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Review of the Effects of Conservation Easements on Surrounding Property Values

Tyler Reeves, Bin Mei, Pete Bettinger, and Jacek Siry

This paper reviews the effects of conservation easements (CEs) on surrounding property values. From the literature, key variable characteristics of CEs that influence surrounding property value are development potential, proximity, and the effect of forest composition and characteristics. Overall, proximity to CEs was found to increase surrounding property values. The tax implications of CEs were also examined. The effect of municipal services, the effect of housing demand, and the potential for self-financing for additional CEs were discussed. CEs were largely found to increase tax revenue by increasing surrounding property values and have the potential for self-financing if designed properly.

Keywords: forestry, hedonic pricing, open space, property tax, real estate

A conservation easement (CE) is a type of voluntary, legal contract between a land conservation agency (a land trust or government agency) that restricts the use of the land to promote its conservation values (Land Trust Alliance 2018). The development rights are transferred to the conservation agency either through donation or by purchase of the development rights. Easements are designed to conserve land that significantly protects open space, promotes recreation opportunities, preserves ecological benefits, and/or preserves historical resources (Wright 1993, Farmer et al. 2011). CEs allow landowners to maintain ownership of their property but prohibit development that violates the terms of the easement. Conservation organizations receiving the development rights enter into a contract with the landowner and agree to monitor and enforce the terms of the easement for the length of the contract (Merenlender et al. 2004, Rissman et al. 2007, Rissman 2013) (For a full description of the details and requirements of CEs, see the tax guide published by the Land Trust Alliance (Lindstrom 2016).

CEs have increased in popularity due to their effectiveness in addressing the problem of increasing amounts of land being converted to development. Between 1970 and 1990, approximately 400,000 acres of rural areas were converted to development yearly in the United States (Garkovich 2000). Today, this rate has increased to more than two million acres annually (Wu et al. 2016, USDA Forest Service 2017b). CEs help maintain the preservation of open space and the continued benefits associated with its preservation. Protected areas can limit fragmentation and overdevelopment, increasing the amount of preserved wildlife corridors and riparian areas. Decreased fragmentation allows for enhanced movement between areas and increases the possibility of genetic exchange (Rissman 2013, Farmer et al. 2015, Braza 2017). CEs can also help protect environmental services such as carbon sequestration, agricultural production, timber production, water filtration, and soil stabilization (Kroeger and Casey 2007, Rissman et al. 2007, Sundberg 2013). Financially, the preservation of open space may increase nearby property values, which in turn could lead to greater tax revenues for municipalities and townships (Mittal 2014).

A CE can be an effective conservation tool for management and policy makers when used properly. When a CE is donated rather than purchased, it can avoid many of the more highly contentious issues of public land acquisition. Additionally, a CE is a much more cost-effective method of preserving land than most fee simple acquisitions (Merenlender et al. 2004, Rissman 2013). Despite its many benefits, a CE is not appropriate in all circumstances. When used improperly, it can result in ineffective conservation outcomes and potentially higher property taxes for nearby residents (King and Anderson 2004, Merenlender et al. 2004). For this reason, it is necessary to know what factors will affect the potential outcomes of a CE before it is implemented.

The effects of CEs on surrounding property value can be highly variable. Land conservation programs must account for the diversity of factors that will potentially change both corresponding surrounding property values as well as conservation outcomes. A synthesis of these factors is needed

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Affiliations: *Tyler Reeves (tgr54347@uga.edu), Bin Mei (bmei@uga.edu), Pete Bettinger (pbettinger@warnell.uga.edu), Jacek Siry (jsiry@uga.edu), Daniel B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602.*

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so that policymakers can have a clearer understanding of the implications of CE implementation. This review seeks to highlight the characteristics of CEs with a substantial forest component. Increasing development pressure and rising property prices have made it more difficult for forest landowners to keep large amounts of forestland intact. A CE or similar alternative such as a conservation use valuation assessment are potential methods to reduce the burden on forest landowners by allowing continued forest operations while reducing the required property tax assessed (Harley Langdale Jr. Center for Forest Business 2017). Specifically, this review focuses on literature using hedonic analyses for valuation as opposed to willingness-to-pay studies. Additionally, while this review seeks to ascertain the effects of CEs on surrounding property values, closely related research on permanent open space preservation is included due to a lack of literature on easements specifically.

Methods

To determine the effects of CEs on surrounding property value, the literature was reviewed with an emphasis on hedonic pricing models, conserved forestland, open space conservation, and CEs. Publications from 1990 to 2017 were considered because of an increase in CE enrollment in the past three decades. The search was expanded to also include those concerning the valuation method of nonmarket environmental amenities published before this period. Typically, cited articles were obtained from an online library search (Web of Science). Search terms were centered on "conservation easements," "property values," and "tax implications." The literature examined focused primarily on the implicit prices associated with easement-related amenities, their effect on surrounding property values, or the value of a CE itself.

This review centers on providing a broad overview of the factors of CEs that affect surrounding property values. Additionally, the tax effects of CEs are also considered. Due to a lack of literature on CEs, studies examining the amenity value of preserved forestland on lands not encumbered with a CE are also reviewed. Several of the same variables affecting how preserved forestland influences property values also likely affect CEs similarly. In reality, not all CEs are characterized by forestland, and preserved forestland would not necessarily be subject to the same restrictions as CEs or vice versa. Where possible, literature focusing specifically on CEs is presented first followed by literature on permanently preserved forest space to frame how this would be comparable to CEs. For this review, the literature was examined in three main areas: the amenity value of CEs, the impact of CEs on surrounding property values, and the impact of CEs on property taxes.

Results

Valuing CEs

There are two main methods to evaluate the amenity value of CEs: the stated preference method, relying on surveys and interviews detailing landowner's preferences and willingness to pay; and the revealed preference method, commonly found by using hedonic models. This review will focus primarily on the use of hedonic models.

Hedonic Pricing Model. Hedonic models operate by valuing products as a differentiated bundle of characteristics. Each of the attributes within the bundle is considered separately with some value attached. The model is generated by estimating the price of a product as a function of these collective attributes. By estimating the potential price from data derived from nearby market prices and attributes, investigators generate estimated coefficients that can be used to represent the marginal implicit prices of these nonmarket products (Rosen 1974, Irwin 2002). Hedonic pricing models are frequently used with housing because of the variety of characteristics that can be associated with it such as footprint (e.g., square feet or meters), number of rooms, distance to major cities, and other measures. The model works by defining a vector of house sale prices (P) as a function of the characteristics of each house. These characteristics are typically divided into four main categories represented in matrix form: the structural components of a house (S), neighborhood and location variables (N), location-specific attributes that measure the amount of nearby land contained within different land uses (L), and time (T). The respective parameter vectors to be estimated from the model are given by $\alpha, \beta, \lambda,$ and δ (Rosen 1974, Irwin and Bockstael 2001, Irwin 2002, Ham et al. 2012, Yoo and Ready 2016).

$$P = f(S, N, L, T; \alpha, \beta, \lambda, \delta), \quad (1)$$

$$\ln P = \alpha S + \beta N + \lambda L + \delta T + \varepsilon, \quad (2)$$

$$\varepsilon \sim N(0, \Omega).$$

The model shown uses a log transformation of price to minimize heteroskedasticity and to address the skewness frequently associated with house sale prices (Wooldridge 2013). The error term is assumed to be independent and have an identical distribution (Ham et al. 2012).

Model Selection. The attributes used to measure the effects of CEs vary considerably. A method that effectively captures the effect of the attributes of interest and how they change must be used. Previous research has demonstrated a preference for utilizing the semi-log model. This model uses a log transformation of the dependent variable to reduce heteroskedasticity and minimize the problems associated with omitted variable bias (Cropper et al. 1988). For continuous variables, the generated coefficient describes the direction, magnitude, and significance of the change in house price by including one additional unit of the variable of interest. For dummy variables, the coefficient represents the additional benefit of that variable being

Management and Policy Implications

The implementation of CEs can result in both positive and negative effects on surrounding property value. With proper planning, CEs have the potential to raise property values and increase tax revenues. This review presents issues that officials should consider before implementing CE programs such as the effect of forest composition on surrounding property values, how forest tracts affect different areas, and what areas should be targeted for CEs. For this review to be useful from a policy perspective, the factors of CEs that provide the greatest benefit in terms of protecting working forests and increasing property values should be prioritized. This means selecting property for conservation that requires little to no additional level of municipal services, is located in areas of lower density and low development pressure, is selected to match the preferred size and structure for the area in which it is located, and is preserved in perpetuity. Properties containing the above characteristics minimize the negative effects of restricting the development potential of land and provide the greatest potential for self-financing through increased tax revenue.

present. Lastly, the log form of the variable is used when including distance, income, and area levels (Ham et al. 2012).

Property and housing prices are influenced by a number of different factors, many of which change in relation to location. Specifically, the value of properties near one another are often systematically related (spatially dependent). This dependence is based on Tobler's first law of geography, which states, "Everything is related to everything else, but near things are more related than distant things" (Tobler 1970). Cliff and Ord (1972) refer to this type of dependence as spatial autocorrelation. Often, spatial autocorrelation is introduced when the prices of houses are based on comparable houses in the same area. Researchers have implemented various techniques to account for this spatial dependence (Cliff and Ord 1972, Anselin and Rey 1991, Cressie 1993, Irwin and Bockstael 2001).

Variable Selection. Many explanatory variables are necessary to capture the amenity value of CEs. Table 1 lists the most frequently used variables included in past hedonic studies. Included as part of the table is a brief description of the variables and their rationales. This list is by no means exhaustive, and several studies have used additional variables as well as some alternative forms of the general variable descriptions. Variables investigated in other studies but not mentioned here include whether the property is near noise-intense activities (Ready and Abdalla 2005), whether the property is near recreational areas (Ham et al. 2012), the slope of the area (Walls et al. 2015), and the year of sale (Mittal 2014).

Effects of CEs on Nearby Property Values

Most studies find that proximity to CEs increases nearby property values. However, there are several different characteristics about CEs that underlie this finding. Some of the important factors found to affect value include development potential (Geoghegan 2002, Irwin 2002, Geoghegan et al. 2003), proximity (Willis and Garrod 1992, Geoghegan et al. 1997, Kim and Johnson 2002, Thorsnes 2002, Nelson et al. 2004, Mittal 2014, Zygmunt and Gluszak 2015, Zhang et al. 2018), and the effect of forest composition and characteristics (Kim and Johnson 2002, Walls et al. 2015, Yoo and Ready 2016, Zhang et al. 2018).

Development Potential. A key feature of CEs is that they are typically granted in perpetuity. As such, the development potential of the area is permanently restricted. This unambiguous preservation of a land use has value to nearby homeowners. Several studies have suggested that open space that is permanently preserved significantly increases nearby property values (Geoghegan 2002, Irwin 2002, Geoghegan et al. 2003). Because CEs result in permanent land preservation, their effects should be comparable to the effects of permanently preserved open space.

Geoghegan (2002) investigated if consumers placed a higher value on property near permanently preserved land. As part of the study, open space was classified into two distinct categories: space that had the potential to be developed, such as privately owned forestland and agricultural land, and space that was permanently preserved, such as lands in CEs and parks. Marginal implicit prices were determined for increasing the percentage of space in a 5,250-ft (1,600 m) buffer surrounding target parcels in Howard County, Maryland. Permanently preserved space increased nearby residential property values by an average of $61,937 as opposed to $17,834 for developable open space. A similar study by Geoghegan et al. (2003) found an increase in the percentage of permanently preserved land in a 5,250-ft (1,600 m) buffer from parcels resulted in an increase in nearby residential property value of $134,270 and $95,555 in Howard and Calvert Counties, Maryland. Property values were not significantly affected in Carroll County, Maryland.

Irwin (2002) also examined the effect of open space permanence on residential house prices in central Maryland. Land categories were divided into permanently preserved or developable open space, public versus private, and type of land use (cropland, pasture, and forest). Public and privately owned conservation land had a positive and significant effect on property values relative to other land use categories investigated. Converting one acre of developable pastureland into private conservation land resulted in an increase of mean residential value of $3,307 or approximately 1.87% of the mean residential value.

Properties near perpetually conserved land are highly desired by landowners. Landowners value the certainty that these properties will not be developed. CEs ensure perpetual conservation and eliminate any concern for development potential. As a result,

Table 1. Most frequently used variables from past hedonic studies on CEs or forestland.

Variable	Description	Rationale
Development potential	Whether property can potentially be developed	Whether individuals place a premium on permanently preserved land
Distance	Distance between a target parcel and the nearest forested area or easement	Whether individuals value being close to forested areas
Forest type	Broadleaf and conifer, trees per acre, and dominant tree height	Whether certain forest characteristics are more desirable than others
Forest patch size	Area of forested patches divided by the total number of forest patches	Investigates the preferred size of forest patches
Forest patch density	Number of forested patches per unit area	Measures whether individuals prefer continuous or fragmented forest landscapes
Buffer(s)	Buffer distances to measure the amount of forestland/conserved area within some predefined space	Determines whether individuals value amenities differently at various scales of measurement
Diversity	Amount of land use categories in an area	Measures whether individuals value a few or diversity of land uses
Fragmentation	The ratio of edge length to interior of parcels	Examines the potential for a loss in landscape use resulting from a decreased interior area
Land use categories	Amount of land in each land use category divided by the total amount of land in all land use categories	Investigates the different values associated with different land use types
Percent conserved	Amount of conserved land within some predefined area divided by total land area	Measures values associated with increased amounts of permanently conserved land within some parcel area
Post	Dummy variable indicating if a land sale took place after the establishment of the nearest easement	Checks for an increase in property value after nearby parcels have been conserved

nearby land prices are raised because consumers are willing to pay for the positive amenity values of permanent open space protection (Geoghegan 2002, Irwin 2002, Mittal 2014).

Proximity. The amenity value of CEs varies with distance. Overall, the effects of CEs are more pronounced the closer they are to a target property. As distance increases from a CE, the price effect diminishes (Chamblee et al. 2011, Mittal 2014). Additionally, the preferred characteristics of CEs change at different scales of proximity. Certain forest characteristics are preferred in the immediate area around residences, while other characteristics are preferred further away from homes (Nelson et al. 2004).

Chamblee et al. (2011) used data on vacant land transactions over a period of 12 years in Buncombe County, North Carolina to determine if conservation takes place in lower or higher priced areas. They found that CEs increase surrounding residential property value by 11%, and this effect decreased with distance from the conserved parcel. However, the price declined less rapidly from easement encumbered properties as compared to properties purchased under fee simple conservation. The respective rates of decline were 1.79% and 0.03% per 328 ft (100 m) for fee simple and CEs. The authors speculated that this might be a result of the perception of lower risk of additional sale and/or development. This implies that CEs may generate a greater amenity effect than fee simple conservation (Chamblee et al. 2011). A similar study was conducted by Mittal (2014) in Worchester, Massachusetts. The study examined the effect of a mixed-bag of open spaces and a subset of CEs on surrounding residential property value. CEs increased surrounding property value, and this effect decreased at a rate of 1% for each measure of distance squared.

Despite a relative lack of research involving the effects of proximity to CEs on surrounding property value, the literature on open space is clear. Proximity to permanently preserved open space tends to increase surrounding property values (Geoghegan et al. 1997, Geoghegan 2002, Irwin 2002). Specifically, proximity to permanently preserved forestland tends to increase surrounding residential property values (Kim and Johnson 2002, Thorsnes 2002, Zygmunt and Gluszak 2015). However, the effect of forestland varies with the measure of proximity.

Willis and Garrod (1992) examined the effect that proximity to forestland had on average home sale prices in Great Britain and found that certain forest types were more preferred. A unit increase in the proportion of deciduous trees located within a 0.67-mile (1 km) grid from homes increased average residential price by $57.91 (£42.81). A unit increase in the proportion of spruce and coniferous trees within the same distance decreased prices on average by $190.74 (£141). Geoghegan et al. (1997) also found differing effects of proximity to forest and agricultural land at varying scales in central Maryland. They measured the effects of proximity to open space using the buffers of 0.06 miles (0.1 km) and 0.67 miles (1 km). They found that a unit increase in the percentage of forestland within the smaller buffer increased average residential sale price by 1.89% but decreased average residential sale price by 3.4% in the larger buffer. They interpreted this as people valued forest space surrounding their houses but preferred more diversity of land uses at a larger scale. Similarly, Nelson et al. (2004) sought to determine if there was a connection between landscape pattern and how individuals valued their property in Gwinnett and Fulton Counties, Georgia. Their results indicated a changing preference of forest landscape patterns at different scales. Measures of patch density for deciduous and mixed forests were recorded at the property, block, and neighborhood level. A marginal increase in the patch density of deciduous and mixed forests in the area surrounding a home increased average residential sale price by $143 and $517, respectively. At the block level, a marginal increase in the patch density of deciduous and mixed forests corresponded to increases of $849 and $2,143. At the neighborhood level, marginal increases resulted in a gain of $1,128 and $8,193. Lastly, decreasing the number and increasing the size of evergreen patches increased house prices by $447 and $2,053 at the block and neighborhood levels. The authors concluded that homeowners preferred deciduous over coniferous trees within their immediate yards. Also, homeowners appeared to prefer a dispersed pattern of trees in their yards. As one increased the distance to the block and neighborhood levels, a mixture of tree species with a dispersed pattern, as opposed to large contiguous tracts, was preferred.

Additionally, areas of preserved forest space demonstrate the same pattern of diminishing price effect with distance. Thorsnes (2002) found that lots bordering suburban forest preserves in Grand Rapids, Michigan were sold at a significant premium ($5,800–$8,400) to those lots not bordering the preserve. However, the positive effects of the preserve were highly localized. There was little benefit for lots not directly bordering the preserve. Kim and Johnson (2002) also found a positive price effect of proximity to the McDonald-Dunn research forest in a study in Corvallis, Oregon. The McDonald-Dunn forest is used by the Oregon State University College of Forestry program for university instruction and research. For each square root of unit distance away from a forest, the average house sale price decreased by an estimated $123. A study by Zygmunt and Gluszak (2015) on undeveloped forestland in Poland found that increasing the distance 328 ft (100 m) from the nearest forest resulted in a 3% decrease in land value. Lastly, a study examining the effects of forest-related CEs on surrounding land value by Zhang et al. (2018) in the Metropolitan Atlanta Statistical Area found that each additional mile away from a CE resulted in a 2% discount in land price. Thus, the positive attributes of proximity to forested areas are more pronounced the closer houses are to the forest boundary.

Effect of Forest Composition and Characteristics. The marginal values of forest composition and characteristics within a CE are not clearly defined. Few studies have investigated these values within the context of CEs. However, the effects of nonencumbered forestland and its composition have been investigated at length (Willis and Garrod 1992, Cho et al. 2009, Ham et al. 2012). The marginal values of forest composition specific to CEs are discussed first, followed by the broader marginal values of unencumbered forestland.

Mashour et al. (2005) investigated how different forest amenities within a CE affected the monetary value of the underlying easement in several counties in Florida. Rather than examining how these traits affected surrounding property value, the authors instead examined how these characteristics affected the actual sale price of the CE. The percent of CE area in upland forest, the percent of CE in wetlands, if the CE allowed silvicultural activity, and if the CE restricted the use of

wetland logging rights were all investigated. A unit increase in the percent area of upland forest resulted in an increase of $38 per acre for the value of the CE. Relinquishing the right to log in wetland areas also increased average CE price by $2,158 per acre. Restricting silvicultural activity did not result in a significant change in the average price of a CE. The large value associated with restricting wetland timber harvest may be due in part to payments received by the Suwanee Wildlife Management division to compensate landowners waiving these rights (Mashour et al. 2005). These results are in line with the goals of programs such as the Forest Legacy Program administered by the USDA Forest Service. This program emphasizes that hydric resources such as wetlands, rivers, and streams be protected (USDA Forest Service 2017a).

An analogous study conducted by Ready and Abdalla (2005) investigated if houses located near land under agricultural easements experienced a price effect from their proximity. They found that houses near agricultural and forestland under easement were worth less than similar houses near unencumbered land. They speculated that this might be a result of the intensity of agricultural production occurring on these lands. Properties adjacent to intensive agricultural production were subject to negative externalities such as increased noise, unpleasant odors, and nonaesthetic views. The effects of agricultural open space can vary from county to county depending on the magnitude of the amenity value of open space and the level of intensity of agricultural production. A study by Yoo and Ready (2016) in two counties in Pennsylvania found similar results. A 10% increase in the proportion of easement protected agricultural land in a 1,312-ft (400 m) buffer surrounding a parcel led to a marginal increase of $167 and a decrease of $408 in average residential sale price in York and Chester Counties. Increasing the proportion of forest cover within the agricultural easements positively affected residential sales price.

Several characteristics of forestland have been shown to affect surrounding property values. Key characteristics of forestland that affect surrounding property value include: forest patch size, forest views, and the heterogeneous nature of forestland. Cho et al. (2009) found differing effects of forest patch size depending on the area in which the parcel was located. Overall, an increase in mean forest patch size was associated with a reduction in housing prices, indicating a preference for smaller forest patches. This result is in line with other studies that found a preference for smaller sized forest patches in neighborhoods (Willis and Garrod 1992, Nelson et al. 2004, Cho et al. 2008). However, conservation of larger patches of forestland around larger metropolitan areas resulted in a higher amenity value for forestland. They attributed this to landowners' preference for larger forest patches due to increased amounts of urban sprawl taking place in these areas. Cho et al. (2008) found that the effects of forest cover varied by the level of neighborhood urbanization. Coniferous species with fragmented forest patches and natural forest edges were preferred in more rural neighborhoods. However, deciduous species of larger patch size and uniformity were preferred in urban areas.

Forest views may also impact surrounding property value. Tyrvainen and Miettinen (2000) found that forest views from homes in Finland increased average home sale prices by 4.9% over homes without a forest view. However, other studies have found a negative or insignificant effect of forest views on surrounding property value. Sander and Polasky (2009) found forestland views did not significantly affect surrounding property values in Ramsey County, Minnesota. Walls et al. (2015) investigated the effect of the percentage of property's view of forestland and other land uses on house sale price. Forest views decreased average sale price by 0.15%. Potential variation in the magnitude and sign of forest views could arise from factors such as the slope of the area and the percentage of area already in certain land uses. Walls et al. (2015) speculated that forest views were not desirable because the topography of the site was flat and the amount of farmland in the region had been decreasing. Thus, increased forest cover likely impeded views, and homeowners might have placed a higher value on farmland because of a perceived scarcity.

Lastly, the heterogenous nature of forestland may affect surrounding property values differently. That is, treating forestland as a uniform land use type fails to account for intra-forest variability. Kim and Johnson (2002) investigated the impact of forests and specific forest attributes on neighboring property values in Corvallis, Oregon. Proximity to forestland increased neighboring property values; however, a larger effect of proximity was detected by accounting for the differences in adjacent forest stands. Taller, mature trees increased the premium associated with forest proximity, while even-aged plantations decreased the premium. An assemblage of stands with 85% or more coniferous trees was preferred and resulted in a marginal value increase of $2,827 compared to tracts with mixed stands. Lastly, parcels from which a clearcut was visible decreased average home sale price by $12,391. A parallel study by Ham et al. (2012) also investigated the effect of accounting for forest heterogeneity had on surrounding property value in El Paso County, Colorado. Key variables tested were whether properties were near noise-intense activities such as timber harvesting and whether recreation opportunities such as biking and hiking trails were located nearby. Proximity to noise-intensive activities decreased average house sale price by $17,690. This offers support for a previous study by Ready and Abdalla (2005), which found negative price effects of intensive agricultural production on nearby property values. The presence of biking and hiking trails did not significantly increase price over that of properties without recreation opportunities. Therefore, the effects of agricultural and forestland on home sale prices appear to be variable. The specific features and activities present play a large role in determining their effect of nearby property values.

Tax Implications

The effect of CEs on a town/municipality's tax base is an important issue for the city council members, residents, and potential owners of CEs in the area. The potential reduction in taxes caused by enrolling property into a CE is important to consider when weighing the option of whether CEs are a viable method for controlling development in an area. Additionally, residents are typically reluctant to see their tax payments increase and are sensitive to policies affecting these payments. Lastly, owners of CEs must consider both the loss in property value associated with restricting their development potential and the potential tax deductions (Kabii and Horwitz 2006).

There is not a consensus opinion on the long-term tax effects of CE programs. Several studies have speculated about the potential effects of CEs on the tax base

(Bolitzer and Netusil 2000, Geoghegan 2002, Geoghegan et al. 2003); however, relatively few empirical studies have been performed (Vandegrift and Lahr 2011). From a purely theoretical standpoint, CE programs could have two separable effects on long-term tax rates. CEs remove more land from potential taxation, effectively reducing the size of the tax base. Therefore, the residents included in the tax base would need to pay more for the same level of municipal services. This is assuming that the prices of the services are not changing because of the CE activity. However, CEs may also increase the demand for adjacent property, raising prices, which could increase the contribution of properties in the area to the tax base (Vandegrift and Lahr 2011, Wu et al. 2016).

Effect of Municipal Services. Previous literature on the effects of open space conservation indicates that as more land is set aside and removed permanently from potential development, the demand for adjacent land will increase, and the price of this land will increase (Geoghegan et al. 1997, Irwin and Bockstael 2001, Geoghegan 2002). Increased property values should then theoretically lead to increased tax revenue for the area. However, there is a caveat associated with this effect. The preservation of the open space must not lead to an increased demand for municipal services. The cost of providing additional services, such as providing sewage line access, typically offsets the gain in property value, and residents end up paying more per capita in property tax (King and Anderson 2004). When little to no additional municipal services are required, the preservation of open space tends to lead to increased property values and thus increased tax revenue. For this reason, CEs represent an ideal form of open space conservation to capture this positive effect. CEs permanently restrict the development rights of the underlying property, effectively eliminating any need for increased municipal services in the area. Additionally, CEs are also unlikely to lead to an increase in demand for municipal services in the surrounding area because of the trend in conservation parcels found by Chamblee et al. (2011). They noted that areas with lower development prospects requiring few additional services were purchased more frequently by land trusts than parcels with greater alternative uses. Often, CE parcels are areas where the most suitable land use is either forestry or agriculture. As a result, conservation of areas with limited development prospects tends to provide more tax revenue than loss (Sundberg 2013).

Effect of Housing Demand. The area where property is preserved also influences the tax implications of CEs. Highly populated areas have high demand for housing. Purchasing land for conservation near these areas is generally more expensive than purchasing land in less populated areas with lower housing demand. Thus, the housing demand of an area can influence whether a potential increase in tax revenue generated by increased property values from proximity to a CE is greater or less than the reduction in property tax caused by its establishment.

Lovell and Lynch (2002) investigated the effect of demand on CE price by examining the change in price with distance in Maryland. As distance from a city increased, the price of CEs decreased. This relationship is also found in a study by evaluating the amenity value of natural attributes in Florida (Larkin et al. 2005). Vandegrift and Lahr (2011) sought to capture the effect of demand by measuring towns' expenditures on land conservation rather than simply the amount of land owned. By accounting for the change in expenditure, they determined that open space spending tended to increase housing values in the area, which should lead to the future benefits of increased tax revenue. Increased conservation spending did decrease the tax base in the short term by removing land that was publicly acquired from being taxed. However, this negative effect was temporary and was offset by the increased property value. Older acquisitions did not make development less desirable and thus did not decrease the tax base into the future.

Conservation organizations should seek to optimize conservation outcomes by purchasing properties that provide that maximum amount of public benefits given the cost of purchasing development rights (Lovell and Lynch 2002). As noted previously, land trusts frequently do so by preserving land with lower development prospects (Chamblee et al. 2011). In particular, purchasing land for conservation with wetlands present is beneficial because of the high biodiversity associated with this land use type and because of its limited development potential (Larkin et al. 2005). Additionally, conservation organizations need to incorporate acquisition costs as part of their conservation acquisition decision-making. Nordman and Wagner (2010) investigated multiple decision criteria in evaluating purchase of conservation land. They concluded that a benefit-cost ratio where acquisition cost was considered provided an effective method of prioritizing candidate properties and selecting parcels that could provide the greatest conservation benefit.

Potential for Self-Financing. One potentially intriguing question about CEs is: If CEs do increase nearby property values and this increase is captured in increased housing prices, could this increased tax revenue be used to fund increased conservation? Lovell and Lynch (2002) estimated the potential marginal return of different farmland characteristics as well as how much farmland would need to be converted to easement land to fund the purchase of an additional acre in Calvert, Carroll, and Howard Counties in Maryland. Funding for preservation came from the Maryland Agricultural Land Preservation Foundation, which receives 14.5% of a state real estate transfer tax and 25% to 67% of an agricultural real estate transfer tax to fund farmland preservation (Lovell and Lynch 2002). To preserve an additional acre of land, approximately 17.9, 8.4, and 22.6 acres of farmland would need to be converted in Calvert, Carroll, and Howard Counties, respectively. An additional investigation in the same area was conducted by Geoghegan et al. (2003). Increases in the percentage of preserved open space significantly affected property values in Calvert and Howard Counties but not in Carroll County. They found that by increasing preserved open space by 1% of the current level, the increased tax revenue would generate a significant portion of the revenue necessary to purchase an additional 1% more acres. Increasing the amount of preserved farmland by 1% (148 acres in Calvert County and 181 acres in Howard County) generated gains in property tax revenue sufficient to purchase an additional 88 and 110 acres of land in the first year. The authors concluded that by increasing the amount of preserved farmland in both counties by 1% and using the additional tax revenue to purchase land for conservation, approximately 2,640 acres could be preserved over a period of 30 years. In a similar study

by Standiford and Scott (2001) in California, the authors found that by increasing the percentage of oak woodlands near the Santa Rosa Plateau housing community, the amount of tax revenue collected could be substantially increased. An increase in the amount of oak woodland acres that would shorten the distance between the community and the wooded area by 10% would add an additional $4 million in property values. This would generate approximately $40,000 additional property tax revenue on an annual basis. However, there would be a limit to potential for self-financing. If all the land within a city or municipality became easement-encumbered property, its tax revenue would decline precipitously. This emphasizes the need for a method to address the balance between increased conservation values and potential loss of tax revenue.

Literature Cited

Anselin, L., and S. Rey. 1991. Properties of tests for spatial dependence in linear regression models. *Geogr. Anal.* 23(2):112–131.

Bolitzer, B., and N.R. Netusil. 2000. The impact of open spaces on property values in Portland, Oregon. *J. Environ. Manage.* 59(3):185–193.

Braza, M. 2017. Effectiveness of conservation easements in agricultural regions. *Conserv. Biol.* 31(4):848–859.

Chamblee, J.F., P.F. Colwell, C.A. Dehring, and C.A. Depken. 2011. The effect of conservation activity on surrounding land prices. *Land Econ.* 87(3):453–472.

Cho, S.H., S.G. Kim, R.K. Roberts, and S. Jung. 2009. Amenity values of spatial configurations of forest landscapes over space and time in the Southern Appalachian Highlands. *Ecol. Econ.* 68(10):2646–2657.

Cho, S.H., N.C. Poudyal, and R.K. Roberts. 2008. Spatial analysis of the amenity value of green open space. *Ecol. Econ.* 66(2):403–416.

Cliff, A., and K. Ord. 1972. Testing for spatial autocorrelation among regression residuals. *Geogr. Anal.* 4(3):267–284.

Cressie, N. 1993. *Statistics for spatial data*. Rev. ed. John Wiley & Sons, New York.

Cropper, M.L., L.B. Deck, and K.E. McConnell. 1988. On the choice of functional form for hedonic price functions. *Rev. Econ. Stat.* 70(4):668–676.

Farmer, J.R., C. Chancellor, and B.C. Fischer. 2011. Motivations for using conservation easements as a land protection mechanism: a mixed methods analysis. *Nat. Area J.* 31(1):80–87.

Farmer, J.R., V. Meretsky, D. Knapp, C. Chancellor, and B.C. Fischer. 2015. Why agree to a conservation easement? Understanding the decision of conservation easement granting. *Landsc Urban Plan.* 138:11–19.

Garkovich, L. 2000. *Land use at the edge: The challenges of urban growth for the South*. Report No. 13. Southern Rural Development Center, Mississippi State University, Starkville, MS.

Geoghegan, J. 2002. The value of open spaces in residential land use. *Land Use Policy*. 19(1):91–98.

Geoghegan, J., L. Lynch, and S. Bucholtz. 2003. Capitalization of open spaces into housing values and the residential property tax revenue impacts of agricultural easement programs. *Agric. Resour Econ. Rev.* 32(1):33–45.

Geoghegan, J., L.A. Wainger, and N.E. Bockstael. 1997. Spatial landscape indices in a hedonic framework: An ecological economics analysis using GIS. *Ecol Econ.* 23(3):251–264.

Ham, C., P.A. Champ, J.B. Loomis, and R.M. Reich. 2012. Accounting for heterogeneity of public lands in hedonic property models. *Land Econ.* 88(3):444–456.

Langdale, H. Jr; Center for forest business. 2017. *Property tax incentives for the Georgia landowner*. Available online at http://www.ugacfb.com/wp-content/uploads/2017/11/2017-Property-Tax-Incentives-for-the-Georgia-Landowner.pdf; last accessed May 11, 2018.

Irwin, E.G. 2002. The effects of open space on residential property values. *Land Econ.* 78(4):465–480.

Irwin, E.G., and N.E. Bockstael. 2001. The problem of identifying land use spillovers: Measuring the effects of open space on residential property values. *Am. J. Agric. Econ.* 83(3):698–704.

Kabii, T., and P. Horwitz. 2006. A review of landholder motivations and determinants for participation in conservation covenanting programmes. *Environ Conserv.* 33(1):11–20.

Kim, Y.-S., and R.L. Johnson. 2002. The impact of forests and forest management on neighboring property values. *Soc. Nat. Resour.* 15(10):887–901.

King, J.R., and C.M. Anderson. 2004. Marginal property tax effects of conservation easements: A Vermont case study. *Am. J. Agric Econ.* 86(4):919–932.

Kroeger, T., and F. Casey. 2007. An assessment of market-based approaches to providing ecosystem services on agricultural lands. *Ecol Econ.* 64(2):321–332.

Land trust alliance. 2018. Conservation options. Available online at https://www.landtrustalliance.org/what-you-can-do/conserve-your-land/conservation-options; last accessed May 11, 2018.

Larkin, S.L., J.R. Alavalapati, and R.K. Shrestha. 2005. Estimating the cost of preserving private lands in Florida: An hedonic analysis. *J. Agr. Appl. Econ.* 37(1):115–130.

Lindstrom, T. 2016. *A tax guide to conservation easements*. 2nd ed. Land Trust Alliance, Washington, DC.

Lovell, S.J., and L. Lynch. 2002. *Hedonic price analysis of easement payments in agricultural land preservation programs*. Working Papers 02-13, Department of Agricultural and Resource Economics, University of Maryland, College Park, MD.

Mashour, T., J. Alavalapati, R. Matta, S. Larkin, and D. Carter. 2005. A hedonic analysis of the effect of natural attributes and deed restrictions on the value of conservation easements. *For Policy Econ.* 7(5):771–781.

Merenlender, A.M., L. Huntsinger, G. Guthey, and S.K. Fairfax. 2004. Land trusts and conservation easements: Who is conserving what for whom? *Conserv. Biol.* 18(1):65–75.

Mittal, J. 2014. Value capitalization effect of protected properties: A comparison of conservation easement with mixed-bag open spaces. *The Journal of Sustainable Real Estate*. 6(1):23–46.

Nelson, N., E. Kramer, J. Dorfman, and B. Bumback. 2004. *Estimating the economic benefit of landscape pattern: An hedonic analysis of spatial landscape indices*. Institute of Ecology, University of Georgia, Athens, GA.

Nordman, E., and J.E. Wagner. 2010. Incorporating acquisition costs in forestland open space programs: Lessons from conservation biology and applications. *J. Forest.* 108(6):282–287.

Ready, R., and C. Abdalla. 2005. The amenity and disamenity impacts of agriculture: Estimates from a hedonic pricing model. *Am J Agric Econ.* 87(2):314–326.

Rissman, A.R. 2013. Rethinking property rights: Comparative analysis of conservation easements for wildlife conservation. *Environ Conserv.* 40(3):222–230.

Rissman, A.R., L. Lozier, T. Comendant, P. Kareiva, J.M. Kiesecker, M.R. Shaw, and A.M. Merenlender. 2007. Conservation easements: Biodiversity protection and private use. *Conserv Biol.* 21(3):709–718.

Rosen, S. 1974. Hedonic prices and implicit markets: Product differentiation in pure competition. *J. Political Econ.* 82(1):34–55.

Sander, H.A., and S. Polasky. 2009. The value of views and open space: Estimates from a hedonic pricing model for Ramsey County, Minnesota, USA. *Land Use Policy.* 26(3):837–845.

Standiford, R.B., and T. Scott. 2001. Value of oak woodlands and open space on private property values in southern California. *Invest. Agrar-Sist. R.* 10(3):137–152.

Sundberg, J.O. 2013. Using conservation easements to protect open space: Public policy, tax effects, and challenges. *J. Property Tax Assess. Admin.* 10(1):5–20.

Thorsnes, P. 2002. The value of a suburban forest preserve: Estimates from sales of vacant residential building lots. *Land Econ.* 78(3):426–441.

Tobler, W.R. 1970. A computer movie simulating urban growth in the Detroit region. *Econ. Geogr.* (46):234–240.

Tyrvainen, L., and A. Miettinen. 2000. Property prices and urban forest amenities. *J Environ. Econ. Manage.* 39(2):204–223.

Usda forest service. 2017a. Forest legacy progam implementation guidelines. Available

online at https://www.fs.fed.us/sites/default/files/fs_media/fs_document/15541-forest-service-legacy-program-508.pdf; last accessed May 11, 2018.

USDA FOREST SERVICE. 2017b. Open space conservation. Available online at http://www.fs.fed.us/openspace/; last accessed 25 August 2017.

VANDEGRIFT, D., AND M. LAHR. 2011. Open space, house prices, and the tax base. *Ann. Reg. Sci.* 46(1):83–100.

WALLS, M., C. KOUSKY, AND Z.Y. CHU. 2015. Is what you see what you get? The value of natural landscape views. *Land Econ.* 91(1):1–19.

WILLIS, K., AND G. GARROD. 1992. Amenity value of forests in Great Britain and its impact on the internal rate of return from forestry. *Forest.* 65(3):331–346.

WOOLDRIDGE, J.M. 2013. *Introductory econometrics: a modern approach*. 5th ed. South-Western Cengage Learning, Mason, OH.

WRIGHT, J.B. 1993. Conservation easements - an analysis of donated development rights. *J Am. Plann. Assoc.* 59(4):487–493.

WU, J.J., W. XU, AND R. ALIG. 2016. How do the location, size, and budget of open space conservation affect land values? *J. Real Estate Finance Econ.* 52(1):73–97.

YOO, J., AND R. READY. 2016. The impact of agricultural conservation easement on nearby house prices: Incorporating spatial autocorrelation and spatial heterogeneity. *J. Forest Econ.* 25:78–93.

ZHANG, W., B. MEI, AND R.L. IZLAR. 2018. Impact of forest-related conservation easements on contiguous and surrounding property values. *For. Policy Econ.* 93:30–35.

ZYGMUNT, R., AND M. GLUSZAK. 2015. Forest proximity impact on undeveloped land values: A spatial hedonic study. *For. Policy Econ.* 50:82–89.