The Value of Open Space: Evidence from Studies of Nonmarket Benefits

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Executive Summary

Open space provides a range of benefits to citizens of a community, beyond the benefits that accrue to private landowners. Parks and natural areas can be used for recreation; wetlands and forests supply storm-water drainage and wildlife habitat; farms and forests provide aesthetic benefits to surrounding residents. And in rapidly growing urban and suburban areas, any preserved land can offer relief from congestion and other negative effects of development.

It is one thing to recognize that open space provides these benefits but quite another to place a monetary value on them. To make important policy and planning decisions about zoning, restrictions on land use, government purchase of lands for parks, and similar initiatives, however, estimates of preferences and even dollar values can be essential. In this study, we review more than 60 published articles that have attempted to estimate the value of different types of open space.

The two major approaches for estimating open space value from the economics literature are the focus of this study: revealed preference methods and stated preference methods. In the first category are hedonic property value studies in which the open space value is inferred by estimating the sales price or value of a property as a function of measures of proximity to open space and other property and neighborhood characteristics. In the second are studies that use carefully designed surveys to elicit preferences or values households place on various types of open space amenities. Both contingent valuation and contingent choice studies are reviewed.

Both the revealed and stated preference studies generally show that there is value to preserving most types of open space land uses, but the values tend to vary widely with the size of the area, the proximity of the open space to residences, the type of open space, and the method of analysis. One conclusion we draw from this review is that the extant literature tends to be case study specific. However, it is possible to draw conclusions from the range of studies about the direction of particular effects, how values vary by location and other influences, and the differences among the methodologies used to estimate values. In addition, we suggest areas where additional research is needed to improve valuation estimates. We also conclude that more analysis is needed about how to conduct studies with broader applicability.

The Value of Open Space: Evidence from Studies of Nonmarket Benefits

Virginia McConnell and Margaret Walls[1]

1. Introduction

Open space provides a range of benefits to citizens of a community, beyond the benefits that accrue to private landowners. Parks and natural areas can be used for recreation; wetlands and forests supply storm-water drainage and wildlife habitat; farms and forests provide aesthetic benefits to surrounding residents. And in rapidly growing urban and suburban areas, any preserved land can offer relief from congestion and other negative effects of development. Both publicly held and privately held lands can provide open space benefits, but because people who do not directly own the land still enjoy the benefits, open space is likely to be underprovided by the private sector.

Concern over the preservation of open space has been growing in recent years as rates of development have increased. There is evidence to suggest that in some areas, the rate of land conversion to development doubled in the late 1990s from rates of earlier decades (USDA 1997). In response, state and local governments, private land trusts, and even the federal government have undertaken a number of activities to preserve different types of land from development.

These activities range from local zoning changes to purchases of land for parks and purchases of conservation easements.[2] The Trust for Public Lands reports that in 2003, voters in 23 states approved the spending of $1 billion on land purchases for open space, parks, and farmland. The American Farmland Trust estimates that approximately $2.2 billion had been spent, as of January 2003, by local and state governments and private land trusts to purchase agricultural conservation easements. These easements have preserved approximately 1.3 million acres of farmland. Such expenditures by government and private conservation organizations suggest that open space provides public benefits to communities, but these dollar expenditures present only a very rough estimate of the size of those benefits. Furthermore, they do not say anything about the relative values of different types, locations, and amounts of open

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[2] Easements are deed restrictions that limit the development activity that can take place on a parcel of land.

space. Presumably, government would like to retain open space land when the benefits of doing so exceed the costs; thus, knowing something about the dollar value of the benefits is important for public policy.

Given competing demands on government budgets and rising land values in development, this benefit–cost question will become increasingly important in the future. In addition, comparing the values of different types of ownership of open space yields useful information to government decisionmakers comparing different conservation goals. For example, purchasing development rights retains private ownership; it is important to know what relative value such land has compared with publicly owned land. Similarly, because forests, wetlands, and farmland may have different values, governments with limited budgets may want to target the most valuable parcels. Also important are the location and size of open space. One question may be whether small areas, located close to residential developments, are more valuable than a single larger area of open space in a more distant location. A wide range of issues along these lines faces policymakers as they make decisions about open space.

In this paper, we review the now quite extensive economics literature on the value of open space.[3] Because many of the services provided by open space—recreation, aesthetics, ecosystem services, and so forth—are not directly traded in private markets, estimating the benefits they provide can be difficult. Economists have used a variety of techniques for valuing nonmarket goods. For purposes of valuing open space, most studies rely on the hedonic property value approach and contingent choice or valuation techniques. We do not include studies that use a travel cost methodology to measure the recreation benefits of natural resource areas and are not aware of any that use the travel cost approach to look at urban and suburban parks. In addition, we do not review in depth the interesting, recent literature that uses calibration of spatial general

[3] Our review is distinguished from other surveys of open space that have been done in recent years by its broad focus on nonuse values for all types of open space, and because it reviews primarily, although not exclusively, studies of applications in North America. Crompton (forthcoming) focuses just on parks and does not include many of the studies we review here; Boyer and Polasky (2004) have recently looked at methods for valuing the ecosystem services of wetlands; a review published by the U.K. Office of the Deputy Prime Minister (2002) focuses primarily on studies done in the United Kingdom and elsewhere in Europe (with a strong emphasis on those using stated preference techniques; and Fausold and Lillieholm (1996) look at the range of values provided by open space, including market values as well as nonmarket values. We include many additional studies that have been published since the Fausold and Lillieholm review.

equilibrium models of urban areas to derive the value of public goods, including open space amenities, and examines the effect of open space on urban spatial structure.[4]

This study covers more than 60 articles that use the various methodologies, published during the past roughly 25 years. The analysis focuses primarily on the value of open space in and around urbanized areas, including parks, greenbelts, natural areas and wildlife habitats, wetlands, and farmland. We devote particular attention to the substantial literature that has developed since the late 1990s, when worries began to grow over urban sprawl and loss of farmland and forests.

Our review finds that open space values vary widely by location, by type of open space, by the services provided, and by study methodology. We provide a comprehensive summary of these results and highlight linkages and similarities in results where possible. We also provide tables of values from some of the most recent and best hedonic and contingent valuation studies. And we conclude with suggestions for future research.

Section 2 begins with a general discussion of how economists estimate the benefits of nonmarket goods. Section 3 focuses on the hedonic price literature, and Section 4, on contingent valuation and contingent choice methods. Section 5 provides some results from studies outside these two main techniques. Finally, concluding remarks and recommendations for future research are outlined in Section 6.

2. Measuring the Benefits of Nonmarket Goods

Parks, general open space, wetlands, and farmlands provide a range of both public and private benefits. Some of the services provided by such open space lands can be relatively easily valued because they are traded in markets, such as the value of crops for land in agriculture, the value of fisheries protection or flood control through the preservation of wetlands, or the value of timber produced from forested lands.[5] The focus of this paper is on those aspects of open space value that are external to market transactions. As described in the introduction, they can include the value of a scenic

[4] See, for example, Hallstrom and Smith (2003), Wu and Cho (2003), Wu and Plantinga (2003), and Walsh (2003).

[5] For example, studies by Swallow (1994) and Acharya and Barbier (2002) have explored the production values of wetland. Another study examined economic activity that uses open space as an input for the production of recreation and other industries in New Hampshire (Resources Systems Group 1999).

view, the value of habitat protection, or the value of improved water quality, and can accrue to land that is publicly held (a park, for example) or privately held (farmland). Because these services are not traded in private markets, there is little information from which to make estimates of their values.

However, economists have developed a variety of techniques to measure both preferences for and the dollar benefits provided by such goods. We focus here on two of these techniques: hedonic price models and stated preference methods, such as contingent choice and contingent valuation (CV). Hedonic price models rely on so-called revealed preference—they use information on house purchase behavior to infer values of open space and other amenities. Stated preference methods make use of surveys to ask individuals directly about their preferences or willingness to pay for carefully defined outcomes, such as the preservation of particular open space areas.

There are a number of other methods for valuing nonmarket benefits. One is the travel cost methodology, which uses observations of individuals' out-of-pocket travel expenditures and time costs to get to a recreation site to infer the value of the site. Several such studies relate to recreational use of open space, but their focus is primarily on large parks or wetland regions, often far removed from urban areas.[6] Relatively recent work using general equilibrium urban models that are calibrated to data from cities allows researchers to infer the value of public amenities, including open space, from spatial variation in the amount and type of the public goods and property values. This is a revealed preference approach that uses a general equilibrium framework, allowing all markets and prices in an urban area to adjust, whereas the hedonic method is partial equilibrium in that it focuses only on the housing market. To date, only a small number of studies have used this approach to value open space in urban areas, and we compare the findings of these studies to hedonic study results below.

Another recent approach is to look at "cost of community services" to infer open space values: it uses estimates of the public service costs—roads, sewers, schools, and so forth—imposed by new developments and assumes that the avoidance of these costs is

[6] See, for example, the study of the value of wildlife reserves in California by Cooper and Loomis (1991). Travel cost studies focus on a limited type of "use" value, the benefit derived from using a particular park or other site for recreation purposes. As we describe in the next section, use values for open space can include recreation benefits and aesthetic benefits from simply seeing the open space, as well as "nonuse" values. Thus the travel cost method provides a lower bound on total benefits.

the benefit provided by open space.[7] This approach is relatively easy because estimates of such costs are readily available, but these avoided costs underestimate the benefits of open space. The avoided costs are monetary savings to the community, but they do not necessarily bear any relationship to the true recreation and aesthetic values provided by the open space land.

People derive different types of nonmarket values from open space. One category of these benefits is called use value. In this case, the benefit is related to seeing or using the open space, such as having a pleasant view, experiencing improved water quality, or having increased opportunity for viewing wildlife. Another set of values derives not from direct use of the open space or services from it, but rather from knowing the open space exists. These are referred to as nonuse or passive use values. People may get utility, or satisfaction, from knowing that farms on the periphery of an urban area exist as they have for generations, even if they never plan to visit those areas. Some studies reviewed here attempt to measure only use value, and others attempt to capture total value, which may include both use and nonuse components.

Revealed preference studies, such as the hedonic applications described below, can measure only use values. Being adjacent to an open space site or having access to such a site means properties will be more valuable. Stated preference techniques can, in principle, measure both use and nonuse values. The evidence from combined revealed and stated preference studies can be used to measure the same use values from open space, and thus serve both as a check on each other and as a basis of comparison. We describe several such studies at the end of this paper. In addition, estimates of total value of an open space area could use a combination of use values from hedonic studies and nonuse values from a CV study.

We first review the hedonic pricing technique and the results of the large literature using these models for valuing open space. We then turn to the stated choice methods, and after a brief description of their advantages and pitfalls, we review the range of those studies related to open space.

3. Hedonic Pricing Models

In this section of the paper, we summarize empirical studies of the value of open space that rely on the hedonic price methodology. This methodology uses

[7] See Fausold and Lillieholm (1996) for a summary.

information on house prices along with characteristics of the house and the surrounding land to infer values of open space. We begin with an overview of the technique and how it has been applied to environmental amenities. We describe some of the general problems associated with the hedonic technique as well as difficulties specific to the valuation of open space. We then discuss the many articles specifically focused on valuing open space.

A. Overview of the Hedonic Technique

A differentiated product can be viewed as a bundle of characteristics. For example, a car comprises characteristics related to size, performance, fuel economy, and so forth; a house is a bundle of structural features—number of bedrooms and bathrooms, square footage, and the like—plus lot size, neighborhood amenities, and environmental and other attributes of the community. Hedonic pricing models express the price of a product as a function of its characteristics or attributes; when the model is econometrically estimated using data on market prices and attributes; the resulting estimated coefficients represent the marginal implicit prices of the attributes. Hedonic price models have proved particularly useful for estimating the value of nonmarket environmental amenities, such as parks and open space, as well as disamenities such as air pollution, noise, and proximity to noxious facilities, such as landfills.

The idea that consumers get utility from the attributes embodied in products is generally attributed to Lancaster (1966; 1979). Rosen (1974) shows how market equilibrium is characterized when perfectly competitive profit-maximizing producers and utility-maximizing consumers choose the amounts of differentiated products to produce and consume.

Application of the hedonic technique to valuation of environmental amenities has a long history. For example, there exist several studies of air pollution—so many, in fact, that Smith and Huang (1995) published a meta-analysis based on the work. Freeman (1993) presents a useful overview of environmental benefit studies using the hedonic technique, along with a clear description of the theory underlying the approach and some empirical pitfalls associated with it. To date, hundreds of articles have been published using the hedonic price model applied to estimation of the benefits of environmental amenities. Applications to parks and open space first appeared with a few articles in the 1970s, focusing primarily on parks, followed by several studies in the 1990s and early 2000s looking at a wide variety of types of open space.

Associated with the hedonic technique are several methodological issues, some of which are more general and apply to any application and some of which have special significance to the study of open space. One issue is the choice of functional form. Parametric models that have been used include the linear, quadratic, log-log, log-linear, semilog, and the Box-Cox transformation.[8] In general, the theory underlying the approach does not provide much guidance about which of these functional forms is most appropriate. Certain kinds of Box-Cox transformations—in particular, one that allows for different transformations of each independent variable—are more flexible than other alternatives. However, many more coefficients are estimated in such models. Cropper et al. (1988) show that when key explanatory variables are omitted, the simple linear model is superior to the quadratic Box-Cox transformation in generating accurate marginal implicit prices.

This is apparently due to the fact that the omitted variables lead to bias in more coefficients in the more complicated version of the model than they do in the simpler model. Omitted variables problems can be quite common in hedonic property value studies, since it is difficult to obtain all the house characteristics that matter to consumers. Day et al. (2003) use a semiparametric approach to estimating the hedonic price function to deal with the issues related to functional form. Bin and Polasky (2003), in a study of wetlands that we review below, follow this approach as well.

A second issue is whether the housing market is in equilibrium or not. Estimation of the model is predicated on the assumption that it is, but if market forces are causing changes in prices and consumers have not fully adjusted to those changes because of adjustment costs, the market may be in disequilibrium. In this case, the data present misleading results about the value of particular amenities. Also, a house's price should equal the net present value of the asset and thus reflect expectations about future amenity levels. Present levels of the amenities might give an inaccurate picture of households' expectations of future levels of those amenities. This could be a particular problem for open space, since privately owned land could be potentially developable; it is difficult to know how neighboring households are forming expectations about the

[8] In a Box-Cox model, the independent variables, and often the dependent variable as well, are transformed in the following way: $g(x) = \frac{x^{\lambda} - 1}{\lambda}$; the parameter λ can be estimated along with other parameters of the model. The transformation is useful because it includes the linear, log-linear, and semilog as special cases (Box and Cox 1964).

future uses of such land. Smith et al. (2002) highlight this point, as do Irwin and Bockstael (2001) and others discussed below.

Estimation of a hedonic price model is also predicated on the assumption that the implicit price function is differentiable and continuous. This will be the case if a full range of houses with varying attributes is available for consumers to choose from, but in many instances, the range of choices is limited. This means that consumers may not be choosing houses that would provide the greatest possible utility, which in turn means that first-order conditions for utility-maximization are not satisfied. Harrison and Rubinfeld (1978) uncover a problem of this type in their study of the value of air pollution reductions in the Boston area. They find that high-income households live where air pollution is high because these are locations with high levels of other desirable attributes; locations with both low air pollution and high levels of other attributes are simply not in the choice set, at least for their sample of households.

A related issue with hedonic models is the extent of the market under study. Straszheim (1974) argues that an urban housing market is really composed of many separate submarkets and that these submarkets need to be separately estimated. Some of the open space studies we review below highlight this issue. Anderson and West (2003), for example, obtain quite different results for central city households versus suburban households in the Minneapolis area; Geoghegan et al. (2003) obtain different results for agricultural open space values across different counties in Maryland. Of course, the smaller the submarket, the more likely it is that the problem mentioned in the previous paragraph is present. Moreover, it can be difficult to delineate submarkets. Day et al. (2004a) attempt to use cluster analysis techniques to determine appropriate markets in a study of the Birmingham (U.K.) housing market. They compare two alternative clustering assumptions, one based on attributes of the property itself and one based on neighborhood attributes. However, their study does not have either environmental amenities or open space as its focus.

These market area questions raise the more general problem in the estimation of hedonic models of spatially autocorrelated errors. Housing prices are influenced by a variety of factors, many of which vary by spatial location. Although hedonic models attempt to capture at least some of that variation (for example, by including submarket variation as described above), there is likely to remain some unexplained spatial variation in price, and therefore spatial correlation of the error terms. If such spatial autocorrelation is not accounted for in the estimation, the results may be misleading. There are actually two ways the spatial autocorrelation problem can arise. First, the

obvious case: variables that cause spatial variation in prices are omitted from the model. This often happens because some of these variables are difficult to observe or measure. The second way involves measurement error, if the scale at which a variable is measured (census tract, for example) does not correspond to spatial scale at which the effect is generated (neighborhood). In the latter case, measurement error, the estimated coefficients from the hedonic house price equation will be inefficient but unbiased. For the omitted variables problem, the estimated coefficients are likely to be both biased and inefficient.

Recent papers by Irwin (2002) and Day et al. (2004b) examine the extent of the omitted variables problem and develop methods to deal with it. Irwin examines the effect on the estimation results of different assumptions about the spatial relationship of the errors terms; Day et al. use the data on the error terms themselves to infer the appropriate spatial relationship. They employ factor analysis and cluster analysis to define housing market segments.

Rosen (1974) describes how the estimated marginal implicit prices of attributes that come out of a hedonic model, along with the various levels of attributes of goods in the marketplace, can be used in an estimation of the willingness to pay (WTP), or demand, for those attributes. Other research shows, however, that this second-stage demand estimation is not as straightforward as Rosen indicates (Bartik 1987; Epple 1987). The problem is that both the marginal implicit price estimated from the hedonic price function and the level of the attribute itself are endogenous and specific to the individual. It is thus nearly impossible to find exogenous variables to be used as instruments in this second-stage demand equation. Ekeland et al. (2004) show that it is possible to identify preferences from estimation using data from a single hedonic market. In any case, almost none of the open space studies below attempt to carry out a second-stage estimation of the demand function. Most focus simply on the estimation results from the hedonic price model, summarizing the marginal price (usually evaluated at the mean house price) of an additional acre of open space, additional percentage of open space in surrounding land, or additional foot closer proximity to open space. These are the kinds of values that we focus on below.

B. Valuing Open Space with Hedonic Pricing Models

In reviewing the literature on hedonic models, we read and analyzed approximately 40 studies published between 1967 and 2003. The focus of these studies

ranges from urban and suburban parkland to nature preserves, forests, wetlands, and agricultural lands. Although many studies include measures of different types of open space, usually each study has a primary focus. We have thus grouped the studies in the following categories: general open space, parks, and natural areas; greenbelts; wetlands; urban/suburban forest preserves, and agricultural lands. Excluded from our survey are studies that focus on environmental attributes other than open space, including those that attempt to estimate the value of a view (Gillard 1981; Rodriquez and Sirmans 1994; Benson et al. 1998).

General open space, parks, and natural areas

The earliest studies using housing prices to implicitly value open space focused on parks. Kitchen and Hendon (1967) look at the distance to a neighborhood park in Lubbock, Texas, and perform simple correlations of house price and distance and house-assessed value and distance. They show that there is a significant *positive* correlation between house price or values and distance: houses farther from the park are more valuable. Although this conclusion is based only on simple correlations that do not control for the many other factors affecting house prices, the result has been confirmed in some other studies looking at urban and suburban parks.

Weicher and Zerbst (1973) look at single-family dwellings in Columbus, Ohio, surrounding five neighborhood parks. They use dummy variables for whether a house is adjacent to and faces a park, backs to a park, or is adjacent to and faces an area of heavy recreational use or a park building. Their results suggest that price is higher if the house faces a park, all else being equal, but lower if it either backs to a park or is across from a heavily used park or park building. More recent studies with a broader focus continue to pick up this negative effect on properties located next to busy urban and suburban parks. King et al. (1991), in a study focused on estimating the value of wildlife habitat in an urban/suburban setting, find that house prices are higher the farther the houses are from neighborhood, district, and regional parks. Shultz and King (2001) pick up the same effect using the same types of explanatory variables—distances to various types of parks and wildlife habitats—defined over Census blocks (and with assessed house values rather than sales prices). Both studies use data from the Tucson, Arizona, area; King et al. data are from 1986, and Shultz and King's, from 1990.

By contrast, both the King et al. study and the Schultz and King study find that house prices increase the closer those houses are to golf courses, large natural areas, and certain types of wildlife habitat. The large natural areas in the studies are protected

areas in the mountains surrounding Tucson. The wildlife habitats are defined and spatially located for the purpose of aiding with land use planning in the Tucson area and are delineated solely on the basis of habitat and not other factors. There are two types of habitat variables; one is found to be statistically significant in explaining house prices and the other is not. Both of the studies also include a "vacant land" variable defined to include units of land 2 hectares or larger not classified as wildlife habitat. In both studies, the greater the distance to vacant land, the higher the house price, all else equal. In the case of both the vacant land variable and the two habitat variables, privately owned land is not distinguished from public land in the model.

An early study by Brown and Pollakowski (1977) finds that publicly accessible open space in lakefront communities in the Seattle area had a positive effect on house prices—the greater the open space area around a house, the higher the price, all else equal. The authors also find that house prices decrease with distance from the lakefront and are higher when the house has a lake view.

A somewhat similar study by Peiser and Schwann (1993) looks at house prices in a Dallas subdivision that has publicly usable open space between houses—what the authors refer to as an internal greenbelt. They find that although houses on the open space generally sell at a premium, the effect is statistically insignificant and much smaller in magnitude than the effect of the size of the private lots themselves. An additional foot of private backyard space is estimated to be worth $384 (in 1985 dollars), while an additional foot of open space is found to be worth less than $4. They conclude that public open space within subdivisions is not that valuable but stipulate that this finding may be specific to the type of subdivision and open space studied. Specifically, their subdivision contained high-end housing with relatively large (averaging one-third to one-half acres) private lots; the greenway was relatively open and used for jogging, ballgames, and the like with views somewhat similar to that of a golf course.[9] The issue of a trade-off within housing developments between public open space and private backyards is also addressed in the Thorsnes (2002) study in section (4), below.[10]

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[9] This study included a contingent valuation survey as well. We discuss these results in Section 3, below.

[10] Lacy (1990) compares appreciation of average house prices in clustered, or open space, subdivisions in Concord and Amherst, Massachusetts, with nonclustered subdivisions. The clustered subdivisions have smaller lots but approximately 50 percent of the development is retained as open space; nonclustered, or traditional subdivisions, have no public open space. He finds that prices appreciate slightly more in clustered subdivisions than in nonclustered ones in

Results in Lutzenhiser and Netusil (2001) confirm the earlier findings about the differential effects that natural areas and urban parks have on house prices. Using data on single-family home sales in Portland, Oregon, in 1990–1992, the authors find that houses near urban parks have lower prices, all else equal, while those near natural areas or specialty parks—smaller parks devoted to a particular use, such as a boat ramp facility—have higher prices. Natural area parks have the largest effect on house prices, and in general, the bigger the better—that is, house prices increase with the size of the natural area. Although being near an urban park is found to decrease price, urban park acreage has a positive effect on price: the larger the park, the higher the average house price, all else equal.

This result could suggest that larger parks insulate nearby residents from the noise, traffic, and other disamenities usually associated with busy parks. At the mean acreage of each type of open space, Lutzenhiser and Netusil estimate that each type has a positive impact on house prices. In an interesting simulation, they go on to use their results to locate the optimal size—the acreage at which house sales prices are highest—of each of the open space types in their study. All of the parks and natural areas are found to be smaller than optimal, but golf courses are found to be almost exactly the right size.

In an earlier study, Bolitzer and Netusil (2000) use the same Portland data as in Lutzenhiser and Netusil to examine the effects of open space on house prices, but they define their variables slightly differently. Instead of urban parks, natural areas, and specialty parks/facilities (along with golf courses and cemeteries), the authors categorize open space as "public park" and "private park" (and also include golf courses and cemeteries). According to the authors, public parks make up the majority of the open space and private parks are "owned by organizations such as the Trust for Public Land" (p. 188). Public parks are found to have a positive effect on house prices, as are golf courses, but private parks have no statistically significant effect. Of these two studies, we feel that the Lutzenhiser and Netusil results are probably more reliable, since the open space categories are more disaggregated.

Anderson and West (2003) argue that it is important to consider jointly the range of attributes provided by open space, including the type of open space, its size, and proximity to it, in hedonic price studies. Moreover, the authors contend, open space

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Amherst; in Concord, where he does not have prices for nonclustered subdivisions, Lacy finds that clustered subdivision prices appreciate more than overall average house prices.

effects should be quite different depending on the location of residents in a metropolitan area. They use 1997 data from the Minneapolis–St. Paul area to estimate separate hedonic price models for the city and the suburbs. Their explanatory variables include distance and size variables for various types of open space—developed neighborhood parks, special parks (natural areas, wildlife refuges, and state and regional parks), golf courses, cemeteries, lakes, and rivers—as well as interactions between distance and size for each type of open space. In addition to estimating separate city and suburb models, they also include neighborhood fixed effects to control for unobserved housing market variables. They find that being closer to any kind of park increases city house prices but has no effect on house prices in the suburbs. They also find that the size of parks and open space has no statistically significant effect on house prices in either the city or the suburbs, when evaluated at the mean distance and size. However, the interaction terms are quite important: the effect of distance differs depending on the size of the park, with prices rising more with proximity to a park, the larger that park.[11]

The Anderson and West study is one of the most thorough studies dealing with the range of theoretical and empirical issues associated with valuing open space through hedonic methods. Their market segmentation model—the separation of city and suburbs along with the incorporation of fixed effects—is an important step forward. The fixed effects help correct for omitted variables problems. In particular, they can correct for spatial auto-correlation and the bias caused by correlation between the omitted variables and the open space variables.[12] Including both distance and size of the open space and the interaction terms is quite helpful in interpreting exactly how open space affects values. Unfortunately, however, the interaction terms make it difficult to separate out the individual effects of size and distance, and some of the results when evaluated at the mean distances and acreages may provide somewhat misleading results about open space values. For example, the mean distance to the nearest lake and the nearest golf course is far enough that because of the interaction term, an additional acre of open space of this type appears to lead to a reduction in the price of a house. On the other hand, for houses located close to these amenities,

[11] The authors find that being closer to a golf course increases suburban house prices but has no effect in the city, and being closer to a lake or river tends to increase house prices in both cities and suburbs.

[12] Spatial autocorrelation is a problem that, if not corrected, causes bias in the standard errors of the estimated coefficients and thus inefficient estimates of those coefficients. It is caused by correlation in the regression residuals across neighboring locations (see Anselin 1988).

it is likely that an additional acre is quite valuable. Another problem is that the authors are unable to include all types of open space in the model. They do not have potentially developable land, whether vacant unused open space or private agricultural or forested lands.

All of the studies above define open space variables by type, size, distance from the house, or combinations of these measures. Acharya and Bennett (2001) present a useful extension by constructing indexes of the spatial diversity and "richness" of open space. The diversity index is greater the more land use categories there are in the area and the more similar their proportions. The richness index is an alternative measure of land use variety that measures the ratio of land use types to the maximum possible number of land use types in the area. Both measures are defined over five broad land use categories ranging from high-density residential and commercial uses to forested lands and agriculture. They run two versions of the model, one with the indexes defined over a 1-mile radius around the property and one with them defined over a ¼-mile radius. They use 1995–1997 data from New Haven County, Connecticut, and in addition to these two indexes, they include as explanatory variables the percentage of open space (of any type) in a 1-mile radius around the house, the percentage squared, and a variable created by interacting their richness index with population density.

They find that an increase in the percentage of open space around a house increases the value of the property but at a decreasing rate (that is, the coefficient on the squared term is negative and significant). Thus, open space (of an unspecified type) seems to have value in this mainly suburban setting. The coefficients on the diversity and richness indexes are negative, however, indicating that property values are higher when land uses are more homogeneous. The coefficient on the interaction variable—population density multiplied by the richness index—is positive, and thus the negative effect of land-use richness is reduced in more densely populated areas. The authors suggest that this means that urban households value diversity in land uses more than those in relatively less dense, or suburban, locations.

The Acharya and Bennett use of diversity measures is interesting, but because all land uses are included in their measures—developed and undeveloped land alike—it is difficult to draw a strong conclusion about what these indexes mean. They could mean that people do not want to live where, for example, high-density residential, low-density residential, and commercial developments are mixed, or they could mean that

people do not want to live where, say, vacant land is mixed with residential land.[13] Without specific types of indexes, it is impossible to say. Nonetheless, these results are somewhat similar to the Anderson and West findings that diversity in uses and open space in general are more valued in urban than in suburban locations. A potentially useful extension may be to create separate indexes for developed and undeveloped lands; for example, an index that measures the diversity of uses across such categories as forests, cropland, pastureland, parks, and wetlands might provide an interesting measure of how variety in open space matters.

Smith et al. (2002) include distance to open space categorized as "fixed" or "adjustable"; in the fixed open space category are golf courses, publicly accessible open space such as parks, and a corridor for a major highway, and in the adjustable category are agricultural, forested, and vacant lands. Unfortunately, because the authors are not confident that they can distinguish agricultural and forested lands for most of their sample—1980–1998 house sales in the Research Triangle area of North Carolina—most of the regressions that they run include only vacant lands in the "adjustable" category. The authors argue that "fixed" open space should positively affect property values, but because "adjustable" open space may be perceived differently by different people, we can not expect it to "clearly signal undeveloped land's contribution to open space amenities" (p. 112). They are highlighting a point made by Irwin and Bockstael (2001), a study that we discuss below in the agricultural lands section.

The authors estimate their model for four separate five-year subperiods. They include distance to nearest vacant land, golf course, public lands, and lands dedicated to the interstate, portions of which were built during the sample period. They also include dummy variables for whether the property is on a golf course, public lands, vacant lands, or the land for the interstate. In general, the results suggest that being on or near a golf course is valuable, but no other open space benefit provides value. In fact, being closer to public open space is detrimental to property values, according to the model's results for all four subperiods. Being closer to the interstate open space corridor is valuable during the 1985–1989 subperiod, detrimental during the 1995–1998 subperiod, and has no statistically significant effect during the other two subperiods.

[13] Stull (1975), in a hedonic price study of the suburban Boston housing market, finds that property values of single-family houses are higher the more homogeneous are surrounding land uses. The greater the proportion of community land devoted to multifamily dwellings, industrial uses, or vacant land and agriculture, the lower the value of single-family dwellings in the community.

Being on (that is, next to) or near vacant land either has no discernible effect or has effects that appear to be at odds with each other.[14]

The authors suggest that their results confirm the problems identified by Irwin and Bockstael (2001): because many land uses are endogenously determined and because people have different expectations for the future use of some types of open space, it is difficult to capture open space benefits. The authors conclude that "the task of developing an index to represent these amenities is more complex than most of the empirical literature has acknowledged" (p. 127). We would add that it is important to break down land uses into more specific categories than the authors have done here. The vacant land use category and the public land use category are probably too broadly defined in this study. Results from several of the studies we reviewed above—in particular, Schultz and King (2001), Lutzenhiser and Netusil (2001), and Anderson and West (2003)—highlight the importance of distinguishing different types of public open space in the hedonic model.

The last study in this category is quite different from the others. Riddel (2001) makes the argument that studies of open space values based on cross-section samples of house sales over only short periods of time are flawed because they fail to account for the important dynamics of the housing market. Several previous studies have also suggested that housing market inefficiencies can lead to lags in the incorporation of amenity effects into prices (Freeman 1993; Smith and Huang 1995); if a housing market is in disequilibrium, a hedonic model estimated on, say, only one year's sales data may yield biased results. In addition, changes in environmental quality can cause changes in related markets, such as the labor market, which in turn lead to second-round effects in the housing market.[15] These effects are not captured in a simple cross-section model. Riddel develops a model that jointly evaluates the effects of trends in environmental quality—open space purchases, in particular—on both the housing and the labor markets. She estimates a model using quarterly data for Boulder, Colorado, from 1981

[14] For example, being located next to vacant land increases a house's price during the 1985–1989 period, while the vacant land distance variable has no statistically significant effect. However, during the 1990–1994 period, being next to vacant land has no statistically significant effect but the distance variable is negative and significant.

[15] If more open space in a community makes that community a more desirable place to live, employers may move to the area hoping to capitalize on cheaper labor, since the nonpecuniary open space benefits can make up for lower wages (Blomquist et al. 1988), leading in turn to population growth and driving up housing prices beyond the initial increase due to the open space.

to 1995, with a housing price index as the dependent variable. Unlike standard hedonic models that include housing and neighborhood attributes as explanatory variables, variables in the Riddel model include employment, average rents, housing stock, wages, vacancy rates, and mortgage rates. The city of Boulder has had an active open space purchase program since the early 1980s; accordingly, the open space variable in the model measures acres of public open space. She finds that indeed there is a lag between open space purchase and the time at which the effect of that purchase is fully capitalized into house prices. She also finds that open space purchases have a positive effect on prices: the 15,000 acres of open space purchased in Boulder between 1981 and 1995 caused prices to rise by 3.75 percent.

Greenbelts

A greenbelt is an area of open space surrounding an urban area and preserved from development. It is used to define the edge of the urban fringe, at least until that time when development "leapfrogs" over the greenbelt. Greenbelts are also referred to as "urban growth boundaries." We identified five hedonic price studies of greenbelts: an early study of Boulder, Colorado, by Correll et al. (1978), three studies of Oregon communities (Knaap 1985; Nelson 1985, 1986), and a more recent study of Seoul, South Korea, by Lee and Linneman (1998).[16]

The Correll et al. study, one of the earliest open space studies, has a sample size. When the model is estimated separately for the three neighborhoods, the sample size ranges from 18 to 36 observations. The authors find that house prices decline with distance from the greenbelt; however, the effect is statistically significant for only one of the three neighborhoods, and that neighborhood was the oldest.

The Knaap and Nelson studies use data on sales of unimproved land, rather than houses. This is an interesting extension of the hedonic price literature, since it may avoid many of the problems associated with unobserved house characteristics in models of house prices. In a more recent study of suburban forest preserves, Thorsnes (2002) uses this same approach. We discuss that study below. Explanatory variables in the Knaap and Nelson studies include zoning and tax rates, as well as socioeconomic

[16] In Oregon, both state and local governments are involved in land use regulation, and every urban area in the state has an urban growth boundary. See Knaap and Nelson (1988) for an interesting discussion of the Oregon situation and a summary of the studies referenced here done individually by the two authors, as well as an earlier study by Beaton et al. (1976), which we were not able to locate.

and demographic information, such as income and race, distance to central business district, and parcel size. The Knaap study finds that properties outside the greenbelt in the Portland metropolitan area are worth significantly less than those inside. Nelson (1986) finds the same effect in Salem, Oregon. These studies provide evidence not on the open space values of greenbelts but rather on the effects on relative property values from the restriction on the supply of buildable land. The Nelson study does provide some evidence on open space values, however, when he estimates rural and urban properties separately and uses variables measuring distance to the greenbelt. In these models, he finds that prices of urban properties within 5,000 feet of the greenbelt rise with proximity to the greenbelt, but rural properties within 17,000 feet of the greenbelt fall with proximity to the greenbelt. The author concludes that urban residents see the greenbelt as an amenity, an effect that gets capitalized into land prices, but farmers nearer the greenbelt incur a negative externality from being closer to urban activities. Both the Knaap and the Nelson studies use data from the late 1970s, and their sample sizes are relatively small as hedonic studies go, ranging from approximately 200 observations in the Nelson studies to 400 in Knaap (1985).

Lee and Linneman have 1,117 observations in the Seoul housing market for the years 1970–1989. Interestingly, they find that although house prices are higher the closer the house is to the greenbelt, all else being equal, the magnitude of the effect has changed over time. From 1970 to 1980, proximity to the greenbelt became more valuable in Seoul, but after 1980, it began to decline. The authors believe that population growth and congestion reduced the value of this congestible public good. Their results lead them to conclude that "a greenbelt policy may be economically efficient at one time but inefficient later as growth continues and the costs of congestion grow" (p. 128).

Wetlands

Wetlands provide a variety of ecosystem services, including water purification and filtration, flood control, and wildlife habitat. In addition, they can be valued for recreation and aesthetic reasons. On the other hand, wetlands can sometimes provide disamenities to nearby residents if there are odors or insects associated with them. Hedonic property value studies of wetlands have focused on wetland size, type, and shape, as well as proximity. Several studies classify wetlands into four types: forested, scrub-shrub, emergent vegetation, and open water. Forested wetlands include wooded swamps and bogs and tend to be located along rivers and streams; they show the least amount of water of the four types. Scrub-shrub wetlands have soil that is usually

waterlogged; they are more open than forested wetlands and have a wide variety of vegetation. Emergent-vegetation wetlands are relatively open; they can be seasonally flooded but can vary from being well drained during most of the year to having up to three feet of water. Open-water wetlands include shallow ponds and reservoirs; they have the most water of the four types.

Findings from hedonic studies of wetlands tend to vary depending on whether the wetlands are in an urban or suburban location versus a rural area. Reynolds and Regalado (1998) and Bin and Polasky (2002, 2003) study rural areas; Doss and Taff (1996) and Mahan et al. (2000) focus on wetlands in urban and suburban locations.

Reynolds and Regalado look at wetlands of different types in rural Florida. They find that forested and emergent palustrine wetlands, which account for 94 percent of the wetlands in their study, have negative effects on property values.[17] Scrub-shrub and shallow pond wetlands, however, appear to have a positive effect. Both of the Bin and Polasky studies use data from a rural, coastal county in eastern North Carolina; the 2002 study uses data from November 1999 to July 2002, and the 2003 study has a slightly smaller sample of house sales from July 2000 to July 2002. In their 2003 study, the authors distinguish between houses on the Outer Banks and those on the mainland. They find that proximity to wetlands has no effect on Outer Banks house prices, but prices of mainland houses tend to increase as distance to the nearest coastal wetland decreases and as distance to the nearest inland wetland increases. In other words, to residents of the mainland, coastal wetlands appear to be amenities, and inland wetlands, disamenities. Wetland size is not found to have a statistically significant effect on housing prices. In their earlier 2002 study, the authors do not separate the Outer Banks from the mainland but still find similar results for the two types of wetlands.

The negative or neutral effect of wetlands in the rural areas in these studies is likely a result of the abundance of wetlands in these areas; they are not a scarce resource. The average distance to the nearest inland wetland in the Bin and Polasky (2003) sample is only 377 feet for properties on the mainland and 1,385 feet for Outer Banks properties.

There is one final methodological point to make about the Bin and Polasky studies. As we pointed out in the introduction to this section, choosing a functional form for hedonic price models is often fraught with problems. Many articles have been

[17] Palustrine wetlands are inland wetlands that lack flowing water and contain ocean-derived salts in relatively low concentrations.

written about the appropriate functional form under different conditions, including when there are omitted variables, and about the merits of the Box-Cox technique (Cropper et al. 1988; Freeman 1993). Bin and Polasky compare results from a parametric model in which house price is regressed on the natural log of distance to the nearest wetland with a semiparametric technique that imposes far less structure on the hedonic price functional form. It is somewhat reassuring that results are quite consistent across the two different approaches, suggesting that the semilog model used in many studies is a reasonably good approach.

Doss and Taff (1996) use data from Ramsey County, Minnesota (suburban St. Paul), to estimate how distance to four types of wetlands affect property values. They find that values decrease as the distance to forested wetlands decreases but values rise as distance to the other types of wetlands decreases. Thus, it appears that open water, emergent vegetation, and scrub-shrub wetlands provide value in suburban areas, but not forested wetlands.

Mahan et al. (2000), in a study of the Portland, Oregon, housing market, distinguish wetlands by the same four types as Doss and Taff but also by whether the wetland is "linear" or "areal." Linear wetlands are relatively long and narrow, often along a streambed, whereas areal wetlands are polygon-shaped. Mahan et al. estimate two forms of their model. The first specification includes the size of the nearest wetland (of any type), the natural log of distance to the nearest wetland (of any type), and dummy variables indicating the type and shape of the nearest wetland. Although wetland size and distance are both strongly significant in explaining house prices —the larger and closer the wetland, the higher the house price—none of the dummy variables are significant. This indicates that the type of wetland does not matter to nearby residents.

In the second model, the authors continue to include size of the nearest wetland (of any type), but instead of a single distance variable and seven dummy variables, they include the natural log of distance to the nearest wetland of each type or shape. This specification yields mixed results: proximity to some types of wetlands appears to positively influence price, but proximity to others has no effect or even a negative effect. Specifically, open-water areal wetlands and scrub-shrub linear wetlands appear to be amenities; open-water linear wetlands, emergent-vegetation linear wetlands, and scrub-shrub areal wetlands appear to be disamenities, and the rest have no effect. The authors say that they put more faith in results from the first model because a given house may be close to one type of wetland but quite distant from another type. It is difficult to say,

based on their second model's results, whether the amenity (or disamenity) is due to proximity or type. Their findings highlight the difficulty in any of these hedonic price models of identifying exactly which land use characteristics to include and how to interpret the statistical results vis-à-vis those characteristics.

Forest preserves

Of the five studies included in this section, four are from Europe and only one is from the United States. Garrod and Willis (1992a) evaluate the benefits of what they call "countryside characteristics" in rural areas of England. Their variables of interest are whether a property has a woodland view and whether more than 20 percent of land surrounding the property is in woodland; they also include a dummy variable for the presence of a wetland in the area. In a related study (Garrod and Willis 1992b), the same authors look at three types of forestry in 1-kilometer areas around houses. Tyrväinen (1997) and Tyrväinen and Miettinen (2000) examine the effects of distance to forested areas and the percentage of land that is forested in two areas of Finland. Finally, the lone U.S. study is by Thorsnes (2002), who examines the effect of a suburban forest preserve on building lot prices.

Garrod and Willis (1992a) find that house prices are higher when more than 20 percent of the land surrounding the house (in a 1-kilometer square) is in woodland. However, having a woodland view tends to reduce house prices. The authors offer no explanation for these differing results. In Garrod and Willis (1992b), the same authors look at the percentage of forested lands of three types in a 1-kilometer square grid around the house: (1) all broadleaved trees; (2) larch, Scots pine, and Corsican pine planted before 1920; and (3) all other conifers planted before 1940. They find that the greater the percentage of land covered in broadleaved trees, the higher the house price, but the greater the percentage in conifers planted before 1940, the lower the house price. The second category (larch, Scots pine, and Corsican pine) appears to have no effect.

Tyrväinen (1997) and Tyrväinen and Miettinen (2000) use data from different areas of Finland in the mid-1980s to analyze how distance to the nearest forest preserve, forested recreation area, and water recreation area, as well as the presence of a forest view and the percentage of forested land in the housing district, affect house prices. According to the authors, forested recreation areas tend to have maintained trails and paths for jogging and skiing, as well as lights and benches. Forest preserves, on the other hand, are smaller and are sometimes just strips of lands used for screening between residences.

Tyrväinen and Miettinen (2000) exclude variables that were statistically insignificant; thus, only the distance to the nearest forest preserve and whether the house has a forest view are included as open space explanatory variables. Results show that having a forest view increases a house's price, all else being equal, and the greater the distance to a forest preserve, the lower the price. Although the explanatory power of the model is relatively high, the authors include very few explanatory variables; the only structural features of the house in the model are floor area, age of the structure, and whether the house is made of brick. This may lead to serious omitted variables bias in the results.

The earlier study by Tyrväinen (1997) appears to be a bit richer in detail. Moreover, the author includes more open space variables—distance to nearest forested recreation area, distance to nearest water recreation area, distance to the nearest beach, and as in Tyrväinen and Miettinen, distance to a forest preserve and percentage of the housing district that is forested (no view variable is included). Interestingly, although being closer to a recreation area tends to increase a house's price, being closer to a forest preserve reduces price, all else equal. Likewise, although being closer to a water recreation area increases price, being closer to a beach tends to decrease price.

As in Tyrväinen and Miettinen, the greater the percentage of land in the housing district that is forested, the greater the house price. The author's explanation for why proximity to a forest preserve has a negative effect on prices centers on the fact that 78 percent of the houses in the study were within 100 meters of a forest preserve, and many houses had mature conifers right next to them. In Finland, because of the long winters, light can be extremely valuable, and the shade provided by these trees could be causing the decreased house values. The results may also suggest that the use values provided by the forest recreation areas are higher than the nonuse open space values provided by the forest preserves.

Thorsnes (2002) uses data from three subdivisions in Grand Rapids, Michigan, each bordering permanently preserved forested lands, to look at the effect that the preserved forests have on building lot prices. The author compares the results with results from a model of house prices. His data are from the late 1970s to 2000, and he estimates separate models for each subdivision. He finds that lots bordering the preserves sell at a premium equal to 19 percent to 35 percent of the total lot prices. However, the benefits of the preserve—at least as they are capitalized into neighborhood property values—appear very localized. Prices of lots across from the preserve are, for the most part, no different from those of other lots in the subdivisions.

In his study, Thorsnes is also able to make some interesting observations about the effects of private lot sizes and private open space vis-à-vis public open space in these subdivisions. Lot size has no statistically significant effect on lot prices in two of the subdivisions and a negative effect on lot prices in the other subdivision. This is an interesting result, since this variable tends to show up as significant and positive in many hedonic models of house prices. Thorsnes concludes that the open space in the forest preserves is substituting, to some extent, for larger lots. He does find, however, that in one subdivision, lots that have low, forested areas with a creek running through them sell for a premium even greater than the premium of lots next to the preserve. These lots do not abut the forest preserve itself but have essentially private forest preserve in their backyards.

Thorsnes also includes a dummy variable for whether the lot backs to a large vacant lot—land that is open space but not off-limits for development. In one of the subdivisions, these lots sell for a price premium, though far less of a premium than that from the forest preserve. In the other two subdivisions, there is no statistically significant effect of the vacant lot on lot prices. These results might say something about the difference between developable versus undevelopable open space, but without knowing more about the actual characteristics of the land, it is difficult to say.

For the most part, the forest preserve and open space variables have the same directional effects on house prices in the Thorsnes study as they have on lot prices, but the magnitude of the effect is different. In two of the subdivisions, the point estimates of the premiums on adjacency to the preserve are more than double those from the lot regression. All of the standard errors are larger. Thorsnes concludes that unobserved heterogeneity in house characteristics probably biases the results from the house sales model.

This kind of omitted variable bias has long been a concern in hedonic price models; the Thorsnes study provides a very interesting empirical examination of this issue. We feel that the author's use of building lot sales data to examine the values of open space, as in the Knaap and Nelson studies reviewed above, is a useful addition to the hedonic price literature. A wider set of studies of this type, applied to other types of open space and in other geographical regions, would be quite useful. In addition, a beneficial extension would include subdivisions with and without forest preserves, rather than just subdivisions located next to preserves, as in the Thorsnes study.

Agricultural lands

As we stated in the introduction to this paper, a number of states, as well as the federal government, are devoting financial resources toward preserving farmland. Farmland is different from many other kinds of open space because private ownership is retained and a (presumably) profit-maximizing business operates on the land. However, if farmland provides an external benefit to nearby residents in the form of aesthetic benefits from the view the land creates or benefits simply from reduced growth and congestion in the area, then spending these resources may be worthwhile. We review here five hedonic price studies that focus on agricultural lands; four of the five distinguish land under conservation easement from potentially developable farmland.

Le Goffe (2000) looks at how weekly rental prices for tourist cottages in rural Brittany in western France are affected by the amount of surrounding land in forest, permanent grassland, and cereal and fodder crops, as well as the livestock density in the area. He finds that the higher the percentage of grassland, the higher the rental prices, but the higher the percentage of forest or other crops, the lower the rental prices. Livestock density also has a negative effect on prices. This study is interesting because unlike most hedonic price models that provide a measure of the direct benefits of open space to local residents, the results here provide an estimate of the value of agricultural open space to nonresidents, those mostly urban tourists who rent the cottages during the summer holiday season.

The remaining four studies all use data from Maryland counties on the urban fringe—areas where agriculture is important but a significant amount of farmland is being converted to residential and commercial uses. All four studies—Irwin and Bockstael (2001), Irwin (2002), Geoghegan (2002), and Geoghegan et al. (2003)—distinguish potentially developable agricultural lands from those under a conservation easement. These studies are the first to differentiate between privately owned open space that is potentially developable, privately owned open space that cannot be developed, and publicly owned and accessible open space.

Irwin and Bockstael (2001) emphasize a methodological point that we mentioned above in our discussion of the Smith et al. (2002) paper. They argue that there are two econometric identification problems that often arise in hedonic studies of open space values, particularly those looking at open space that is privately owned and potentially developable. One is that the measures of open space included as explanatory variables

are often endogenous—whether a neighboring parcel is in a particular use (open space or developed), or is a function of the value of the parcel under study (and vice versa). This means that the open space variables are correlated with the error term in the regression and the resulting coefficient estimates are biased. The second, related problem occurs if there are unobserved variables affecting house prices that are spatially correlated. If there are, they will cause the error term to be correlated with the open space variables and, again, lead to biased coefficients. Irwin and Bockstael correct for the first of these problems by using an instrumental variables procedure, with soil characteristics instrumenting for their open space variables.

Irwin and Bockstael's sample is nearly 56,000 houses sold in four Maryland counties between January 1995 and December 1999. Their open space variables are (1) the percentage of surrounding land in private, developable open space, (2) the percentage of surrounding land in public open space, and (3) the percentage of surrounding land in private open space under conservation easement. They do not distinguish between land uses; for example, private land in forestry, cropland, pasture, and so forth are all grouped together.

All of their open space variables are found to positively affect housing prices, with the largest effect from private, conservation easement lands, followed by private, developable lands, and then public lands. They find that their instrumental variables procedure improves the results over a simpler model that does not account for the omitted variables and endogeneity problems. The public open space and conservation easement open space variables have about the same effect on house prices in the simple procedure as in the instrumental variables procedure, but the coefficient on the private, developable open space variable changes sign and has a negative effect on house values.

Irwin's (2002) study follows on the Irwin and Bockstael study, using the same sample of four Maryland counties, but disaggregating the land uses into the following categories: (1) private cropland, (2) private pasture, (3) private forests, (4) private land (of any type) in easement status, (5) nonmilitary public open space, and (6) military open space.[18] The open space variables are defined as the percentage of land in a 400-meter buffer surrounding the house that is in each of these uses; remaining land uses—

[18] The counties are Calvert and Charles in southern Maryland, Anne Arundel County which contains the city of Annapolis, and Howard County, a rapidly growing county north of Washington.

low-, medium-, and high-density residential uses, commercial/industrial uses, and a catchall "other" category—are also included. Instrumental variables are included to account for the endogeneity of the open space variables, as in the Irwin and Bockstael (2001) paper, and in addition this paper attempts to account for the spatial correlation of the error terms. For the latter, Irwin estimates the model with only a randomly drawn subset of the housing data that does not include nearest neighbors to each house. Since nearest neighbors are believed to be spatially similar, dropping them from the sample should reduce the likelihood of correlated errors. Alternative definitions of nearest neighbors are examined in a sensitivity analysis. The study finds that house prices increase with increases in the proportion of surrounding land that is in easement status or in public, nonmilitary open space. However, house prices decrease with increases in the percentage of land in forestry, and the cropland variable is statistically insignificant.[19] Increases in the percentage of surrounding land in any of the residential or commercial/industrial categories decreases house prices, all else equal. Some of the numerical results are summarized in Table 1, below. Most of the open space land use results are robust to the definition of the nearest neighbors.

Geoghegan (2002) uses a smaller dataset than the Irwin and Bockstael and Irwin studies, 5,600 house sales in Howard County, Maryland, between September 1993 and June 1996. She includes the percentage of surrounding land in a 1,600-meter buffer that is in private, developable open space—cropland, pasture, and forests—and the percentage in preserved open space—farmland and forested lands in easement status as well as public lands such as parks.[20] Both open space measures are found to positively affect house prices, but the permanent open space variable has a larger effect. Geoghegan does not employ an instrumental variables or other procedure to control for endogeneity of her land use variables.

Geoghegan et al. (2003) provide the most recent analysis of Maryland properties. They estimate separate models for Calvert, Howard, and Carroll counties in Maryland, and their data include house sales from July 1993 to June 1996. As in the earlier studies, they use an open space measure that is the percentage of surrounding land in each use;

[19] Because the percentages have to sum to 100, the percentage of surrounding land that is pastureland is left out of the model. Thus, the insignificant coefficient on the cropland variable implies that the effects of surrounding cropland on house prices are no different from the effects of surrounding pastureland.

[20] Geoghegan says that the 1,600-meter buffer was chosen because it was the distance for a 20-minute walk from the center of the property; she did not do any sensitivity analyses with different buffer sizes.

the uses are preserved open space and developable open space (agricultural and forested lands), as in the Geoghegan study. Two buffers are included in each regression: a 100-meter buffer around the property and a 1,600-meter buffer. The 100-meter buffer is an attempt to capture a view of open space from the property, and the 1,600-meter buffer, as in the earlier Geoghegan study, is included to capture open space within walking distance. The results are quite mixed and vary substantially across the three counties. In Carroll County, all of the open space variables are either statistically insignificant or decrease property values. In Calvert County, preserved open space in a 1,600-meter buffer around the property increases property values, but all other open space variables decrease them. In Howard County, preserved open space in both a 1,600-meter and 100-meter buffer increases property values, and developable open space in a 1,600-meter buffer reduces property values and developable open space in a 100-meter buffer has no statistically significant effect.

The Geoghegan et al. findings suggest that the value of open space results is highly location dependent. Of the three counties they analyze, Carroll County is subject to the least development pressure and Howard County the most. This could explain the finding that open space seems to have more value in Howard County. The Calvert County results are difficult to interpret, however. This county is also feeling development pressures; although it has a smaller population than Howard, it has had the highest population growth rate of all Maryland counties in the past decade and has an active farmland preservation program (see McConnell et al. 2003). The results also call into question the earlier studies of the Maryland housing market that aggregate house sales across several counties into one dataset. Furthermore, the issue of how to define the open space buffer around the property is obviously open for discussion, given the quite different results across the different studies. One point about the buffer that the studies do not make clear is how the private lot itself is handled in the calculation of these percentages. In these suburban and exurban counties, lot sizes of two, five, and even ten acres are quite common; a 100-meter buffer would thus include a substantial portion of private property. Geoghegan et al. mention this issue, but none of the authors say exactly how it is handled in their models.

C. Summarizing Results across the Studies

The studies surveyed in this section cover a wide range of types of open space and a variety of ways of measuring that open space. Moreover, the studies are from different geographic areas of the United States, as well as from other countries. All of

these differences provide a rich source of information on open space but make any summary analysis of actual dollar values exceedingly difficult. Nonetheless, we feel it is worthwhile to make some attempt to do this. We include in Table 1, below, only U.S. studies published in the 1990s or 2000s, only those studies that we feel have a large enough sample size, and only studies focused on urban and suburban open space. We do not include values of golf courses, since these are not natural open space and are often private operations. We also omit values from lakes, streams, and rivers, although several of the studies include such values. In general, proximity to golf courses and lakes is highly valuable. Also, we leave out the studies of rural wetlands. Finally, in cases where authors have published more than one study using virtually the same dataset, we include in the table only the study that we consider to be the best, usually the most recent one.

The benefits of open space estimated in these studies vary widely. In some cases, the marginal implicit prices are even negative, meaning proximity to some types of open space actually reduces house values, and in other cases, they are not significantly different from zero. In an attempt to make comparisons somewhat easier, we report each value as a percentage of the mean house price in the study (or building lot prices, in the case of the Thorsnes study). These numbers are shown in parentheses under the dollar values.

As a percentage of mean house prices, open space values in terms of distance—the marginal implicit price of being located 200 meters closer to a given open space area—range from negative to 2.8 percent of the average house price. The Shultz and King study does not report mean house prices, but the data are from Tucson, Arizona, in the mid-1990s, when the median price was around $115,000. Thus, the two types of open space that are estimated to provide positive values, large natural areas and Class II wildlife habitats, are valued at approximately 0.07 percent to 0.4 percent of median house values. The percentages obtained from the models that use dummy variables rather than continuous distance or percentage of surrounding land variables tend to be higher; being near open space raises average house prices by as much as 16.8 percent in one study. This is to be expected, since the margin at which the value is being estimated is greater, in a manner of speaking: the values measure the benefit of being located close to, or next to, open space rather than a specific distance from open space.

Increasing the percentage of surrounding land that is open space—the last three studies in the table—tends to increase average house prices by less than 1 percent; in the Geoghegan et al. study, these values are sometimes zero or negative. The Irwin and

Geoghegan et al. studies highlight the significance of permanently preserving open space from development. As noted in footnotes to the table, one cannot directly compare the Irwin and Geoghegan et al. values shown in the table. However, both studies find additional value from lands under conservation easement. Interestingly, though, the Geoghegan et al. findings vary widely across the housing submarkets used in that study. These results suggest that there could be problems aggregating across counties, regions, and areas.

Finally, we can compare these results to one recent estimate from a structural equilibrium model of the land market in an urban area. Walsh (2003) develops such a model and calibrates it to data from Wake County, North Carolina, home of the state capital and a fast-growing urban area. Walsh calculates that the average household, currently living one-half mile from open space, would be willing to pay a one-time amount of $4,104 (in 1992 dollars) to reduce its distance from open space by one-quarter mile. This estimate is consistent with the range of results from the hedonic results shown at the top of Table 1 on page 31. [21]

4. Stated Preference Methods for Open Space Valuation

The second type of study addressed in detail in this paper is the stated preference approach, which attempts to induce individuals to reveal their preferences through their behavior in hypothetical markets. Stated preference methods include such approaches as contingent valuation (CV) and, more recently, contingent choice models. The CV method uses surveys to elicit the value individuals or households place on a resource such as open space. The surveys ask respondents directly about their willingness to pay (WTP) for a carefully defined public good or service. Individual responses can be assessed to characterize respondents' preferences and value for the good in question and can be aggregated to obtain the total value of the good or resource to the community.

One advantage of the CV method is that it can, in principle, provide estimates of the full value people have for open space, including use values derived from such benefits as recreation or a pleasant view as well as nonuse values that one might have

[21] This is the first-round, partial equilibrium effect captured in the housing market and thus is comparable to the numbers in Table 1. However, in the simulation, Walsh's general equilibrium model accounts for spillover effects of land policies in one zone to another, as well as the general equilibrium effects on benefit estimates from the migration caused by land policies. These effects tend to reduce the magnitude of the first-round benefit estimate.

from just knowing that open space exists. Contingent choice models are based on a somewhat different approach. They, too, employ surveys to elicit preferences, but they offer respondents choices among alternative options and, from the responses, characterize preferences or estimate values.

The CV method has been frequently used to obtain estimates of value from a range of resources, including a number of studies related to open space and land preservation. It has been used, for example, to value the benefits from urban greenways and other urban parks, urban forest amenities, wetlands, farmland, and large regional forests, all of which we discuss below. The use of the contingent choice method is relatively new in valuing open space. The handful of studies that have used this technique to date are also described below. First, we review some of the most important aspects of survey design and implementation and the difficulties in interpretation of these stated preference approaches.

A. Overview of Stated Preference Methods

The CV approach has been widely used to value nonmarket benefits of many resources and is increasingly accepted as a valuation method. This is in part because it has come under intense review and criticism from both outside the economics profession (Kahneman and Knetsch 1992), and from within it (Hausman 1993; Arrow et al. 1993). As a result, CV has been extensively studied, the resulting values have been compared with other approaches to valuation, and much has been learned about how to design these studies.[22] Careful description and explanation of the good being valued are critical to ensure that respondents clearly understand what they are valuing (Smith 1992). The description must convey exactly how much of a resource is being valued (quantity), its characteristics (some measure of quality), and the context of where it stands with respect to other similar assets. Most studies make extensive use of focus groups to identify information problems and refine the survey instrument.

The issue of context is particularly important for avoiding what is referred to as the embedding problem (Kahneman and Knetsch 1992; Smith 1996). In CV studies, survey respondents may not be valuing the specific good in question but reflecting some general value of a larger set of environmental resources. People who are asked about preserving a particular farm or farm area may give a response that reflects their

[22] See Mitchell and Carson (1993) for an early discussion of CV methods, and Bateman et al. (2002) for an overview of more recent developments.

Table 1. Estimated Values of Open Space Proximity from Selected Hedonic Price Studies

	Marginal value in $ (as percentage of mean house price)
Models with Dummy Variables [a]	
Lutzenhiser and Netusil (2000)	
Living within 1,500 feet of natural areas	$10,648 (16.1%)
Living within 1,500 feet of specialty parks/facilities	$5,657 (8.5%)
Living within 1,500 feet of urban parks	$1,214 (1.8%)
Thorsnes (2002)	
Backing to forest preserve	$5,800–$8,400 (19%–35% of **lot** price; 2.9%–6.8% of **house** price)
Models Using Distance **Living 200 meters (approx. 1 city block) closer to each type of open space**	
Anderson and West (2003) [b]	
Developed park	$458 - city; $0 - suburbs (0.44% - city)
Special park (state/regional park, natural area, wildlife refuge)	$600 - city; $0 - suburbs (0.58% - city)
Shultz and King (2001) [c]	
Large resource (natural) areas	$ 81
Class II wildlife habitat	$429
Undeveloped park	–$206
Regional/district park	–$ 98
Neighborhood park	–$568
Class I wildlife habitat	–$130
Doss and Taff (1996) [d]	
Forested wetland	–$ 960 (–0.91%)
Emergent-vegetation wetland	$2,720 (2.6%)
Open-water wetland	$1,980 (1.9%)
Scrub-shrub wetland	$2,900 (2.8%)

Table 1. Estimated Values of Open Space Proximity from Selected Hedonic Price Studies—Continued

Mahan et al. (2000) [e]	
Wetland of any type	$286
	(0.23%)
Smith et al. (2002) [f]	
Public open space	–$553
	(–0.33%)
Models using % of surrounding land	
Irwin (2002)	
Conversion of 1 acre of developable pastureland to: [g]	
Conservation land	$3,307
	(1.87%)
Public (nonmilitary) land	$994
	(0.57%)
Forestland	–$1,424
	(–0.82%)
Low-density residential land	–$1,530
	(–0.89%)
Acharya and Bennett (2001)	
1% increase in open space surrounding house:	
In 1,600-m (1-mile) buffer	$75
	(0.06%)
Geoghegan et al. (2003) [h]	
1% increase in open space surrounding house:	
Private ag/forestland in easement status and public parks in 1,600-m buffer	$0 to $1,306 (0% to 0.71%)
Private ag/forestland in easement status and public parks in 100-m buffer	$0 to $1,106 (0% to 0.05%)
Private ag/forestland (developable) in 1,600-m buffer	–$599 to (–$312) (–0.39% to –0.21%)
Private ag/forestland (developable) in 100-m buffer	–$768 to $0 (–0.05% to 0%)

Notes for Table 1

[a] The reported results for Lutzenhiser and Netusil are from the version of their model that has dummy variables for each open space type and acreage and acreage squared for each type; values in the table are for mean acreage and are 1990 dollars. Ranges for Thorsnes are for the three subdivisions in the study; lots were sold over a range of years and it is unclear from the study whether the house prices were deflated to same year. Values as a percentage of house price for the Thorsnes study are obtained by dividing estimated values from the building lot regression by mean house prices for the three subdivisions (the hedonic price study of house sales was not used here).
[b] Anderson and West include open space acreage and distance interacted with each other for each type of open space. The reported values for distance are evaluated at mean acreage; at mean distance, the estimated values for acreage were insignificant and are not reported here.
[c] Shultz and King do not report mean house prices; thus we are unable to report the values in percentage terms.
[d] Doss and Taff have a quadratic model in distance; values are calculated at mean distance for each type of wetland. Mahan et al. values are calculated at a distance of 1 mile and at mean house price. These authors also estimate the marginal value of increasing the nearest wetland size by 1 acre to be approximately $24 (evaluated at the mean house price).
[e] The mean house price for the 1995–98 years is used to calculate marginal value in terms of percentage of mean house price for the Smith et al. study.
[f] Irwin uses percentage of surrounding land in various categories as independent variables in the model (with the percentages summing to 100) and uses her results to calculate the dollar values we present here in the table—the dollar value of *converting* 1 acre of developable pastureland to each of the other categories.
[g] Values for both Irwin and Geoghegan et al. are evaluated at mean house prices. In Geoghegan et al., three counties are estimated with separate models, and thus a range of results is reported. Although both their focus and their methodology are similar, Geoghegan et al.'s results cannot be directly compared with Irwin. Dollar values in this table for the Irwin study are for *conversion* of an acre of land from developable farmland to the other categories listed (see previous footnote), whereas Geoghegan et al. dollar values are for a 1 percent increase in each category of open space, all else being equal.

value for farmland preservation as a whole, or even to just explain the "warm glow" of having given to a land preservation cause.

One study, by Lockwood et al. (1993), attempts to deal with the problems that arise from embedding by providing detailed information about the context of the resource being valued in the questionnaire. This study examines the value of preserving additional parts of a section of old-growth forest in Australia. The survey instrument made it clear that the forest area in question was part of a much larger section of old-growth forest, which, in turn, was part of a larger region of national parks. By comparing with a control group, the authors find that the extent of embedding is reduced when this extensive explanation of context was included. In general, problems of incomplete information are diminished if surveys are conducted using in-person, in-

depth interviews (Mitchell and Carson 1993).[23] To conduct surveys this way, however, is expensive. Most of the studies described here on open space valuation use phone or mail surveys.

Perhaps the most consistent and serious problem that has been found in evaluation of CV studies is that hypothetical questions posed on surveys are likely to result in overestimates of value. Some studies, such as the Lindsey and Knaap (1999) analysis of urban greenways described below, have been able to compare the values people give to hypothetical questions about their willingness to pay for a good, with the actual payments they make when the money is collected. They and others[24] find that the mean of the WTP responses to hypothetical questions is often higher than the mean of the actual WTP results. In particular, in studies involving nonuse values, responses elicited by CV surveys appear to be higher than actual values, when a comparison to actual payments is feasible. Comparisons involving hypothetical and actual values for use values for different resources appear to be much more similar (Portney 1994). Some of these differences may be due to the way the CV question is asked. Payment questions that are realistic or that seem "consequential" to the respondent are likely to result in the most accurate estimates of value as we describe below (Carson et al. 2000).

Much research has gone into exploring ways to design surveys that will mitigate the problem of hypothetical bias. Cummings and Taylor (1999) developed an elicitation method for requesting donations to environmental organizations that describes the problem of hypothetical bias in some detail to respondents, in an attempt to make them understand the problem before they respond to the survey. They find that including explanations of such "cheap talk" in surveys reduces the problem of overstating values. Loomis et al. (1996) also find that clearer explanations in the survey of what WTP means reduce the extent to which stated preferences exceed actual payments. Another approach is to make questions sound as though they are not hypothetical, by stating that respondents will have to pay increased taxes or make other required payments.

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[23] We note that the Hanley et al. (1998) study, described below, for farmland preservation in Scotland is able to compare results of mail and in-person survey methods, and for a number of groups, finds no statistically significant outcome in valuation between the two.

[24] Another study that is able to compare the responses of nonbinding surveys with actual election results is that done with data on referendum voting on open space in Corvallis, Oregon (see Vossler et al. 2003). The similarity of actual and stated WTP depends critically on how the undecided survey votes are counted.

However, tax payments as vehicles for payment are a problem, especially in U.S. studies, because they tend to generate protest votes.[25]

Another important issue in CV analysis that is also related to the hypothetical nature of CV questions has to do with the way the valuation question is asked. Studies can ask the respondents to value the resource in an open-ended question. For example, how much would you pay for the preservation of a certain resource? A variant of this is the payment card approach, where respondents are given a large range of values and asked to choose which best reflects their WTP. It has been shown in some cases that the range of values presented can influence the outcome (Mitchell and Carson 1993). The ideal payment method is one that is most likely to induce respondents to truthfully reveal their preferences.

A single, take-it-leave-it question is most similar to what people face in a normal market setting, and it appears to give respondents the best incentive to tell the truth (Arrow et al. 1993). Respondents are asked, in a yes/no format, "If the cost of preserving the resource is $X, would you be willing to pay that amount?" A different payment amount can be presented to groups of randomly drawn individuals, and a valuation function can be derived from the results. Yet another approach is the double-bounded format, in which a yes response to the first question results in a yes–no question for a higher amount, continuing until the respondent replies no. The dichotomous choice methods result not in a point estimate but in a range of values for each respondent's WTP (e.g., between $X1 and $X2). Although the approach has some advantages, it has recently been shown to result in larger estimates of WTP than simple open-ended questions (Hanley et al. 1998; Hammitt et al. 2001).[26]

A critical issue in the design and assessment of CV studies is how to deal with respondents who say their value for the resource in question is $0. Some such responses

[25] If respondents do not think they should have to pay for the provision of a public good, especially in the form of higher taxes, they may give a different WTP (even $0) than their true WTP (see Cummings et al. 1995).

[26] A recent study by Cameron et al. (2002) compares seven elicitation methods, varying across payment mechanisms: six were stated preference and one was revealed preference. Among the stated preference methods, they find that the responses to four appear to imply the same underlying preference functions. Only the mechanisms that ask directly for WTP—the open-ended format and the payment card method—appear to produce different results. The authors conclude that direct questions about WTP may induce respondents to think about the issue differently than more indirect questions to ascertain values. Brown et al. (1996) compares elicitation questions with actual behavior about donation for public lands.

are likely to accurately reflect an actual $0 value, but others may be the result of either strategic behavior (free riding, for example), protest bids (if the respondent thinks the good should be provided without his or her contribution), or rejection of the idea of valuation. In these latter cases, the zero bid does not reflect a true $0 value for the resource. Carefully designed questionnaires or in-depth personal interviews that explore the reasons for $0 bids are necessary.

Finally, several issues arise in inferring the value of the resource from the CV responses. One of the most important is how to aggregate across individuals to obtain a total value. There are questions about who should be included in aggregate value estimates, what values should be attributed to residents at different locations and with different characteristics, and how should uncertainty be dealt with? The way these issues are handled produces very different results for total value.

There have been some recent developments in the use of stated preference methods for estimating the benefits of various amenities. They can be generally referred to as choice experiments. Respondents are asked to choose between alternative bundles that differ in the types and levels of attributes; often price is one of the attributes. By presenting several choices and varying attribute levels, researchers can determine the implied ranking of the attributes, which attributes have the greatest effect on marginal WTP, and the value or preference for joint attributes.[27]

These studies offer an interesting and relatively new way to approach estimation of the preferences and valuation of open space amenities. They offer advantages over standard CV studies in that they allow for the estimation of value of individual characteristics of open space that may be more easily transferred to value open space in other regions, and they can be designed to avoid embedding problems, since specific amounts of different characteristics are being valued. We discuss several such studies in the next section.

In summary, designing stated preference studies to produce credible results is complex. Results may depend on the method of elicitation, the information made available to the respondent, and other aspects of the survey design. However, CV and choice-based analyses can provide very useful and even essential information about preferences and values for policy decisions over open space. For one thing, it is the only

[27] We note that one of the choice approaches, conjoint analysis, has been shown to result in WTP values that are somewhat higher than those for conventional CV studies (see Stevens et al. 1997).

way to elicit nonuse values. For another, it is usually the only way to uncover details about the values that people hold. For example, hedonic studies may reveal that a property has higher value because it is next to open space, but surveys may be able to make sense of how different attributes of the open space contribute to that value. Below, we discuss the design and results of the many different studies, which vary by type of open space, survey method, the particular values being addressed, and the circumstances and location of the site. This makes it difficult to generalize, although we will attempt to summarize broad findings at the end of each section.

B. Contingent Valuation and Choice Analysis Studies of the Value of Open Space

We reviewed more than 20 studies of different types of open space, including general open space in urban areas, agricultural lands, and wetlands. Most of these are contingent valuation studies, but there are several choice analysis studies as well. We focus primarily on studies in the United States and Canada, but we also include several applications from Europe that provide some useful insight. We separate the review in this section into a somewhat broader set of categories than we did for the hedonic studies: general open space in urban areas (including parks, urban recreation areas, and greenbelts); farmlands; and wetlands.

General open space in urban areas

There are a relatively small number of studies using CV techniques that attempt to measure some aspect of the value of open spaces in urban areas. The extant studies assess the values of preserving indefinitely an undeveloped parcel of land in a neighborhood, the value of forested urban recreation areas, and the value of maintaining a greenway along an urban creek. Some studies combine revealed preference techniques (hedonic pricing methods) with stated preference methods (both contingent pricing and contingent choice) for assessing the value of living adjacent to open space in an urban area. We discuss those combined approaches in section C, below.

Breffle et al. (1998) use CV analysis to estimate the value of a 5.5-acre parcel of undeveloped land in Boulder, Colorado. The preserved parcel has the potential to provide residents with both use values, such as pleasant views of the site and access to a neighboring mountain for recreational purposes, and nonuse use values, such as knowing that habitat is being protected. The study was limited to the roughly 1,561

residents who live within one mile of the site. The survey was administered in person to a random sample of these households; 72 households were actually interviewed, which represented a 63 percent response rate in two attempted visits.

The study design avoids many of the problems of CV analysis. For example, providing context about the park relative to others in the urban area avoids embedding issues. The main WTP question—"How much would you be willing to pay to keep this land undeveloped forever?" (one-time payment)—is not tied to potential tax payments because of concern that respondents might act strategically to avoid paying for the purchase of the land. The 72 sampled households' median estimated WTP to preserve the parcel is $234. WTP is found to be increasing in income and decreasing in distance. The authors use an estimated equation that includes income and distance to extrapolate WTP to the whole neighborhood within 1 mile of property, and they calculate a total value of $774,000. They find this amount to be greater than the cost of the land ($600,000) with probability of 92 percent. In this study, there is no problem of nonrespondents, since all households that were contacted willingly participated.

The study by Peiser and Schwann (1993), discussed above in the section on the use of the hedonic method, also has a survey component. This study analyzes neighborhood open space by looking at the value of public greenbelts in a private urban subdivision. All 200 residents of the Dallas subdivision were mailed a survey that asked about household demographics, house characteristics, and open space values. The first part of the open space valuation question related to how much more the respondents value their house because of the presence of the greenways in the subdivision. Then the household was asked (a) if you are located next to the greenway, would you want to fence off part of this public greenway if you could, to make it part of your own private space? (only 22 percent said yes to this); or (b) if you are not on the greenway, would you want to live on the greenway even though you would have less private backyard space? (50 percent said yes). In general, the survey responses were very positive about the presence and the value of the greenways for the subdivision.

As described above, the hedonic estimation does not support this result—households were willing to pay very little in terms of a higher house price to live on the greenbelt. It is not clear however, whether this reflects market value for public versus private open space or something about the way the developer priced the different lots. Or, this result could be just a function of greenway design in this subdivision. Hence, it is difficult to generalize these results.

Another interesting paper on urban greenways is by Lindsey and Knaap (1999). This study assesses the value of maintaining one part of a large series of connected corridors and open spaces in Indianapolis. The site under study is the Crooked Creek Greenway, a 20-square-mile watershed of a fairly degraded urban stream in the middle of the city. The property around this greenway is privately held for the most part, but around schools and parks there is access to forested and undeveloped areas along the creek. The study uses a CV approach to assess household WTP to an existing nonprofit foundation that organizes occasional cleanups, educational projects, and other voluntary management efforts in the Crooked Creek Greenway. It is notable that respondents were not asked to contribute directly to purchase of the greenway lands or for specific levels of cleanup of the region. What is being purchased is a contribution to the foundation for its work over a two-year period. A relatively large number of respondents (roughly 20 percent) indicated $0 because they needed more information before they would be willing to contribute. This casts some doubt on the results of this study, but there are some interesting features of the approach that are worth discussing.

Surveys were mailed to three groups of households: property owners living in the Crooked Creek Greenway, renters in the greenway, and a sample of all residents living in the county. A unique feature of this study is that about half the questionnaires sent to each group included a hypothetical question about WTP for the foundation efforts, and half included a solicitation for actual donations to the foundation. The questionnaires were similar in all respects except for this difference in hypothetical versus actual WTP. The response rate to the questionnaire was higher for property owners within the greenway compared with county residents as a whole, and much higher than for renters in the greenway area (43 percent, 21 percent, and 8 percent, respectively). Also, response rates for all three groups were higher for the survey with the hypothetical question than for the solicitation for real money; for example, 47 percent of owners responded to the survey but only 39 percent of owners responded to the solicitation. The percentage of those who said they were willing to contribute some positive amount was, as expected, higher for the survey group than for the solicited group (51 percent survey and 36 percent solicitation for property owners; 22 percent survey and 11 percent solicitation for county residents as a whole). There were, however, a large number of $0 responses in all cases. These were the result of factors such as too little information, a belief that government should pay (25 percent–30 percent of owners) or that the effort had no value (30 percent–35 percent of the county residents sample).

The mean WTP is found to vary greatly depending on the treatment of the zero bids. Interestingly, the mean WTP for those who indicated they would pay more than $0 is similar between those who received the hypothetical question and those who got the actual solicitation. The big difference in these groups is that the number with a positive WTP falls when real money is requested. This may be some indication that the hypothetical questions are reasonable at getting at actual values, but that there may be free-riding or the belief that payments should be somehow more collective.

The mean WTP for those willing to pay more than $0 is about $35–$45 for property owners in the greenway, $10–$13 for renters living in the greenway area, and $30–$35 dollars for residents in the county as a whole. The mean values fall off dramatically when the zero bids are included, because there were so many zero values. The results from this study highlight the importance of not only how zero bids are treated, but also what is assumed about the nonrespondents. Nonrespondents can be treated as similar to the respondents (selection problem is likely), or they can be treated as having zero value, which is likely an extreme lower bound. This range of assumptions produces results that can vary by orders of magnitude, especially in the case of the county residents whose response rates were low.

One of the interesting studies from Europe is by Tyrväinen and Vaananen (1998), who use CV analysis to estimate the value of urban forested areas in Finland. This study looks at the value of two types of urban forested areas. The first part of the study examines the value of large, forested recreation areas on the outer edges of a town of 48,000—areas popular for hiking, jogging, skiing, and relaxation. The second focuses on smaller forested areas within already-developed areas of the city that are under pressure to be developed.[28] The uses of these latter areas are to provide pleasant views of the forest, and perhaps viewing wildlife. The survey was pretested and in 1995 was mailed to 500 randomly selected residents. The response rate was about 65 percent, which is fairly high for a mail survey. The respondents tended to be users of the forests, with 80 percent engaging in recreation uses at least once per week. It is unclear whether there is a selection problem in the responses because no information about use of the parks from any other source is provided to confirm this kind of frequency of use among the overall population. It certainly appears to be higher than would be the case among urban households in the United States.

[28] See the discussion of Tyrväinen (1997) and Tyrväinen and Miettinen (2000), above, in Section 2.

Respondents were first asked their WTP a tax for maintenance of the recreation forested areas so that they could continue to remain open. The other question was about the WTP to prevent the development into housing of forested areas in the town. The authors point out that although tax payments do not work well in the United States, taxes for use or maintenance are the norm in Finland and thus quite well understood and accepted. The study attempts to avoid any embedding problems by making clear how many other forested areas surround the town, and that the survey pertains only to those explicitly asked about. The mean WTP for the large forested recreation areas is found to be 108–141 FIM ($25–$32 in 1995 U.S. dollars) per season. There were a relatively small number of zero bids—about 5 percent–15 percent of the sample. The second part of the study, on the WTP to prevent the development of small forested areas, had a lower positive response rate and more zero bids than for the recreation areas. However, the mean values of these responses are slightly higher, at 190–206 FIM ($44–$47 in 1995 U.S. dollars) per year each year over three years to prevent development. WTP for these areas is regressed on income, age, use of the area, and view of the area. The authors find both use and view of the area to be highly significant. Distance from the site is correlated with use and view.

Overall, the study finds that the aggregate monetary benefits are much higher than the current maintenance costs for the forested recreation areas. For the smaller urban forested areas, the study finds that the amenity values are up to five times higher than the value of the timber if the forest is cut down. However, the right comparison would include the price the land would bring in housing plus the value of the timber.

Finally, Johnston et al. (2002b) use a contingent choice approach to determine the WTP for development options in rural western Rhode Island. They develop a survey that allows them to elicit household choices among many different characteristics of development for a 400-acre site, including the amount of and proximity to open space. It is important to note that this survey is of residents in the area and assesses their preference for new development in the region. The authors find that households prefer continuous, unfragmented development and—of most relevance to this survey—open space that is isolated from and not adjacent to the residential development. These preferences are also found to be independent of public access to the open space areas. A major finding of the Johnston et al. (2002b) study is that spatial attributes and the presentation of material that includes spatial components in CV and choice studies, in the form of text, maps, and pictures, can have important and sometimes subtle effects

on the study results. Attention to such spatial detail will be important in future analyses of open space valuation.

Agricultural land

As described above, there are several possible public benefits of preserving farmland in rural areas. If farmed areas are adjacent to or near urban or suburban properties, they may provide residents with scenic views of farm fields or greater ability to observe wildlife. Even if farm regions are not adjacent to residential areas, households may want to drive into the countryside and see farmland. In addition, there are potential nonuse values if urban residents benefit from just knowing that local land continues to be used for farming as it has been in the past, even if they will never drive by or visit these farms. Only stated preference methods can get at these nonuse values, though separating the use and nonuse components can be quite difficult. Also, preserving farmland may have value, not for what it does provide, but for the development it keeps out. Several studies have attempted to measure one or more of these values using the CV method, and we describe them below.

Because the open space benefits of farmland preservation accrue not to the farmers themselves but to third parties, a case can be made that the amount of farmland in the private market will be less than the social optimum.[29] Farmers do not take account of these external third-party benefits and therefore do not keep enough land in farming. Drawing on some of the estimates of the value of farmland in the provision of amenities described below, Lopez et al. (1994) examine how close three communities are to their optimal levels of land in farming. Of the regions they study, one—a small rural community in Massachusetts—is close to the optimum under current land uses, but the other two (in Massachusetts and Alaska), which have more development and higher incomes, have too little land in agriculture compared with the optimum.

Several studies have attempted to look at the value of the preservation of farmland as a way to prevent development in rapidly growing urban areas. The first was by Halstead (1984), who examines the willingness of residents in three diverse counties in Massachusetts to pay to preserve agricultural farmland. Mail surveys were used to elicit WTP responses to successively greater degrees of development of

[29] There are, however, so many other interventions into farm commodity and land markets that it is very difficult to say where the current situation is relative to the optimum. See Gardner (1977) for an overview of the economic issues with farmland preservation.

farmland near the respondent's residence. Only 85 surveys from all three counties with complete responses could be used in the analysis. The mean annual value of the WTP per respondent to avoid development is found to range from $28 to $60 per year for low levels of development to $70 to $176 for high-density development. Distance from the respondent's home to the nearest farmland is not found to have a significant effect on WTP, but income does have a positive effect. WTP does vary a good deal across the three county jurisdictions, with higher WTP in the more heavily developed areas. This study, however, has only very small samples in each of the regions (33 is the largest), making it difficult to put a lot of faith in the statistical results. In addition, the survey does not identify the number of acres preserved, so it is not possible to derive from the results an estimate of the value per acre.

Looking at a similar question in a fast-growing county in South Carolina, Bergstrom et al. (1985) approach the study design in a different way. In a mail survey that resulted in just over 500 responses, they ask for WTP to maintain situation A and therefore avoid situation B. Situation A is depicted in text and pictures as prime agricultural land that remains undeveloped, whereas situation B shows the same lands in a heavily developed state. The comparison question is asked for a range of different amounts of prime agricultural lands that could be protected in the county, from one-quarter of all such lands, to one-half, to three-quarters. Several payment vehicles are explored, including tax payments and payments to a private conservation fund. Annual mean household WTP is found to be increasing in the number of acres preserved and ranges from $5.70 to $8.94. WTP is positively related to income, age, and education level, but the payment vehicle and distance to the agricultural areas have no significant effect on WTP. When the values are aggregated across all households in the county, the per acre values range from $34 to $13, with increasing numbers of acres preserved. These estimates indicate a low value for the amenity value of farmland and are lower than those for the other farmland preservation studies.

A unique feature of this study is that it seeks to separate out the public amenity value of preserving farmland from other benefits, including food supply and jobs. The authors describe the amenity values as being made up of scenic and nostalgic values, both of which the survey attempts to value. Respondents are divided into two groups. One group receives a lengthy description of the different benefits of farmland preservation, with explanation of the distinct nature of the amenity benefits; the other group gets no explanation of the benefits. The results of the valuation estimates of the two groups are statistically different, with the group having the more detailed

explanation responding with lower average WTP. The authors conclude that the group with no explanation is unable to separate the public amenity values from the more general values that farmland provides.

The study by Beasley et al. (1986) also examines the value of preventing the development of farmland. Their study focuses on urban fringe residential areas and nearby farmland in Alaska. The approach is to obtain estimates of residential household WTP for preventing incremental amounts of development of the currently farmed areas. The survey instrument includes maps and pictures of alternative hypothetical development scenarios for specific areas that were, at the time of the survey, exclusively in farming. The survey was administered in person to a random sample of 153 households near Fairbanks in 1983. Follow-up questions reveal that there were about 20 percent protest bids, and these are dropped from the analysis.

The survey included two WTP questions. Households were asked to look at pictures of the specific areas currently being farmed that were near the urban fringe areas—scenario A. They were then asked to compare these with pictures showing moderate development interspersed with farms for the same region—scenario B—and asked what they would be willing to pay per year to keep A and avoid B. In a second phase, respondents were asked to look at pictures of scenario C, in which virtually all of the land was developed. They were again asked WTP, this time to avoid C and maintain A. The results indicate that the mean WTP is $76 per household per year to maintain A over B, and $144 per household per year to maintain A over C. The authors then extrapolate these results to the entire region[30] and calculate the net present value of the amenity value under different interest rate assumptions. For example, the net present value per acre of preserved farmland at a 5 percent discount rate is $500 (1984 dollars).

One drawback of this study is that it is limited to only the two development options. It could be that some small, specifically configured farmed and developed areas would provide a greater net social benefit than the scenarios shown. However, it is one of the only stated preference studies that looks at farmland at the periphery and asks about the value of preventing the development of farmland.

Bowker and Didychuk (1994) extended the analysis of the value of farmland preservation by Beasley et al. (1986), Halstead (1984), and Bergstrom et al. (1985). Bowker and Didychuk designed a CV instrument to examine the value of farmland

[30] It is not clear from the text exactly how this is done.

preservation in the province of New Brunswick, in eastern Canada. The Moncton region, one of the three major population centers of the province, was under intense development pressure, with losses in farmland over the previous 20 years of almost 75 percent. Four residential areas were sampled in 1991 using a personal interview method to determine household WTP for preserving a specific number of farmland acres. The survey size was 140, with only 92 usable responses in the final analysis.

Households were asked to indicate how much they would pay from a range of values into a trust fund for preserving farmland for the number of acres specified. One unique feature of the study is that there were four acreages that could be preserved, ranging from about 23,000 acres to 95,000 acres, or total preservation of farmland in the area. However, each household was asked about only one of the four acreages. Thus, the study is able to assess whether embedding is a problem. If WTP is not statistically different for the different acreages, it is not clear that a marginal value function can be derived for preserving additional acreage of farmland. The household WTP values are different and range from $49 per household for preserving 23,000 acres to $86 per household for preserving 95,000. When aggregated across households and converted to a per acre basis, the average value per acre of the nonmarket benefits is about $97. This is about 6 percent—16 percent of land values in the area at the time. The authors argue that this is not sufficient to justify the costs of purchasing farmland in this area.

This study also finds another interesting feature, as did the Beasley et al. (1986) study above, namely that household income is not a significant predictor of WTP for farmland preservation. And although the other studies described above did not find distance to matter, this study finds the value of preservation actually increases with household distance from the farmed areas. Finally, whether households make actual use of the farmed areas and whether they are active members of conservation groups are both important in this study for determining WTP. This latter point could have a significant effect on how households should be aggregated in a given region to determine the community value of preserving farmland.

Another study of farmland values was by Ready et al. (1997). The authors use a contingent valuation survey to determine whether households would be willing to pay additional taxes for a proposed program to retain land in thoroughbred horse farming in Kentucky.[31] Each participant was given a single choice about paying a tax, with the

[31] This study also had a hedonic component, but the hedonic estimate was based on national data for which the unit of observation was the county level. The number of horse farms per

choices across participants ranging from $5 to $500. In addition, there were four survey versions, varying in the extent of horse farms that would be lost without the proposed program, from 25 percent loss up to 100 percent loss. The sample was recruited by a random phone survey, and a mail questionnaire was sent to all who agreed to participate. Of 394 households on the random phone list, there were 194 completed surveys; of these the authors identify 22 percent as protest votes.

A logistic function is estimated in which the probability that the household would say yes to the tax rate depended on a range of factors, including the value of the tax amount and the number of farms lost. The median value of one lost farm is estimated to be $0.49 per respondent per year (1990 dollars). The marginal value of a lost farm increases rapidly, rising to $1.02 after a 25 percent loss in all farms.

Rosenberger and Walsh (1997) look at the value of preserving western ranchland. A survey was mailed in 1993 to a random sample of 320 households in Routt County in Colorado, a region that was under intense development pressure with the growth of ski resorts during the early 1990s. Average annual household WTP for preserving additional increments of ranchland range from $72 for increasing the total amount preserved from 25 percent to 50 percent, to $118 for increasing the percentage from 50 to 75. The marginal willingness to pay for additional acres preserved declines as more acres are preserved. The authors argue that with a county population of only about 10,000, the total WTP is not sufficient to warrant the purchase of much ranchland in the region. However, when the value of ranchland to visitors of the area is considered, they conclude that the estimated benefits might be large enough to warrant more preservation.

The last study in this group (Hanley et al. 1998) is from the United Kingdom and compares the results of CV and contingent choice methods for valuing preservation of farmlands in an area in Highland Perthshire in Scotland. The particular area of farmland is one of a number of large environmentally sensitive areas (ESAs) in the United Kingdom, where farmers are paid to continue farming to protect wildlife habitat and landscape quality. A dichotomous choice (yes–no question) CV survey was administered in the early 1990s to more than 800 people in three groups: the general public in England and in Scotland, and visitors to the region. In-person interviews were administered to the third group, and for the general public, both mail surveys and

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county was the measure of the amenity, but this coefficient was negative in the hedonic property equation.

interviews were used. The average WTP per year to preserve the ESA was £42 (mail) and £57 (in-person interview) for the general public, and £73 for visitors. There is evidence of significant nonuse value in that respondents who had not visited the area were willing to pay for protecting it. This particular survey is part of a broader CV study, which leads to some interesting results. WTP estimates from the dichotomous choice payment mechanism can be compared with a similarly administered open-ended payment format (how much would you pay?) and, as other studies have found, the open-ended format results in lower WTP than the dichotomous choice. Also, the open-ended format CV results found no significant difference in WTP between the mail and in-person survey methods.

In the second phase of the study, a choice experiment (CE) is implemented for the same environmentally sensitive area. The CE includes a range of choices among attributes of the ESA, using maps, pictures, and text, and through in-person interviews asks respondents to choose which outcome they prefer in pair-wise comparisons. The authors argue that there is a similarity in the method of the dichotomous choice CV study described above and the choice experiment in that both ask respondents to make a choice that reveals their WTP: in the CV case they are choosing whether they are willing to pay a certain amount to preserve the entire ESA, and in the CE case they are choosing between options that reveal the value of changes in individual attributes, such as the amount of woodland or wetlands. It can be argued that the sum of the marginal or component attributes from the CE study and the total value estimates from the CV study should be comparable. The study finds the total CE estimates to be slightly higher than the CV estimates but not statistically different[32] (average per year of £107 for CE compared with £98 for the CV).

Hanley et al. argue that the CE method is best used for looking at the marginal (individual attributes) values of open space resources and may therefore be best-suited for benefits transfer. Attributes of open space will vary across sites, and a CE in one area can provide an estimate on which to base the additional value of certain attributes in other regions. The authors point out some unresolved issues for using the CE method, however. First, there are many characteristics of the overall resource, but one set of characteristics must be chosen for the CE study. What is the right set of characteristics? In some cases, where the open space resource has limited and clearly identifiable characteristics, this may be easy, but in other cases, it could be quite difficult. In

[32] Within the 95 percent confidence interval (Hanley et al. 1998, p. 10).

addition, it may not be correct to add the value of the characteristics to estimate a total value, not only because not all characteristics may have been valued, but also because it ignores interactions between characteristics. We come back to other applications of the CE method in this paper in the wetlands section, below.

Wetlands

Two recent review articles survey analysis of research on the value of wetlands (Heimlich et al. 1998; Boyer and Polasky 2004). Much of the analysis is on rural wetlands, but some studies address wetlands adjacent to or near urban areas. Studies that use the hedonic method for valuing wetlands were described above. In this section, we review the results of a relatively small number of wetland studies that use either CV analysis or the contingent choice methods.

Several studies use CV analysis to obtain household values of wetlands based on the services they provide. Lant and Roberts (1990) use the CV method to study the value of improvements to wetland areas around the Iowa–Illinois border. They conduct 200 in-person surveys in 1987 in which they ask respondents for their willingness to pay for both direct recreational benefits from improvements to wetland areas and improved intrinsic value, which includes a range of ecological and water quality benefits. They find that the intrinsic values, distinct from the recreation values, range from $37.61 to $47.16 per year (1987 dollars) for marginal improvements in wetland quality. The values increase with income levels. Stevens et al. (1995) estimate the willingness to pay for flood control and water quality protection resulting from wetlands in New England. They find that the value per acre per year is $77.15 (1993 dollars).

Other studies examine the willingness to pay of residents from broad geographic areas for large rural wetlands. Whitehead and Blomquist (1991) asked Kentucky households about their willingness to pay for a large forested wetland in the western part of the state that was being threatened by surface coal-mining operations. The WTP component of the survey was framed as a dichotomous choice question asking whether households would be willing to pay into a preservation fund to preserve the wetlands. Information provided by the survey included reference to a range of services from the wetlands, including water quality, groundwater recharge, fish and wildlife habitat protection, flood control, and species preservation. In other words, respondents were being asked to provide a total value of the wetland, which is likely to have included both use value and nonuse value. To the extent this particular region is perceived as unique or irreplaceable, the nonuse value could have been substantial.

After extensive focus group testing and a random recruiting process, the survey was mailed to residents; a 31 percent response rate resulted in a sample size of 215. The study finds the value of the Clear Creek wetland to range from $5 to $17 for each Kentucky resident. Part of the variation in values is because of the different amounts of information respondents have about alternative or substitute wetlands in the region. Better information about the availability of reclaimed lakes and wetlands in the area, which are required with the introduction of surface mining, reduces the average WTP for each household by about $6.

The Pate and Loomis (1997) study focuses on the total value households have for protecting several natural resources in California, including wetlands in the San Joaquin Valley. The focus of the study is not only on household value but also on how the value of the wetland changes with distance from the site. In this case, the households surveyed are from a large geographic area, including both in and outside the valley, plus Nevada, Oregon, and Washington. A random mail survey was followed by a telephone interview, and the WTP question was framed as dichotomous choice: Would you be willing to pay $X in additional taxes per year to improve the wetlands by a specific program, as defined in the survey?

The response rate was 51 percent; of the 1,003 completed responses, 228 were residents of the San Joaquin Valley itself. The average willingness to pay for the wetland improvement project is found to be $215 per household per year in the valley, and the amount declines quickly with distance: WTP in Oregon is found to be $68 per household per year. The authors hypothesize that distance may be correlated with and therefore a proxy for information about the resource. The results show that membership in environmental organizations tends to increase WTP, and age of the respondent tends to decrease their WTP.

Woodward and Wui (2001) review the range of studies of the value of wetlands, including studies using hedonic methods, net factor income methods, and CV methods. They do several meta-analyses based on 39 studies across wetlands in different locations, each providing different types of services. They do some simple bivariate analyses and find, surprisingly, that wetlands providing more services are not necessarily associated with higher average WTP values. In terms of the data quality and econometric analyses, they find that those studies judged strong on these measures do not result in significantly higher or lower average value per acre. The stronger studies have an average value of $915 an acre, and those with weaker underlying data and analyses have average values of $986 an acre (all in 1990 dollars).

In a regression analysis using all of the studies, Woodward and Wui are able to look at the separate effects of both different characteristics of the wetlands and different methods for valuation. They find that although the CV estimates of value tend to be lower than estimates using other methods (for example, the travel cost method), they are not statistically different from the others, so there is no evidence of bias in the CV approach. In terms of wetland services, they find a great range of estimated average values and a good deal of uncertainty around those estimates. For example, wetlands with opportunities for bird watching provide the highest value (mean of $1,212 per acre, with the confidence interval varying from $528 to $2,752), and general amenity services, the lowest ($3 per acre).

Several studies, in an attempt to understand the attributes of wetlands that are of most value without having to obtain actual values for wetlands, used conjoint analysis instead of the standard CV approach. Conjoint analysis, as described above, also uses survey methods but asks respondents to choose among a number of alternatives, rather than provide a direct estimate of willingness to pay.

The study by Lupi et al. (2002) uses a choice experiment to examine trade-offs in preferences between natural wetlands and mitigated or restored wetlands. Restored wetlands are those that replace wetlands lost or damaged by development and include newly created wetland areas. The survey asked individual respondents to determine whether a restored wetland compensates for the loss of a natural wetland. Different attributes or wetland characteristics were developed that allowed for comparison between drained and restored wetlands, including type of wetland, size, public access, and species habitat. The 58 participants in the survey each made five choices about restored versus original wetlands with different characteristics. One of the results derived from the responses is that it would take 1.64 acres of mitigated wetland to make up for an acre of lost original wetland. This ratio is highly dependent on the characteristics of the wetlands assumed, however. Another result is that individuals will accept reductions in wetlands acreage if there is at the same time an improvement in other attributes of wetlands that are restored—for example, in the habitat quality they provide.

Another study uses conjoint analysis to examine preferences about salt marshes, a type of wetland, in Rhode Island (Johnston et al. 2002a). An expert panel was convened to determine how attributes of salt marshes (size, type) are linked to bird and fish habitat functions. The contingent choice experiment then was designed to determine preferences for alternative restoration plans that improved marsh services.

In-person interviews were used, with a total of 661 surveys completed. Each respondent received four sets of discrete choices, each with two alternative multi-attribute restoration plans, resulting in 2,341 individual contingent choices. In each case, the respondent could choose one of the two plans or neither plan. The survey revealed that individuals favor plans that include restored bird and fish habitat, larger areas, areas that provide public access, and mosquito control, and plans that are less costly. In order of preference, the services preferred are mosquito control, then increased shellfish population, fish populations, and birds. Finally, the authors are able to use the results of this survey to assess public preferences over alternative restoration plans, including the additional value to respondents of one plan over the other.

These conjoint analyses provide a useful technique for ranking preferences. However, it is important to note that ranking of services is likely to vary a good deal by geographic region, depending on the type of services provided, the number of substitutes, and the aesthetic and recreational preferences of residents.

C. Combined Stated and Revealed Preference Studies

A number of studies combine and compare the outcomes from stated preference analyses, such as CV or conjoint studies, with revealed preference analyses, such as hedonic property value studies. There have been many such comparisons in the broader resource valuation literature. Carson et al. (1996), in a review of some 83 studies that include comparisons of the two methods, conclude that stated preference contingent valuation estimates average about 75 percent to 90 percent of corresponding revealed preference values. We review studies in this section that use and compare a hedonic method with stated preference results for the same resource.

Earnhart has two studies that combine stated and revealed preference techniques to value open space amenities. The first (Earnhart 2001a) assesses the value of aesthetic benefits associated with residential locations, using a combined revealed preference analysis and a choice-based conjoint survey in a study of housing choice in Fairfield, Connecticut. This is a relatively new approach that combines data from two approaches—a discrete choice hedonic analysis of household preferences and a stated preference method that allows households to choose among alternatives—into a single estimated equation of housing value.[33]

[33] For an explanation of this general technique, see Adamowicz et al. (1994).

The stated preference part of the analysis allows a thorough exploration of household valuation of the amenity variables in the analysis. The amenity variables explored are water-based amenities, including adjacency to Long Island Sound and to a river, stream, or lake; and land-based amenities, such as adjacency to a forest, wood, or open field. The study also attempts to measure the value to surrounding households of the restoration of an altered wetland to its original character. The stated preference component was a mail survey to more than 400 households; about 100 usable surveys were returned. Residents were to select among three houses in a choice set of houses with differing characteristics that focused on the amenities surrounding the house sites, described in words and by pictures.

Earnhart estimates the hedonic discrete choice model and the contingent choice model separately first. He then estimates the discrete choice logit framework with both sets of data in the joint estimation. He finds the joint estimation techniques to be an improvement over the revealed preference approach alone. The effect of land-based amenities in general and the distinction between forest and open space are more clearly identified in the joint estimation. Both water-based amenities (adjacency to the sound and to rivers, streams, lakes) and land-based amenities (fields or forests) have positive value, and for land-based amenities, forests are preferred to fields. Being adjacent to the sound has higher utility for residents than adjacency to rivers and streams. Finally, restored marshes or wetlands generate higher utility than disturbed marshes.

In developing estimates of the value of the amenities from the discrete choice results, Earnhart obtains a range of different results based on differing use of the data and estimated coefficients. The best estimates appear to use the results from the stated preference data for utility levels, and marginal utility of income from the revealed preference model. The latter is used because the estimates of the effect of housing price on housing choices appears to be too small in the stated preference data.[34] Under these assumptions, water-based amenities are valued at an average of $14,135 per household, and land-based amenities, at $17,520 (5.8 percent and 7.2 percent, respectively, of the median house price of $245,000). Individual water features range from $11,000 to $21,000, with lake or pond providing the highest value. Adjacent forest has a value of $18,000, and an open field, $8,000. Finally, under the most reasonable assumptions, the

[34] This is because households are asked to choose among housing based on their current financial situation, and they may face choices outside of their income set. In this case they may not make choices that are realistic, given their incomes.

value of marsh restoration is found to be $6,684 per house (2.7 percent of the median house price).[35]

The second Earnhart study is a working paper (2001b) that examines the value of living near open land to suburban residents as measured by actual and hypothetical property value data. In this study of households living on the outskirts of Lawrence, Kansas, household preferences for living adjacent to open space (in this case, prairie) are assessed using three different methods: the hedonic property value method; the contingent pricing method, in which households are asked for an additional amount that they would pay in their current house to have adjacent undeveloped prairie land; and, last, a choice-based conjoint analysis. The latter approach does not ask directly for WTP but offers households a series of options, each with different amenities and different prices, and households must choose which they prefer.

For the hedonic pricing analysis, data were collected on all single-family houses that were sold in the Lawrence region during a three-month period at the beginning of 1999. There were 471 observations on sale transactions, including the characteristics of the houses. Each site was visited and the surrounding land uses for each was assessed. Being adjacent to a prairie was determined to be the most important amenity. For the stated preference analysis, a survey was mailed to each of these same households. The survey had three parts: the first asked the contingent pricing questions, the second offered options for the choice-based conjoint analysis, and the last asked for socioeconomic characteristics.

The contingent pricing questions asked households to compare a house similar to their own (recently purchased) house with a house adjacent to a prairie that has a 50–50 chance of being developed in the future, and then with a house adjacent to a prairie that will never be developed. The survey asks in each case what the household would be willing to pay for the added prairie amenity. These data are then used to regress the house characteristics and the prairie adjacency on the house price as given in the contingent price responses. The results are compared with the traditional hedonic estimation of house prices. In both cases, there is a clear enhanced value of the property from proximity to the prairie: the hedonic model results show that the existence of the prairie adjacent to the house increases the house value by about $15,000, or 9 percent, whereas the contingent pricing approach shows that value is raised by about $8,000, or

[35] However, the estimates of value vary a great deal depending on which model and set of assumptions are used.

7 percent, if there is an adjacent prairie that will not be developed (the samples are slightly different). Earnhart attempts to combine the datasets to get more robust results than would be obtained by using each separately, but the attempts at combining them are not entirely satisfactory and do not add information to the above findings.

The second part of the stated preference component of the survey provides data for the choice-based conjoint analysis. Households were given 10 sets of three-way house comparisons. Each house choice set included the same physical characteristics of the house but differed on adjacency to the prairie and on price. The choices were constructed so that if the respondent chooses rationally, the choices should bracket the respondent's WTP for the prairie amenity. However, the survey finds that respondents did not always choose rationally or have a clear set of preferences for living next to the prairie.[36] And of those who did, the results fall into extreme categories. About 18 percent have no value for the prairie, and about 39 percent indicate a very high value, of $25,000 or more.[37]

The fact that a fairly large number of responses (19 percent) were irrational percent casts some doubt on how well the respondents understood the survey questions or were able to sort out their preferences for the amenity. Finally, when the choice-based data are compared with the contingent pricing data, it is found that, at least for the households who chose rationally in the choice-based questions, the marginal values implied by the contingent price component are lower than those based on the choice data. This suggests that households tend to undervalue the amenity when asked to provide an estimate of its value directly.

Johnston, et al. (2001) take a different approach. They examine the differences in the estimates of nonmarket amenity values for farmland in Suffolk County, New York, using two valuation methods—a hedonic approach and a contingent choice approach—and find insight from combining the two methods. They find in the hedonic analysis of properties that the closer a property is to the nearest farm, the lower the house value. Hence, the value of nearby farmland is found to be negative (this is not inconsistent with some of the hedonic study results of Section 3, Table 1, above).

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[36] An example of an irrational response would be if the respondent had first chosen the house next to the prairie over the nonprairie house (baseline) when prices were the same, next chose the nonprairie house when the price of the prairie house was $3,000 higher, but then chose the prairie house when its price was $5,000 higher than the nonprairie baseline.

[37] These are the results for the case in which the adjacent prairie lands are permanent. This study also examines the case in which the prairie has a 50–50 chance of being developed.

The contingent choice study, on the other hand, finds in a random in-person survey of county residents that the average resident has positive WTP to preserve natural lands in the region of $.035 to $.143 per household per acre per year. Households had the highest value for farmland, with lower values for other natural lands, such as wetlands and undeveloped lands. Farmland values aggregated across all year-round households in the region were estimated from these results at about $1,200 per acre per year (1995 dollars, or $1,355 in 2000 dollars, as shown in Table 2 on page 59). This is quite high compared with earlier studies of the value of farmland, described above, in which total per acre values were lower than $1,000.[38]

The authors argue that the results of the hedonic and contingent choice studies are not inconsistent because of the range of services provided by preserved land. Some of the services may differ by household location—for example, being too close to farmland may result in negative amenities from odors and the like. The contingent choice analysis, on the other hand, is obtaining values for preservation that are unlikely to vary much by location—for example, for preservation of rural heritage, prevention of low-density development, and other general amenity services. These results suggest that the costs and benefits of land preservation policies may vary across groups. Those affected most by farm preservation in Suffolk County, or the residents living closest to the farming areas, are most likely to oppose preservation.

Results from the combined stated and revealed preference methods indicate that these approaches offer promise. They provide better detail about the variation in amenities, for one thing. For example, the more controlled experimental part allows the researcher to directly vary the amenity being valued while holding other things constant. This technique gets around potential multicollinearity in variables. It also provides more observations on the amount of amenities and on the less common amenities that are difficult to observe. However, studies to date raise a number of questions that must be addressed, including aggregation problems and inconsistency in some of the results.

D. Combining Results Across the Stated Preference Studies

Table 2 on the next page summarizes the results of some of the stated preference studies. Average WTP values from those studies that estimate the value of some open

[38] The authors express more confidence in the ranking of values of different types of open space, with farmlands being the most preferred, than they do in these dollar values of farmland. The dollar estimates tend to be sensitive to the model specification.

Table 2. Estimated Values for Open Space Services from Stated Preference Studies

Type of open space and study	Average WTP (2000 dollars)	Measure of value aggregated over households (2000 dollars)
Urban		
Undeveloped land parcel of 5.5 acres *Morey et al. 1998 (CV)* (1995$)	$264/household (one-time payment)	$1.5 million, total households within a 1- mile radius
Farmland		
Preserve farmland from development in South Carolina *Bergstrom et al. 1985 (CV)* (1982$)	$9–$16/household/year[a]	$23–$61/acre
Preserve farmland from development in Alaska *Beasley et al. 1998 (CV)* (1984$)	$126-239/household/yr[b]	$830/acre
Preserve land from development in Eastern Canada *Bowker and Didychuk 1994 (CV)* (1991$)	$62–$109/household/year[a]	$123/acre 6%–16% of value of farmland
Preserve western ranchland from development in Colorado *Rosenberger and Walsh 1997 (CV)* (1993$)	$86–$144/household/year[a]	
Preserve farmland from development in Suffolk County, New York *Johnston et al. 2001 (contingent choice)*[c] (1995$)	$40–$162/household/acre/year[a]	$1,355/acre/year
Wetlands		
Value of improvements in ecological and water quality benefits (nonrecreational benefits) *Lant and Roberts 1990 (CV)* (1987$)	$56–$71/year for improvements in wetlands	Recreational and ecological values said to be as high as market value of cropland.

Table 2 Estimated Values for Open Space Services from Stated Preference Studies—Continued

Value of storm water retention *Stevens et al. 1995 (CV)* (1993$)	$92/acre/year	
Meta-analysis of value of wetlands *Woodward and Wui (2001)* (1990$)		$1,205/acre average across all studies $1,597/acre for bird watching
Value of adjacency to water-based services *Earnhart 2001a (contingent choice and revealed preference)* (1996$)	$15,400/house (5.8% of house value in 1996)	
Value of adjacency to land-based services *Earnhart 2001a* (1996$)	$18,700/house (7.2% of house value in 1996)	
Value of adjacency to restored marsh (compared with degraded marsh) *Earnhart 2001a* (1996$)	$7,340 per house 2.7% of median house price in 1996	

[a] per thousand acres for increments of 25% additional land preserved.
[b] per thousand acres for an increment of 50% additional land preserved.
[c] These results tended to be sensitive to estimated model specification.

space service are included. As was the case with the hedonic studies described above, these estimates from across studies must be compared with caution. They come from a range of studies done in different time periods (from the early 1980s to the late 1990s) and in different regions, and each identifies a different service or set of services from open space areas. These services may or may not be comparable with each other. For example, the Lant and Roberts (1990) study of wetlands focuses on the ecological value of improvements to wetlands that may be some distance from the surveyed households, whereas the Earnhart (2001a) study is for houses that are adjacent to a restored wetland. In addition, values tend to be strongly influenced by income levels and the extent of urbanization in a region (open space is more valuable where it is in relatively short supply). Finally, the values in Table 2 are simply averages and do not include any measure of the distribution of values from each study. In some studies, such as that by Earnhart (2001a), the distribution of estimates can be quite large, depending on the underlying assumptions of the particular model estimated. We can account at least for

difference in aggregate price levels throughout this long period by converting the results to constant dollars. The estimates in Table 2 are all in 2000 dollars.

There are, however, some summary comments and conclusions we can draw from the stated preference studies. First, income appears to have a fairly consistent and positive effect on WTP for different types of open space amenities; only the Beasley et al. (1986) and the Bowker and Didychuk (1994) studies find that income is not significant. Second, the effect of distance to the open space areas is mixed in these studies. Being closer to urban parks and greenways is, in general, positively related to WTP, but the evidence is somewhat mixed for wetlands and farmland preservation. Being closer to farmland does not appear to matter in most studies, but WTP is actually higher at greater distances in the Bowker and Didychuk (1994) study. Third, in most of the studies reviewed here, a particular open space amenity is not explicitly described, so it is not clear which services or sets of services respondents are valuing. For example, in the farmland preservation studies, it is difficult to know whether the values estimated include only the prevention of development, or whether households are valuing other services from undeveloped farmland as well. Thus, even in these CV studies, which are able to include nonuse values as part of total value, it is not clear how much can be attributed to nonuse values and how much to use values.

The contingent choice approach is able to isolate the value of individual characteristics of the open space amenity by the way choices are framed (Hanley et al. 1998, Johnston et al. 2002a). It has been argued that CV is best suited for determining the total value of a particular resource, but contingent choice methods are better for identifying marginal values or characteristics of that resource. Hanley et al. argue that contingent choice approaches have greater potential for transferring the estimated value of open space benefits found in one area to other areas.

It is notable that the value of farmland varies substantially across the studies. The Bergstrom et al. (1985) study finds very low values of farmland relative even to land prices in South Carolina at the time of the study. Other studies find the nonmarket value of farmland close to the value of land in other uses. This variation in results may be due in part to study design but could also be due to the existing amount of farmland in the region and other location factors.

It is useful to compare the results of the stated preference studies in Table 2 with the results from the hedonic studies in Table 1. Because stated preference methods are hypothetical, there is concern that they may be overestimates of WTP. Revealed

preference estimates can provide some validation when the nature of the open space values being measured is similar.

First, it is important to note some of the many reasons why estimates using these approaches may not be comparable. Often the nature of what is being valued is quite different. Hedonic studies tend to estimate the value of additional open space very close to one's residence, which would be primarily related to scenic views and rural character, while the stated preference studies are likely to be capturing broader, more general perceived benefits from open land preservation, including nonuse values not measured at all in hedonic studies. In addition, if hedonic studies have already captured the value of the open space that is capitalized into property values, then residents living close to the open space site have already paid for access to the open space, and this would affect their WTP in CV studies. Finally, hedonic studies are able to measure the value of only marginal changes in the open space amenity, while the stated preference studies are usually designed to provide estimates of the value of large changes in the amount or provision of the amenity. Even contingent choice studies, which are able to measure different characteristics, are usually comparing with-policy and without-policy (such as "it has a restored marsh, or it doesn't"). [39] Hence, not only are the services being measured often distinct, but also the magnitude of the change is quite different.

However, we can draw some interesting conclusions from looking at the two tables. Although we might expect the stated preference results to be high for several reasons (the presence of nonuse values and the hypothetical nature of the CV market), there is no strong evidence that they are higher than the hedonic estimates for the various categories of open space. For example, in terms of preservation of agricultural areas, estimates of the value of an additional acre from the CV studies are consistent with or somewhat lower than the estimates of the Irwin (2002) and Geoghegan et al. (2003) hedonic studies for an additional acre of conserved farmland. For wetlands, the meta-analysis by Woodward and Wui (2001) has an average per acre value that is consistent with most of the results from the Doss and Taff (1996) hedonic study. The Earnhart (2001a) study, which combines revealed and stated preference techniques, tends to have higher estimated values for adjacency to wetlands than the hedonic studies. However, in the Earnhart study itself, the separate stated preference values are

[39] Recent general equilibrium approaches to inferring the value of open space—Walsh (2003) and Hallstrom and Smith (2003)—use yet a different method that should also be able to capture broad measures of the value of open space.

much higher than the revealed preference values. This difference appears to be primarily a result of the conjoint analysis study design (Earnhart 2001a, p. 27).

5. Other Studies of Open Space

Here we review briefly other studies that have attempted to look at alternatives to direct valuation of nonmarket benefits. There is a large area of literature that attempts to rank public attitudes toward the services provided by open space preservation. Surveys of households about what aspects of open space are most important provide insight not only about public preferences but also about the public's understanding of the types and services provided by preserving undeveloped areas.

A. Studies of Public Preferences

Kline and Wilchens (1996) examine public preferences for farmland preservation programs in Rhode Island. In a face-to-face survey of a sample of 515 individuals, they ask qualitative questions about why programs currently in place for preserving farmland in Rhode Island are important. Respondents are asked to rate the importance of nine reasons for preserving farmland (the nine reasons were determined through work with focus groups before the survey was begun). On a rating scale of 1 to 10, all nine have ratings above about 7. The most important are those that preserved environmental quality, including protecting groundwater, protecting wildlife habitat, and preserving natural places. The attributes that are found to be somewhat less important are those that slowed development or preserved public access; preservation of farming as a way of life and rural character are found to be in the middle. Using factor analysis to determine the underlying factors of most importance, the authors find that the environmental aspects of preserving open space are most important, with aesthetic, agrarian, and antigrowth next in descending order of importance. Their results suggest that at least for farmland preservation, a range of values are important to the community, and the primary public value of farmland preservation programs may not be related to agrarian values but is likely broader.

Hellerstein et al. (2002) come to a similar conclusion in a review of the literature on preferences for rural amenities. They find that the results of studies of public preferences about farmland protection are not conclusive about the most important values provided by such preservation. No specific attribute or set of attributes seems to dominate. One study of farmland preservation outside Chicago (Krieger 1999) finds that quality-of-life and antisprawl issues are the most important. Other studies have

mixed results about whether active farms are more valued than simple open space protection. These authors also look at the legislative intent of farmland protection programs in different states and find that these programs are often intended to provide a range of outcomes, including orderly development, food security, enhancement of the local farm economy, environmental services, and protection of rural amenities.

A recent survey of residents of Kent County, Michigan, explored the importance of farmland preservation and what was most important to residents in the maintenance of farming areas. This county contains several large and growing urban areas, such as Grand Rapids, but has also been an important farming area of Michigan for many years. The survey results indicate that about half of the residents may support farmland preservation programs if the cost of the program is low. The number supporting such programs falls off rapidly as the cost of the preservation program rises. The most important reason for preserving farmland was local heritage, and there was a strong consensus that farmland that is preserved should be agriculturally productive and protective of the environment. However, the latter two characteristics may be mutually exclusive in some cases.

Several earlier studies find strong public support for the idea of reducing land conversion to development (Furuseth 1987, in a study in North Carolina, and Molnar and Smith 1984, in a study of Alabama). Both studies find strong, broad support for protection, especially of agricultural lands. However, there is less evidence of real commitment to specific measures that would mitigate such losses. The Alabama study in particular found that even though people supported the idea of farmland protection, they did not support any of the range of policies that would result in such protection.

B. Studies of Community Voting

Another approach to estimating open space benefits examines voting behavior for bond funding or referenda on spending of public money for land preservation. For example, Bates and Santerre (2001) examine the demand for open space in Connecticut communities. They look at expenditures on the purchase of open space through local jurisdiction bonds in 169 towns and cities. They are able to estimate the demand for open space as a function of price (the cost of the bonds) and the income level of the community. They find that demand for open space is relatively insensitive to changes in the price, but very sensitive to differences in income across jurisdictions. The average income elasticity is found to be about 1.0, which is similar to income elasticity estimates for parks and recreation services found by other authors.

6. Conclusion

Many communities in the United States are struggling to preserve open spaces and limit suburban sprawl while still providing affordable and desirable housing and encouraging economic growth. In their efforts to preserve open lands, state and local governments, as well as land trusts and conservation organizations, must figure out how much land to target for preservation, whether that land should be in private or public ownership, where open space should be located, and what types of open space—farms, forests, wetlands, parks, etc.—are the most desirable. Many public opinion surveys suggest that people value open space, and recent voting on bond issues and referenda supports this view. However, only economic analyses relying on well-established statistical techniques, reliable and extensive data, and well-framed research methodologies can provide evidence about the dollar value of these important nonmarket goods. Such estimates will be important in policy debates over the public versus private value of open space land in the future. In this survey, we have reviewed the large and growing literature on the economic value of open space.

It is very difficult to generalize results from the wide range of studies that have been conducted. Each study deals with a particular open space area or set of areas that are unique to a particular region and time period. And each study is measuring a set of services provided by the open space to a particular group of households. Estimated values vary widely across the studies and sometimes even within the studies. For example, hedonic models estimated on data from adjacent counties can turn up vastly different results. Thus, one conclusion that we draw from the extant literature is that open space values are case study–specific. Policymakers looking for a specific dollar value to attach to a particular open space project may find it difficult to use the existing research for that purpose. What can be gleaned from the literature is some general results about the direction of particular effects, how values vary by location and other variables, and the differences between the methodologies used to estimate values.

Far more revealed preference hedonic studies exist than do studies using stated preference approaches, such as contingent valuation or contingent choice. It is important to understand that the values estimated for the two types of studies may be capturing quite different kinds of benefits. Hedonic studies, which rely on property values to infer benefits, provide estimates of the marginal value of living near open space. In some places for some kinds of open space, these values can even be negative—for example, several studies find that living next to a busy park can reduce property

values. Because they rely on actual market data, hedonic studies have much to recommend them. However, they are not capable of providing estimates of the full range of open space benefits. Stated preference methods like contingent valuation can, in theory, capture a more comprehensive set of benefits, but results are highly dependent on study design and implementation.

Many existing CV studies of open space have relatively small sample sizes and suffer from some methodological problems. However, some of the studies have uncovered very interesting findings that could not come out of a hedonic study. For example, it is difficult, if not impossible, for hedonic models to identify the attributes of open space that people value; CV studies can and have made some inroads in this regard. In addition, some CV studies have been able to show the important role played by context; when undeveloped lands are shown to be under more threat of development, the amounts that respondents say they are prepared to pay for preservation rises.

Values from both CV and hedonic studies vary with the type of open space under study. The hedonic studies find, for example, that whether wetlands have value to nearby residents depends on proximity of the wetland, the location under study, and in some cases, the type of wetland. Wetlands in rural areas tend not to have value, and some studies show that forested wetlands also are not valuable, but wetlands in more urban locations and those wetlands showing more open water are valuable. CV studies, on the other hand, tend to find that wetlands of all types have value, though again, the values seem to be lower in rural locations than in urban and suburban locations. Unlike the hedonic studies, the CV studies can and do, to some extent, identify the attributes of wetlands that provide value. Survey respondents indicate that bird and fish habitat and protection of water quality appear to be important in this regard.

Hedonic studies of farmland have provided some interesting results about the value of permanently preserved farms—those under a conservation easement—versus potentially developable farms. However, the results of the studies are mixed; one particularly interesting paper finds that values vary greatly across the three counties the researchers analyzed. All of the studies find, however, that preserved land has greater value than potentially developable land. Because they rely on property values, the hedonic farmland studies provide evidence of benefits to surrounding residents. The CV studies that we reviewed examine the value of preserving land in farming for households that are distant from that land. They find mixed evidence about how much households are willing to pay to preserve farmland under threat of development, but

they do find that households are willing to pay higher amounts the greater the perceived threat. They also find that those with higher incomes are willing to pay more to preserve farmland.

Both CV and hedonic studies generally show that there is value to preserving parks, greenways, forests, and other natural areas in urban locations. However, the values vary widely with the size of the area, the proximity of the open space to residences, and the type of open space. As we stated above, busy urban parks often have negative effects on property values for nearby households; this shows up in several hedonic studies. And the hedonic studies show mixed results for different kinds of open spaces, with some natural areas and wildlife habitats increasing property values and others decreasing them. One good recent hedonic study finds very different results for urban areas and suburban locations, with all kinds of open space providing more value in urban areas than in suburban ones. Greenbelts, or so-called urban growth boundaries, appear to have value, but one interesting study finds that those values can change over time. CV studies find that preserved forests, greenways, and prairies in urban areas have value, as do open spaces in clustered subdivisions. Interestingly, the study that finds that open spaces in subdivisions provide value does not find those same results showing up in a hedonic property value study of houses in that same subdivision.

Given the disparity in results across studies of different scope, methodology, and focus, much more research needs to be done on the important issue of valuation of open space. Though both revealed and stated preference methods have merit, it is important that they be applied to the right problems and that no matter which method is employed, the analysis be done to the highest standards. This is particularly true for CV and contingent choice studies, which have the potential to provide detailed information about values but cannot be undertaken casually. We feel that contingent choice methods show particular promise, however. Their virtues are that they allow for variation—even a narrowly defined variation—in the open space good in question and directly link that variation with dollar values on the questionnaire. At the same time, though, they do not require that respondents provide direct dollar WTP estimates. Rather, a set of hypothetical choices is provided on the survey and values can be elicited from the choices.

Stated preference approaches also can tease out the particular reasons for the values respondents give. For example, respondents can be asked whether values are related to the avoidance of development and the externalities that go with it or are due

to the preservation of pleasant views, recreation, wildlife habitat, and so forth. This can be quite useful information for local planners and policymakers trying to decide what lands to target for preservation.

Hedonic price models have more limited application, but still provide useful information. And given that they are simpler and less expensive than the survey-based approaches, it is important to think about where they have the most value and how they might be improved. We feel that the incorporation of fixed effects and the appropriate segmentation of housing markets is critical for future studies. For example, in suburban markets, incorporation of subdivision-level fixed effects may improve estimates. Existing studies show that the same model estimated with data from different locations can yield very different results: urban versus suburban markets and counties that are next-door neighbors have produced different findings with respect to open space values.

In addition, how open space is assumed to provide value and what variables are included in the econometric model could use more research. Existing studies use dummy variables for whether a property is next to a particular kind of open space, or distance variables, amount of acreage, and percentage of surrounding lands that are in different kinds of open space. Surveys could be used to help inform hedonic models about which variables best capture what it is that people value and what is likely to be capitalized into house values.

Although we conclude from the existing research that open space values appear to vary widely across locations, by type of open space, and by research methodology, more analysis is needed about how to conduct studies with broader applicability. Policymakers at all levels of government are interested in having good estimates of open space benefits to balance against more readily available estimates of costs. Yet, money is not often available to carry out individual valuation studies at every location.

Within the stated preference methods, it has been argued that traditional CV analysis is best suited for determining the total value of a particular resource, but contingent choice methods are better for identifying marginal values or characteristics of that resource. In that regard, contingent choice approaches may have greater potential for allowing transfer of benefits of characteristics found in one area, to estimates of benefits of increasing or improving that aspect of open space in other areas. However, there remain some difficult issues related to identification and aggregation of

individual characteristics in the contingent choice study design. More research is needed on this important question of benefits transfer.

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