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Trends and Drivers of Conservation Easements in the United States

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Trends and drivers of conservation easements in the United States

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The use of conservation easements has been increasing in the United States. However, patterns of growth over time are different for individual states. Little is known on how determinants of conservation easements interact with one another and affect the choice of conservation approaches. The study objective was to analyze conservation easement trends and examine underlying choice determinants in the United States. Panel data models were employed to assess determinants of easement acres and contracts from 1995 to 2015. Findings revealed that the northern United States has the most percentage of land area under conservation easements. The growth in conservation easements was positively related to gross state products, land market values, air quality, and land use, while it was negatively related to state population density, conservation spending, easement duration and endangered species. Public policymakers would use these findings to integrate easement efforts into local planning to meet conservation and land-use objectives.

Keywords: determinants, easement acres, easement contracts, panel data model

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CHAPTER I

INTRODUCTION

Dynamics of development and population growth have resulted in increasing fragmentation, conversion, and parcelization of lands, thereby, drastically impeding the ability to manage and maintain the benefits they provide. The world is losing open spaces for human development at an alarming rate. Most of the development happens on private land. Agricultural land in the United States has decreased about 20 % since 2001 because of the expansion of nearby urban areas (Riitters and Costanza 2019). About 6,000 acres of open space are lost daily due to residential and commercial use in the United States, a rate of four acres per minute (U.S. Forest Service 2020). Development pressure has also increased land values and property taxes, making it expensive for landowners to keep their land intact (Block et al. 2004). Conservation easements have been one of the most used tools to protect ecosystem benefits (Gustanski and Squires 2000).

A conservation easement is a voluntary legal agreement that transfers identified individual property rights from a public or private landowner to an easement holder to protect conservation values for certain duration or for perpetuity (Vizek and Nielsen-Pincus 2017). An easement[1] holder is a non-profit or government entity that holds land and the right to enforce the provisions of the conservation easement "in trust" for the public good (Owley and Rissman 2016). A conservation easement allows a landowner to maintain property ownership but restricts

[1] Easement in this research always refers to a conservation easement not others.

development that negatively impacts conservation. A conservation easement is appealing to easement holders as it is less expensive than the outright purchase of the land (Shaffer et al. 2002). It protects natural amenities as current and future owners are bound to the easement's terms and conditions agreed upon by the easement originators (Gustanski and Squires 2000). The easement also protects the economic and community benefits such as natural services, and land and natural amenities that arise from the production of resources, products, goods, and services (Sundberg 2013). Other influential factors for landowners entering into a conservation easement on their property are preserving sense of place (attachment of people to a place), and societal, cultural, and financial motives (Farmer et al. 2011; Miller et al. 2011; Merenlender et al. 2004).

Conservation easements have protected millions of acres of valuable wildlife habitat, rivers, lakes, wetlands, oceans, and other open spaces from development and resource exploitation (Rissman and Merenlender 2008). Farmland conservation easements have protected some of the fertile soils and farmland in the United States, ensuring that they will be producing food in the future. Conservation easements have also protected community character and structure through community involvement, connections and networking (Horton et al. 2017), and by limiting development, easements are saving taxpayer money on public infrastructure, and other costs associated with unregulated sprawl as well as protecting economic impacts (Farmer et al. 2011; Fishburn et al. 2009). A spatial model for three Maryland counties suggested that having land under an easement increased surrounding property values which, in turn, increased property tax revenue to a level sufficient enough to finance easements (Geoghegan et al. 2003). If conservation easements are accurately valued to protect land with real conservation benefits, then they will ensure that future generations enjoy open spaces and other ecosystem services by preventing development and improving management of natural resources on the property.

Conservation easement might not be a good option for all landowners. To qualify for the federal tax deduction, the conservation easement must be permanent. The restrictions in property will remain for multiple generations to come. The future value of the property will likely be diminished as a result of the restrictions of the easements. Also, not all land will qualify for a conservation easement. Having a tax or financial circumstances may prevent landowners to enter into an agreement with an easement holder.

With increased awareness of the importance of private lands to environmental conservation efforts, the use of conservation easements as a conservation tool has increased during the past three decades for national, state, and local land trusts (Farmer et al. 2011). The number of acres protected under conservation easements by 2015 was 21 million, an 834% increase from two million acres in 1995 (National Conservation Easement Database 2020). Also, conservation easements have gained popularity internationally throughout Latin America, Canada, Australia, and the Caribbean (The Nature Conservancy 2020). The growing use reflected the widespread use of conservation easements.

Although there has been a dramatic growth in conservation easements in the United States, this growth varies across states when measured in terms of change in the number of acres protected and easement contacts over the years (Fishburn et al. 2009). Many external and internal factors including socioeconomic, bio-physical, and legal and policy affect how conservation easements conserve land (Yuan-Farrell et al. 2005). So far, little has been known on how these factors interact with one another and affect what has been conserved or how it has been conserved (Fishburn et al. 2009; Fishburn et al. 2009; Merenlender et al. 2004). Also, previous studies have shown the urgency of implementing best practice guidelines for designing easements and having a more comprehensive picture of what balance of conservation approaches are desirable for managing conservation easements (Bastian et al. 2017; Fishburn et al. 2009). To address these research gaps, a better understanding of the determinants of conservation easements across the United States is necessary. Therefore, this study identified and described factors leading to the variability of growth in conservation easements across the United States. The study is the first of its kind to analyze determinants of conservation easements using a panel data model for 49 states.

This research had three specific objectives:

Objective 1: Examine the general trends towards the use of conservation easement in the United States.

Objective 2: Analyze the impact of different socioeconomic, bio-physical, and policy factors on increasing conservation easements acreage.

Objective 3: Analyze the impact of different socioeconomic, bio-physical, and policy factors on number of conservation easement contracts.

CHAPTER II

LITERATURE REVIEW

Development in exurban and rural areas in the United States has proliferated since 1950 with an expansion of population after World War II (Brown et al. 2005). It is estimated that urban land in the United States will increase substantially from 3.6% of the total land base in 2010 to 8.6% by 2060 (Nowak and Greenfield 2018). Development and parcelization of private land cause habitat fragmentation; thereby, threatening biodiversity at all levels from ecosystems to species (World Wildlife Fund 2018). A common approach used to control the extent and location of the development is conservation easement acquisition (Gustanski and Squires 2000). Conservation easements are being used globally by land trusts and government agencies as one of the primary tools to achieve conservation goals on private lands (Fishburn et al. 2009). An easement can keep the property in private hands and on the tax rolls; however, it also protects specific conservation values of a property in accordance with the landowner and easement holder objectives (Byers and Ponte 2005). As of 2015, around 21 million acres of land are under conservation easements in the United States, a substantial increase from two million acres in 1995 (National Conservation Easement Database 2020). However, there is a spatial difference in the growth of conservation easements among states (Merenlender et al. 2004). Bio-physical, socioeconomic, and legal and policy factors influence the nature and number of conservation easements within each state (Milder and Clark 2011; Fishburn et al. 2009; Gustanski et al. 2000).

Fishburn et al. (2009) studied how a proportion of conservation investments has changed over time across the United States and for individual states by analyzing all conservation easements and fee simple transactions made by The Nature Conservancy (TNC) in the 48 contiguous states between 1954 and 2003. They examined the balance of investments when measured in terms of the area protected and upfront costs of protecting the land. They explored the influence of six biological and socioeconomic variables using bivariate and multivariate regression models. They found a highly significant positive relationship between year (1954 – 2003) and proportion of investments made as easements measured both in acres and dollars for the United States. At a state level, they found spatial differences in the growth rate of easements. The rate of growth of easements was high no matter how it was measured in states like Texas, Utah, and Maine, whereas the rate of conservation easements decreased in both measures of investment in Missouri. However, they could not identify consistent predictors explaining this pattern. They suggested the need for a broader discussion on type and structure of conservation approaches that work best in different ecological, socioeconomic, and policy contexts.

Albers and Ando (2003) studied whether the variation in the number of land trusts in states across the United States could make economic sense i.e. cost and benefits by modeling the number of land trusts actively engaged in conservation in each state in 1988 and 1998. They highlighted two competing forces: spatial externalities in conservation that increase the efficiency of having few land trusts and diversity in conservation goals leading to greater efficiency in specialization and de-concentration. Using a random-effect negative binomial model, they found that land price in a state had a significant positive relationship with the number of land trusts. Similarly, the number of endangered and endemic species was significantly and negatively correlated with the number of land trusts. So, the increase in the number of endangered and endemic species decreased the number of land trust. Human population density also had a significant negative influence in the study. On the contrary, comparing the demographic characteristics of counties in Georgia with and without an easement, Crehan et al. (2005) reported more land trust activities and easements in counties with higher population densities, and mean incomes. So, these studies showed mixed influence of population to the number of land trust. When the number of local and state land trusts increases, acres protected by conservation easements also increase (Aldrich and Wyerman 2005). The study suggested further empirical analysis to explore the relationship of these variables with conservation agents and conservation activities.

Bastian et al. (2017) compared landowner (i.e., conservation easement suppliers) and land trust (i.e., conservation easement demanders) motivations for entering into easements within the western United States by using a stated choice survey and random utility model analysis. Their results suggested that both landowners and land trusts were more likely to choose conservation easements that were in perpetuity (permanent). However, the result was not consistent with Miller et al. (2011) who analyzed factors impacting landowner willingness to enter into a conservation easement in Wyoming and Colorado. They indicated that landowners had concerns with permanent conservation easements. Bastian et al. (2017) reported a significant and negative influence of public access for landowners and an insignificant negative influence on land trusts. Overall, the result was consistent with other studies (Cropper et al. 2012; Miller et al. 2011). Bastian et al. (2017) also indicated that higher offered benefits (financial incentives) positively impacted landowner as a supplier and negatively impacted land trust easement choice as a demander. The result coincided with findings that landowners expect some financial support for their contribution (Vizek and Nielsen-Pincus 2017; Miller et al. 2011), but that land trusts also expect some level of sacrifice in terms of compensation from landowners (Cropper et al. 2012). The study suggested a need for addressing the potential balance between a landowner and land trust. For this, land trusts should consider developing strategic plans with their conservation priorities and community attachment to identify landowners with the same values.

Parker (2004) described the choice to conserve land with conservation easements using time series and cross-sectional data from the Land Trust Alliance - a national conservation organization representing land trusts across the United States. The study used regression analysis to estimate the percent of acreage that land trusts controlled with conservation easements. Results showed that trusts tend to hold easements when transaction costs are low, and gains from landowner specialization are high. Most trusts preferred to preserve scenic views over large parcels of agricultural land. Parker described the influence of increased state and federal tax benefits to the landowners who transfer rights to trusts. He also identified the emergence of model state legislation, which reflects legislative accommodation of land trusts. Land trust reliance on easements increased most rapidly in states that subsequently adopted the easement statute. This result was consistent with the notion that easement enabling statutes increased the likelihood that courts will enforce conservation easements. In the study, provision for providing forest amenities, rare species habitat, wetlands, and watersheds/water quality did not affect acreage held in easements by land trusts.

Yuan-Farrell et al. (2005) studied the spatial distribution of easements as a conservation strategy by surveying 117 land trusts in California and found that the distribution of easements varied substantially among the 58 counties of California. Population density, developed private land, and land market value were significantly and positively related to easement density, whereas, endangered and threatened species were negatively associated with easement density.

They concluded that the large variance among counties could be due to easements being implemented sooner i.e., having a long duration of conservation easement in some places than others, as easements were comparatively new. This result could be generalized across states, as some states implemented easement laws more promptly than others. This could create variation in the growth of conservation easements across states.

Merenlender et al. (2004) reviewed the literature on the current attractiveness of conservation easements to protect undeveloped land. They showed that little information was available on patterns of areas and resources being conserved under conservation easements. They also reported that studies reviewed offered little information on how conservation easements work best in particular ecological and political settings. There are ample research on why landowner participates in a conservation easement or what motivates landowner to enter into one (Horton et al. 2017; Vizek and Nielsen-Pincus 2017; Brain et al. 2014; Cropper et al. 2012), and these research tend to study landowner experience with a conservation easement and a land trust. However, there is little information on which easement characteristics are attractive to landowners.

Farmer et al. (2011) analyzed factors motivating private, non-industrial landowners who placed conservation easements on their properties. They collected data on landowner property characteristics, and factors related to their decision in Iowa, Michigan, Ohio, and Wisconsin. Results suggested that landowners were more likely to enter into an easement when substantial financial benefits (tax incentives or direct payments) were provided. This finding indicated the importance of financial incentives for landowners. States might differ in the provision of these incentives, and some states may even lag in offering them (Milder and Clark 2011). States like

Colorado and Virginia, where state tax incentives are available, have the fastest rate of easement growth in the United States (Aldrich and Wyerman 2005).

Although numerous studies have examined factors motivating landowners and land trusts to enter into a conservation easement, there is a lack of research solely focusing on drivers of conservation easements. Even if we consider those motivating factors as determinants of conservation easements, how all these factors interact with one another and influence conservation easement is unknown. Also, previous studies have focused on a particular organization either the Land Trust Alliance or the Nature Conservancy looking to implement conservation easements. The impact of combined factors covering a large-scale is still unknown. A better understanding of variables that influence the creation and nature of conservation easements is necessary to understand the growth patterns and to develop better conservation approaches for conservation easement effectiveness.

CHAPTER III

METHODS

Study area

This study covered 49 states, including Hawaii and Alaska. Due to the insufficient data, Rhode Island was excluded. States were classified into four geographic regions following the Forest Service Resources Planning Act (RPA) regions (U.S. Forest Service 2014) to describe the trend in the growth of conservation easement across regions. These regions are used by both the RPA Assessment and the Forest Inventory and Analysis program. There were 19, 12, 5, and 13 states in North, Rocky Mountain, Pacific Coast, and South respectively.

Econometric model

Panel data model

The panel model endowed regression analysis with both spatial and temporal dimensions. It analyzes the differences between individuals or firms, as well as changes within individuals or firms over time. There are mainly three categories of panel models: pooled regression, variable coefficient, and variable intercept. A pooled regression model assumes that the intercept and coefficient of the model would not change with individuals and time. A variables coefficient model assumes that an individual's regression equation has a different intercept and coefficient. A variable intercept model assumes that an individual's regression equation has the same coefficient but different intercepts to capture heterogeneity. The model assumes that the effect of time-varying variables is not individually but collectively significant and has the property of random variables-uncorrelated with all other included and excluded variables (Liu et al. 2018). This study did not aim to model each state or year but to analyze the overall characteristics of all states, so the variable coefficient model was rejected, and the variable intercept model was used. A general panel data regression model to estimate a dependent variable was given in Equation 3.1 (Baltagi 2008):

$$y_{it} = \alpha + \boldsymbol{x_{it}\beta} + u_{it} \tag{3.1}$$

The disturbances followed a one-way error component model:

$$u_{it} = \mu_i + v_{it} \tag{3.2}$$

where *i* was cross-sections dimension and *t* was time-periods, y_{it} was a dependent variable, α was intercept term of individual heterogeneity, x_{it} was an independent variable/regressor, μ_i was a cross-section specific effects and uncorrelated with the regressors, and, v_{it} was an idiosyncratic error (i.e., it varied with time and individuals).

A random-effect model was used to analyzed determinants of conservation easement acres as there was no correlation between the unique errors and the independent variables (i.e., no endogeneity) (Greene 2012). The variable intercept model with a random effect is given in Equation 3.3 (Baltagi 2008). Most variables were measured as logarithms since the logarithm of the data would not change the nature and relationship of included variables and was helpful to heteroscedasticity elimination.

$$y_{it} = \alpha + \boldsymbol{x_{it}\beta} + \mu_i + v_{it} \tag{3.3}$$

where, μ_i was a cross-section specific random effect and was constant through time.

Count data model

The second dependent variable number of contract was a non-negative discrete variable, so, the count-data model was used for estimation of determinants of the number of easements contracts. The Poisson regression model, a non-linear model, has been widely used for such data. The distribution with parameter λ_i took the following general form as in Equation 3.5 (Greene 2012):

$$f(y_{it}) = \text{Prob}(Y = y_{it}) = \frac{\left(\exp(-\lambda_{it})\right)\lambda_{it}^{y_{it}}}{y_{it}!} \qquad (3.4)$$

y_{it} = 1, 2, 3 …

where,

$E\ (y_{it}) = \lambda_{it}$ and $V\ (y_{it}) = \lambda_{it}$.

The Poisson regression model was given by

$$\log\lambda = \boldsymbol{X}\beta,$$

where, β can be estimated either by an iterative non-linear weighted least square method or by maximum likelihood method. The Poisson model was assessed first. However, the goodness of fit suggested the assumption that the mean of the dependent variable is equal to its variance was not valid. Hence, the Poisson model was rejected. Usually, the preferred model in such a case has been the negative binomial model, which allows for overdispersion (Aggarwal 2004; Albers and Ando 2003). The negative binomial model was derived from the Poisson model by introducing the unobserved effect u_{it} into the conditional mean μ_{it} such that

$$\log\mu_{it} = \log\lambda_{it} + \log u_{it} \qquad (3.5)$$

The negative binomial regression model takes the form:

$$\log\mu_{it} = x_{it}\beta + e_{it} \tag{3.6}$$

where, e_{it} reflects a specification error or a cross-sectional heterogeneity and $\exp(e_{it})$ is gamma-distributed.

One of the general forms of the negative binomial distribution is given in Equation 3.7 (Greene 2012):

$$f(y_{it}|\boldsymbol{x_{it}}, u_{it}) = \frac{\big(\exp(-\lambda_{it}u_{it})\big)(\lambda_{it}u_{it})^{y_{it}}}{y_{it}!} \tag{3.7}$$

The distribution had mean λ and variance $\left(\lambda + \frac{1}{\theta}\right)$. Here, y_{it} was the number of easement contracts in a state i during a year t, $y_{it} = \exp\{\boldsymbol{x_{it}\beta}\}$ $\boldsymbol{x_{it}}$ was the matrix of independent variables for state i during year t, and θ was the value of unobserved dispersion parameter. As the study had a short panel (i.e. five-year panel), there could be a bias in the parameter estimates if a fixed effect estimator is used, so a random effect negative binomial model was used (Greene 2012). This estimator specified the distribution of the dispersion parameter to vary randomly among states. The inversion of the dispersion parameter $\left(\frac{1}{1+\theta}\right)$ had a β (*r*, *s*) distribution, where *r* and *s* were just incidental parameters.

The elasticity of different independent variables

In regression, the elasticity is the statistic measuring the relative impact of an estimated parameter. It is the percentage change in dependent variable given a percentage change in an independent variable. The elasticity for random effect model of Equation 3.3 is given by Equation 3.8 (Greene 2012):

$$\varepsilon_{y,x} = \left(\frac{\partial y}{\partial x}\right)\left(\frac{x}{y}\right) = \frac{\partial \ln y}{\partial \ln x} \tag{3.8}$$

For the negative binomial model of Equation 3.7, elasticity is estimated by Equation 3.9:

$$\varepsilon_z = \beta_z z \tag{3.9}$$

where, z was the mean of the independent variable.

R 3.5.1 (R Core Team 2018) and Stata 15 (Statacorp 2017) software were used for the analysis.

Variable description and data sources

From the reviewed literature, three categories of independent variables were identified to explain the determinants of conservation easement acreage and the number of contracts (Table 3.1). The summary statistics of those variables are listed in Table 3.2. The survey years were 1995, 2000, 2005, 2010, and 2015. The first group of independent variables consisted of socioeconomic characteristics, which was related to state social and economic factors. GDP was the total gross domestic product of a state. Conservation efforts or investments made by states largely depended on the state GDP (Fishburn et al. 2009; Crehan et al. 2005). States differed in their GDP per capita as some states have high GDP than others. LMV was the total land market value of a state. The impact of LMV was uncertain as some studies found positive impacts (Yuan-Farrell et al. 2005; Albers and Ando 2003), and some found negative impacts (Fishburn et al. 2009). POP was a population density of a state. TOLD was land development pressure, measured by the change in household numbers in a state. DLAND was total acres of non-federal land developed in a state. An increase in population and land development was perceived to increase the number of conservation easements; however, Albers and Ando (2003) reported negative impacts of population density. CS was the conservation spending of the Land Trust Alliance.

The second group consisted of biophysical characteristics, which were related to a state's environmental condition. NORTH, RM, PC, and SOUTH were dummy variables equal to 1 for a state that falls in a particular region. ETS was the total number of endangered and threatened species in a state. The influence of ETS was negative at a state level (Yuan-Farrell et al. 2005; Albers and Ando 2003), but uncertain at the country level. FOREST was the share of forest land area to the total land area in a state. An increase in forest area was perceived to increase conservation easements. GINI was the toxic air exposure score for a state. With the rise in the GINI score, it was assumed people be more conscious about the environment, thereby increasing conservation activities. ETS, FOREST and GINI were time invariant.

The third group was legal and policy characteristics, which represented legislative provisions of easement-enabling statutes in a state. HOLDER was change in the number of conservation easement holders. When the number of holders increased, acres and contracts of easements also increased (Aldrich and Wyerman 2005). ENACT was the duration of a conservation easement law in a state. Easements being implemented sooner in some states than others could create differences in conservation easement acres, as easements are relatively new (Yuan-Farrell et al. 2005). TAX was dummy variable equal to 1 if a state has a provision of state tax incentives for easement landowners; 0 otherwise. The effect of TAX was not consistent in past studies. Vizek and Nielsen-Pincus (2017) reported a positive impact of financial incentives to landowners; however, financial factors were the lowest-ranked motivation for landowners in Farmer et al. (2011). PLAND was the total acres protected under the International Union for Conservation of Nature (IUCN) in a state. PERP was dummy variable equal to 1 if the state has a provision for holding a conservation easement in perpetuity, 0 otherwise. Landowners didn't prefer to enter into easements in perpetuity (Stroman and Kreuter 2014; Miller et al. 2011), but easement holders with conservation goals had preferences for conservation easements with contract lengths in perpetuity (Cropper et al. 2012). ENCT and PLAND were time-invariant variables. Overall, the past research did not provide any expectations or direction for most of these variables.

The research design is a panel data, and 49 states were included in the data set. Given the availability of data, state-level data were collected from 1995 to 2015 over a five-year interval i.e., 1995, 2000, 2005, 2010, and 2015. GDP was retrieved from the Bureau of Economic Analysis (2018). LMV was obtained from the National Agricultural Statistics Service (2019). POP and TOLD from United States Census Bureau (2019), NORTH, RM, PC, and SOUTH from the U.S. Forest Service (2014), CS and PLAND from the Land Trust (2016a), and DLAND from Natural Resources Conservation Service (2019). ACRE, HOLDER, CNTRCT were compiled from the National Conservation Easement Database (2019). ETS data was collected from U.S. Fish & Wildlife Service (2019). FOREST was obtained from the National Land Cover Database (2019), and GINI was collected from Boyce et al. (2016). Legal and policy data for ENACT, TAX, PERP were from Gustanksi and Squires (2000) and updates made along the time were reviewed.

Table 3.1 Variable definition and data sources included in the panel random effect and the negative binomial model.

Variable	Definition (source)
Dependent variables	
ACRE	Changes in conservation easement areas in a state every five years from 1995 to 2015 (1,000 acres) (a)
CNTRCT	Changes in the number of conservation easement contracts in a state every five years from 1995 to 2015 (100) (a)
Independent variables	
Socioeconomic	
GDP	Gross domestic product of a state by survey years ($ billion; current value) (b)
LMV	Total land value of a state by survey years ($1,000 / acre) (c)
POP	Population density of a state by survey years (person / square mile) (d)
CS	Conservation expenditure of land trusts in a state by survey years ($ millions) (e)
TOLD	The pressure of land development, measured by the change in household numbers in a state every five years from 1995 to 2015 (100,000) (d)
DLAND	Change in the non-federal land area developed in a state every five years from 1995 to 2015 (100,000 acres) (f)
Bio-physical	
NORTH	1 if a state is in the North; 0 otherwise (g)
RM	1 if a state is in the Rocky Mountain; 0 otherwise (g)
PC	1 if a state is in the Pacific Coast; 0 otherwise (g)
SOUTH	1 if a state is in the South; 0 otherwise (g)
ETS	Number of endangered and threatened species in a state (h)
FOREST	Share of forestland to total land area in a state (%) (i)
GINI	Toxic air exposure score of a state (GINI index) (j)
Legal and policy	
HOLDER	Change in the number of conservation easement holders in a state every five years from 1995 to 2015 (a)
ENACT	Duration of a conservation easement law in a state, measured as the difference between 2019 and the enactment year (years) (k)
TAX	1 if a state has a provision of state tax incentives for landowners with a conservation easement; 0 otherwise (k)
PLAND	Land area protected under the International Union for Conservation of Nature in a state (100,000 acres) (e)
PERP	1 if a state has a provision for holding conservation easements in perpetuity; 0 otherwise (k)

Notes: There were five survey years: 1995, 2000, 2005, 2010, and 2015. Variables (ACRE, GDP, LMV, and PLAND) were scaled to natural logarithm to generate interpretable coefficients in fitting the random effect model. Data sources were (a) National Conservation Easement Database (2019), (b) Bureau of Economic Analysis (2018) (c) National Agricultural Statistics Service (2019), (d) United States Census Bureau (2019), (e) Land Trust (2016a), (f) Natural Resources Conservation Service (2019), (g) U.S. Forest Service (2014), (h) U.S. Fish & Wildlife Service (2019), (i) National Land Cover Database (2019), (j) Boyce et al. (2016), (k) Gustanski and Squires (2000).

North states are Connecticut (CT), Maine (ME), Massachusetts (MA), New Hampshire (NH), Vermont (VT), New Jersey (NJ), New York (NY), Pennsylvania (PA), Delaware (DE), West Virginia (WV), Maryland (MD), Missouri (MO), Wisconsin (WI), Michigan (MI), Illinois (IL), Ohio (OH), Minnesota (MN), Indiana (IN), Iowa (IA). Rocky Mountain states are North Dakota (ND), Nebraska (NE), Kansas (KS), South Dakota (SD), Idaho (ID), Wyoming (WY), Montana (MT), New Mexico (NM), Arizona (AZ), Utah (UT), Colorado (CO), Nevada (NV). Pacific Coast states are Alaska (AK), Washington (WA), Oregon (OR), California (CA), Hawaii (HI), South states are Florida (FL), Georgia (GA), North Carolina (NC), South Carolina (SC), Virginia (VA), Alabama (AL), Kentucky (KY), Mississippi (MS), Tennessee (TN), Arkansas (AR), Oklahoma (OK), Texas (TX), Louisiana (LA).

Table 3.2 Summary statistics of variables used in the panel random effect and the negative binomial model.

Variable	Minimum	Maximum	Mean	S.D.
Dependent variables				
ACRE	0.02	1315.84	81.46	132.32
CNTRCT	0.01	82.37	4.35	7.78
Independent variables				
Socioeconomic				
GDP	21.60	2,558.17	304.60	371.39
LMV	0.30	14.24	3.26	2.85
POP	0.90	1,195.70	167.17	222.49
CS	0	185.84	6.89	23.62
TOLD	0.04	18.14	1.70	2.43
DLAND	0.07	8.27	1.46	1.55
Bio-physical				
NORTH	0	1	0.16	-
RM	0	1	0.25	-
PC	0	1	0.27	-
SOUTH	0	1	0.32	-
ETS	4	118	29.37	25.72
FOREST	105.26	636.71	154.26	77.30
GINI	0.64	0.92	0.71	0.10
Legal and policy				
HOLDER	0	311	9.06	22.85
ENACT	22	50	37.16	6.83
TAX	0	1	0.31	-
PLAND	0	5.32	0.40	0.88
PERP	0	1	0.49	-

Notes: S.D. was the standard deviation. The number of observations was 245.

CHAPTER IV

RESULTS

Trends in the use of conservation easements

The growth in conservation easement acres has accelerated in the past three decades as landowners have become more concerned about the loss of open space, habitats, farmland, and recreational spaces. There was a highly significant positive relationship between year and easement acreage (ACRE = -129.03 + 0.10year; $r^2 = 0.49$; $p < 0.001$).

The easement growth measured in terms of acres protected from 1995 to 2015 by region and state is given in **Error! Reference source not found.** and 4.2. In 1995, acres held in a conservation easement in the United States was 0.12 % (2,328,274 acres) compared with 0.93 (21,111,182 acres) in 2015. As of 2015, the most acreage occurred in the North (1.79%) and Rocky Mountain (0.92%) regions, while the least acreage occurred in the Pacific Coast (0.38%) and South (0.90%).

Within the North region, as of 2015 the most acreage was in Maine (10.69%), and least in West Virginia (0.25%). Within the Rocky Mountain region, as of 2015, the most acreage was in Montana (2.69%) and the least in Nevada (0.04%). Within the Pacific Coast region, as of 2015, the most acreage was in California (1.58%) and the least in Alaska (0.03%). Within the South region, as of 2015, the most acreage was in Virginia (4.53%), and the least in Oklahoma (0.21%).

At an individual state level, annual growth rate from 1995 to 2015 was determined. The maximum increase at a state level was for Kentucky (44.06 %), and the minimum for New Mexico (4.19 %). The median increase was for Colorado (14.82 %). The statistics were positive for all states. The calculated annual growth rate for the individual state was shown on the map (**Error! Reference source not found.**). The growth rate of easements had decreased in 2015 for most states (e.g., In Colorado, growth rate from 2005 to 2010 was 77 %, whereas, the growth rate was only 27.48 % from 2010 to 2015). These statistics showed that the trend towards greater reliance on easements was broadly distributed in the United States.

Table 4.1 Acreage changes of land enrolled in conservation easements in the United States by region and state from 1995 to 2015.

Geographic region	Percentage of area under conservation easement		Annual growth rate (1995 – 2015) %
	1995	2015	
All	0.12	0.93	11.65
North (19 states)	0.19	1.79	11.11
Maximum	2.67 NH	10.69 ME	
Median	0.11 HI	1.96 VT	
Minimum	0.00 WV	0.25 WV	
Rocky Mountain (12 states)	0.14	0.92	10.89
Maximum	0.48 MT	2.69 MT	
Median	0.03 ID, UT	0.58 ID, ND	
Minimum	0.00 AZ	0.04 NV	
Pacific Coast (5 states)	0.03	0.38	11.29
Maximum	0.43 HI	1.58 CA	
Median	0.01 OR	0.76 WA	
Minimum	0.00 AK	0.03 AK	
South (13 states)	0.06	0.90	11.43
Maximum	0.45 VA	4.53 VA	
Median	0.04 FL	1.03 AR	
Minimum	0.00 OK	0.21 OK	
Individual states			
Maximum	2.67 NH	10.69 ME	
Median	0.04 FL	0.95 SD	
Minimum	0.00 AK	0.03 AK	

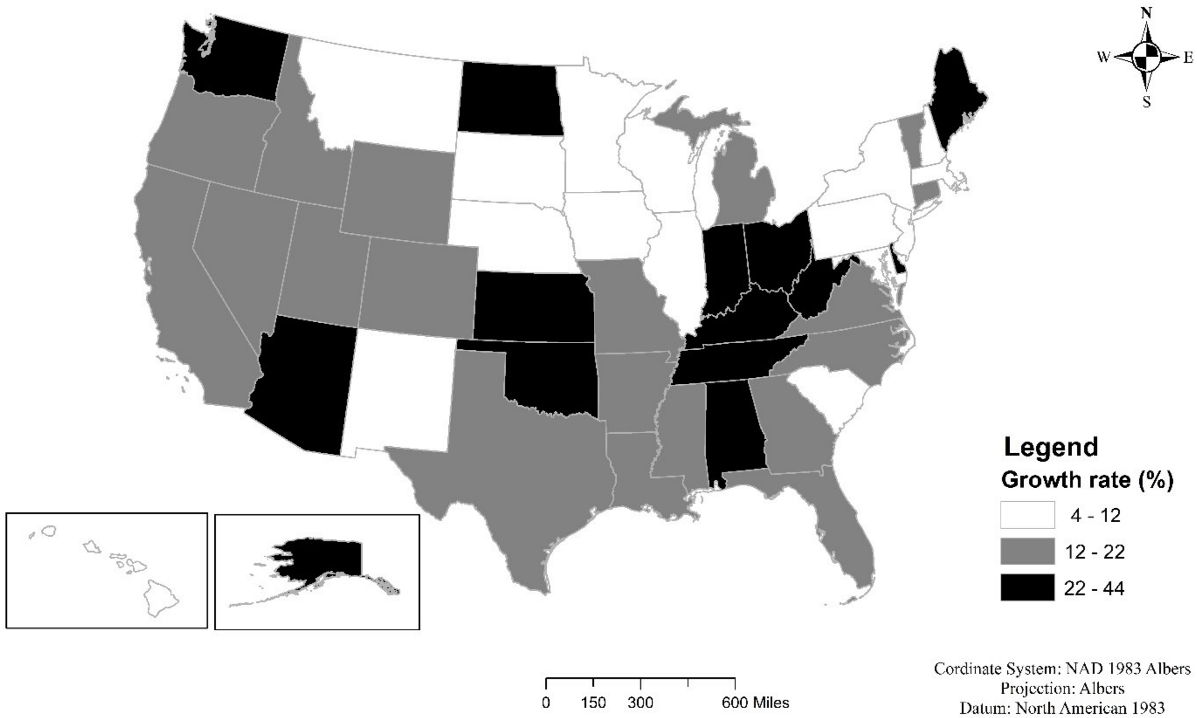

Figure 4.1 Spatial distribution of the annual growth rate in acres enrolled in conservation easements in the United States from 1995 to 2015.

The growth in conservation easement measured in terms of number of contracts is given in Table 4.2. In 1995, number of conservation easement contracts in the whole United States were 20,479 compared with 113,259 in 2015 with 4,639 contracts per year. As of 2015, more number of contracts were made in North (76,303), and the least in the Pacific Coast (9,294). Contracts per year from 1995 to 2015 was more for the North (2,989), the least in the Pacific Coast (398).

Within the North region, as of 2015 the maximum number of contracts were made in Wisconsin (14,836), and the least in Vermont (237). Number of contracts per year was most in Maine (556), and the least in Vermont (10). Within the Rocky Mountain, as of 2015 the maximum number of contracts were made in Colorado (3,707) and the least in Nevada (32). Number of contracts per year was most in Montana (169), and the least in Nevada (1). Within the Pacific Coast, as of 2015 the maximum number of contracts were made in California (6,821) and the least in Hawaii (38). Number of contracts per year was most in California (284), and the least in Hawaii (1). Within the South, as of 2015 the maximum number of contracts were made in Virginia (6,036) and the least in Oklahoma (353). Number of contracts per year was most in Virginia (258), and the least in Oklahoma (17). These statistics showed the trend that states had most contracts in 2015 for each region, they had the maximum contracts per year. New

Table 4.2 Number of conservation easement contracts in the United States by region and states from 1995 to 2015.

Geographic region	Number of conservation easement contracts		Contract per year
	1995	2015	(1995 – 2015)
All	20,479	113,259	4,639
North (19 states)	16,513	76,303	2,989
Maximum	5,150 WI	14,836 WI	556 MI
Median	344 ME	2,050 IL	76 OH
Minimum	13 WV	237 VT	10 VT
Rocky Mountain (12 states)	1,343	12,527	559
Maximum	433 MT	3,707 MT	169 MT
Median	21 NE, NM	710 ID, WY	24 ID, WY
Minimum	1 ND	32 NV	1 NV
Pacific Coast (5 states)	1,317	9,294	398
Maximum	1,124 CA	6,821 CA	284 CA
Median	68 OR	361 OR	14 OR
Minimum	7 AK, HI	38 HI	1 HI
South (13 states)	1,306	15,135	691
Maximum	863 VA	6,036 VA	258 VA
Median	28 NC	786 MS	35 MS
Minimum	1 OK	353 OK	17 OK
Individual states			
Maximum	5,150 WI	14,836 WI	556 MI
Median	79 MS	926 NC	42 KY
Minimum	1 ND, OK	32 NV	1 HI, NM

Number of conservation easements acres per contract was determined for geographic region to see the trend (**Error! Reference source not found.**). Number of acres per contract was increasing for all regions except Rocky Mountain. Conservation easement acres per contract for the whole United States was 113.69 in 1995 as compared with 186.40 in 2015. For the North, number of acres per contract was 48.38 in 1995 while 97.02 in 2015. For the Rocky Mountain, number of acres per contract was 781.44 in 2015 as compared with 544.49 in 2015. Similarly for the Pacific Coast, number of acres per contract was 133.67 in 1995 as compared with 232.52 in 2015. For the South, number of acres per contract was 232.66 in 1995 as compared with 312.27 in 2015. These statistics showed that contracts are not increasing with the rate of increase in acres.

Table 4.3 Number of conservation easement acres per contract across geographic regions in 1995 and 2015.

Geographic region	Conservation easement acres per contract	
	1995	2015
All	113.69	186.40
North (19 states)	48.38	97.02
Rocky Mountain (12 states)	781.44	544.49
Pacific Coast (5 states)	133.67	232.52
South (13 states)	232.66	312.27

Impacts of different factors on increasing conservation easement acreage

Model fit and diagnostic test

The Breusch-Pagan Lagrange multiplier (LM) test was used to decide between random effect regression and a pooled OLS regression. The null hypothesis stated that there were no significant differences across units (i.e., no panel effect). The null hypothesis was rejected, and the random effect regression model was used ($\chi^2 = 18.48$, p-value = 0.0002). To test for a fixed effect and random effect, the Hausmann test was used where the null hypothesis stated that the preferred model was a random effect vs. the alternative fixed effect. As the obtained p-value was greater than 0.05, the null hypothesis was failed to reject ($\chi^2 = 11.71$, p-value = 0.181). So, the random effect model was used. The model fit was significant at < 0.001% significance level with χ^2 (18) = 128.80.

Diagnostic tests/ other tests were performed to evaluate model assumptions. The Durbin Watson (DW) test revealed that there was no autocorrelation/serial correlation in the dataset (DW value = 1.9). In the Breusch–Pagan (BP) test, we rejected the null hypothesis of homoscedasticity. There was the presence of heteroscedasticity in the data set as the obtained p-value was smaller than 0.05 (BP = 181.47, p-value = <0.0003). To account for heteroscedasticity, a robust covariance matrix estimation was used. The corrected standard error (S.E.) from the robust covariance matrix was included in the result (Table 4.4).

Results from the estimated coefficients and elasticities

Results from the final model estimation are presented in Table 4.4. Among six coefficients in a socioeconomic category, four were significant. The coefficient for GDP and LMV were positive and significant at a 1% significance level with an elasticity of 2.310 and 0.520, respectively. POP with an elasticity of -0.062 and CS with an elasticity of -0.056 were significant at a 5% level or better. DLAND and TOLD didn’t show any significant effect. GDP and LMV had a significant positive influence, whereas POP and CS had a significant negative influence on the number of conservation easement acres.

Among the biophysical characteristics, GINI had a significant positive effect with an elasticity of 0.517. ETS had a significant negative impact at a 1% level with an elasticity of -0.065. Geographic regions RM, PC, and SOUTH had a negative coefficient when a base comparison was with NORTH. GINI had a positive influence whereas ETS had a negative influence on the number of conservation easement acres.

Of the five variables representing state legislatures, PLAND, PERP, and CNTRCT were significant at a 1% level, while ENACT and TAX were not significant. The elasticity for PLAND, PERP, and CNTRCT were 0.134, -0.038, and 0.014, respectively. PLAND and CNTRCT had a positive influence whereas PERP had a negative influence on the number of conservation easement acres.

Table 4.4 Determinants of land acreage enrolled in conservation easements in the United States from a panel data model with a random effect from 1995 to 2015.

Variable	Estimate	S.E.	S.E. (corrected)	Elasticity
Intercept	-23.358**	5.556	4.342	
Socioeconomic				
Log(GDP)	0.927**	0.220	0.166	2.312
Log(LMV)	0.710**	0.221	0.194	0.520
POP	-0.383**	0.099	0.111	-0.062
Log(CS)	-0.051**	0.023	0.019	-0.056
TOLD	0.05	0.049	0.024	0.008
DLAND	0.006	0.094	0.071	0.001
Bio-physical				
RM	-1.460**	0.530	0.634	-0.347
PC	-0.498	0.604	0.812	-0.128
SOUTH	-0.669	0.549	0.702	-0.021
ETS	-0.023**	0.008	0.005	-0.065
FOREST	0.002	0.002	0.001	0.025
GINI	7.462**	1.939	1.813	0.517
Legal and policy				
HOLDER	-0.065	0.041	0.044	-0.006
ENACT	0.008	0.026	0.028	0.028
TAX	0.087	0.347	0.329	0.003
Log(PLAND)	0.166**	0.050	0.054	0.134
PERP	-0.819**	0.335	0.338	-0.038
CNTRCT	0.034**	0.013	0.022	0.014

Notes: S.E. was the standard error. The corrected S.E. was obtained after addressing heteroscedasticity from the white test. The total number of observations was 245, covering five years and 49 states.
** Significance at 5% or better

Complementary to the elasticity at variable means as reported in Table 4.4, a more comprehensive observation of the elasticity could be made by graphing the effects on linear prediction (i.e., vertical axis) over the whole range of an independent variable (i.e., horizontal axis). It was displayed for four variables (i.e., GDP, LMV, GINI, and PLAND) (Figure 4.2). The slope of the curve was the elasticity of the variable on the horizontal axis. The upward trend of the curves indicated a positive relationship between the independent variable and the prediction probability of the conservation easement area. In contrast, a downward trend indicated a negative relation. Taking the variable of the LMV as an example, for all the observations, at the sample mean (i.e., 7.5 and the dashed line in Figure 4.2), the slope of the curve was the elasticity for LMV as reported in Table 4.4.

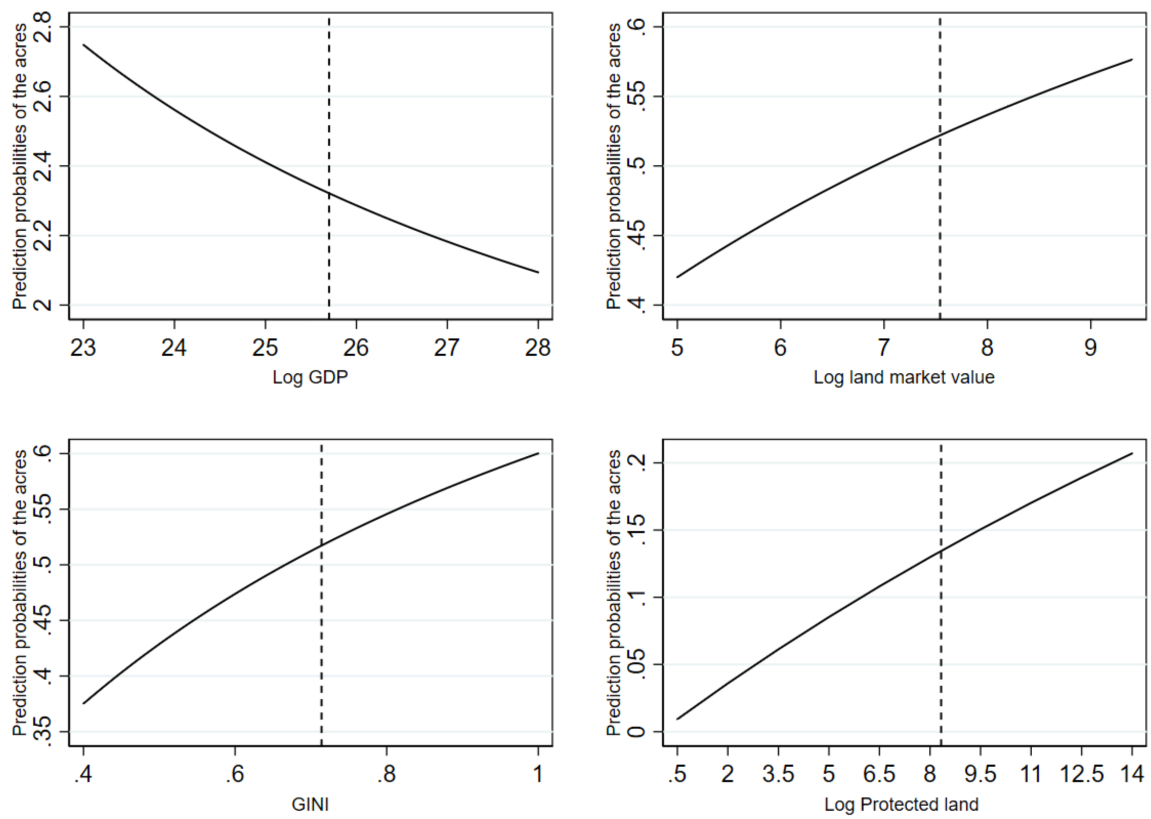

Figure 4.2 Impact of selected variables on the predicted probabilities of acres enrolled in the conservation easements in the United States from 1995 to 2015.

Dash lines denoted the mean value of a selected variable. Selected variables were log (GDP) ($), log (LMV) ($), GINI (index), and log (PLAND) (acres).

Impacts of different factors on the number of easement contracts in a state

Model fit and diagnostic test

The likelihood ratio test suggested that the overall random effect negative binomial model was significant (χ^2 (15) = 129, p-value < 0.001). The test statistics was negative two times the difference of the log-likelihood from the Poisson model and the negative binomial model, χ^2 (01) = 156.97 with an associated p-value of < 0.0001. This large test statistics suggested that data was over-dispersed and not sufficiently described by the Poisson distribution. Incidence Rate Ratios (IRR) [i.e., exp ($\boldsymbol{\beta}$)] were calculated to facilitate the interpretation of variables included in the model. The final set of variables, IRR, their corresponding elasticity, and standard errors (S.E.) are presented in Table 4.5.

Results from the estimated coefficients and elasticities

Among the 15 variables regressed in the model, 11 variables had a positive impact, whereas four variables had a negative effect on the number of easement contracts (Table 4.5). IRR was used to interpret the result. If the IRR is 1.50, then a percentage point increase in an independent variable would increase the count by 50 % when all other variables are at their means. IRR exceeds one for the variable having a positive relationship with the dependent variable.

Among the six variables representing socio-economic characteristics, GDP, LMV, and TOLD were positively significant at a 10 % level, while CS was negatively significant at a 5 % level. With a one million dollar increase in GDP, there was an increase of 55 % in the number of CE contracts. LMV seemed to be the most important variable resulting in a 75-76 % increase in the number of contracts when LMV was increased by 1000 dollars. The effect of CS was negligible.

Of the five variables representing bio-physical characteristics, only two variables (ACRE and FOREST) were significant. An increase of 10 acres in ACRE was associated with a 16 % increase in the number of contracts. Of the four variables representing legislative characteristics, only ENACT (at 1% level) and PLAND (at 10% level) were significant. An acre increased in PLAND led to a 14% increase in the number of contracts.

Table 4.5 Determinants of the number of conservation easement contracts in the United States from the negative binomial model with a random effect from 1995 to 2015.

Variable	IRR	S.E.	Elasticity
Intercept	0.490	0.905	
Socioeconomic			
GDP	1.556*	0.241	0.152
LMV	1.755*	0.321	0.210
POP	1.035	0.060	0.077
CS	0.001*	2.909	-0.056
TOLD	1.033*	0.019	0.075
DLAND	1.023	0.041	0.045
Bio-physical			
ACRE	1.163*	0.023	0.166
ETS	0.995	0.004	-0.187
FOREST	0.997*	0.001	-0.590
GINI	0.800	0.964	-0.215
Legal and policy			
HOLDER	1.015	0.013	0.018
ENACT	1.041*	0.014	2.016
TAX	1.195	0.179	0.074
PLAND	1.144*	0.092	0.073
PERP	1.165	0.189	0.101
$\boldsymbol{ln(r)}$	0.524		
$\boldsymbol{ln(s)}$	4.851		
Log-likelihood	-1572.4		
Wald χ^2	129.1		

Notes: IRR was the incidence rate ratio. The number of observations was 245, covering five years and 49 states. The inverse dispersion parameter had a β (r, s) distribution, where r and s were just incidental parameters.
*Significance at 10% or better

Complementary to the elasticity at variable means as reported in Table 4.5, make a more comprehensive observation of the elasticity could be made by graphing the effects on linear prediction (i.e., vertical axis) over the whole range of an independent variable (i.e., horizontal axis). It was displayed it for four variables (i.e., GDP, LMV, ACRE, and PLAND) (Figure 4.3). The slope of the curve was the elasticity of the variable on the horizontal axis. The upward trend of the curves indicated a positive relationship between the independent variable and the prediction probability of the number of contracts. In contrast, a downward trend showed a negative relation. Taking GDP as an example, for all the observations, at the sample mean (i.e., 0.256 and the dashed line in Figure 4.3), the slope of the curve was the elasticity for GDP as reported in Table 4.5.

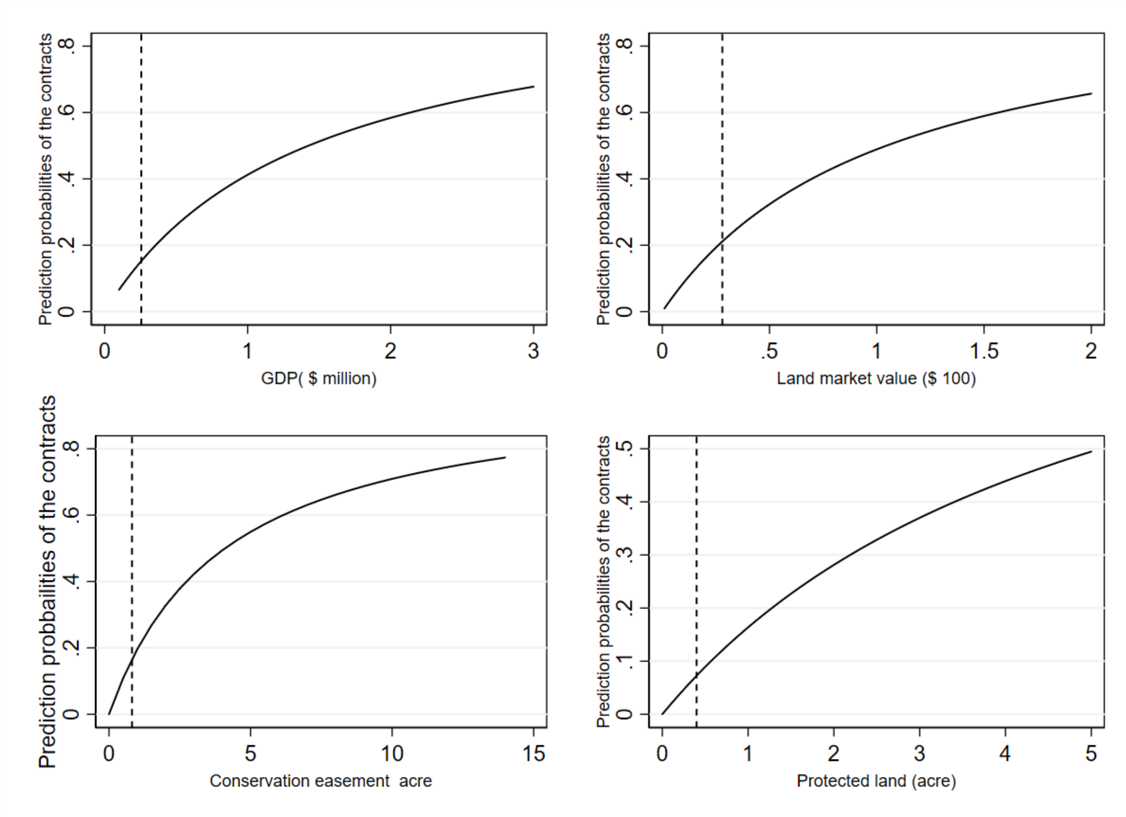

Figure 4.3 Impact of selected variables on the predicted probabilities of the number of easement contracts in the United States from 1995 to 2015.

Dash lines denoted variable means on the horizontal axis. The selected variables were GDP ($ million), LMV ($ 100), ACRE (acres), PLAND (acres).

CHAPTER V

DISCUSSION

In recent years, conservation easements in the United States have been gaining popularity. As of 2020, it is estimated that 40 million acres nationally are preserved by conservation easements. This is more acreage than exists in national parks in the lower 48 states. To help understand the distribution and variation of conservation easements, the impact of different factors on the growth of conservation easements was analyzed in terms of acres protected and the number of easement contracts. Trends of conservation easements was also examined across geographic regions and selected states using area protected as a comparison metric.

There are numerous works looking at factors affecting landowner and land trust preferences and motivations for conservation easements at different scales. However, there was little in the way of literature on national level factors influencing conservation easement growth at any scale. Therefore, the comparisons of this study results were made with those studies about landowners and land trusts.

Growth of easements by area and number of contracts has continued to rise exponentially. Different organizations have used conservation easement to protect property, but their popularity started to increase in the 1970s (Kiesecker et al. 2007). As of 2005, the American Pacific Coast was the fastest-growing region in terms of the number of acres protected (Aldrich and Wyerman 2005). In our study, the South emerged as the fastest-growing region, nearly tripling acres held under easements in five years from 2010 to 2015. This high demand for conservation easements in the South could be linked to high participation in nature-based recreation (hunting, fishing and wildlife watching), and more marginal and private lands, further supported by to protection favorable environmental policy [e.g., Farm Bills, The Endangered Species Act 1973 (ESA)].

Across states, the growth rate in the easement acres varied from 4% to 44 %. This variation was explained by the impact of associated factors. States with the slow growth rate were in mostly in Rocky Mountain and North. There is more potential for states in the South and Rocky Mountain to increase conservation easements. States in these regions still have relatively less acreage under easements.

States that had least percentage of area under conservation easements including OK, AK, AZ, and WV had high annual growth rate. North and Rocky Mountain had relatively more percentage of area under conservation easement but had a low annual growth rate. This could be associated with a high marginal cost for enrolling additional easement acreage. The cost for a new easement transaction would be high if a state already had more private land under easements. Another region might be these regions that have more percentage under easements have reached a saturation stage where they have no available space for further conservation easement enrollment. This study recommends future research in this aspect.

The study result of a decreased easement growth rate in 2015 was consistent with the finding that easements under the Land Trust Alliance and The Nature Conservancy have decreased with an increase in government funding for other working land programs (Parker and Thurman 2011). Another explanation might be those easement holders, which have focused mostly on acquiring new conservation easements in past years, are now shifting their focus in the management of easements they hold. The Land Trust Alliance had spent approximately one billion dollars in implementation and management (for monitoring, stewardship, legal defense, enforcement, and operations) of easements compared to about 695 million dollars spent in land acquisition from 2010 to 2015 (Land Trust Alliance 2016b). This was further supported by a significant negative influence on conservation spending (CS). Wallander (2019) reported that conservation spending of easement programs was steady while working land programs conservation spending increased from 1996 to 2017. The negative sign on CS might also indicate that the rate of increase in land market value was higher than the rate of increase in CS made by easement holders.

In our study, GDP was found to have a positive impact on the growth of easements. States with high GDP might invested more in conservation programs, or they would give more donations to a conservation program. This was consistent with past research indicating the importance of the state economy to land trust activities and conservation easements (Fishburn et al. 2009; Crehan et al. 2005). However, an increase in conservation easement acres might decrease the contribution of forestry and farm sectors to a state economy.

LMV had a positive impact on the growth of easements. The higher cost of land was related to increased development pressure. Places facing high development pressure would have a threat to save remaining open spaces and high demand for quality environmental factors. This was further supported by a positive and significant parameter associated with air quality (GINI). When air quality deteriorates in a locale, demand for an easement in that place increases, so areas with high development pressure might invest more in conservation programs for a healthy environment (Aldrich and Wyerman 2005). For a land trust, easements are more cost-effective than the out-right purchase in places with higher land prices (Yuan-Farrell et al. 2005). However, some studies have suggested that conservation easements might not be cost-effective in areas with the greatest developmental pressure due to externalities (Fishburn et al. 2009; Albers and Ando 2003). Since the study analyzed general characteristics at the national level, it might not represent the trend for a specific state or land use.

While past studies had highlighted the importance of protecting lands with a scenic view, as well as ecological and historical significance (Cropper et al. 2012; Aldrich and Wyerman 2005; Parker 2004), we found a positive impact of PLAND in the growth of conservation easements. Environmental objectives, including protection of wildlife habitats and natural and historical places, have been critical objectives of farmland preservation programs in the United States (Stroman and Kreuter 2015). This result also demonstrated the importance of easements in maintaining a scenic landscape, habitat connectivity, and historical sites. Furthermore, this might relate to a landowner's obligation to protect such lands, which might be an essential driver in land conservation.

A negative coefficient on the population density (POP) might indicate that easement holders with ecosystem preservation goals consider high population density as a threat to their objectives. Therefore, they would be looking for lands that provide ecosystem services away from population centers. Also, densely populated areas might contain only a few land parcels for conservation or parcels with limited conservation value (biological, ecological, social or cultural) (Cropper et al. 2012; Albers and Ando 2003). On the contrary, some studies have reported more land trust activities and easements in locales with high population density (Crehan et al. 2005; Yuan-Farrell et al. 2005). The negative impact of threatened and endangered species (ETS) could be linked to the public perceptions that these endangered species are to be protected by federal and state regulations and conservation activity. Thus, there is no need for private conservation efforts.

Usually, land trusts were found to choose conservation easements that were in perpetuity for their long-term goal of ecosystem conservation (Bastian et al. 2017; Cropper et al. 2012). Landowners indicated concerns with permanent conservation easements as they don't want to impose their decision on their descendants and therefore they are not sure if they would like a conservation easement or not (Stroman and Kreuter 2015; Miller et al. 2011). In our study, PERP was negatively related with ACRE and was statistically significant. This implied a negative influence of perpetual duration. Landowners and easement holders would have different preferences or choice for making decision. So, conservation easements should be drafted such that they compile all relevant laws, carry out landowner intent, and provide easement holders with the flexibility needed to administer easements consistent with their conservation objectives considering a changing condition. This could potentially increase the volume of easement transaction.

States enacted easement statutes in different years, and they varied in the provisions they allowed for conservation easements to protect lands (Gustanski and Squires 2000). Places, where easement statutes were implemented sooner, had more easement acres than other sites (Yuan-Farrell et al. 2005; Parker 2004). A positive sign on ENACT supported the notion that states with a long duration of easement laws had more easement acres. In previous studies, federal and state tax incentives were considered one of the main drivers for a landowner to choose an easement (Bastian et al. 2017; Farmer et al. 2011; Parker 2004). Thus, TAX was expected to have a significant impact on easement growth. However, it was statistically not significant in our study. It might be that landowners do not highly prioritize financial incentives as a motivation to enter into an easement agreement. Landowner receiving economic returns from the land was less likely to place an easement except for absentee landowner who does not consider financial incentives to place an easement (Farmer et al. 2015).

This study had a few limitations. First, conservation easement related data were collected from the National Conservation Easement Database (NCED). Data represent the whole United States but might not cover nationwide real easements number status since not all easements are recorded in the database. Second, the rest of the data were retrieved from different sources. Those data were collected with different objectives and at different times. Third, functional forms of independent variables were changed for both General Linear Model (GLM) and Maximum Likelihood (ML) models to ensure a better model fit.

CHAPTER VI

CONCLUSIONS

In recent decades, conservation easements have emerged as one of the widely used tools for open space preservation. The study categorized different factors that might have influenced the growth of conservation easements in a state. A panel data analysis of 49 states over 20 years (1995-2015) suggested consistent predictors explaining the spatial differences in the growth of easements across the states. The increase in conservation easements across states was positively related to gross domestic product, land market value, air quality, forest area, and land use. In contrast, the growth was negatively related to population density, conservation spending, easement duration, and endangered species in a state.

The result of the study provided a broader picture of how we should structure and what combination of different socioeconomic, bio-physical, and legislative factors is desirable to increase the volume of easement transaction as well as the efficiency of an existing easement. The study explored the legal characteristics of an easement, including duration, financial incentives, and land use that were considered attractive to landowners.

Empirical evidence from the study has several implications. It would help easement holders and landowners with a clearer understanding of factors influencing conservation easements, providing them with opportunities to successfully negotiate an agreeable conservation easement. This could increase the number and quality of conservation easements resulting in an increase in acreage under conservation easement at more efficient market value, thereby improving overall market efficiency. Findings from the study would assist policymakers as they are responsible for allocating scarce resources for land conservation and land use planning. Public policymakers would be able to use these findings to review decisions on conservation funding (e.g., farm bill) as well as integrate conservation easement efforts into local plans to better meet public conservation and land use objectives. Conservation outcomes could be changed by considering the factors identified in this study. If public policymakers identified that landowners do not prefer a perpetual easement, they might consider changing easement laws to address the potential balance between landowners and easement holders.

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