Crowding Out Open Space: The Effects of Federal Land Programs on Private Land Trust Conservation

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ABSTRACT. *We examine the effects of U.S. federal land programs on private conservation using county-level panel regressions. Private conservation data measure acres held by The Nature Conservancy (TNC) and by participants in Land Trust Alliance (LTA) censuses. Government data measure federal landholdings (e.g., national parks and forests) and enrollment in the Conservation and Wetland Reserves (CRP and WRP). We find a small crowding-out effect from the CRP on LTA trusts. With TNC, we find crowding in from the CRP and crowding out from federal landholdings. Our theory gives insights as to why these and other effects (e.g., population and income) differ between TNC and the LTA trusts.* (JEL H41, Q38)

I. INTRODUCTION

Several empirical papers analyze whether or not government spending has "crowded out" the private provision of public goods, and the findings vary widely depending on institutional context.[1] Estimates range from a decrease of 0.13 to 0.18 private dollars for each government dollar spent for public radio (Kingma 1989; Kingma and McClelland 1995), 0.23 for international relief and development aid (Ribar and Wilhelm 2002), 0.50 for domestic social services (Payne 1998), and up to 0.60 for arts organizations (Dokko 2009).[2] Khanna, Posnett, and Sandler (1995) estimate "crowding in" of 0.09 for British charities, and Payne (2001) finds evidence that federal research grants have crowded in private donations to U.S. research universities by 0.65 dollars per dollar. In what is apparently the only empirical analysis focused on environmental nonprofits, Heutel (2007) does not find evidence of crowding out or of crowding in.

In this paper, we examine the crowding-out hypothesis in a new empirical context that also focuses on environmental goods. Here we estimate the effects of U.S. federal land conservation programs on the growth of private conservation through land trusts. Land trusts are nonprofit organizations that conserve environmental amenities such as open-space scenery and wildlife habitat primarily by owning land and by holding conservation easements. The Nature Conservancy (TNC) is the nation's largest, but over 1,500 smaller trusts operate in local regions throughout the United States. Nationwide, the number of trusts grew from 537 in 1984 to 1,537 in 2003. The number of acres they held increased from 1.2 million in 1984 to over 10.8 million in 2003. During the same period, over 30 million acres were enrolled in the federal government's Conservation Reserve Program (CRP), and over 1 million acres in the Wetland Reserve Program (WRP). Over 3 million acres were acquired by federal land agencies, adding to a federal estate of over 450 million acres in the lower 48 states.

Our econometric analysis evaluates the crowding out (or crowding in) of land trust acres at the county level using a panel regres-

[1] Theories developed by Warr (1982) and Roberts (1984) imply that government provision should displace, or "crowd out," private donations on a dollar-for-dollar basis. The neutrality (and futility) of government spending, however, hinges on some restrictive assumptions that are relaxed in later theoretical papers (see, e.g., Bergstrom, Blume, and Varian 1986; Rose-Ackerman 1986; Andreoni 1990).

[2] The cited studies use field data. Other empirical studies use data from laboratory experiments to infer incomplete crowding out (see, e.g., Andreoni 1993; Bolton and Katok 1998; Eckel, Grossman, and Johnston 2005).

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sion framework. Using data from TNC and from Land Trust Alliance (LTA) censuses, we have identified or estimated the total acres held by land trusts in each U.S. county in 1990 and 2000. On the government side, we have constructed a county-level panel of CRP acres, WRP acres, and federal government land holdings as measured by payments in lieu of taxes (PILT) records. We estimate separate crowding-out and crowding-in effects for TNC and the LTA trusts because the goals and scope of these organizations differ. Examining the response of private conservation to federal programs contributes to the land conservation literature in general and in specific ways. In a general sense, our study contributes to the literature examining the unintended effects of government land policies on private land use. Examples include papers by Wu (2000) and Lueck and Michaels (2003).[3]

Our study also contributes to a small empirical literature on the demand for land trusts and on the relationship between government and land-trust conservation. Albers and Ando (2003) find a positive relationship between the amount of government acres in a state and the number of land trusts operating at the state level using a pooled regression model for 1988 and 1998. Mulholland (2004) uses a longer time series and finds a positive relationship between the number of trusts operating at the state level and federal Conservation Reserve Enhancement Program spending. Albers, Ando, and Chen (2006) examine spatial variation in levels of privately conserved acres across townships within California, Illinois, and Massachusetts. They find a negative correlation between the number of acres conserved publicly and privately in Illinois and Massachusetts, but a positive correlation in California. The sign of correlations between private conservation and factors such as income and population density also vary across states.[4] Our analysis contributes to this literature by examining determinants of the growth in land trust acres (rather than in the number of trusts) across all U.S. counties and relating this growth to the growth in government acres using a panel (rather than a cross-sectional) data set.

Our analysis begins with a description of the spatial patterns of growth in land trust and government conservation. We next present a theory of the effects of changes in county income and government conservation on land trust growth. Our econometric methodology allows for state-specific growth trends, along with county-fixed effects, and employs a Gibbs sampler to account for censoring—a number of counties had zero trust acres in either 1990 or 2000. We conclude with a detailed interpretation of how the empirical results relate to the theoretical framework. We also propose explanations for why the effects of government acquisitions, population growth, per capita income growth, and other factors differ between TNC and the LTA trusts.

II. SPATIAL GROWTH IN LAND TRUST AND GOVERNMENT ACRES

National-level data on land trust and government conservation mask interesting spatial patterns of growth within the United States. In this section we describe data from the LTA and TNC that we use to construct our county-level panel of acres held by land trusts. We also describe the county-level panel of CRP acreage, WRP acreage, and federal government land holdings as measured by PILT records. By combining PILT records and data on the CRP and WRP we cover the largest and most relevant federal land and conservation programs active between 1990 and 2000.[5]

[3] Wu shows that CRP enrollment raises agricultural output prices, thereby giving farmers incentives to bring marginal land that was previously idle back into cropland production. This "slippage" effect militates against the program's goal of idling cropland. Lueck and Michaels find evidence that U.S. Endangered Species Act restrictions have caused preemptive habitat destruction on forest lands in North Carolina, an obvious perverse result.

[4] In related research, Kotchen and Powers (2006) examine the appearance and passage of open-space ballot initiatives in different U.S. jurisdictions. The income of residents is generally positively associated with the probability of an initiative appearing and passing, but the effects of other factors (e.g., population density and growth) are less robust to the geographic region of analysis.

[5] The federal government also affects land trust activity through various matching grant programs including the Forest Legacy Program and the Farm and Ranchlands Protection Program. However, these programs are relatively small and were not started until the late 1990s.

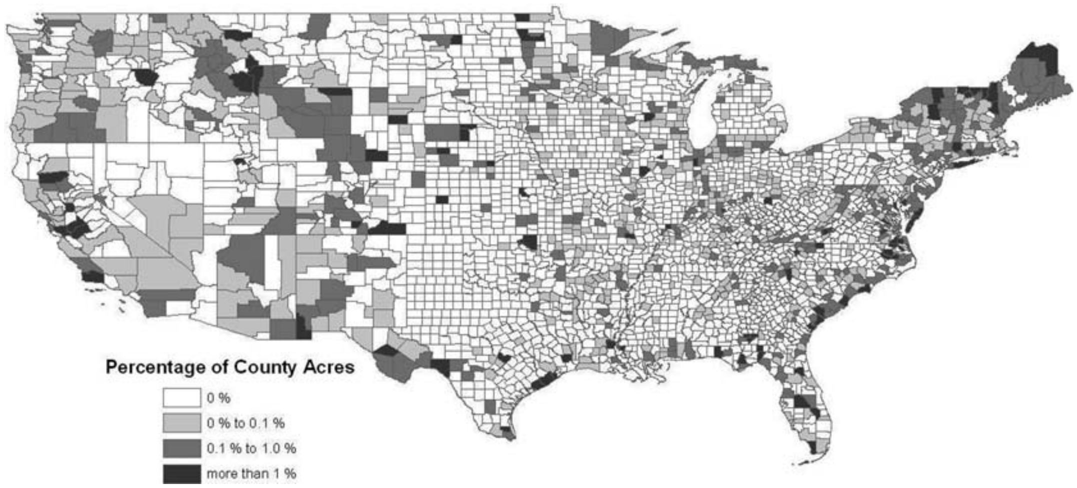

FIGURE 1
The Nature Conservancy Acres by County, Year 2000

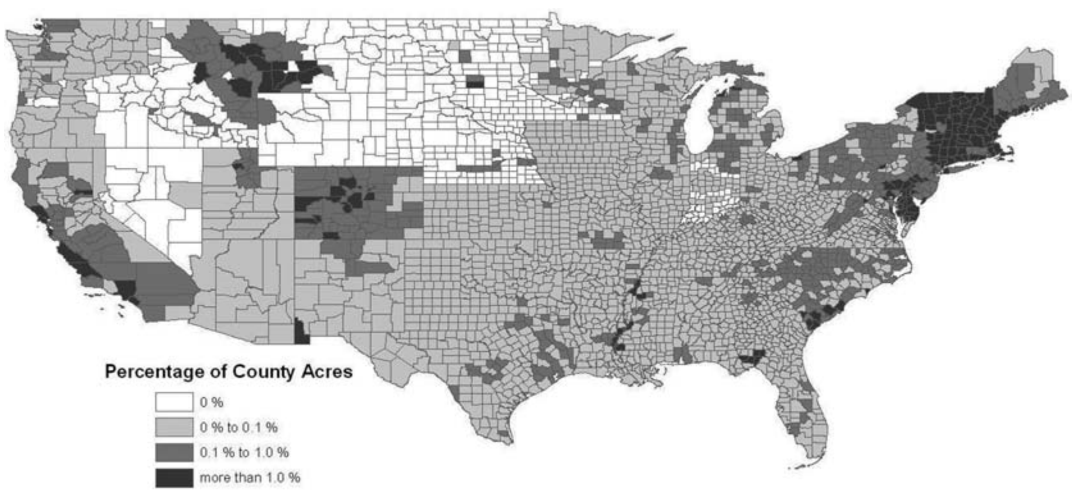

FIGURE 2
Land Trust Alliance Acres by County, Year 2000

Land Trusts

Land trusts conserve land by owning it outright or by holding conservation easements. Conservation easements are legally binding agreements that usually prevent landowners from actions such as developing dense residential or commercial structures but may also prohibit agricultural or forestry management practices (Parker 2004). The terms conveyed in conservation easements "run with the land" into perpetuity. That is, until an easement is amended or extinguished by a judge, successor landowners and successor trusts are bound to the terms agreed upon by the original parties (Korngold 1984; Mahoney 2002).[6]

[6] Conservation easements fall under the broader umbrella of servitude law. Servitude law also governs rights of travel across another's land, rights to use another's land or

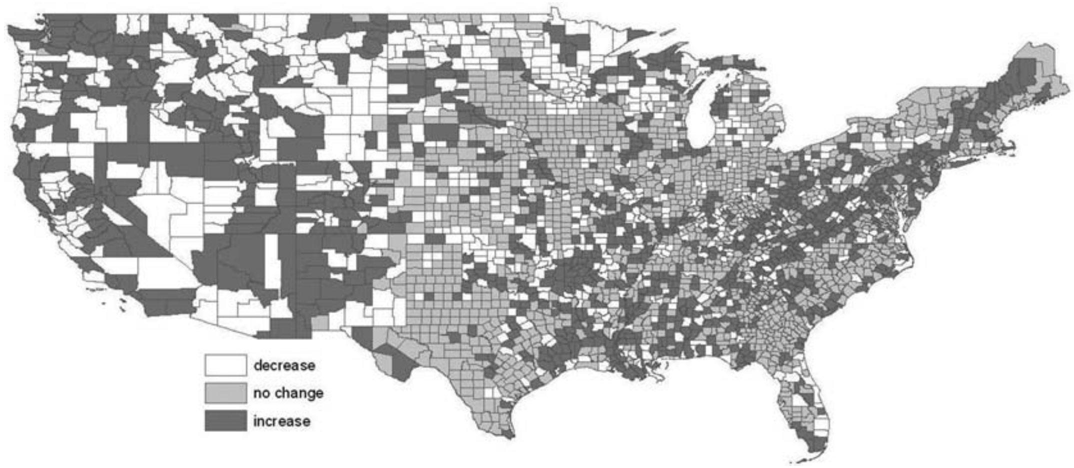

FIGURE 3
Change in Payments in Lieu of Taxes Acres by County, 1990–2000

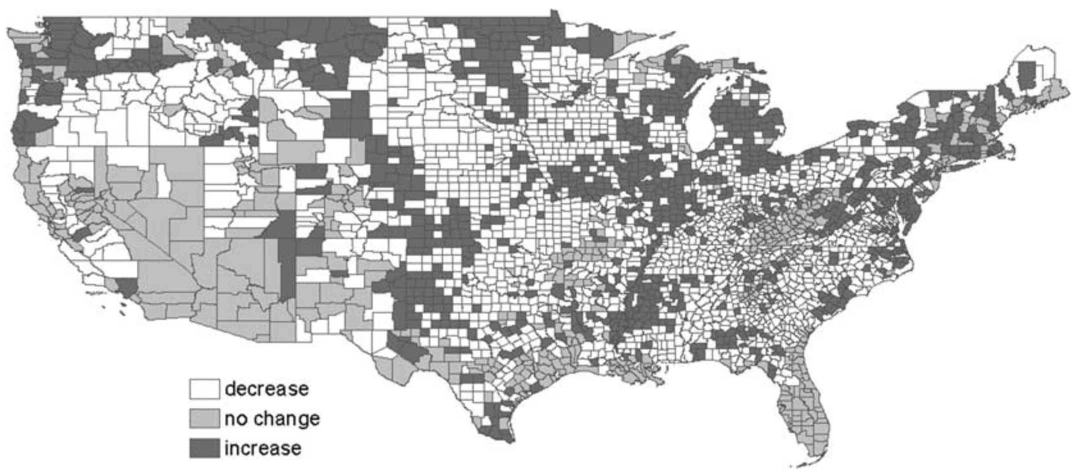

FIGURE 4
Change in Conservation Reserve Program Acres by County, 1990–2000

The majority of land trusts are small, local organizations with TNC being the major exception. TNC is different from the other over 1,500 land trusts (the LTA trusts) for several reasons. First, it is much larger. In 2000, TNC easement and owned acres were approximately 48% of the total of all TNC and LTA acreage. Second, TNC tends to purchase land and easements more often than do the LTA trusts; many of the LTA trusts primarily solicit donations of easements from landowners.[7]

remove resources from it, and the covenants of housing associations (Dnes and Lueck 2007).

[7] Federal and state-level tax benefits are available to landowners who donate either fee simple or conservation easements to land trusts. Federal income tax deductions have been available since at least 1976, federal estate tax benefits for easements were expanded in 1997, and a handful of states introduced tax credits in recent years, nearly all of these after 2000 (Parker and Thurman 2004; McLaughlin 2004).

Third, TNC focuses specifically on conserving and actively enhancing habitat for plants and animals, while the LTA trusts more often simply provide open space scenery. Figure 1 shows TNC acreage at the county level in 2000.

LTA data on land trust activity are available at the land trust level, rather than the county level, and 30% of LTA trusts operate in multiple counties. What we know about the LTA trusts from surveys conducted during 1990 and 2000 is how much acreage they hold, either in fee simple or through conservation easements, across all of the counties in which they operate. For the subset of LTA trusts operating in multiple counties, we construct county-level observations by dividing the acreage of each trust equally among the counties in which it operates and, for a given county, adding up the acreage across the trusts that operate in the county. Figure 2 shows the resulting measure of LTA acres at the county level in 2000.

Federal Land Conservation

The federal government is obligated to compensate county governments for property tax revenue foregone due to its owning land and, therefore, keeps time-series records of land it owns at the county level (Espey and Owasu-Edusei 2002). The acreage data are knows as payments in lieu of taxes, or PILT, data. The federal PILT agencies are the Forest Service, the Park Service, the Fish and Wildlife Service, the Bureau of Land Management, the Bureau of Reclamation, the Corp of Engineers, and the Army. Figure 3 shows the changes in PILT acres from 1990 to 2000 across U.S. counties. As the figure shows, there is substantial within-state variation in changes in federal acres rather than widespread regional trends. These changes are plausibly exogenous to the conservation choices of the much smaller land trusts.

The CRP since 1985 has signed contracts with farmers to leave land idle (and undeveloped) for 10-year or 15-year terms.[8] It has been reauthorized in each farm bill since 1985: in 1990, 1996, 2002, and 2008. It now pays farmers to idle approximately 35 million acres, a land mass larger than the state of Florida and constituting 10% of U.S. cropland, at an annual cost of $1.7 billion (in 2001).

The criteria for eligibility in the CRP has evolved over its successive reauthorizations. Initial criteria emphasized wind erosion, while 1990 revisions added water quality criteria. Bids under the CRP's current incarnation are ranked by an environmental benefits index (EBI), one element of which is the annual rental payment bid by the landowner. Other than cost, the EBI is an aggregation of points awarded for a combination of inherent land characteristics and practices in which the enrollee agrees to engage. U.S. Department of Agriculture now ranks in a single national pool the EBI scores and accepts all those above a cutoff determined to achieve a target acreage. Landowners who agree to engage in certain wildlife management practices are eligible for cost sharing with the federal government.

While CRP acreage is spread across the lower 48 states, it is far from evenly distributed. Close to 30% of CRP acreage is found in the northern Great Plains, primarily North Dakota and Montana. Another 30% is found in the more southerly Great Plains areas of Colorado, Nebraska, Kansas, Oklahoma, and Texas. However, despite aggregate growth between 1990 and 2000, and as Figure 4 shows, many counties within these states actually experienced decreases in CRP acres over the decade. Figure 4 also shows that there was substantial variation in the *changes* in CRP enrollment within states, which we exploit econometrically.

The other program we analyze is the WRP. The WRP is much smaller and younger than the CRP. It was established by the 1990 Farm Bill, allowing the U.S. Department of Agriculture to acquire perpetual and 30-year conservation easements from farmers who agree to stop cultivating acres in order to restore former wetlands. The bulk of WRP acquisitions during the 1990 to 2000 period occurred after 1994, with the greatest number of acres enrolled in Louisiana, Mississippi, and Arkansas by 2000. Participating landowners retain the

[8] See Thurman (1995, Chapter 3) for a more detailed historical discussion of the CRP and other environmentally justified agricultural programs.

rights to lease lands for recreational hunting but forgo rights to further develop land. Nationwide, there are now over 1.7 million acres enrolled in the WRP, with a Congressionally set cap of 2.275 million acres.

In what ways are the land use effects of PILT acreage, the CRP, and the WRP similar to those of conservation easements and land trust acquisitions? Ultimately, we maintain that these are empirical questions. However, one can usefully distinguish the programs from land trust actions along several dimensions. First is length of commitment. Easements are forever (see Mahoney 2002). The tenure of federal land ownership depends on political factors but is typically long term, while CRP contracts are either 10 or 15 years. It is worth noting that while 10 years is shorter than forever, the present value of a 10-year annuity constitutes almost 40% of the value of a perpetual annuity at a 5% discount rate. The present value of a 15-year annuity is over 50% of the value of the perpetuity, suggesting that preserved for 15 years is better than half as good as preserved forever.[9]

Another comparison of PILT acres, the CRP, and the WRP with land trusts concerns the type of land protected. Many of the PILT agencies may target remote lands unlikely to be developed soon. Similarly, land under CRP contract cannot be farmed or developed during the contract period, but is it likely to be land that would be the target of land trust attention? While one might be a priori skeptical that CRP acreage affects land trusts, we note that the CRP has been found to slow development (Johnson and Maxwell 2001) and that a component of the CRP's EBI is wildlife habitat, a particular focus of many land trusts. Similarly, the WRP's primary focus is the restoration of wetlands for wildlife and water quality, goals often shared with land trusts.

III. THEORETICAL FRAMEWORK

We develop a model to motivate and interpret our estimates of the factors explaining land trust growth. The model posits that donors to land trusts are demanders of land-based amenities (e.g., scenic views, recreation opportunities, and wildlife). Land trusts are assumed to provide the amenities demanded by their donors and to maximize their net benefits. This view ignores the interests of employees of trusts and the members of their boards of directors and assumes that the trusts act as agents on behalf of consumers. We also do not explicitly consider the various ways in which land trusts overcome free-rider problems and induce consumers of amenities to become land trust donors.[10] We represent trusts then as demanders of land, influenced by the income of residents in the areas in which they operate and by the price of land.

Income and Price Effects

A county's land, assumed homogeneous, is allocated to market purposes (commercial and residential real estate) and to nonmarket purposes (government-owned land and privately preserved land.) Denote the quantity of land in market uses as q^M and the land held by trusts as q^T. The sum of the land uses equals the fixed total of land available in the county:

$$q^M + q^T = Q. \qquad [1]$$

Government land is considered to be fixed thus far, and so Q should be interpreted as the county's total land net of government-owned land.

The quantities of land allocated to the two uses are determined by demand functions that depend upon the county's income and the price of land. The two demand functions are given by

$$q_D^M = f^M(P,I) \text{ and } q_D^T = f^T(P,I). \qquad [2]$$

For exogenous levels of income, the equilibrium price of land is determined such that [1] holds. Taking the total differential of [1], using the demand functions in [2], yields

[9] There is also evidence that CRP conservation endures beyond the 10- or 15-year contract period. This is because a significant amount of cropland formerly under the CRP remains retired after contracts have expired (see Roberts and Lubowski 2007).

[10] For evidence and discussion on how land trusts deal with free-rider problems, see Sundberg (2006) and Anderson (2004).

$$(f_P^M + f_P^T)\,dP + (f_I^M + f_I^T)\,dI = 0, \quad [3]$$

where subscripts denote partial derivatives.

Equation [3] implies the following response of land price to an exogenous change in income:

$$\frac{dP}{dI} = -\frac{f_I^M + f_I^T}{f_P^M + f_P^T}\,. \quad [4]$$

If the two demand functions have positive income derivatives and negative price derivatives then $dP/dI > 0$, an increase in income serves to bid up land prices.

The equilibrium change in price induced by a change in income can be expressed in elasticity form as

$$\frac{d\ \ln\ P}{d\ \ln\ I} = -\frac{\alpha_M \eta^M + \alpha_T \eta^T}{\alpha_M \varepsilon^M + \alpha_T \varepsilon \eta^T}\,, \quad [5]$$

where $\alpha_j = q^j/Q$, the share of county land in use j, for $j = M$ and T; η^j is the income elasticity of demand for land in use j; and ε^j is the price elasticity of demand for land in use j, defined to be negative. Equation [5] shows the equilibrium elasticity of price with respect to county income to be the (negative of the) ratio of the land-share weighted sum of income elasticities to the land-share weighted sum of price elasticities. To the extent that the shares of county land held by land trusts are small, the change in price will be dominated by the income and price elasticities of demand for land in market uses.[11] In this case,

$$\frac{d\ \ln\ P}{d\ \ln\ I} \approx -\frac{\eta^M}{\varepsilon^M}\,. \quad [6]$$

Now consider the effects of a change in income on the equilibrium quantities of land used by trusts. Given that an exogenous increase in county income induces an increase in the equilibrium price of land, the net effect on trust land holdings is the sum of two effects:

$$\frac{dq^T}{dI} = f_I^T + f_P^T \frac{dP}{dI}\,. \quad [7]$$

Multiplying through [7] by I/q^T expresses the response in q^T in elasticity terms:

$$\frac{d\ \ln\ q^T}{d\ \ln\ I} = \eta^T + \varepsilon^T\,\frac{d\ \ln\ P}{d\ \ln\ I}\,. \quad [8]$$

For a positive income elasticity and negative price elasticity, the sign of [8] is ambiguous, as the first term on the right-hand side of [8] is positive and the second is negative. An increase in income is more likely to increase trust land use in a county if the trust's income elasticity is large, its price elasticity is small in absolute value, and the equilibrium rise in land price is small.

Further, applying the approximation in [6] for small land trust acreage shares, we have

$$\frac{d\ \ln\ q^T}{d\ \ln\ I} \approx \eta^T - \eta^M\,\frac{\varepsilon^T}{\varepsilon^M} = \eta^T\left(1 - \frac{\varepsilon^T \eta^M}{\varepsilon^M \eta^T}\right). \quad [9]$$

As equation [9] makes clear, if the price and income elasticities of market and land trust demand functions are the same, then $d\ln q^T/d\ln I = 0$: increases in county income will induce no change in land use by land trusts (or in market uses). Because the total amount of land in the county is fixed, an increase in income cannot increase the land used by both organizational forms. The increase in land held in equilibrium by land trusts is increasing in the trusts' income elasticity of demand and decreasing in the income elasticity of demand for land in market uses.

Finally, note that if a land trust is not obligated to spend donations from residents of a given county on conservation in that county, as is true for TNC, then a land trust's activity in a county may be little affected by income in that county. If η^T is near zero then [8] is unambiguously negative. The only effect on such a trust of an increase in the income of a county is that due to the resulting increase in land price, which induces the trust to protect less land.

Government Land Use Changes

Now we augment the model to explicitly incorporate government land acquisition. We

[11] The mean proportion of private land in a county held by LTA was 0.0027 in 2000, and only nine counties had a proportion greater than 0.10. For TNC the mean proportion in 2000 was 0.0016, and only six counties had a proportion greater than 0.10.

consider government land to include government-owned land or land restricted in its use by contract with the government, like the CRP and WRP.

Denote the quantity of government land as q^G and assume that government land provides amenities that are viewed as imperfect substitutes (or complements) for the amenities provided by land trusts. Then the demand for land from land trusts depends directly on government provision, as well as price and income:

$$q_D^T = f^T(P, I, q^G), \quad [10]$$

and the adding-up constraint for land in the county becomes

$$q^M + q^T + q^G = Q. \quad [11]$$

Totally differentiating [11] implies that the equilibrium price response to a change in q^G is

$$\frac{dP}{dq^G} = \frac{1 + f_G^T}{-(f_P^M + f_P^T)} . \quad [12]$$

The denominator of [12] is positive and the numerator is positive, assuming that trusts don't more than offset the change in q^G. Thus, an increase in government land bids up the price of land.[12]

As in the case of a change in income, the effect of a change in q^G on land trust land holdings is a composite effect:

$$\frac{dq^T}{dq^G} = f_G^T + f_P^T \frac{dP}{dq^G} . \quad [13]$$

The change in land trust land due to a change in government land involves a direct effect and the effect of the induced change in price. If the direct effect is negative, as when government and private conservation are substitutes, then the negative price effect is reinforcing.[13] If the direct effect is positive, then the price effect serves to offset some of the positive effect of an increase in government land holding.[14] We refer to the net effect of changes in government land—which we estimate—as crowding out if negative, and crowding in if positive.

IV. EMPIRICAL ANALYSIS

A Decadal-Change Panel Model with Censoring

We analyze county-level changes between 1990 and 2000 in land trust acreage. Both types of trusts, LTA and TNC, had zero acreage in a number of counties in 1990 and 2000, with the censoring being more severe for TNC. In 1990, TNC held zero acres in 75% of the 3,026 sample counties; in 2000, that percentage fell to 69%. In 1990, LTA trusts held zero acres in 28% of counties; in 2000, that percentage fell to 12%. We deal with this issue by estimating a latent variable Tobit model.

The conditional distribution of the latent variable in the two years is described by

$$y_{i0}^* = \phi_i + x_{i0}'\beta + \varepsilon_{i0}$$
$$y_{i1}^* = \phi_i + x_{i1}'\beta + \varepsilon_{i1} \quad [14]$$

for $i = 1, \ldots, N$. County-level (latent) acreage is modeled as depending on time-varying covariates whose marginal effects, the elements of β, are constant across counties. These covariates include county acreage in federal land programs, as well as county income and population levels. There are county-specific intercepts, implying that identification of β comes from decadal changes in the covariates.

[12] The mechanism through which the price effect occurs is a reduction in the supply of developable land. This reduction is temporary in the case of CRP and WRP contracts. Although CRP and WRP enrollment could reduce the price of land under contract, we assume that enrollment increases the price of nearby lands not under contract (via an increase in the option value of the developable land).

[13] The direct substitution effect may be small if there are purely private benefits from donating to land trusts. These benefits may be of the "warm glow" or "prestige" ilk (Andreoni 1990), or they may be more tangible. Donors of conservation easements receive tax relief (see Anderson and King 2004), and tangible benefits to cash donors may include access to land-trust property (Sundberg 2006).

[14] The direct effect can be positive if there are economies of scale in the benefits of conservation (see Albers, Ando, and Chen 2006; Wu and Boggess 1999).

If latent acreage were observed, the specification in [14] would be equivalent to the following cross-sectional specification of acreage changes:

$$\Delta y_i^* = \Delta x_i' \beta + \Delta \varepsilon_i. \quad [15]$$

But acreage levels are censored, so that observed acreage is given by

$$y_{it} = y_{it}^* \text{ if } y_{it}^* > 0$$
$$y_{it} = 0 \text{ if } y_{it}^* \leq 0. \quad [16]$$

The fact that acreage levels are censored, and not acreage changes, implies that model [14] with its 3,026 county fixed effects must be estimated, instead of the much smaller-dimensional model of changes in [15].[15]

In the empirical analysis reported here, we assume that the error terms in [14] are normally distributed and employ the Gibbs sampling technique of Chibb (1992). The Gibbs sampler is a Markov chain Monte Carlo algorithm that treats the latent (unobserved) values of land holdings in censored counties as parameters. The sampler simulates observations for the latent variables from a distribution that is normal conditional on the other parameters in the model and then uses the simulated data to draw values from the posterior of the parameters of interest. The Bayesian method assumes diffuse priors on the model's parameters; we focus on the posterior distributions of the marginal covariate effects, the elements of β.

Beyond the effects of time-varying covariates and time-constant county fixed effects, there is the possibility of another type of effect: growth factors. Such factors distinguish the decadal acreage growth across county types, and one important distinction among counties arises from state boundaries. Land policy varies by state, with some states promoting land trust acquisitions through cost sharing and easement purchase programs. Due to variations in state income tax structures and write-offs available for easement donors, states differ as to the tax benefits from donating land to a trust. And easement enabling legislation varies at the state level (Parker 2004). Such variation should induce variation in land trust growth, which we account for with the following modification of model [14]:

$$y_{i0}^* = \phi_i + x_{i0}' \beta + \varepsilon_{i0}$$
$$y_{i1}^* = \phi_i + \theta_s + x_{i1}' \beta + \varepsilon_{i1}. \quad [17]$$

Equation [17] can equivalently be written in the form that we estimate:

$$y_{it}^* = \sum\nolimits_{j=1}^{N} \phi_j d_i^j + \sum\nolimits_{s=1}^{48} \theta_s D_{it}^s + x_{it}' \beta + \varepsilon_{it}, \quad [18]$$

where $d_i^j = 1$ if $i = j$ and $d_i^j = 0$ otherwise; $D_{it}^s = 1$ if county i is in state s and $t = 1$, $D_{it}^s = 0$ otherwise.[16]

Empirical Results

Panel (a) of Table 1 reports descriptions of the posterior distributions from the Gibbs sampler for the equation [18] model applied to LTA acreage. Panel (a) of Table 2 reports descriptions of the model applied to TNC acreage. (We estimate LTA and TNC effects separately because the goals and scope of these organizations differ as described in Section II.) All of the models considered in Tables 1 and 2 allow for state-specific variation in growth (the θ_s parameters in equations [17] and [18]).[17]

Panels (b) of Tables 1 and 2 add to the model a short list of additional growth factors. These are time-invariant forces that induce

[15] If we tried to estimate [15], then the censoring point for changes over 1990 to 2000 would be equal to the (negative) number of acres held in 1990. This censoring point would be unique for many counties because counties had different levels of land trust acreage in 1990. Estimating [14] instead of [15] allows us to exploit the fact the censoring point for levels of acres is always zero. Estimating the panel model [15] does force us to estimate over 3,000 county fixed effects, which are not of direct interest.

[16] We cannot estimate time-invariant fixed effects for each state because those would be perfectly collinear with the county fixed effects. Instead, we allow states to have different growth over 1990 to 2000 by interacting state indicator variables with the 2000 indicator variable.

[17] There is strong evidence from the posterior distributions that state growth factors are important, but we do not discuss them here. The inclusion of state growth factors reduces substantially the residual variation for both LTA and TNC models, but more so for LTA than for TNC.

TABLE 1

Land Trust Alliance Acreage Determinants: 1990–2000 Posterior Distributions from Gibbs-Sampled Panel Tobit Model

	Panel (a)			Panel (b)		
	Mean	Elasticity	Mean/Std.	Mean	Elasticity	Mean/Std.
Time varying covariates						
CRP	− 0.026		− 2.17	− 0.026		− 2.14
WRP	− 0.012		− 0.24	− 0.021		− 0.40
Federal land	− 0.002		− 0.38	− 0.003		− 0.51
Population	0.009	0.74	4.80	0.005	0.17	2.74
Income	− 0.016	− 0.34	− 0.48	0.021	0.73	0.63
Growth factors						
Amenities				233.8	0.55	4.05
Farm size				− 0.19	− 0.21	− 0.86
County size				0.002	4.08	8.33

Note: The dependent variable is LTA acreage. Observations include counties in all U.S. states except those in Alaska and Hawaii. Aroostook, Maine, and Hidalgo, New Mexico, are also excluded, as are counties for which covariate data are missing. $N = 3{,}026$ observations for 1990 and 3,026 for 2000. Elasticities are evaluated at year 2000 means and measure the proportional effects of the covariates on the latent variable.

TABLE 2

The Nature Conservancy Acreage Determinants: 1990–2000 Posterior Distributions from Gibbs-Sampled Panel Tobit Model

	Panel (a)			Panel (b)		
	Mean	Elasticity	Mean/Std.	Mean	Elasticity	Mean/Std.
Time varying covariates						
CRP	0.099		3.20	0.095		3.20
WRP	0.012		0.08	0.018		0.13
Federal land	− 0.030		− 2.20	− 0.031		− 2.18
Population	− 0.003	− 0.27	− 0.69	− 0.002	− 0.17	− 0.45
Income	− 0.239	− 6.11	− 2.76	− 0.146	− 3.75	− 1.70
Growth factors						
Amenities				− 145.2	− 0.41	− 0.95
Farm size				2.29	1.51	4.98
County size				0.0007	0.79	1.36

Note: The dependent variable is TNC acreage. Observations include counties in all U.S. states except those in Alaska and Hawaii. Aroostook, Maine, and Hidalgo, New Mexico, are also excluded, as are counties for which covariate data are missing. $N = 3{,}026$ observations for 1990 and 3,026 for 2000. Elasticities are evaluated at year 2000 means and measure the proportional effects of the covariates on the latent variable.

cross-sectional variation in the decadal growth of land trust acreage. Panels (b) add the following time-invariant variables: the U.S. Department of Agriculture amenity index for the county, the county's median farm size in 2002, and the size of the county measured as the number of nonfederal acres in 1990. Because we add these three variables to a model that already accounts for state-level variation in growth, these effects should be interpreted as measuring growth variation within states.

The posterior distributions were approximated with 5,000 draws from the Gibbs sampler. A burn-in sample of 500 draws was discarded at the beginning of each Gibbs run, and, after the burn-in, each fourth draw was retained until 5,000 draws had accumulated. Computations were performed in Matlab, and the resulting posterior distributions are shown in Figures 5–7. Figure 5 displays the marginal posterior distributions for the parameters of the model explaining LTA land holdings. Figure 6 displays the posteriors for the TNC pa-

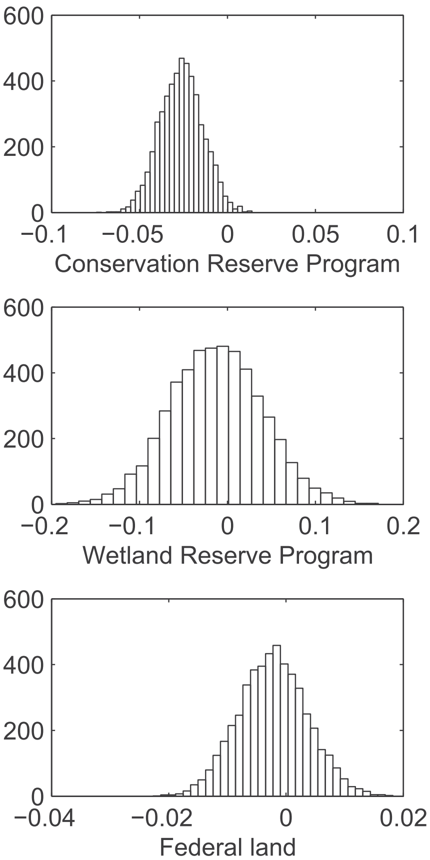

FIGURE 5
LTA Posterior Distributions from Gibbs Tobit Table 1 (Panel a) Specification

rameters. Figure 7 overlays the corresponding distributions so that one can assess the size and relative precision with which we estimate the LTA and TNC effects.

Income Effects

To interpret the income and population effects in the context of the theoretical framework, recall that the theory considers changes in *aggregate* income. Increases in either per capita income (holding population constant) or population (holding per capita income constant) represent an increase in county aggregate income. Increases in county aggregate income increase the demands both for market goods using land (e.g., real estate) and for nonmarket goods using land, such as land trust conservation. The income-induced increase in demand for land will increase its price, thus mediating to some extent the quantity increase. As discussed, a scenario in which an increase in aggregate income would increase the quantity of land trust conservation is one in which trusts' income elasticities are large, their price elasticities are small, and the equilibrium rise in land price is small.

Applying this logic to the LTA trusts, which largely raise money and hold easements locally, the effects of population and income are ambiguous and depend on the strength of income and price effects. In Table 1, there is strong evidence for an economically significant population effect, although the effect is sensitive to the inclusion of

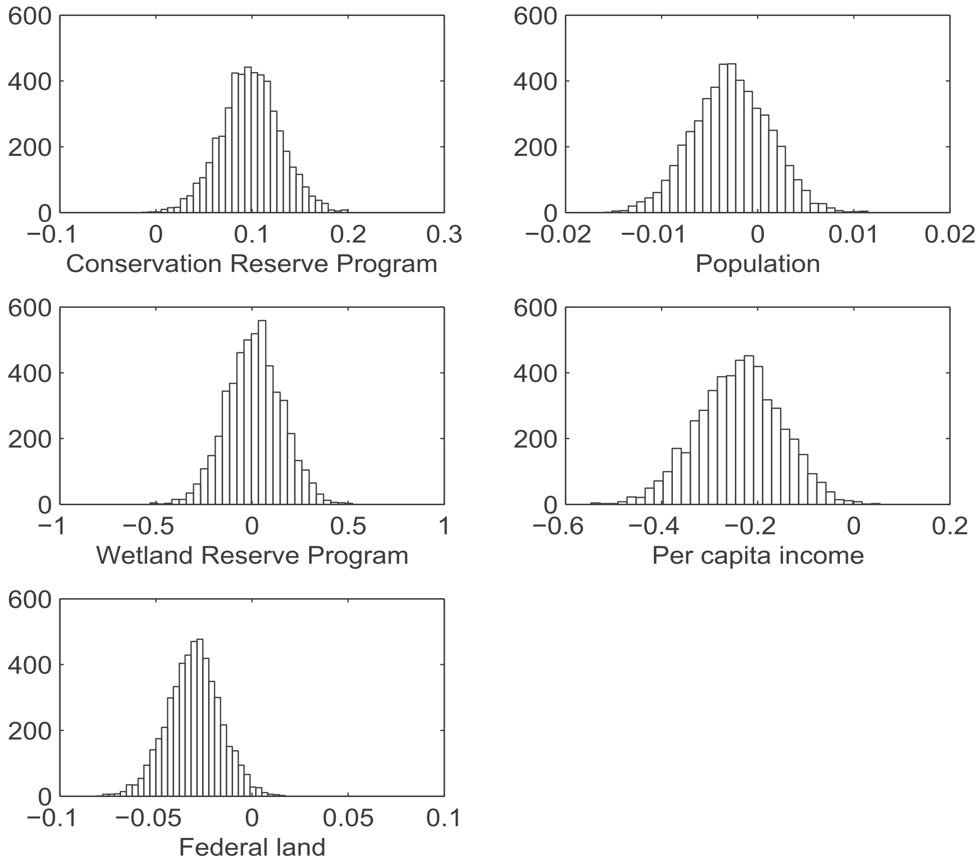

FIGURE 6
TNC Posterior Distributions from Gibbs Tobit, Table 1 (Panel a) Specification

growth factors in Panel (b).[18] The mean-evaluated elasticity of LTA acreage with respect to population in Panel (b) is 0.17 (posterior mean), which is an effect almost three standard deviations away from zero.[19] The posterior estimate of the effect of an increase in per capita income is not reliably different from zero.

The argument above implies that the effects of income and population are ambiguous insofar as each acts to increase a county's aggregate income. But why might the effects of population and income be different? One possible reason is that an increase in population, holding constant per capita income, increases county income by adding newcomers with incomes identical to those of current residents, thus adding to the county's demand for land at the average propensity to consume for current residents. However, increasing per capita income and holding population constant adds to the county's demand for land at the marginal propensity to consume of its current residents. If the marginal propensity is smaller

[18] This effect is sensitive to the inclusion of growth factors because changes in population over the decade are correlated with the growth factors, especially with the index measuring natural amenities. The amenity index combines climate, topography, and access to water into a measure of the natural features of a county that humans find attractive.

[19] The elasticities reported are not adjusted for censoring. They measure the response of the latent variable to the right-hand side covariates, not the response of the conditional expectation of a particular county's acreage with respect to the covariates. They are best thought of as responses to the covariates in counties for which the probability of positive land trust acreage is close to one.

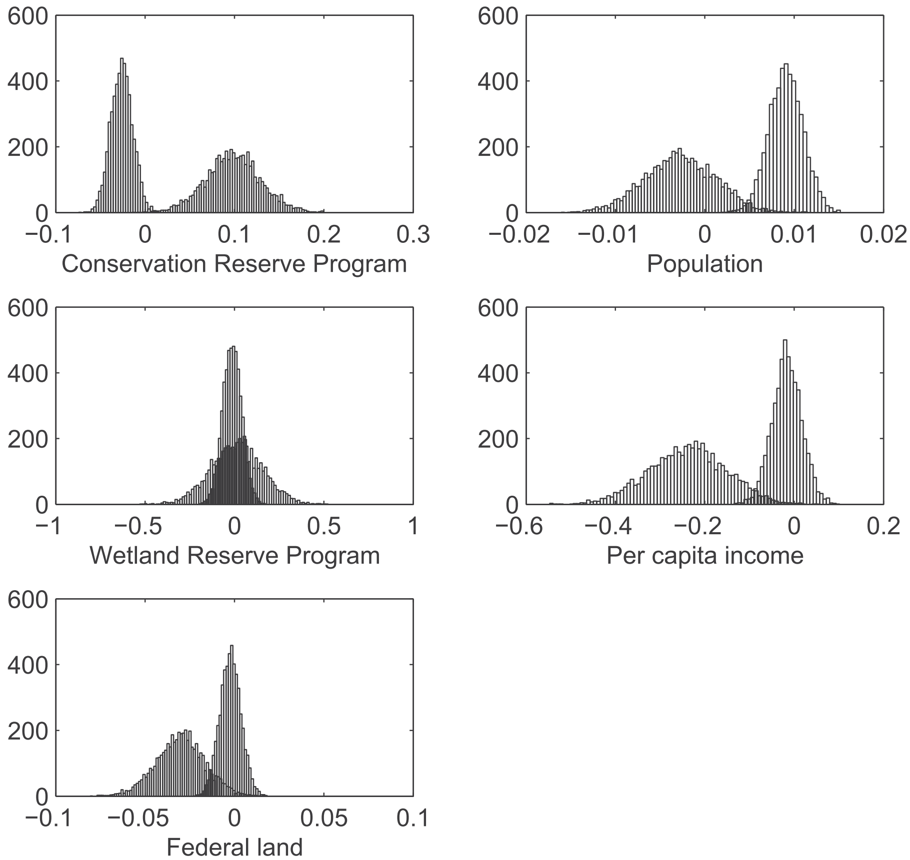

FIGURE 7
Overlaid Posterior Distributions of LTA and TNC Parameters, Table 1 (Panel a) and Table 2 (Panel a) Specifications; In Each Case, the More-Peaked Distribution Is LTA

than the average propensity, the increase in population would have a stronger positive effect on land trust growth than the increase in per capita income, which is what we see in Table 1.[20]

Next consider the very different effects of income and population on TNC land holdings in a county, as shown in Table 2. A key difference between TNC and an LTA trust is that TNC operates nationally and globally. Money is raised and allocated to what TNC considers to be its highest-priority wildlife protection projects. TNC provides nonmarket land amenities but does so in locations not strongly connected to the sources of its funds. Thus, an income-induced increase in the demand for the public goods provided by TNC in a county will increase TNC donations, but not necessarily TNC activity in the county.

The effect on TNC activity in a county from an increase in that county's aggregate income will come primarily through the price effect discussed above. Higher county income (through larger population, per capita income, or both) increases the demand for market and nonmarket uses of land, thus raising its price. If TNC behaves rationally, it reduces its land-acquiring activity in the county and spends its

[20] Another reason that the effect of population and per capita income might differ for LTA holdings is that population growth is a more visible signal of a decline in undeveloped land in a county than is per capita income growth. Population growth adds to the perception of crowdedness and so to an increase in demand for land trust activity.

money where the marginal wildlife habitat benefit per dollar is larger. Given this logic and our model, the predicted effects on TNC acres from both population and per capita income are unambiguously negative.

The posterior means of these TNC effects are both negative, much more so in elasticity terms for income than for population. As Panel (b) indicates, a 1% increase in county per capita income is estimated to reduce TNC acreage in the county by 3.75%, with the posterior mean being 1.70 standard deviations away from zero. This effect is sensitive to the inclusion of growth factors because 1990 to 2000 changes in per capita income are correlated with the growth factors—particularly with county size and median farm size. While the estimate of the population effect also is negative (an elasticity of -0.17), it is smaller and not convincingly different from zero. One might distinguish between the population and income effects on TNC land if TNC saw population growth as a more important driver of development than income growth. TNC might then see increases in population as a signal of greater urgency to protect wildlife habitat, offsetting to some degree the price-mediated decrease in TNC demand for land in the county.

Government Program Effects

Consider next the crowding-out estimates with respect to the CRP. Table 1 shows that the posterior mean for the effect of the CRP on LTA acreage is -0.026 in both panels. All land variables are measured in acres, so the coefficients are acre-for-acre effects. The effect of the CRP is small but is reliably negative: each additional acre of CRP land reduces LTA land holdings by 0.026 acres. The posterior mean lies 2.17 standard deviations away from zero.[21]

The model for TNC shows a larger and positive effect of the CRP: each additional CRP acre crowds in TNC holdings by 0.095 (the posterior mean), which lies more than three standard deviations away from zero. We can think of two explanations for this rather striking difference in the response of the two types of land trusts to government retirement. The first relates to the different goals of the two types of trusts. The smaller trusts that are members of the LTA tend to focus on conserving open-space scenery, while the TNC focuses more on wildlife habitat. By postponing development on enrolled land, the CRP provides a substitute for open-space provision otherwise provided by LTA trusts. By augmenting wildlife habitat on enrolled land, the CRP induces TNC conservation on adjacent lands, because the two methods of wildlife conservation are complements. This explanation for the different effects of the CRP on LTA and TNC is most compelling if the economies of scale (or scope) in wildlife conservation are greater than those present in scenic open-space conservation. With economies of scope, the TNC can augment wildlife habitat more efficiently by operating adjacent to areas already providing wildlife habitat through the CRP.

The second reason for the contrast relates to the different methods of conservation across the two types of land trusts. The smaller LTA trusts conserve land primarily by holding conservation easements. In contrast, TNC manages and often owns outright the land it preserves. As an owner of land (rather than easements) TNC has the opportunity to benefit from the CRP by putting acres of its land into the reserve.[22] From this perspective, a crowding-in effect of the CRP makes sense. To the extent that LTA trusts are more-passive holders of easements, which their easement donors still own and manage, the LTA trusts are less likely to use the CRP as a management tool by enrolling land it owns into the CRP.[23]

[21] We do not report elasticities for the crowding-out coefficients because they are directly interpretable as acre per acre effects.

[22] The TNC has enrolled land it owns in the CRP, but more often in the WRP. See the Environmental Working Group's data on TNC from their Farm Subsidy Database at http://farm.ewg.org/farm/persondetail.php?custnumber=008595067&summlevel=detailbyyear.

[23] The option for trusts to enroll land they own into the CRP suggests that trust acres may be crowding in CRP acres, which in turn suggests that our estimates give a lower bound to the true crowding-out effects of the CRP. This intuition is corroborated by 2SLS (noncensored) regression results that employ CRP changes from 1985 to 1990 as an instru-

The estimated effects of acreage from the WRP are small and the posterior distributions lap well to either side of zero, both for the TNC model and the LTA model. This may imply that acreage enrolled in the WRP is less substitutable for the acres acquired by both types of land trusts than is acreage enrolled in the CRP, but it seems more likely that there is simply not strong enough variation in the sample in WRP acreage to allow informative inference as to its effect. WRP acreage is, in fact, much more geographically concentrated than is CRP acreage, implying that the WRP effect may be confounded with state growth factors.

Another contrast between TNC and LTA is the effect of land enrolled in the federal estate. The measured effect of federal land (as measured by PILT data) is small and not reliably different from zero for LTA trusts, but larger, negative, and reliably so for TNC. A 1-acre increase in federal land over the decade is associated with a 0.03-acre reduction in TNC land, the posterior mean lying more than two standard deviations from zero.

To check the robustness of the PILT results to potential reverse causation, we estimated two-stage least squares (2SLS) (uncensored) regressions of the model. The instrument for 1990–2000 changes in federal acres is 1984–1990 changes, which is the previous time period for which we have data. The 2SLS strategy purges reverse causation, because contemporaneous LTA changes could not have caused lagged changes in government land. The coefficients on the government-owned land coefficients in the 2SLS regressions are almost identical to the ordinary least squares (OLS) coefficients, implying that reverse causation is not a problem in this setting.

Another concern is that the PILT coefficients may be biased upward if there are omitted factors that were causing increases or decreases in both federal and private conservation. To check the robustness to this type of omitted variable bias, we ran a less-restricted version of the LTA and TNC (uncensored) regressions that allow each of the federal land agencies to have a separate effect on private conservation. In these regressions the most-negative coefficients appear on changes in U.S. Army and Corps of Engineers (COE) land. The most-positive coefficients appear on changes in U.S. Forest Service and Fish and Wildlife Service land. The changes in Army and COE land are plausibly exogenous with respect to land trust demand, whereas changes in Forest Service and Fish and Wildlife Service land may be driven by the same forces driving private conservation. Consequently, the negative coefficients on Army and COE land probably more accurately identify the causal effect of interest. These results and corroborating 2SLS regressions that use Army and COE land as an instrument for all federal land provide evidence that our main regression results are probably understating the true crowding-out effect of PILT land.[24]

To summarize, there are identifiable effects of government conservation on land trusts, but they are small when considered on an acre-by-acre basis. There are several possible explanations for this. First, the land acquired by government may not provide the kind of scenic or wildlife habitat sought by land trusts. Second, the requirement that conservation easements be held in perpetuity restricts land trusts from selling easements in response to government conservation. Any crowding out of easements, therefore, must come from situations where land trusts increase easement acreage in response to decreases in govern-

ment for CRP changes from 1990 to 2000. The 2SLS CRP coefficient estimates are purged of any reverse causation (because lagged changes in the CRP cannot be caused by contemporaneous changes in trust acres) and are strictly less than the posterior means for both the LTA trusts and for TNC. We do not highlight the 2SLS results, however, because we believe that the direction of crowding in largely runs from the CRP to land trusts. That is, if land in a county were not eligible for the CRP, then land trusts could not use it as a management tool.

[24] The 2SLS (uncensored) regressions employ the sum of Army and COE land as an instrument for federal land. These 2SLS regressions generate a stronger negative relationship between government and land trust conservation when compared to OLS. The OLS and 2SLS coefficients on the federal land variable from regressions of the uncensored model are nearly identical in the TNC regressions. In the LTA regressions, the 2SLS coefficient is negative and significant, while the OLS coefficient is positive (but nearly zero) and statistically insignificant.

ment conservation. Third, private benefits may accrue to land trust donors that cannot be crowded out by government. These benefits may be of the "warm glow" or "prestige" ilk (Andreoni 1990), or they may be more tangible. The tangible benefits that donors of easements receive in the form of tax relief and access to land-trust land (see Anderson and King 2004; Sundberg 2006) cannot be crowded out by government land acquisitions.

Growth Factors

Panels (b) of Tables 1 and 2 add to the model growth factors—time-invariant forces that induce cross-sectional variation in the decadal growth of land trust acreage. The amenity index combines climate, topography, and access to water into a measure of the natural features of a county that humans find attractive.[25] The LTA trusts provide open-space amenities, and it is plausible that an acre protected in a high-amenity county will be perceived to be more valuable by donors and potential donors to the trust, and so LTA growth will be greater in high-amenity counties. We find just that. The amenities coefficient in the LTA equation is more than four standard deviations away from zero. To assess the size of the amenities effect, we construct a scaled measure equal to the proportionate change in land trust growth due to a change in the amenities index from the 25th percentile of its distribution to the 75th percentile.[26] Such an interquartile change in the index induces a 14% increase in LTA land holdings, evaluated at the posterior mean of the amenities effect.

In contrast to LTA trusts, TNC's stated mission is to preserve wildlife habitat. To the extent that wildlife habitat and human-based amenities are uncorrelated, we expect to find no evidence of an amenities effect for TNC, and we do not. The posterior mean of the amenities effect for TNC is, in fact, negative but lies less than one standard deviation away from zero.

The second growth factor is median farm size. The predictions for a farm size effect come from transactions cost considerations. For TNC, the costs of providing a given level of wildlife habitat will depend upon the costs of assembling parcels of land in sizes commensurate with wildlife range. In counties with large farms, TNC deals with fewer landowners per acre and faces lower costs per acre of habitat protection. Thus, we predict that TNC growth will be higher in counties with larger median farm sizes. To the extent that the LTA trusts are more-passive recipients of conservation easements, their land holdings should not be explained by variations in farm size.

As with the amenity effects, the median farm size variable provides another empirical contrast between LTA growth and TNC growth. The farm size effect is large and reliably positive for TNC, but not reliably different from zero for LTA trusts. For TNC, the posterior mean lies almost five standard deviations away from zero. A 1% increase in the median farm size is estimated to induce a 1.5% increase in TNC holdings in a county, consistent with the joint hypothesis that farm size is a proxy for the transactions costs of land protection and that TNC minimizes costs.

The last growth factor reported in Tables 1 and 2 is county size. For both LTA trusts and TNC, larger counties gained more acres over the 1990–2000 period than did smaller counties. The effects are small (0.0003 acres per acre for LTA and 0.0007 acres per acre for TNC) and roughly equal to the average growth per acre for each category.

Finally, notice that the introduction of the three growth factors influences the estimated effects of population and income change. The posterior mean of the LTA population effect is reduced by 44% in going from Panel (a) to Panel (b) of Table 1. The posterior mean of TNC per capita income effect is reduced by 64% in going from Panel (a) to Panel (b) of Table 2. The measured displacement effects

[25] Criteria used in the index imply that a county is more desirable with more varied terrain and a higher proportion of water surface. Warmer winter and cooler summer temperatures and lower humidity also enhance desirability. The index is scaled something like a *Z*-score, with a mean approximately equal to zero. All counties lie between −6.4 and +11.2.

[26] We calculate this nonstandard scale measure of effect instead of an elasticity because the amenities index, like a *Z*-score, has a mean approximately equal to zero. Proportionate changes relative to the mean would have little meaning.

of the federal land programs are essentially unchanged, however, by the introduction of the three growth factors.

Other Specifications and Robustness

The primary focus of our study is the set of land protection determinants discussed to this point: income, federal land activity, land amenities, and transaction costs. One can imagine other possible determinants, and we explore several of them in this section. Because they are less central to the paper's focus, we include the full empirical results in two tables in an appendix. An important conclusion is that the results we have discussed to this point are robust to consideration of these other determinants.[27]

The effects so far considered are contemporaneous, although the 10-year time span analyzed might stretch the definition of that term. Further, the specifications do not consider the possible interactions between LTA trusts and TNC. We consider such effects in expanded versions of our empirical model augmented to include lagged acreage effects and contemporaneous acreage change effects. We present estimates from this augmented model in Table A1 and interpret their meanings in the appendix text. Broadly speaking, we find evidence of momentum effects for LTA acreage: an additional acre of either LTA- or TNC-protected land in a county in 1990 implies additional fractions of an acre in 2000. We find no such evidence of momentum with respect to TNC acreage. Separately, we find no contemporaneous effect of TNC acres on LTA land holdings or of LTA acres on TNC land holdings.

A second set of explanatory factors is also considered in the appendix. Table A2 expands the model to include three additional effects that our theoretical model does not consider. The first is educational attainment, measured by the percentage of county residents who hold bachelor's degrees. The second effect allows for the possibility that private conservation within a county may be influenced by public conservation in surrounding counties. We create three "doughnut" variables—one for each of CRP, WRP, and federal land. The doughnut variables aggregate the number of publicly conserved acres in each land type for all of the surrounding counties having a centroid within 50 miles of our county of interest. The estimated effects of the CRP and federal land doughnut variables are not reliably different from zero in the LTA model. In the TNC model there is some evidence that the crowding-in effect of the CRP, and the crowding-out effect of federal land, are reinforced by government conservation in surrounding counties.[28]

Finally, Table A2 allows for the possibility that water-based amenities have had a different impact on land trust growth than have land-based amenities. To do this we decompose the amenity *z*-score into the component determined by a county's water area (i.e., lakes, rivers, and coastal frontage), and the component determined by nonwater amenities (i.e., temperature, humidity, and topography). In the LTA model we find evidence that both water and nonwater amenities have induced growth. In the TNC model, however, we find that a county's water area negatively effects growth.

Appendix Tables A1 and A2 show that variables other than the ones we model explicitly have helped to determine county-level changes in land trust conservation from 1990 to 2000. Adding these variables to the empirical model, however, does not change our conclusions about the effects of the CRP, federal

[27] On the robustness of our results to different measures of LTA land holdings we offer the following. When LTA trust holdings are allocated to counties in proportion to county size, rather than equally across counties, the empirical finding are broadly similar. The proportional-allocation analysis provides somewhat stronger evidence of negative federal land effects, less evidence of positive population effects, and less evidence of negative CRP effects. In a second robustness check, we filtered the data according to a county data reliability index, retaining only those counties for which the LTA acreage was known with certainty (that is, for counties in which only one LTA trust operated). In this much smaller sample of LTA counties we found results broadly consistent with those in Tables 1 and 2, but less precise. Posterior means of coefficient tended to be larger in absolute value in the smaller sample and posterior variances were larger.

[28] We are grateful to a referee for suggesting that we include doughnut variables. One finding that is not easy for us to interpret is the positive effect of the WRP conservation in surrounding counties on LTA acres.

land, population, and income on LTA and TNC conservation.[29]

V. CONCLUSIONS

In summary, we find small but reliably measured responses of private land trust activity to changes in federal CRP enrollments and to changes in the size of the federal estate. We also find economically significant effects of population growth, per capita income growth, and natural amenity endowments on land trust growth. Further, the size of the effect varies in predictable ways by type of land trust.

By measuring the spatial response of private land trust activity to federal land programs we make three contributions. First, our analysis is among the first to provide a quantitative understanding of the interaction between government and private provision of environmental public goods. Heutel (2007) finds no evidence of crowding out in his study of environmental nonprofits, which in combination with our results raises the question: are crowding-out effects systematically smaller for environmental public goods than for nonenvironmental public goods? This strikes us as an interesting topic for future research.

Second, the analysis in our paper contributes to a specific understanding of the real effects of government land policies, allowing for the fact that private citizens and institutions respond to them. Here we find that the CRP is affecting land trust activity despite the fact that land trusts were virtually nonexistent when the CRP antecedents were first introduced. This finding contributes to previous research that has identified other unintended consequences stemming from the CRP.

Third, we contribute to an empirical understanding of land trust growth, which is one of the most striking trends in U.S. conservation in recent years. Here we find that LTA growth is strongest in areas with rapid population growth, and with attendant increases in the conversion of open space. The growth in TNC conservation is strongest in counties with slow rates of income growth, apparently because TNC acquisition choices are more sensitive to changes in land price.

The importance of land trusts is likely to grow in light of recent federal legislation that increases the tax benefits available to donors of conservation easements.[30] Future research that improves our understanding of the incentives and constraints of land trusts—and those of donors of conservation easements—can aid in identifying other determinants of private land conservation.

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[29] We also analyzed the robustness of our results to consideration of spatial autocorrelation in the model's error term. To do so, we estimated spatial error models (SEMs) using data from counties that were uncensored in both 1990 and 2000, specifying the spatial weights matrix two different ways: (1) as the inverse of distance between county centroids, weights row-normalized to sum to one with a cutoff distance of 300 miles, and (2) as a linearly declining function with alternate settings of the zero-effective-weight distance of 50, 100, and 150 miles. We reestimated the Tables 1 and 2 (Panel a) models with the different weight matrices, using the Kelejian-Prucha method-of-moments estimator.

In the TNC estimates we found no evidence of bias due to spatial autocorrelation. Whichever weight matrix we used, the OLS coefficients and standard errors were very similar in size to those from the SEM. In the LTA estimates, the evidence was a bit more mixed. OLS and SEM coefficients and standard errors were nearly identical using inverse-distance weights and using linear weights with a 50-mile effective distance. Some differences were found between SEM and OLS coefficients using linear weights with a 100- or 150-mile effective distance: SEM coefficients were smaller than OLS coefficients, but patterns of statistical significance were unchanged. These results are consistent with those of Bell and Bockstael (2000), who show that differences in results across spatial weighting matrices can be sizeable. Even with large diameter linear weights, however, none of the bottom-line inferences about the influences on LTA conservation were changed: all coefficients that are statistically significant with OLS remain statistically significant with the SEM.

Our summary conclusion is that accounting for spatial autocorrelation does not change our inferences about the different effects of CRP, federal land, population, and income on LTA and TNC conservation. This conclusion is especially strong with respect to TNC conservation. For LTA conservation, it is tempered only to the extent that one insists on modeling spatial autocorrelation over large distances and with linearly declining weights. See Kelegian and Prucha (1999).

[30] Federal income tax benefits for easement donors were expanded during 2006–2009 and, more recently, for 2011. See www.landtrustalliance.org/policy.

APPENDIX: ROBUSTNESS AND ALTERNATIVE SPECIFICATIONS

TABLE A1

Land Trust Acreage Determinants: 1990–2000 Posterior Distributions from Gibbs-Sampled Panel Tobit Model

	Panel (a): LTA Acreage		Panel (b): TNC Acreage	
	Mean	Mean/Std.	Mean	Mean/Std.
Time varying covariates				
CRP	−0.023	−1.94	−0.026	−2.14
WRP	−0.021	−0.42	−0.021	−0.40
Federal land	−0.005	−0.79	−0.003	−0.51
Population	0.006	3.04	0.005	2.74
Income	−0.011	−0.34	0.021	0.63
Growth factors				
Amenities	176.0	3.13	233.8	4.05
Farm size	−0.21	−1.02	−0.19	−0.86
County size	0.0018	6.90	0.002	8.33
Dynamic and other-trust-type effects				
LTA in 1990	0.57	7.86	−0.16	−0.96
TNC in 1990	0.14	8.28	0.03	0.84
Change in LTA 90-00			0.003	0.07
Change in TNC 90-00	0.011	0.42		

Note: The dependent variable is LTA acreage. Observations include counties in all U.S. states except those in Alaska and Hawaii. Aroostook, Maine, and Hidalgo, New Mexico, are also excluded, as are counties for which covariate data are missing. $N = 3{,}026$ observations for 1990 and 3,026 for 2000. These specifications differ from those in Tables 1 and 2 because dynamic and other-trust-effects are included.

TABLE A2

Land Trust Acreage Determinants: 1990–2000 Posterior Distributions from Gibbs-Sampled Panel Tobit Model

	Panel (a): LTA Acreage		Panel (b): TNC Acreage	
	Mean	Mean/Std.	Mean	Mean/Std.
Time varying covariates				
CRP	−0.032	−2.35	0.081	2.59
CRP: surrounding area	0.003	0.87	0.012	1.30
WRP	−0.071	−1.19	0.001	0.01
WRP: surrounding area	0.020	1.89	0.036	0.74
Federal land	−0.003	−0.54	−0.031	−2.31
Federal land: surrounding area	0.001	0.12	−0.017	−1.54
Population	0.005	2.58	−0.001	−0.27
Income	0.008	0.22	−0.130	−1.40
College grad percent	49.3	1.30	−17.7	−0.16
Growth factors				
Amenities: water area	177.1	1.92	−529.8	−2.08
Amenities: nonwater	260.3	3.87	32.1	0.18
Farm size	−0.225	−0.99	2.038	4.21
County size	0.002	8.49	0.001	1.10

Note: The dependent variable is LTA acreage. Observations include counties in all U.S. states except those in Alaska and Hawaii. Aroostook, Maine, and Hidalgo, New Mexico, are also excluded, as are counties for which covariate data are missing. $N = 3{,}026$ observations for 1990 and 3,026 for 2000. These specifications differ from those in Tables 1 and 2 because surrounding county and education effects are included as covariates. In addition, the amenities index is unbundled into water and nonwater components.

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