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The Effects of Land Conservation on Productivity

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Abstract
In this research the relationship between productivity of land conservation is analyzed using panel data of the GDP and acres conserved of all 50 U.S. states from 1998-2005. Two main theories of the conservation productivity relationship exist. The first maintains that conservation impedes productivity because it does not allow land cultivation. Conversely, the second theory maintains that land conservation has a positive effect on GDP due to the recreation and tourism it creates. Through the use of fixed effects and random effects regressions, the amount of land conserved per state is not a significant predictor of state GDP The GDP of different industries were then used to analyze the influence of conservation on certain industry GDPs. Conservation was not a significant predictor of all industry GDPs either. While these findings suggest that conservation does not a have a significant effect on GDP, they also lead us to believe that the relationship between conservation and GDP is non-linear.

Keywords
Conservation, GDP

Introduction

In recent years, developed nations have become more environmentally conscious about global consumption of natural resources. Conservation awareness and efforts have increased tremendously as activists and politicians recognize the detrimental effects of rapid consumption of resources. However, these conservation efforts can counteract national productivity. Countries often gage economic health by means of productivity. This productivity has always been measured by increases or decreases in economic output, or *gross domestic product* (GDP). There are many factors that model GDP, which includes employment, hours worked, consumption, technology, investment and government spending. As these factors increase, GDP does as well. So when growth in GDP is observed, so does the consumption of resources necessary for production growth. Similarly, there are many factors that influence conservation efforts. Factors that determine the amount of land conserved are conservation investment, tax subsidies, environmental policy on local, state and federal levels, environmental education and awareness in the area, species richness, and state identity. As a result of the many influences affecting output and conservation there appears to be no definitive consensus on the nature of their relationship.

Current literature supports two main theories about the relationship of land conservation and economic output. A more pessimistic view poses that an increase in conservation results in less available land and other resources available for cultivation. Thus, restriction to natural resources creates an inverse relationship between GDP and conservation. Proponents of conservation believe that efforts do not decrease overall GDP, but reallocates the value added to different industries. By using conserved land for recreational and tourism purposes, GDP can increase along with biodiversity and species richness. We can assume that land put under conservation that is not in development plans will increase GDP through recreation, tourism, and transportation services. Conversely, if land is directly taken out of production or there is a possibility of the land being cultivated in the future, adversaries argue that the restrictions will reduce GDP. Others believe that the value added to GDP from recreation and tourism will be the equal to, if not more, than the original GDP output from land cultivation and harvesting.

Underlying these theories is the concept of the Kuznet curve. The Kuznet curve represents the relationship between environmental degradation and output. It is represented graphically by a parabola. The theory contends that in order for economic output to increase, natural resources and land are needed. As an economy grows and natural resources are consumed, environmental degradation increases. Environmental degradation continues to increase until the public realizes the negative impact on the environment. Firms will then be forced to produce more efficiently. This will cause environmental degradation decrease, while output still continues to increase. This is depicted graphically by a movement right along the Kuznet curve where the slope of the line is negative (Dietz et al. 2002).

In this paper we attempt to identify and better understand the relationship between land conservation and production. More specifically, we wanted to test whether conservation efforts mitigate or support GDP growth and identify which industries conservation effects most.

Literature Review

To frame our hypothesis and construct our model, we examined the findings of previous literature. While the relationship between output and conservation has been discussed theoretically, it has been relatively unexplored in an empirical sense. Two main methods were used in the literature to explore this relationship, which helped inform our approach.

The first method used economic factors to predict conservation efforts. This approach is utilized in *"Linkage of Conservation Activity to Trends in the U.S. Economy"* by Pergams, Czech, Haney and Nyberg. The authors incorporated a variety of variables, such as GDP, personal income, the Dow Jones Industrial Average and the S&P 500 stock market index to predict conservation investment. Pergams et al. found GDP to be the most highly correlated with conservation investment. Personal Income had the second highest correlation out of all the predictors, while both stock market indices showed little correlation with conservation investment. We decided to include GDP and personal income into our model as a result of the strong relationship with conservation investment found in Pergams et al.'s paper.

Simon Dietz and W. Neil Adger use a similar approach in "*Economic growth, biodiversity loss and conservation effort*" when assessing the relationship between economic growth, biodiversity loss and biodiversity conservation efforts. They predicted area of land conserved using income per capita, population density, time, and the level of democracy. Dietz and Neil conducted fixed effects and random effects regressions using panel data from various countries. They found that environmental policy from government increases with economic development, and that economic development is correlated to, but not a determining factor of the area of state protected land. This supports the theory of the Kuznet curve because at a certain point, economic growth results in a decrease in economic degradation. Our main takeaway from this paper was Dietz and Neil's use of fixed and random effects regressions. Their panel data was very similar to ours, thus we too used fixed and random effects regressions.

The second popular approach is to predict economic output using land conservation as well as other variables, which is what we aim to do in this study. This method was found in "*The Conservation Economy in America: Direct* *investments and economic contributions*," where the researchers test the effects of conservation investment on state GDP and on the GDP of individual industries within each state. Through IMPLAN and multiplier analysis, it was concluded that conservation investment does significantly impact the economy positively on a state and national level. We chose this approach because of the flexibility of the model to examine different industries. Their findings supported the idea of conservation efforts adding to GDP and not minimalizing it.

Higher opportunity costs of conservation have been linked to poverty stricken areas. Around the world, we see that those in poverty, mainly in rural areas, are very dependent on the land and the biodiversity it offers. In the current literature, some argue that efforts to increase biodiversity conservation counteract efforts to decrease poverty. Others would believe that conservation efforts and poverty can be solved together. These arguments can be paralleled to the opposing views on the relationship between conservation and economic growth. In *"Biodiversity Conservation and the Eradication of Poverty*", Adams et al. attempt to determine whether conservation efforts aid poverty eradication or if it hinders these attempts. They came to two conclusions. First, people in poverty around the world usually depend more on biodiversity than those of higher income classes. Second, under certain circumstances, conservation can help eliminate poverty. We thought that this was interesting because the two opposing arguments associated with biodiversity conservation and poverty is very similar to our question of whether conservation hinders GDP. Intuitively, we would expect to see an increase in GDP if there was a decrease in poverty rates under these certain circumstances.

From these research articles we come to the following conclusions about the literature. First, conservation investment does positively impact GDP and economic growth, GDP is a good predictor of conservation contributions, environmental policy increases with economic growth, but does not necessarily result in increases in the area of land conserved.

Data

To analyze of the relationship between GDP and conservation, panel data from the United States' Bureau of Economic Analysis was used. The panels were divided by state and year (1998-2005). Variables used were GDP, acres of land conserved, conservation investment, income, and population. Additionally, we selected certain GDP components by industry from the United States' Bureau of Economic Analysis in order to see whether certain industry GDPs were effected by conservation.

Year: For our dataset, we collected all of our data in between the years of 1998 and 2005.

State: We collected data for all 48 states for every year between 1998 and 2005. Mississippi and Tennessee were excluded due to a lack of data. District of Columbia, and all other United States' territories were also excluded.

GDP: Total Gross Domestic Product in millions were collected for each state from the United States Bureau of Economics Analysis. GDP was used as the dependent variable of our models.

Acres Conserved: This variable represented the amount of acreage conserved by public funds. We retrieved this information from the Conservation Almanac. It is important to note that these values do not include any privately or NGO funded conservation property.

Public Dollars Spent on Conservation: These values were also found from the Conservation Almanac and represent the amount of public funding spent on conservation.

Personal Income: This data was collected from the United States Bureau of Economic Analysis and represents the yearly total personal income for each state. We expect that higher personal income will have a positive correlation with output since higher incomes give households the ability to consume more goods. When more goods are consumed firms produce more satisfy the demand.

Population: This data was collected from the United States Bureau of Economic Analysis and represents the population for each state. We expect population to increase with GDP because the greater the population, the larger the labor force is, which should result in an increase in output.

Industry GDP Variables: Other variables included in the model include the GDP contributed from the following industries per state: Agriculture, forestry, fishing and hunting, Mining, Utilities, Construction, Manufacturing, Nondurable goods manufacturing, Wholesale trade, Retail trade, Transportation and warehousing, Information, Finance, Insurance, Real estate, rental, and leasing, Professional and business services, Management of companies and enterprises, Administrative and waste management services, Educational services, health care, and social assistance, Arts, entertainment, and recreation, Accommodation, and food services, Other services, except government, and Government.

Methods/Model

We first analyzed the relationship between GDP and acres conserved by examining the relationship between the two variables of interest graphically. The correlation between the two can be seen in the figures below. Figure 1 and Figure 2 represent the GDP in years 1998 and 2005, respectively. Figure 3 and Figure 4 display the number of acres conserved in 1998 and 2005, respectively. The Y- axis for all graphs below measures the number of states.

Figure 1

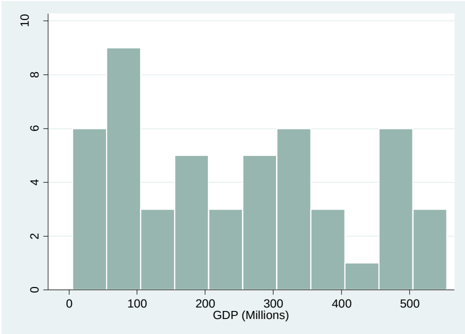


Figure 2

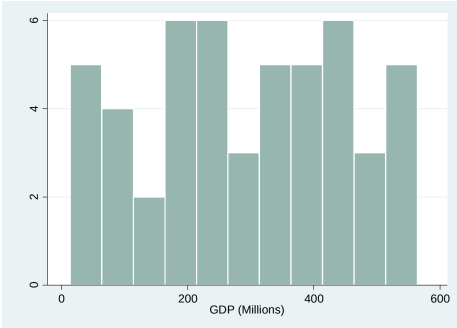


Figure 3

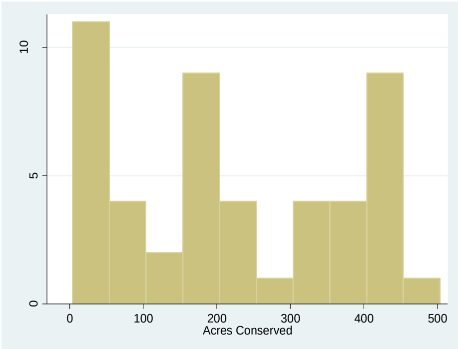
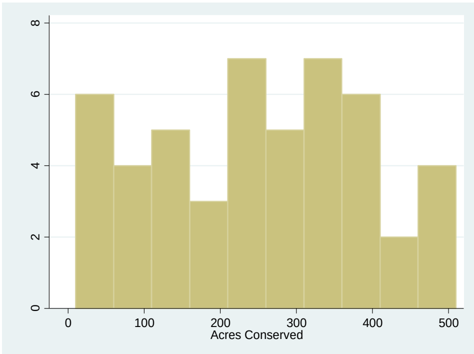
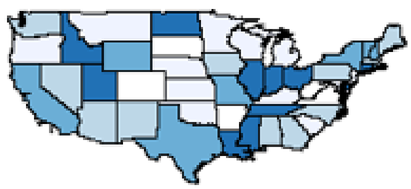


Figure 4

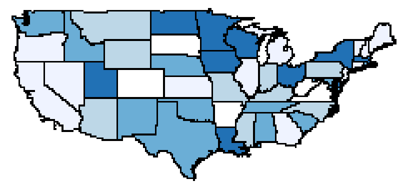


When comparing Figure 1 and Figure 2, a significant increase in state GDP is seen. This is depicted by the distribution of the states moving to the right of the graph. A similar pattern is found in acres conserved. This increase in the number of states with higher levels of GDP and acres conserved suggests that acres conserved could actually positively impact output. In order to support or refute this theory the states that have increases in GDP must be the same states with increases in acres conserved. In order to account for the changes of each state, we looked for a visual correlation by utilizing Stata mapping. Maps 1 and 2 correspond with Figures 1 and 2. Maps 3 and 4 correspond with Figures 3 and 4. We also produced yearly maps for each industry GDP in question in order to compare and contrast to the yearly acres conserved maps.

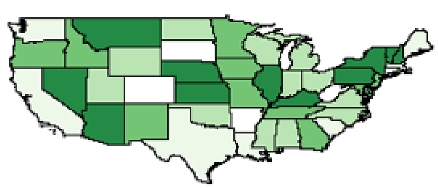
Map 1



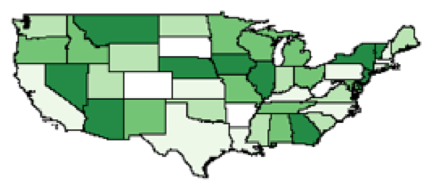
Map 2



Map 3



Map 4



There does not appear to be a clear pattern between output and conservation. It must be stated that these graphs and maps can only be used to make inferences about correlation and say nothing about causation between the two variables. The same ambiguity was present from the comparisons of different industry GDP and conservation maps.

To determine the nature of the correlation, we created two models consisting of both economic and environmental factors. The first equation incorporates the two main variables of interest, acres conserved and public dollars spent on conservation, as well as personal income, population, and the various industry variables listed in our data section. All industry variables were measured in terms of dollar value added to overall GDP. By including every sector that makes up GDP, we could work with a complete GDP model before adding our conservation variables and avoid omitted variable bias.

The second equation contains only acres conserved, public dollars spent on conservation, personal income, and population. The purpose of this was to identify the effect of conservation on each specific industry. We were mainly interested in whether conservation positively affected recreational and tourism and if it negatively affected certain industries, such as forestry or agriculture. When modeling for tourism, it is partially represented by the variable of accommodation, and dining services industries. If conservation did help boost recreational, tourism, and transportation industries, then we wanted to compare its magnitude with its possibly detrimental effects to other industries.

Equation 1:
$Y_{ij} = \beta_0 + \beta_1 L_{ij} + \beta_2 P_{ij} + \beta_3 I_{ij} + \beta_4 N_{ij} + \beta_5 T_{ij} + \varepsilon$
$i = Year$
$j = State$
$Y = State\ GDP$
$L = Land\ Conserved\ in\ Acres$
$P = Public\ Dollars\ Spent\ on\ Conservation$
$I = Personal\ Income$
$N = Population$
$T = Industry\ GDPs$

Equation 2:
$T_{ij} = \beta_0 + \beta_1 L_{ij} + \beta_2 P_{ij} + \beta_3 I_{ij} + \beta_4 N_{ij} + \varepsilon$

To examine the model with panel data, we applied fixed and random effects regressions. The fixed effects regression controls for unobserved heterogeneity between each state by removing any time invariant components of the model. Additionally, it implies that state differences are caused by state specific characteristics not covered by the regressors. Random effects regressions differ in that they assume state individualities are unimportant and differences between states are random. Here both models make intuitive sense. State GDP could be affected by state specific characteristics, such as industries that are specific to certain states or public views toward production and conservation. Conversely, the differences could be caused by outside factors that are not specific to each state, such as fiscal and monetary policy. This would make the random effects model a better option (Dietz et al. 2002).

Once the regressions for both the equation 1 and equation 2 were conducted, a Hausman test was applied to decipher the best regression method. The purpose of the Hausman test is to detect exogeneity of the unobserved error component. If the unobserved effects are exogenous then the fixed effects and random effects models asymptotically equivalent and the random effects model should be used. We find that with chi-squared values of .0000 and .0001 both equation 1 and equation 2 models pass the Hausman test. Thus, we reject the null that fixed effects and random effects regressions are not asymptotically equivalent and conclude that the unobserved effects of the error term are not exogenous, meaning that the fixed effects regression is a better method for our model.

Results

The fixed and random effects results of equation 1 are below. Column 1 correspond with the fixed effects regression and column 2 corresponds with the random effects regression.

Table 1:

	(1) GDP (Millions)	(2) GDP (Millions)
Acres Conserved	0.0146	-0.0392
	(0.00261)	(0.107)
Public Dollars Spent	0.00260	0.0618
	(0.00686)	(0.140)
Personal Income	0.00000503*	0.00000409*
	(0.000000303)	(0.00000195)
Population	-0.000223	-0.000193**
	(0.0000573)	(0.0000664)
Agriculture, forestry, fishing, and hunting	16.28*	-0.0401
	(1.081)	(0.0718)
Mining	16.28*	-0.0295
	(1.081)	(0.0166)
Utilities	0.00121	-0.220
	(0.00957)	(0.171)
Construction	0.00962	0.0160
	(0.00420)	(0.101)
Manufacturing	-0.00398	0.00166
	(0.00102)	(0.0168)
Nondurable goods manufacturing	0.0411*	0.124***
	(0.00218)	(0.0356)
Wholesale trade	5.425	-0.0846
	(0.961)	(0.129)
Retail trade	5.479	0.000688
	(0.958)	(0.0927)
Transportation and warehousing	-0.0181*	0.0106
	(0.000959)	(0.0341)
Information	0.0794*	0.124
	(0.00527)	(0.0975)
Finance, insurance, real	-0.0215*	0.00821

estate, rental, and leasing		
	(0.000855)	(0.0302)
Professional and business services	-0.0973*	-0.253
	(0.00320)	(0.135)
Management of companies and enterprises	0.0894*	0.258
	(0.00378)	(0.211)
Administrative and waste management services	0.174*	0.319
	(0.00865)	(0.293)
Educational services, health care, and social assistance	-0.0394	-0.322**
	(0.00703)	(0.102)
Arts, entertainment, and recreation	-0.612*	0.222
	(0.0273)	(0.737)
Accommodation and food services	1.019*	0.133
	(0.0335)	(0.983)
Other services, except government	-0.0783	-0.239
	(0.00818)	(0.170)
Government	-0.00251	0.191**
	(0.00242)	(0.0671)
Constant	349.8	-63.22
	(158.2)	(277.3)
Observations	30	30

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

As you can see from Table 1, significant variables were Personal income, Agriculture, forestry, fishing, and hunting, Mining, Nondurable goods Manufacturing, Transportation and warehousing, Information, Finance, Insurance, Real estate, rental, and leasing, Professional and business services, Management of companies and enterprises, Administrative and waste management services, Arts, entertainment, and recreation, and Accommodation, and food services. All significant industries had a positive relationship with GDP except, Finance, Insurance, Real estate, rental, and leasing, Professional and business services, Management of companies and enterprises and Arts, entertainment, and recreation. The lack of significance for industry GDP variables, as well as the negative coefficients is surprising and contradicts logic. These unexpected results may be a sign that omitted variable bias is present. We found our main variable of interest, acres of conserved land, was not a significant predictor of GDP. Additionally, Public dollars spent on conservation was also not significant for both regression models. This suggests that conservation may not have a meaningful impact on state production, as previously perceived.

When examining the estimates further we find vast differences in the magnitude of the coefficients of each explanatory variable. This is illustrated when studying the results of our two industry variables of interest, Agriculture, forestry, fishing, and hunting and Accommodation and food services. Agriculture, forestry, fishing, and hunting has an estimate of 16.28 while Accommodation and food services only has an estimate of 1.019. One reason for this is that some industries simply contribute more GDP than others. Another possibility that supports this reasoning is that there is a multiplier effect, which our model does not account for. The multiplier effect suggests that an economic change for one area or sector of the economy not only has a direct impact on the economy, but also generates subsequent changes in other parts of the economy. This can be characterized by the "trickle-down effect." In other words the differences in the magnitude of our coefficients could mean that some variables had stronger multiplier effects than others. One last cause of the differences in magnitude could be that some of the explanatory variables contain multiple industries, while others, such as Mining only contain one component of GDP. The more components that are bundled into one variable, the greater effect the variable will have on GDP and thus the coefficient of the variable will be larger. As a result of this difference between the estimates, we can assume that the GDP added from recreation and tourism is not sufficient enough to compensate for the GDP lost from Agriculture, forestry, fishing, and hunting if conservation efforts individually affect these industries.

Next, the effect of land conserved on industry specific GDPs was measured using our second equation. While we modeled every industry GDP, we focused primarily on the following industries because of their association with conservation: Agriculture, farming, fishing, and hunting (Farming, Forestry, fishing, and related activities), Manufacturing, Transportation, Real Estate, Accommodation, and Food services. We also broke some of these sector GDPs down into sub-sector components. For example we separately tested the variables farming, forestry, fishing, air transportation, rail transportation, transit and ground transportation, and Rental and leasing services. All of our results concluded that conservation was not a significant predictor for any industry GDPs or its components. This effectively meant that conservation did not have a strong enough effect to influence our GDPs in question.

Conclusion

With growing awareness of detrimental effects to our environment from over consumption of natural resources, it is inevitable that conservation efforts will continue, if not increase. With that in mind, if the United States' economy continues growing and expanding, it will require consumption. Thus, it is essential to know the relationship between conservation and the economy.

From our first model, we conclude that conservation is not a good predictor of state GDP. However, we can takeaway from the varying magnitudes of our significant estimates that certain industries GDPs contribute more to overall GDP than others via the multiplier effect. Also, it should be noted that there are many variables that contribute to GDP and not all of them are included in our model. Therefore, our model's simplicity makes it difficult to predict GDP with complete accuracy. From our second model, we found that conservation is not a significant predictor for industry GDPs that we associated with conservation. Again, the simplicity of this model makes it hard to predict true industry GDP values. Our findings could serve as a starting point for further research about the relationship between conservation efforts and economic growth.

Challenges of our model and data were accounting for the many factors that influence output, and furthermore, these factors can vary drastically from state to state. This means that conservation may have a significant impact on the output of some states, but not others. Furthermore data on the state level is not always accurate and contains high levels of variation. Down the road, it may be beneficial to include specific state attributes to each equation because not every state has the same characteristics.

Overall, this paper attempts to find the relationship between GDP and conservation. From our fixed and random effects regressions, we found that conservation does not have a significant effect on GDP, however, these were linear estimates. The relationship between GDP and conservation could be a non-linear function, in which conservation initially decreases with GDP growth, but then at some point conservation and GDP increase together via the Kuznets curve. In the future, using a non-linear function might be a better approach to model GDP and conservation's relationship.

Works Cited:

Adams, Vanessa M., Robert L. Pressey, and Robin Naidoo. "Opportunity costs: Who really pays for conservation?." *Biological Conservation* 143.2 (2010): 439-448.

Adams, William M., et al. "Biodiversity conservation and the eradication of poverty." *Science* 306.5699 (2004): 1146-1149.

Czech, Brian. "Economic growth as the limiting factor for wildlife conservation." (2000): 4-14.

Dietz, Simon, and W. Neil Adger. "Economic growth, biodiversity loss and conservation effort." *Journal of Environmental Management* 68.1 (2003): 23-35.

Kohn, R. E. (1999). Thresholds and complementarities in an economic model of preserving and conserving biodiversity. *Socio-Economic Planning Sciences*, *33*(2), 151-172.

Pagiola, S., Von Ritter, K., & Bishop, J. (2004). Assessing the economic value of ecosystem conservation.

Pergams, Oliver RW, et al. "Linkage of conservation activity to trends in the US economy." *Conservation Biology* 18.6 (2004): 1617-1623.

Wernick, I. K., Waggoner, P. E., & Ausubel, J. H. (1997). Searching for leverage to conserve forests: The industrial ecology of wood products in the United States. *Journal of Industrial Ecology*, *1*(3), 125-145.

The Conservation Economy in America: Direct investments and economic contributions. (2013, February 8). Retrieved May 17, 2015

Torres-Reyna, O. (n.d.). Panel Data Analysis Fixed and Random Effects Using Stata. Retrieved May 17, 2015.