from 40.78 to 63.69, contrasted with an expansion to only 41.78 in the closed city model with variable lot sizes. The difference is explained by the response of migrants to the amenities provided by the conservation easement. The influx of new residents shifts up the rent function, making development of land farther from the CBD economical.

With the baseline parameters, the values of $PTA_{1,1}$ and $PTA_{1,2}$ are much larger than $PTA_0$. Raising $\gamma$ increases this difference, and lowering $\gamma$ narrows the difference. For small enough $\gamma$, $PTA_{1,2} < PTA_0$. In this case, there is very little change in the rent function, and so the new property taxes resulting from in-migration are not sufficient to offset the loss of property taxes on the land with the easement plus the additional requirements for public services. As the size of the easement shrinks ($\alpha$ is raised toward one), the values of the three measures converge. As the size of the easement increases ($\alpha$ falls toward zero), the values of $PTA_{1,1}$ and $PTA_{1,2}$ first increase and then fall. The other models produced a similar pattern. If the conservation easement is large ($\alpha$ is small) and it provides little utility to residents ($\gamma$ is small), then $PTA_0$ can exceed both $PTA_{1,1}$ and $PTA_{1,2}$. In this case, the easement pushes residents farther from the CBD, but it provides little in the way of amenities.

**Table 5.5**
Numerical Solution for the Open City Model with Fixed Lot Sizes

| **Computed Variable** | **Value** |
|---|---|
| *No conservation easement* | |
| $z_0$ | 40.78 |
| $R_0(0)$ | 10,524 |
| $R_0(z_0)$ | 1,000 |
| $X^*(0)$ | 50,000 |
| $X^*(z_0)$ | 22,816 |
| $PTA_0$ | 231 |
| *With conservation easement* | |
| $z_1$ | 63.69 |
| $z_0 - \alpha z_0$ | 8.16 |
| $z_1 - z_0$ | 22.91 |
| $R_1(0)$ | 291,520 |
| $R_1(z_0)$ | 27,701 |
| $R_1(z_1)$ | 1,000 |
| $PTA_{1,1}$ | 4,630 |
| $PTA_{1,2}$ | 4,044 |

The result is a loss of population and a decline in the total property taxes collected relative to the provision of public services.

## SUMMARY

The effects of conservation easements on markets for developed land vary, depending on the underlying assumptions of the model. Table 5.6 summarizes the effects of a conservation easement on land rents within the city, city size, and property taxes relative to public services for each model version. The conservation easement increases land rents within the original city in all model versions and displaces some of the city's population to the area beyond the original boundary of the city. On these newly developed parcels, housing rents must exceed the agricultural rent to attract the land away from agriculture. In equilibrium, the rents on these parcels must be below those on parcels closer to the CBD; otherwise, residents would prefer to move. The result is that rents are bid up throughout the original city. With fixed population and lot sizes, the city expands by exactly the size of the easement. However, when lot sizes are variable, the increase in land rents induced by the easement causes residents to consume less land for housing. The result is higher densities throughout the original city and an increase in city size that is less than the size of the easement. With variable population, the change in city size depends on how attractive the amenities are to current and new residents. Thus, the increase in city size can be greater or less than the size of the easement.

As for property taxes, a conservation easement often raises the ratio of property taxes to developed land, provided the easement is not too large. The easement increases land rents throughout the city, which typically raises the total property taxes collected. A relatively small easement results in a small expansion in the city and a small increase in public services. However, as the easement becomes larger the city's residents must live farther and farther from the CBD. Property taxes then

**Table 5.6**
Summary of the Effects of a Conservation Easement on Markets for Developed Land

| Variable | Fixed Population and Fixed Lot Sizes | Fixed Population and Variable Lot Sizes | Variable Population and Fixed Lot Sizes |
|---|---|---|---|
| Land rents within the city[a] | Increase | Increase | Increase |
| City size | Increase in city size equals size of easement | Increase in city size is less than size of easement | Increase in city size can be greater or less than size of easement |
| Property taxes relative to public services | $PTA_{1,1}$ exceeds $PTA_0$. $PTA_{1,2}$ exceeds $PTA_0$ for relatively small easements. | $PTA_{1,1}$ and $PTA_{1,2}$ exceed $PTA_0$ for relatively small easements. | $PTA_{1,1}$ and $PTA_{1,2}$ exceed $PTA_0$ for relatively small and relatively large easements. |

[a] The area between the central business district and the start of the easement at $\alpha z_0$.

eventually fall, because higher commuting distances diminish developed land rents. Meanwhile, more public services must be provided if the land under the easement requires these services. The result is that the easement, if large enough, can reduce the public service provision per unit of developed land.

## *Valuation of Conservation Easements*

This section considers the value of conservation easements that restrict future land development. It examines, first, the theoretical basis for property valuation and then derives an expression for the value of a conservation easement. Next, it examines several alternative approaches to estimating easement values. Finally, it provides estimates of average easement values for each county in the United States in 2002.

### THEORETICAL BASIS FOR VALUATION OF CONSERVATION EASEMENTS

According to the fundamental asset market equation, in a competitive property market the price of a land parcel should equal the present value of the maximum expected net revenues that the land will generate through time.[5] If, for example, the price were below this value, then an investor could earn a higher rate of return by purchasing the land parcel than by investing in an alternative interest-bearing asset. Competition among investors exerts upward pressure on the price of the parcel. If the price were above this value, then the alternative asset yields a higher return, there are no buyers for the parcel, and the price must fall to clear the market.

Suppose that agriculture and development are the two feasible uses of the land, the land is currently in agricultural use, and land development is irreversible. Then, the price of the parcel in time 0 will be given by

$$P(0) = \int_{s=0}^{s^*} R^A(s)e^{-rs}ds + \int_{s^*}^{\infty} [R^D(s) - rC]e^{-rs}ds, \tag{26}$$

where $R^A(s)$ and $R^D(s)$ are the instantaneous net revenues from agriculture and development in time $s$, respectively; $rC$ is the annualized cost of developing the land; $r$ is the rate of return on an alternative investment; and $s^*$ is the optimal time needed to develop the land. Profit-seeking investors will choose $s^*$ to maximize the expected value of the land. Differentiating (26) with respect to $s^*$ yields[6]

$$R^A(s^*) = R^D(s^*) - rC\,. \tag{27}$$

At the optimal development time, the net revenues from agriculture should equal the net revenues from development less annualized conversion costs.

Capozza and Helsley (1989, 1990) consider the structure of land prices within the framework of an urban spatial model. In the 1990 study, land development is irreversible, and future returns to development are stochastic. The authors show that, in this case, agricultural land prices have three components: the value of agricultural

5. This result follows from standard arbitrage arguments.

6. The second-order condition states that at the optimal conversion time the rate of change in net revenues from development exceeds the rate of change in the net revenues from agriculture.

rents, a growth premium related to the deterministic trend in development rents, and an option value related to irreversible land development. The option value measures the value of the opportunity to delay irreversible land development and thereby obtain additional information about the profitability of future development. In their econometric analysis of average agricultural land values in U.S. counties, Plantinga, Lubowski, and Stavins (2002) decompose agricultural land prices into agriculture and development components, as in (26), and find evidence that option values are capitalized into prices.

Consider a conservation easement applied to the land parcel just described. In particular, suppose that the easement prohibits future development of the parcel indefinitely. The owner of the parcel will now obtain the discounted expected net revenue stream given by

$$(28) \qquad P^A(0) = \int_{s=0}^{\infty} R^A(s)e^{-rs}ds.$$

$P^A(0)$ is simply the price of the land were agriculture the most profitable use of the land. To accept $P^A(0)$ instead of $P(0)$, the owner must be compensated by an amount

$$(29) \qquad P^{CE}(0) = \int_{s^*}^{\infty} [R^D(s) - R^A(s) - rC]e^{-rs}dt,$$

where $P^{CE}(0)$ is the price of the conservation easement in time 0. $P^{CE}(0)$ measures the additional expected net revenues provided by development from time $s^*$ onward, net of conversion costs.

The analysis presented earlier ignores property taxation.[7] Suppose that property is taxed at rate $t$ and the assessment reflects the fair market value of the property. Then, the time 0 price of the parcel becomes

$$(30) \qquad \tilde{P}(0) = \int_{s=0}^{s^*} [R^A(s) - t\tilde{P}(s)]e^{-rs}ds + \int_{s^*}^{\infty} [R^D(s) - rC - t\tilde{P}(s)]e^{-rs}ds,$$

where $\tilde{P}(s)$ denotes the price of land in time $s$ with property taxation. ($\tilde{P}(s)$ appears on the right-hand side of the equation to measure the assessed value of the property.) Within a similar framework, Anderson (1986) examines the effects of taxation on the optimal timing of development. He shows that when the pre- and postdevelopment tax rates are the same, as in (30), taxation has no effect on the optimal development time.[8] However, when the tax rates differ, taxation can either speed or slow the development of the land. Here it is assumed that when the conservation easement is applied, the property is assessed according to its value in agricultural use. When a uniform tax rate is applied, the price of the conservation easement is written as

7. All 50 states provide some form of preferential tax assessment for agricultural land, typically use-value assessment (Wunderlich 1997). Anderson (1993) shows that use-value assessment delays the optimal development time.

8. This finding assumes that the development time has no effect on the stream of subsequent development rents.

$$\tilde{P}^{CE}(0) = \int_{s^*}^{\infty} [R_D(s) - R_A(s) - rC]e^{-rs}ds$$

$$(31) \qquad - t\int_{w=0}^{s^*} \left[\int_{s^*}^{\infty} [R_D(s) - R_A(s) - rC]e^{-rs}ds\right]e^{-rw}dw$$

$$- t\int_{w=s^*}^{\infty} \left[\int_{s=w}^{\infty} [R_D(s) - R_A(s) - rC]e^{-rs}ds\right]e^{-rw}dw\,.$$

The first term on the right-hand side of (31) is identical to that in (29). The last two terms reflect the tax savings from the assessment for agricultural use rather than the higher-valued developed use. Thus, in this case taxation lowers the price of the conservation easement. Two unresolved issues are how the price of the conservation easement would be affected by differential tax rates on agricultural and developed uses and by use-value assessment for agricultural land.

## ALTERNATIVE APPROACHES TO VALUING CONSERVATION EASEMENTS

This section describes three commonly used appraisal methods for valuing conservation easements: (1) the comparable sales method, (2) the before-and-after method, and (3) the income approach (Wiebe, Tegene, and Kuhn 1996).

***Comparable Sales Method*** This approach uses the sales of similar easements to value the easement being appraised. If an individual donates a conservation easement and claims it as a charitable contribution, the Internal Revenue Service states that "if there is a substantial record of sales of easements comparable to the donated easement, the fair market value of the donated easement may be based on the sales price of such comparable easements." However, it is often difficult to compare a "substantial" number of similar sales, because only a small number of transactions may have taken place in the area and the terms of conservation easement agreements may have differed. For example, some easements may not only restrict the development of a property, but also limit the use of billboards, specify the types of crops that can be planted, or impose controls on erosion or pesticide use. Meanwhile, this method is becoming more practical as the number of acres under conservation easements continues to grow throughout the United States (Land Trust Alliance 2004).

***Before-and-After Easement Sales Method*** This approach compares the value of unencumbered properties with the value of properties with restrictions similar to those imposed by the conservation easement. The value of unencumbered properties would be estimated using, for example, the comparable sales method. For encumbered properties, one approach, called the zoning classification method, considers the price of parcels sold in conservation zoning districts that are subject to restrictions similar to those imposed by the conservation easement. The value of the conservation easement is computed as the difference between the values of unencumbered and encumbered properties. A more formal approach is to estimate a hedonic price equation using data on sales prices and the attributes of properties. In the hedonic analysis of Nickerson and Lynch (2001) described earlier, the coefficient on the variable measuring preservation status is an estimate of the value of the development rights.

Another approach to estimating the encumbered value of land is to determine the present value of income from the property in its restricted use. If this use is agriculture, then ideally one would determine the rental prices for parcels with similar characteristics. If the rental price is assumed to be constant through time, then the value of the land in agriculture is simply the rental price divided by the alternative rate of return. Using the earlier notation, the price of the conservation easement is $P^{CE}(0) = P(0) - P^A(0)$, where $P(0)$ is estimated from comparable sales and $P^A(0) = R^A / r$, where $R^A$ is the estimated annual rental rate for agricultural land. Plantinga and Miller (2001) use this approach to estimate the value of development rights in Orange County, New York. A hedonic price equation is estimated using data on unencumbered farmland values and is then used to predict prices at different locations in the county. The present discounted value of net farm revenues is subtracted from each predicted price to obtain the value of development rights.

Boykin (2000) discusses an approach that relies on the market value of fully developed property. The costs of development are subtracted from this value to obtain the value of undeveloped, but developable, land—that is, the unencumbered value. A similar approach is used in Plantinga, Lubowski, and Stavins (2002) to estimate the rents accruing to urban land. The value of land in agricultural use (the encumbered value) is then subtracted from the unencumbered land value.

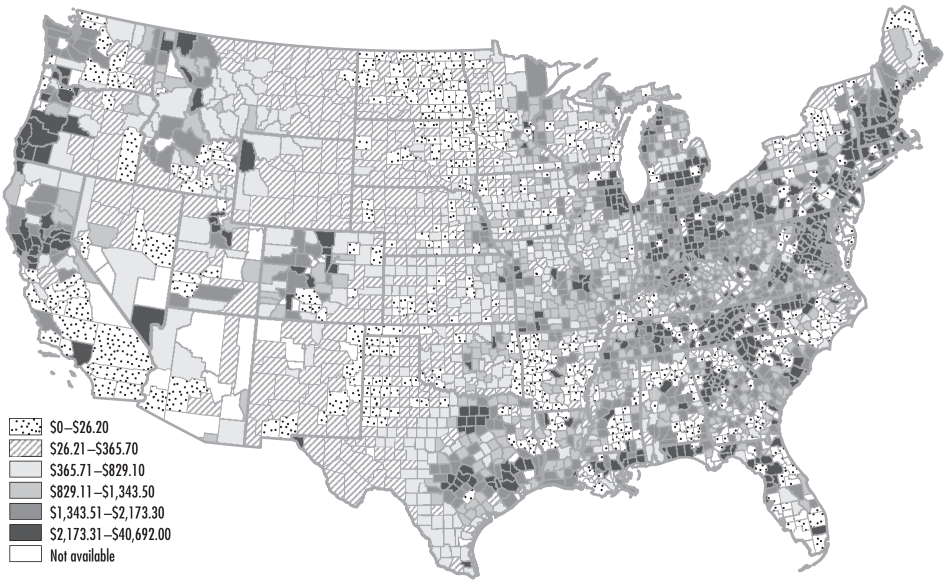
***Income Approach*** The third approach, discussed by Wiebe, Tegene, and Kuhn (1996), is to directly estimate and compare the discounted income streams associated with the unencumbered and encumbered properties. As discussed earlier, this estimation may be relatively straightforward for the encumbered case if the land is restricted to remaining in agriculture. However, it is much more complicated for the unencumbered property, particularly if the land is likely to be developed at some time in the future. In this case, the analyst must estimate the time of development, account for uncertainty over future returns to development, and consider option values associated with irreversible development. The comparable sales approach would appear to be a more practical approach to estimating the unencumbered value.

## CONSERVATION EASEMENT VALUES IN U.S. COUNTIES

Here the value of conservation easements in U.S. counties is roughly estimated using 2002 data from the Census of Agriculture. The census provides estimates of the average market price of farmland per acre in each county. This value is then used as an estimate of $P(0)$, and $R^A$, the average net revenue per acre from agriculture, is then estimated for each county. $R^A$ is computed as the total market value of agricultural products sold plus total federal farm payments less total farm production expenses, normalized on total farmland acres in the county.[9] Assuming that it remains constant over time, $R^A$ is divided by $r = 0.05$ to obtain $P^A(0)$. The average value of the conservation easement is then estimated as $P^{CE}(0) = P(0) - P^A(0)$.

9. This measure of $R^A$ ignores, among other things, taxes on farm income.

**Figure 5.4**
Estimated Average Value of Conservation Easements on Farmland, by County: 2002 (in dollars per acre)




The results are presented in figure 5.4. The values range from $0 to $40,692 per acre (York County, Virginia). Other counties with high values are Pinellas, Florida ($30,083 per acre), and Mercer, New Jersey ($21,166). The highest values are found in the Northeast, in the upper Midwest, and on the West Coast. High values are seen near cities such as Houston, Minneapolis, and Denver. The value of conservation easements is lowest in the Plains states, which have a large amount of agricultural land and relatively low development pressures (Plantinga, Lubowski, and Stavins 2002). Averaging across counties reveals an average value of conservation easements of $1,288 per acre. The American Farmland Trust (2005) finds that the average price paid for easements is about $2,000 per acre. The lower figure obtained here stems in part from the inclusion of counties with a zero or very low easement price. In practice, easements are more likely to be established on land that is likely to convert out of agriculture (see figure 5.1).

## *Conclusions*

Easements have become an increasingly popular tool for land conservation, as evidenced by the number of easement programs at the federal level, the funds provided to state and local governments through ballot initiatives, and the growth in the use of easements by private land trusts. This chapter has addressed some of the economic issues that arise with conservation easements.

The economics literature on conservation easements provides consistent evidence that they generate spillover effects on neighboring property values. In many cases, the effects are positive, suggesting that neighboring property owners benefit from the open space provided by easements. However, at times the effects are negative, which might indicate the externalities, such as dust, odors, and noise, associated with intensive agricultural production. The empirical results are mixed about the effects of a conservation easement on the value of the property itself. Although theory indicates that conservation easements should reduce the value of undeveloped land, several empirical studies find statistically insignificant effects. One possibility is that the prices used in these analyses reflect the value of living on the property. Even if the assessed value of structures is subtracted from the sale price, the residual will, in general, be higher than the value of undeveloped land. Several empirical studies have examined the effects of conservation easements on property taxes. The most detailed of these (King and Anderson 2004) finds that conservation easements raise property tax rates in the short term but lower them in the long term. The explanation offered is that, in the short term, easements reduce the property tax base by lowering assessed values, but in the longer term they raise the property tax base through amenity effects on property values.

The findings of the theoretical analysis presented here are consistent with the empirical literature. This analysis has focused on the longer-term impacts of conservation easements in that adjustments are permitted in housing prices, housing sizes, and population. The analysis found that in most cases conservation easements raise property taxes relative to the provision of public services. This increase can result from the amenity effects discussed earlier, or from the displacement of some of the city's residents. Meanwhile, the easement may lead to the development of housing farther from the city center. Rents on these parcels must be sufficiently high to attract the land away from its alternative use, and, in equilibrium, these rents must be below those of parcels closer to the city; otherwise, residents would prefer to move. The result is that rents are bid up throughout the original city, raising the property tax revenues collected on these parcels. For relatively small easements, this increase in property taxes—whether from amenity or displacement effects—outweighs the loss of property taxes on the land with the easement as well as the effects of any increase in the provision of public services. With large enough easements, however, the displacement of the city's residents may lower property tax revenues as high commuting costs diminish developed land rents. In this case, easements can reduce property taxes relative to the provision of public services.

These theoretical results suggest some avenues for further empirical investigation. Future analyses might try to identify separately the amenity and population displacement effects of easements on property taxes. The results of such research may be of interest to policy makers, because the amenity effects derive from welfare-enhancing benefits whereas the displacement effects are linked to higher commuting costs borne by a subset of residents. Similarly, it might be useful to estimate the separate effects of conservation easements on the property tax base and public service provision. The theoretical results of this study indicate that easements have an ambiguous effect on the requirements for public services. They may increase with strong amenity effects that attract new residents and decrease if easements result in higher densities close to the city center. Finally, this chapter has provided a theoretical basis for the future specification of empirical models. The results indicate that the ratio of property tax revenues to public services should depend on factors such as income, transportation costs, rents from alternative land uses, marginal tax rates, and the location of land with easements. Moreover, the size of conservation easements should have a nonlinear effect on property taxes relative to public service provision.

This chapter has also examined the valuation of conservation easements from theoretical and empirical perspectives. In a competitive market, the price of a conservation easement will be equal to the present discounted value of the difference in the development and agricultural rent streams from the time of development onward. The most straightforward way to measure this price is to recognize that it is equivalent to the difference between the unencumbered and encumbered values of the land. In principle, these quantities are observable, or they can be estimated with standard approaches. Here a rough estimate was obtained of the value of conservation easements for all counties in the United States using data on the average market values of farmland and net revenues from agricultural production. Two unresolved valuation issues were identified as well. First, how is the price of a conservation easement affected by differential tax rates on agricultural and developed land? This problem is complicated by the fact that the differences in these rates affect the optimal development time. Second, how does the use-value assessment for agricultural land affect the price of conservation easements? These questions are left for a future inquiry.

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