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**State-Level Variation
in Land-Trust Abundance:
Could it Make Economic Sense**

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October 2001 • Discussion Paper 01–36



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Abstract

Few economic analyses examine land trusts, their decisions, and the land-trust “industry,” despite their growing importance. For example, statistics on the wide variation in the number of trusts in different regions of the United States raise questions about whether such variation makes economic sense. This paper builds a model to identify the optimal number of private conservation agents. The model depicts two competing forces: regional spatial externalities in conservation benefits that increase the efficiency of having fewer agents and organizational costs, and fund-raising specialization, which increases the efficiency of having more agents. Using state-level variables, we perform a count-data analysis of the number of trusts conserving land in each state. We find that the number of trusts actually observed is consistent with the optimal number of trusts that is predicted by the model on the basis of the relative importance of spatial externalities and organizational size in different regions.

Key Words: Land Trusts; public goods; organizational size; conservation benefits; U.S. land conservation

JEL Classification Numbers: Q2, H4, L3

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State-Level Variation in Land-Trust Abundance: Could it Make Economic Sense

Heidi J. Albers and Amy W. Ando *

I. Introduction

Protected lands provide important conservation benefits in the United States. These lands employ a unique production function to create a wide variety of public goods, ranging from species protection to water quality maintenance to recreation. Although state and federal governments manage public lands to provide these benefits, private land trusts augment the supply of benefits by increasing levels of private conservation efforts. By 1998, at least 1,211 land trusts were operating in the United States (LTA, 1998), where a land trust is defined as a nonprofit private organization actively engaged in land conservation activity. The acreage of land protected by such groups tripled in the 1990s.

Despite the growing importance of land trusts in the provision of valuable public goods, few economic analyses have examined the structure of the land conservation industry. The high number of trusts combined with the variation in the number of trusts per state across the United States—which ranges from none to more than 100—raises questions about whether there are too many trusts in some areas and/or too few trusts in other areas. If too many trusts emerge, the trusts may be providing conservation benefits in a socially inefficient manner by failing to coordinate activities. If too few trusts emerge, the existing trusts may not provide enough conservation or may incur efficiency losses by attempting to manage portfolios of conservation activities that are too diverse.

This paper draws upon theory from industrial organization, public finance, and conservation economics to develop a model that explores the qualitative nature of the optimal number of land trusts to have operating in a given setting.. That efficient industry structure is influenced by the production function for a variety of conservation benefits and the total demand

* We are grateful to Soyoko Umeno and Meghan McGuinness for research assistance. This paper benefited from comments from attendees of the Southern Economics Association Meetings and from seminar participants at the University of Minnesota and the University of Illinois. Responsibility for all errors remains, as usual, with us. This material is based upon work supported by the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under project number ILLU-05-0305.

for conservation benefits. Using the model as a guide, the paper then conducts an empirical exploration of the numbers of land trusts in the 50 states to determine whether the patterns we see in those numbers could plausibly be desirable, and to identify aspects of this industry that require further analysis to determine whether policy development is warranted. This empirical analysis finds broad consistency between the number of trusts in each state and the number of trusts predicted by the model of tradeoffs between spatial externalities and organizational size. The discussion of these results, however, proposes some alternative explanations for the findings in order to highlight the results that call for further exploration.

II. Literature

Several bodies of literature contribute to our understanding of the cost-effective structure of the land-conservation industry, though none addresses this industry directly. First, a strand of work in the public finance literature¹ implies that, even in the face of government provision of public goods, some private provision of public goods through land trusts will occur—any crowding-out will be incomplete. Furthermore, while private provision of public goods will almost always fall short of the socially optimal level as individuals “free-ride” off one another’s contributions, specialization and deconcentration in the industry may mitigate the free-rider problem (Bilodeau and Slivinski, 1997).

Second, the industrial organization literature includes discussion of the optimal number of firms and product differentiation within a given industry. Micro-theory models of perfectly competitive industries imply that industries in long-run equilibrium will contain the optimal number of firms operating at the optimal scale of production. Models of monopolistic competition, however, show that unregulated actions of private firms can result in excess entry and product differentiation.² Economides and Rose-Ackerman (1993) even find this result in the case of nonprofit organizations providing somewhat-local public goods. The number of land trusts we see, therefore, may not necessarily represent the socially preferred outcome.

¹ This work on private provision of public goods includes theoretical papers such as Andreoni (1989), and empirical tests of the extent to which public provision crowds out private provision, such as Kingma (1989).

² For example, the classic excess-entry result is found in Mankiw and Whinston (1986).

Third, a literature in conservation and environmental economics focuses on how funding, be it government or private, should be allocated to achieve the highest level of conservation benefits. This body of work finds that coordination of conservation activities can produce higher benefits for the same level of funding, because coordination allows for various externalities to be internalized. For example, Wu and Boggess (1999) demonstrate that pressure on the government to allocate funds across watersheds reduces the overall level of conservation achieved. The production of some types of conservation benefits may, then, require a large minimum efficient scale to take advantage of cost savings from coordinating activities.

III. Theoretical Framework

As we bring together these literatures, it becomes clear there is a basic tension in the question of how many land trusts should be working to provide conservation benefits: niche diversification versus coordination of conservation decisions. Niche diversification, with its high number of land trusts, is desirable because it may increase total donations to conservation. Coordination across activities, and the low number of land trusts necessary to achieve that coordination, may yield increased cost effectiveness by reducing externality problems in the production of some conservation benefits. This section suggests that, in a given region, the optimal number of trusts reflects these conflicting forces in addition to factors that influence the total demand for conservation and the organizational costs of production.

In our model, the optimal number of trusts is a function of the optimal amount of land to be conserved and of the underlying production function of those benefits. For simplicity, the model here considers the output (Q) of conservation activities to be a single aggregate benefits measure of all the environmental services provided by undeveloped land. Embedded in that aggregate are benefits ranging from biodiversity conservation to recreation. The optimal level of benefits, Q^* , that should be provided by conserving land is found by solving the standard problem of maximizing net conservation benefits. Thus, Q^* is found where the aggregate marginal cost of providing benefits equals the aggregate marginal benefit of further conservation (see Figure 2).

Conservation groups produce these benefits by choosing, purchasing, and managing plots of undeveloped land. The cost curves for a representative group are shown in Figure 3, with the

minimum efficient scale (MES) of conservation denoted q^* . If we make the simplifying assumption that all groups have identical cost functions, then the optimal number of conservation groups active in a region, N^* , is given by $N^* = Q^*/q^*$. Thus, the efficient number of groups will be affected by factors that influence the total amount of conservation we want by shifting the marginal costs and benefits of conservation. Perhaps more interestingly, the socially optimal number of conservation groups will vary even for a given level of Q^* with factors that influence the minimum efficient scale of conservation production.

In order to understand the likely shape of the cost curves facing individual conservation groups, we must understand the nature of conservation production. The primary input into the production of conservation benefits is land. Unlike inputs into traditional production functions, however, not every unit of land yields the same increase in output (here, benefits). For example, 1 acre of forestland may provide important erosion-control benefits to a neighboring stream while an identical acre of forestland away from the stream provides far fewer benefits. Similarly, one plot may contain many species while a different but similarly sized plot contains only a few. The production of some level of conservation benefits, then, is not a simple function of the quantity of land measured in total acres. Rather, it is a function of which particular pieces of land have been conserved.

Adding more complexity, the conservation benefits generated by a particular piece of land can depend on the conservation status of other plots. In a standard example, the marginal value of an acre of one type of forest declines as the amount of that forest type that is conserved increases. In some cases, however, the conservation benefit function contains thresholds, which implies ranges of increasing marginal benefits to land conservation in the same area (Wu and Boggess, 1999). Furthermore, in a wildlife example, the marginal value of a small piece of forest may be very high if that plot provides a corridor for wildlife to travel between two larger conserved areas but that same piece of forest may provide few benefits if the other areas are not conserved. Again, the production of conservation benefits is a function of bundles of land parcels rather than of the sum of individual values (Albers 1996). Thus, an optimizing

conservation group must solve a cost-minimization programming problem that finds the lowest-cost bundle of land parcels that produces the level of conservation benefits it wants to produce.³

Where spatial coordination is an important component of the cost minimization problem, the cost function may display increasing returns to scale even at large levels of conservation activity. This situation is likely to occur where the bulk of land conservation values come from activities such as the preservation of large mammals, the protection of biodiversity, or the improvement of hydrological services. Such activities create this situation because, for example, in the case of species protection, island biogeography, minimum habitat size analyses, and the single large or several small (SLOSS) debate all suggest that, in many cases, more benefits flow from large contiguous plots than from the same area split over many plots, making coordination important (Soule, 1986; Shafer, 1990). Similarly, which plots remain forested within a watershed determine the water flow, flood control, and water-quality benefits provided by that watershed. The need for such spatial coordination could push the optimal structure of the land-trust industry toward a structure of few trusts, each operating at a high MES.

We should not assume, however, that spatial coordination is so prevalent and so important that private land conservation is always a natural monopoly. In some areas, government lands (parks, reserves, etc.) may provide the benefits for which coordination is important or move beyond any threshold in the benefits function. In addition, not all components of conservation benefits display sweeping economies of scale. In urban areas, for example, open space may be conserved largely for recreational and aesthetic values. Those values may be large for small parcels, and the value of one park may be little affected by the precise location of other spaces. These characteristics of the conservation benefits could lower the MES of private conservation production.

Economies of scale in aggregate conservation also may be limited by another set of phenomena. As a single conservation group produces increasing quantities of aggregate conservation benefits, that output becomes increasingly heterogeneous. This places a growing burden on the management ability of the organization.⁴ Furthermore, it may harm the group's

³ Ando et al. (1998) provides an example of the cost function that emerges from such a production function for the number of U. S. endangered species protected by land set-asides.

⁴ Some models of the firm that help to explain this occurrence are summarized in Tirole (1990), p. 46.

ability to raise funds for its conservation activities, because many donors are interested in only a subset of the conservation benefits the monopoly group provides. The analysis of Bilodeau and Slivinski (1997) indicates that, under such circumstances, the problem of public-good underprovision can be somewhat mitigated by replacing the monopolist with several groups that specialize in providing particular kinds of conservation benefits. Organizational costs and fundraising considerations move the land-trust industry toward a structure of many small, specialized land trusts. Anything that lowers the MES of conservation, *ceteris paribus*, leads the optimal land-trust industry to have a larger number of more specialized trusts.

The optimal number of conservation agents depends on the relative strength of these competing forces. The size of the minimum efficient scale of conservation production should increase with factors that elevate the importance of spatial coordination in land conservation and decrease with features that elevate the importance of conservation-group specialization. Where the benefits of decisionmaking coordination are high, it is likely better to have fewer conservation groups; where the public goods are very local in scope or very diverse in nature, society may benefit from having a larger number of more specialized conservation groups. Because these features vary across regions, the model predicts variation in the number of trusts across regions that does not always correspond to variation in the optimal amount of land to conserve in the region.

IV. Empirical Framework and Data

We have data on the number of land trusts actively engaged in conservation in each of the United States in 1988 and 1998. We also have collected a set of independent variables inspired by the theoretical framework described above that we expect to influence the optimal number of groups in each state and year. Many of these factors might alter the total amount of conservation that should optimally be provided in a state, or influence the minimum efficient scale at which conservation can be conducted in a state. Our purpose in the empirical analysis is to test whether

these variables have any power to explain the variation in the number of conservation groups we observe across states and across time.⁵

The dependent variable—number of land trusts—is tabulated for each year in Table 1. The table makes clear that this variable has classic features that call for count-data modeling: the values are non-negative integers that are clustered around fairly low values (especially in 1988). However, the presence of several states with fairly large numbers of land trusts means that the Poisson model, with its assumption that the mean of the dependent variable is equal to its variance, is unlikely to be valid. It has become standard in such situations to use the negative binomial model, which includes an “overdispersion” parameter that effectively allows the variance of the process to exceed the mean. Because we have a two-year panel, we use a random-effects negative binomial model.⁶ This estimator specifies the distribution of the dispersion to vary randomly among states (in particular, the inverse of the dispersion parameter has a Beta(r, s) distribution (StataCorp 1999, pp. 383-390)) but the dispersion parameter for any given state is assumed to be drawn from the same distribution in each year.⁷

The independent variables are listed with summary statistics in Table 2.⁸ Based on the theoretical framework, we include variables that might be expected to affect the optimal total quantity of conservation and/or the MES of conservation production. If the observed numbers of land trusts track the optimal numbers of such groups, we expect variables that increase the total quantity of optimal private conservation in a state to increase the number of land trusts, *ceteris paribus*, while we expect variables that increase the size of the MES of conservation production to decrease the number of land trusts. In some cases, a variable could operate in two opposing directions; the regression results can be interpreted as evidence of the relative magnitudes of those forces for that particular case.

⁵ The empirical strategy adopted here assumes implicitly that the number of conservation groups is in equilibrium at each point in time. It may be possible that we observe a population of conservation groups that is always in the process of adjusting towards the optimal levels instead. Such alternative models could be explored in future research.

⁶ The panel is too short to plausibly use a fixed-effect negative binomial model.

⁷ This estimator is inspired by Hausman et al. (1984). For more details about count-data models, see Cameron and Trivedi (1998) or Greene (1997).

⁸ Details on the sources and definitions of all variables used in the analysis are found in the Data Appendix.

We include a number of variables that may affect the optimal total amount of private conservation for a given state. We expect the overall size of the state, the percentage of land that is classified as urban, the median income of state residents, the percentage of the population with at least four years of college education, the total population, the population density, and the population growth rate to increase demand for conservation. Because the degree of environmentalism in a state is likely to affect the demand for land conservation, we proxy for the strength of environmentalism in a state with the percent of voters in that state who voted for George Bush in the presidential election of 2000, with low values signaling stronger environmentalism.

Some features of a state's ecology could contribute to an increase in the demand for conservation land and thus to the number of land trusts. To capture these effects, we include the number of endangered species, the number of endemic species, and the number of mammals with large home ranges (here, larger than 1 km²) as explanatory variables. We include a measure of the cost of undeveloped land because it might be correlated with increased demand for private conservation if it proxies for the development pressure on open lands, though high land values might instead act to decrease the total amount of land conserved in equilibrium through increased production cost. Finally, if much land is protected by federal and state governments, such as land in parks, wildlife reserves, and open space, then total private conservation activity might rationally be reduced through a standard crowding-out mechanism.

We also include variables that might influence the MES of conservation production. The previously described measure of government-protected areas falls in this category. In states with a large amount of land conserved by the government, land trusts may be able to focus on small-scale conservation activities, such as providing local open space, because the government already is protecting enough land to provide benefits that require coordinated activities. This kind of focus could be a force for increased optimal land-trust proliferation. By contrast, an increase in the MES of land conservation production decreases the optimal number of land trusts. Our theoretical discussion stresses that the MES will be raised by any characteristic of the state's ecological system that forces conservation activities to be coordinated in order to provide benefits in an efficient manner.

To capture such effects, we also include road density as a measure of ecosystem fragmentation; watershed density to reflect the importance of threshold effects in watershed protection (Wu and Boggess, 1999); total land area to capture the size of land parcels; and the numbers of endangered species, endemic species, and large-ranging mammals to reflect the need for coordinated activities to insure habitat protection.

Finally, we include a variable not shown in Table 2 that is a dummy equal to one for observations in 1998, and zero for observations in 1988. This variable controls for nationwide changes in institutions from one decade to the next that might have acted to increase the number of conservation groups operating around the country.

There are 100 observations in the sample—one for each state in 1988 and in 1998. We gathered time-specific values for the independent variables where possible. However, some variables—like total area, the number of watersheds per area, and the number of endemic species and big mammals—are intrinsically constant during the time period we studied.

V. Results

Table 3 contains results from a random-effects negative binomial regression of the number of land trusts in a state and at a point in time on independent variables listed in Table 2. Because the coefficients themselves have little intuitive value, the last column in the table gives the average percent change in the predicted number of land trusts associated with moving from the mean value of the independent variable to one standard deviation above that mean. We perform a likelihood-ratio test comparing the random-effects model to one that pools the observations and does not allow the dispersion to vary among groups. This test rejects the restricted model.⁹

The result on the dummy variable for observations from 1998 reveals a strong, increasing time trend in the number of land trusts across the country, even when potentially important time-varying variables are controlled for. However, many other factors seem to be associated with variation in the number of land trusts in each state, and the results on the coefficients of interest are largely consistent with the intuition of our model. For a given kind of conservation activity,

⁹ The test statistic is $\chi^2(1) = 26.98$; Prob > chi2 = 0.0000.

the number of conservation groups rises with factors we expect to increase the efficient amount of conservation to provide in total. Furthermore, trusts seem to proliferate in states where land trusts might be expected to provide local or niche benefits, such as local open space, while fewer trusts arise in states where land trusts might aim to provide benefits that require coordination across pieces of conserved land, such as species protection.

There are several variables we might expect to increase the optimal total amount of land conservation, and thus increase the optimal number of land trusts; some of them prove to be positive and significant in the regression analysis (Table 3). The regression finds positive, significant, and strong relationships between the predicted number of trusts and both the percent of land in a state that is urban and the total population. An increase in the degree of environmentalism, here represented by a decrease in the percent of voters choosing Bush in 2000, also proves to be positively and significantly correlated with the number of trusts. The direction of these results is not surprising because more people, and especially more environmentally minded people, demand more conservation.

We might have expected the rate of population growth to have a similar positive correlation, because such growth might lead to increased pressure on open space, but this variable is insignificant.¹⁰ Similarly, we might have expected the variables controlling for income and education to have positive coefficients, but they are insignificant. In no specification is education significant, but income has a significant positive coefficient when the Bush variable is excluded. A high correlation between income and voting for Bush in the 2000 presidential election makes it difficult to identify any separate effects of income and ideology.

The cost of land could increase or decrease the optimal amount of conservation activity. Increases in the cost of land might act to decrease the total amount of conservation in equilibrium, because the cost of buying land is a significant component of the cost of producing conservation benefits. However, the cost of land may proxy for the pressure on undeveloped land and thus signal increased marginal benefits of acquiring conservation land. If the strong positive correlation revealed by the regression is in any way optimal, it must be that the signal of

¹⁰ We tried using the number of new housing starts as a proxy for expansion pressure on open space, but it, too, was insignificant.

development pressure and conservation demand contained in this variable overwhelms the implications of average land values for the cost function.

Two variables in the regression, road density and watershed density, could act as measures of features of the remaining ecological units in the state that would increase the MES of conservation, and thus decrease the optimal number of land trusts needed to provide a given amount of conservation in the state. Road density proxies for the degree of fragmentation of the remaining natural lands, and fragmentation could be expected to increase the benefits of coordination of conservation activities; the more fragmented an ecosystem, the more sensitive are conservation benefits to the particular plots that are conserved. Similarly, as in Wu and Boggess (1999), the benefits derived from watershed protection face important thresholds; meeting those thresholds may be more difficult if conservation activities are dispersed across many, small watersheds rather than focused. If fewer land trusts arise in states where fewer are optimal, the significant negative coefficients on road density and watershed density are consistent with a story in which these features of the land increase the need for coordinated activities, which increases the MES of production, which decreases the optimal number of land trusts.

The analysis includes several variables that could play dual roles in determining the number of land trusts because they could increase the total amount of conservation that is optimal—tending to increase the optimal number of land trusts—but also increase the MES of conservation—tending to decrease the optimal number of land trusts. In the case of mammals with big ranges, conservation activity might need to be coordinated to provide enough appropriate or contiguous habitat to support such species, increasing the MES of conservation to protect them. Working in the opposite direction, however, there is some evidence¹¹ that we place a disproportionately high value on protecting “charismatic megafauna,” which suggests that states with many far-ranging mammals may have a relatively high level of demand for conservation land. The regression results find a positive correlation between the variable and the number of land trusts; for this pattern to be optimal, it must be that the demand effect swamps the MES effect for this variable.

¹¹ See, for example, Simon, Leff, and Doerkson (1995) and Metrick and Weitzman (1996).

The variables that measure the numbers of endangered and endemic species in each state also could increase both the total demand for conservation land and the need for coordination in conservation activities. In the regression results, both of these variables are significantly negatively correlated with the number of trusts, though the significance of the coefficient on the number of endangered species is not robust across specifications and neither effect is a strong contributor to the overall variation in the numbers of land trusts.

Still, how could it possibly be desirable for states with more endangered and endemic species to have fewer land trusts? It may be that our results simply reveal an inefficient dearth of land-trust activity in states with species in special need of protection. Alternatively, intuition from our theoretical framework could be used to argue that this negative correlation could make sense if the presence of such species has a bigger impact on the MES of conservation than on the total amount of optimal conservation. Further, the result may not be perverse if people consider endangered species to be protected by federal regulations and conservation activity, and thus not in need of private conservation efforts. We cannot distinguish between these possible interpretations with the data at hand; thus, there is a need for future research.

The regression reveals a positive, significant correlation between the amount of government-protected land in a state and the number of land trusts that operate there. This finding flies in the face of what might be standard public-finance intuition about government provision of conservation crowding out private conservation activity. However, our theoretical framework identifies two ways in which this result could be consistent with optimal patterns of land-trust proliferation. First, the amount of government-protected land in a state may proxy for the inherent value of land for conservation purposes, which could increase the total amount of optimal private conservation in the state.¹² Second, if the government has protected large amounts of land, the residual demand for conservation benefits may be largely for recreation, open-space aesthetics, efforts to plug high marginal-benefit holes in government-protected areas,¹³ or other benefits that have a smaller efficient scale of production. In this case, the

¹² Scott, Abbitt, and Groves (2001) contend, however, that most government conservation land occurs on land that is not particularly highly valued for conservation purposes, which casts the mechanism proposed here into doubt.

¹³ One example might be a land trust arising to create a wildlife corridor between two government conservation areas.

government's conservation of land leaves room for niche diversification, land trusts operate at low MES, and more trusts arise.

Even if government conservation does not “crowd-in” more acres of private conservation, it could yield more land trusts by moving the portfolio of conservation activities toward those that require smaller trusts if the MES effect outweighs any crowding-out of total private acreage. This result is worthy of further analysis, especially to distinguish between the government's impacts on the MES of conservation and on the total amount of private conservation provided.

One of the most surprising findings is the significant, negative correlation between the total land area of a state and the number of land trusts operating in that state. It was our expectation that the relationship between these two variables would be dominated by a positive correlation between total land area and the optimal amount of total private conservation land demanded. It may simply be that big states have too few land trusts (or small states have too many).¹⁴ There are, however, at least two plausible stories that are consistent with this pattern being reasonable. First, if the MES of conservation in large states is itself relatively big, and if that effect is strong, the negative correlation we see could mimic the optimal pattern of land-trust proliferation. Second, it may be that optimal total conservation is more an increasing function of population and other variables than of total land area; in fact, if the threat to remaining open space in large states is low, or if land abundance lowers the marginal benefit of conserving any particular parcel of land, then optimal private conservation levels may, in fact, be inversely correlated with state size. Though such stories can, in the framework we set forth, be told, more study of possible excess entry into the land trust industry in small states and/or too little entry in large states is clearly needed.

Another result eludes both conventional wisdom and the insight of our model. We would expect that dense population would increase the threat faced by remaining open space, raising the marginal benefit of conservation, the efficient amount of conservation to be supplied, and the optimal number of groups. Instead, the coefficient on population density is significant and negative, implying that there are fewer trusts in densely populated areas. It is tempting to dismiss this finding as an anomaly, because if New Jersey, which is much more densely populated than

¹⁴ We note that this result is not shaken by including a dummy variable for Alaska, or by including a regional dummy for New England.

all other states in the country, is dropped from the analysis, this counter-intuitive result goes away.¹⁵ Alternatively, it may be that this relationship arises because densely populated areas contain few land parcels for conservation or parcels with limited conservation value, or that state-level population density is simply not the correct variable to capture the demand for local open space within urban centers. Regardless, more research could be used to understand the impact of population density on the structure of the land trust industry—or at least to understand what is going on in New Jersey.

VI. Conclusion

The large number of lands trusts in some states and the wide variation in the number of trusts across states raises concern that the private provision of conservation benefits from land protection occurs inefficiently due to excessive and/or under-entry in some regions. To examine this issue, we combine insights from the industrial organization literature, the public finance literature, and the conservation economics literature to form a model that predicts the number of land trusts as a function of characteristics of the production of conservation benefits and of the demand for these benefits. An empirical test of this model eases the concern about widespread inefficiency in the land-trust industry but also identifies some important questions for future research.

Are there too many conservation groups? The model and empirical work presented in this paper enable us to say at least some things in response to this question. First, it is not likely that provision of conservation benefits is a natural monopoly in all parts of the country; at least some of the land-trust proliferation we observe is likely to be a good thing. Second, land area alone is unlikely to determine the efficient quantity of conservation or the cost-minimizing number of groups to provide it. Third, because the factors contributing to the amount of conservation land demanded and to the efficient scale of private production vary widely across states, the wide variation in the number of trusts per state does not signal an inefficiently structured industry. In fact, our analysis reveals patterns in the numbers of land trusts in the 50 states that are broadly consistent with the patterns our model tells us we would see in the numbers of groups if they were chosen optimally.

¹⁵ The bulk of the other findings remain unchanged by this change in the sample.

Following basic intuition about the demand for an amount of conserved land, the model makes clear that factors such as population level and environmental ideology will affect the optimal amount of conservation and, hence, the number of groups. Consistent with this, we find that such factors are indeed positively correlated with the number of land trusts in a state. Following the explicit exploration of the production of conservation benefits, the model also points out, however, that the minimum efficient scale of providing “conservation benefits” will vary depending on the precise nature of the benefits that are the focus of conservation efforts in a state. If the dominant conservation concerns in a state contain regional spatial externalities, such as minimum habitat sizes or other cumulative effects, the benefits from coordination across land parcels increase the minimum efficient scale of the land trust and thus decrease the number of land trusts that is optimal for a given level of benefit provision. If the conservation benefits are more local, such as neighborhood open space, the minimum efficient scale will be smaller and many specialized, small groups will better provide that level of benefits. In our empirical analysis, the number of land trusts per state does vary with factors that are likely to influence the efficient scale of conservation activity, and that variation mimics what we would expect to see if the numbers of groups were optimized. The absolute numbers may not be optimal, but at least there seem to be more groups active in states where it is desirable to have more.

Because land conservation benefits are a public good, the government plays an important role in their provision, but what gaps in government policies are private land trusts filling? We find a positive correlation between the number of land trusts and the amount of government-protected land; that result is consistent with several answers to the question posed. First, if government-protected land proxies for the value of land for conservation purposes, the land trusts may simply be addressing the shortfall between government-protected area and the high level of optimal conservation in that state. Interpreting the result through the lens of the minimum efficient scale of conservation, however, the land trusts might operate at a low MES either if they see opportunities to achieve thresholds with relatively small areas—filling physical gaps in the government’s protected area system—or if their focus centers on local benefits because the government land provides other benefits. Thus, while we find that the number of land trusts increases with the acreage of government-protected areas, it is not possible to discern whether this increase occurs because government-protected land signals a large, optimal amount

of conservation land; because more small land trusts focus on locally-accruing conservation benefits; or because more small land trusts form local links to create coordinated conservation benefits.¹⁶

In addition to identifying the relationship between public and private provision of these public goods as an important area for further research, this model and empirical exploration recommends three other aspects of private land conservation for more extensive, potentially policy-relevant, analysis. First, the negative relationship between population density and the number of trusts runs counter to much of conservation economics' conventional wisdom, and further empirical analysis appears warranted to explore this anomaly. Second, the negative correlation between state land area and the number of trusts raises questions about whether policies or other factors in large states tend to deter entry into the land-trust industry or whether the size of the state effects the efficient scale of production through the size of parcels or the abundance of land. Third, although the negative correlation between endangered species and the number of trusts might be explained by intuition about the efficient scale of conservation from our model, there is still reason to worry that this pattern is seriously suboptimal. The empirical analysis here largely supports the contention that land trusts enter the industry in a way that at least mirrors an efficient process, but also identifies these three areas for further research that have important policy implications.

In our exploration of the optimal number of conservation groups, we have analyzed features of the demand for, supply of, and production function characterizing the provision of land-conservation benefits. However, a similar framework could be used to analyze the optimal number of nonprofits to provide any public good, and to evaluate whether the proliferation we observe at least mirrors that which would be best. It is in keeping with standard economic intuition that there are many groups involved in raising funds for research on common diseases such as breast cancer, whereas a single fund lobbies for support for research on a variety of extremely rare diseases that have small individual constituencies. This paper indicates further, however, that we expect relatively more nonprofits to be active in the provision of public goods when the production of such goods requires a small efficient scale of production. For example,

¹⁶ One next step in our research agenda includes an empirical examination of the tendency of government land conservation to crowd-out private conservation agents or to create a seeding effect and attract private land trusts.

coordination might be important in providing widespread famine relief in foreign countries, while many small groups should arise to feed local homeless and impoverished populations. If the market structure for the provision of public goods does not follow this pattern, the policy question becomes one of methods to encourage the socially efficient number of private providers of public goods.

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Appendix: Data

Variable	Description	Source(s)
Number of land trusts	Number of groups conserving land in the state	Bates, 1989; LTA, 1999.
Total area	Total acres of land in the state \div 100,000	Weber, 2000.
Cost of land	Average value of agricultural land from Census of Agriculture (1000s of \$1998)	USDA/ERS, 1995a; NASS, 1999.
Percent urban	((Acres of land classified as “developed”, i.e. urban area or rural transportation land) ^a \div (Acres of land in the state)) * 100	USDA/NRCS (2000).
Protected government areas	Sum of the acres of land in the following categories, divided by 100,000: state parks, state forests, National Parks ^b , National Wildlife Refuges, USDA Forest Service land, land in the Conservation Reserve Program, land in the Wetland Reserve Program ^c .	NASPD, 1989, 2000; NASF, 1998, 1988; NPS, 1998; USFWS 1988, 1998; USDA/FS, 1988, 1998; USDA/ERS, 1995, 1998; USDA/NRCS, 1988.
Road density	(Number of lane miles in the state) \div (Acres of land in the state)	OHPI/FHWA, 1998; FHWA, 1988.
Watershed density	(Number of watersheds in the state) \div (Acres of land in the state) * 100,000	USEPA, 2000.
Endangered species	Number of endangered species in the state listed on the federal endangered list by end of 1988, 1998.	USFWS, 2000a.
Endemic species	Number of species endemic to the state	Stein et al., 2000.
Big mammals	Number of mammals found in the state with home ranges greater than 1 km ²	ABI, 2000.
Percent voted for Bush	The percent of votes in the state during the 2000 presidential election that went for Bush	Cable News Network (2001).
Median income	Median household income (1000s of \$1998) ^d	USBC, 2000.
Education	Percent of the population with four years or more of college education ^e	USBC, 1991; Day and Curry, 1998.
Population	Total population ^f \div 100,000	USBC, 1995, 1999.
Population growth rate	Percent population growth rate from the previous year	USBC, 1995, 1999.
Population density	Number of people per acre of land	Calculated from above.

Notes:

^a These data come from the National Resources Inventory (NRI) and are thus for 1987 and 1997 instead of 1988 and 1998. Data are not readily available for Alaska from the NRI, so values of developed (or urban) acreage were extrapolated for that state using, in part, a similar statistic available only for 1988 (OHPI/FHWA, 1998).

^b Acreage in any multi-state park was allocated evenly among each of the states in which the park was located for purposes of generating state-level acreage totals. Similar data on acreage by park was not available for 1988. Hence, 1988 state summaries of national park acreage were constructed by identifying the 1998 parks that did not exist in 1988, and subtracting their acreage from the 1998 totals.

^c The Wetland Reserve Program did not exist in 1988, so acreage for this category in that year is zero.

^d These figures are intercensal estimates of median income.

^e Educational attainment is of persons 25 years old and over. The value attributed to 1988 is actually the percent of that population in 1989 that completed 4 years of college or more; the value attributed to 1998 is the percent that earned a bachelor's degree or more in 1998.

^f These figures are intercensal population estimates.

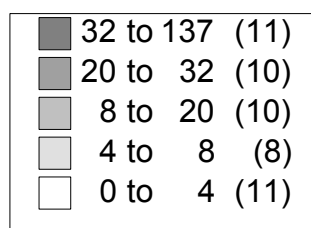
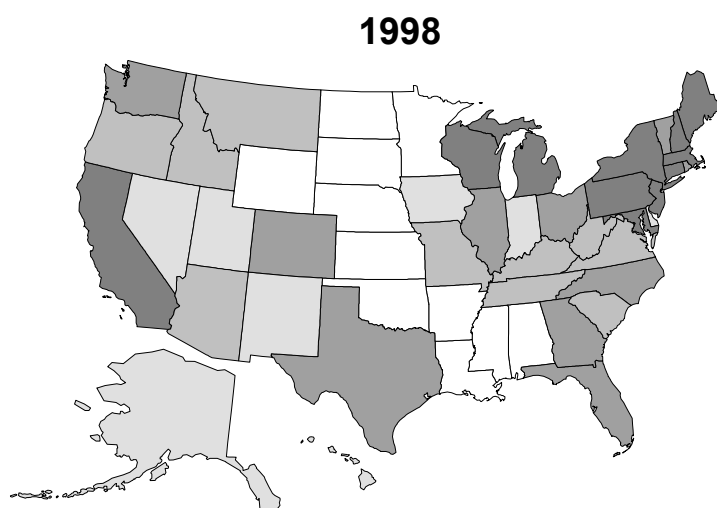
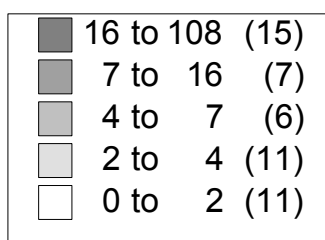
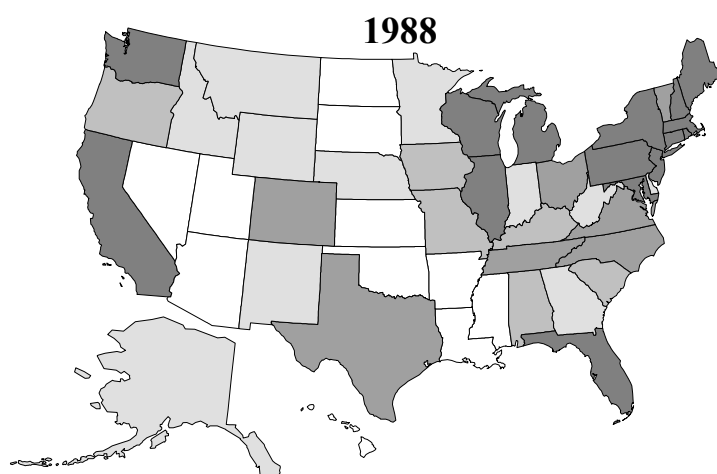
Figure 1: Number of Land Trusts, by State

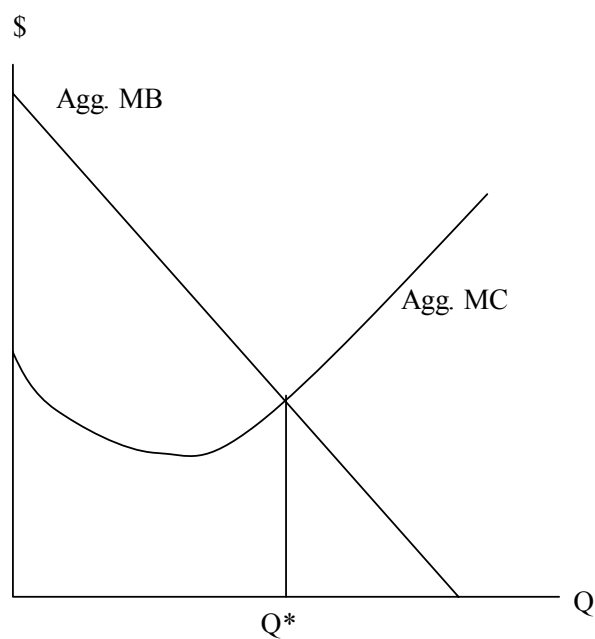
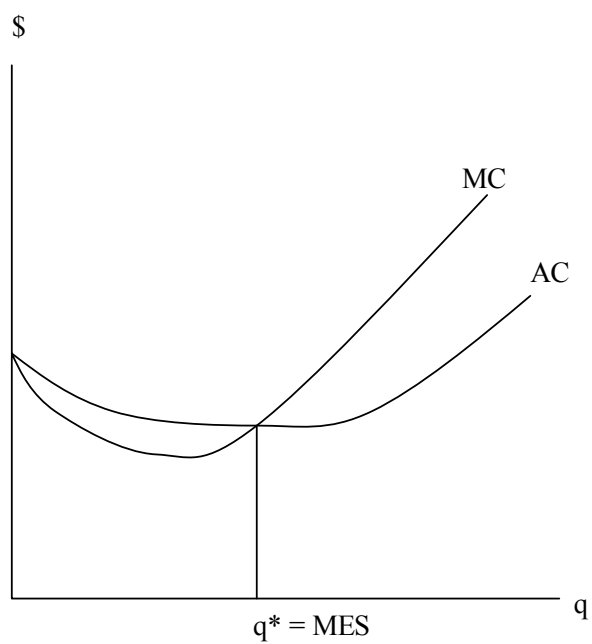
Figure 2: The Optimal Level of Conservation Benefits**Figure 3: Cost Curves for Individual Group**

Table 1: Tabulation of Dependent Variable

Number of Land Trusts (N)	# of States with N Land Trusts in 1988	# of States with N Land Trusts in 1998
0	6	1
1	5	4
2	3	4
3-5	10	8
6-10	7	8
11-30	13	13
31-50	2	6
51-70	2	1
71-90	0	2
91-110	2	0
111-140	0	3

Table 2: Summary Statistics of Variables

Name	1988	1998			
	Mean	Mean	Stand. Dev.	Min.	Max.
Number of land trusts (# of groups in state)	14.88	24.22	31.56	0	137
Total area (100,000 acres)	*	476	565	9.89	3782
Percent urban (% of state acres developed)	6.00	7.38	6.53	.54	31.86
Median income (1000s of 1998\$)	38.653	38.055	10.355	25.030	93.841
Education (% with 4+ years college)	20.37	23.77	4.36	16.20	34.00
Population (100,000 people)	49.23	53.96	59.36	4.80	326.83
Population density (population/area)	.22	.231	.295	.002	1.450
Population growth rate (%Δ pop. from prev. year)	.77	.90	1.16	-.49	7.39
Percent voted for Bush (% votes in state for Bush in 2000)	*	50.55	8.76	32	69
Cost of land (1000s of 1998\$/acre)	1.616	1.713	1.494	.199	6.775
Endangered species (# on federal list)	23.26	42.08	52.18	9	302
Endemic species (total # in state)	*	85	259	0	1480
Big mammals (# in state w/ range>1km ²)	*	20	5	4	36
Protected govt. areas (100,000 acres)	91.62	97.62	244.28	.10	1682.57
Road density (lane miles/acre)	.0024	.0052	.0031	.00068	.0139
Watershed density (100,000*#watershed/acre)	*	.19	.12	.04	.71

Note: A “*” indicates that values in 1988 are the same as in 1998 for all states.

Table 3: Results of Random-Effects Negative Binomial

Variable	coef.	S. E.	Significance	Importance
Total area	-.0010	.00048	**	-.19
Percent urban	.14	.046	**	.30
Median income	.0012	.0037		
Education	.023	.022		
Population	.013	.0026	**	.26
Population density	-3.7	1.2	**	-.21
Population growth rate	-.012	.071		
% voted for Bush	-.077	.016	**	-.26
Cost of land	.59	.16	**	.32
Endangered species	-.0031	.0018	*	-.04
Endemic species	-.0015	.00047	**	-.11
Big mammals	.051	.025	**	.09
Protected govt. areas	.0016	.0087	*	.15
Road density	-168.3	39.8	**	-.13
Watershed density	-2.3	1.2	*	-.09
Year is 1998	.75	.15	**	.29
Constant	5.7	1.8	**	
r	21.5	19.4		
s	4.2	1.7		

Notes:

- 1) The dependent variable is the number of land trusts in the state.
- 2) ** indicates significant at the 5% level; * indicates significant at the 10% level.
- 3) The log-likelihood value is -298.63.
- 4) The variables r and s are the mean and variance of the Beta distribution characterizing the inverse of the dispersion coefficient.
- 5) "Importance" is calculated by finding the average predicted numbers of land trusts if the variable is set to its mean (Pmean) and the average predicted numbers of land trusts if the variable is set one standard deviation above its mean (Pmean+sd), and calculating $(\ln(Pmean+sd)/\ln(Pmean))-1$. For the year dummy variable, the "mean" is for the year to be 1988 and the "mean + 1 standard deviation" is for the year to be 1998.