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The complex links between governance and biodiversity

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Abstract: We argue that two problems weaken the claims of those who link corruption and the exploitation of natural resources. The first is conceptual. Studies that use national level indicators of corruption fail to note that corruption comes in many forms, at multiple levels, and may or may not affect resource use. Without a clear causal model of the mechanism by which corruption affects resources, one should treat with caution any estimated relationship between corruption and the state of natural resources. The second problem is methodological: Simple models linking corruption measures and natural resource use typically do not account for other important causes and control variables pivotal to the relationship between humans and natural resources. By way of illustration of these two general concerns, we demonstrate that the findings of a well known recent study that posits a link between corruption and decreases in forests, elephants, and rhinoceros are fragile to simple conceptual and methodological refinements.

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Introduction

The importance of government corruption as an explanation for environmental degradation gained popularity with the drastic decline of forests and certain species of wildlife in the 1970s and 80s (e.g. Myers 1979; Hecht & Cockburn 1989; Gibson 1999; Ross 2001). Indeed, it seems only commonsensical that politicians and officials with short time horizons and few legal checks on their power are likely to augment their wealth (and the wealth of their supporters) by supporting the over-harvesting of natural resources such as forests and wild animals. It appears self-evident that corrupt politicians and bureaucrats in developing countries play a nontrivial role in environmental degradation.

An increasing number of studies thus seek to make generalizable claims about this connection between corruption and environmental outcomes by testing hypotheses with cross national data. Exploiting relatively new data sets that offer measures related to government quality, some analysts have found significant relationships between proxies for corruption and resource outcomes. One of the most recent studies is Smith et al.'s (2003) analysis in Nature that finds strong relationships between corruption and the decline of elephant, rhinoceros, and forests. Their results add empirical plausibility to arguments directly linking corruption and biodiversity loss.

But the relationship between corruption and natural resources is far more complex than is captured in current work and this complexity may be lost in attempts at simple generalizations. For example, countries practicing “good governance” may also overexploit resources. Where poverty is widespread and the population uniformly prefers to degrade resources in order to bolster current consumption, an honest, responsive, and representative government may advance policies that run counter to conservation goals. Moreover, corruption can appear at different levels of government, whereas the available indices of government performance and quality are only measured at the national level. We have worked in tropical countries whose central governments have a reputation for relatively low levels of corruption, yet in remote regions local officials contribute demonstrably to habitat and biodiversity loss. Finally, not all forms of corruption lead to overexploitation. Wanton nepotism in a government does not necessarily lead to assaults on biodiversity; neither does the stealing of tax monies, the extraction of bribes at customs booths, etc. Countries with such characteristics may be ranked as corrupt, but such corruption may have little to do with the natural resources. The links between politics and environmental outcomes, therefore, are unlikely to be captured well by simple models and inappropriate statistical tests.

In this brief essay, we explore two fundamental issues about cross-national studies attempting to link corruption and environmental outcomes. The first is conceptual, and turns on how corruption is used to infer causality. Corruption and environmental outcomes are commonly both the result of sets of political and economic institutions at different levels that are weak or missing (Barrett et al. 2001). Consequently, corruption and natural resources might be related, but not in the causal ways commonly posited in simple models. For example, weakness in enforcing rules even at the community level can foster both corruption and overexploitation of natural resources (Gibson, Ostrom & Williams 2005). Inference with respect to the relationship between corruption and conservation requires far more nuance than commonly appears in published studies.

The second fundamental issue relates to the statistical methods appropriate to testing hypotheses using cross-national data. Methodological weaknesses in such analyses – incomplete data, improper research designs, and inadequate tests – often lead to invalid conclusions about how corruption may influence the stocks of forests, elephant, and rhinoceros. Such concerns are familiar to social scientists, e.g., from the extensive literature on economic growth based on cross-country regressions (Barro 1997; Durlauf & Quah 1999), but perhaps less mainstream within conservation science, although a large number of economic studies of tropical deforestation with relatively sophisticated methods have existed since the late 1980s (Kaimowitz & Angelsen 1998). While an understanding of how politics – like corruption – affect resource outcomes is surely required for better policymaking, simple causal models may at best be misleading, and at worst counterproductive.

To explore these two issues, we use the prominent Smith et al. (2003) study as a foil to unpack the important issues that analysts need to address when seeking to explain the links between corruption and outcomes on the landscape. Smith et al.'s study uses national level indicators of corruption and biodiversity in a cross national design, and find that there are significant and negative relationships between the two.

Explaining the Links between Corruption and Natural Resources

There is growing interest in the effect of government quality on economic, political and environmental outcomes. It is widely accepted that governments that are less corrupt and that have more efficient bureaucracies – i.e., have better "governance" – produce more effective policy (Tendler 1997). Indeed several policies emanating from donors, watchdog non-governmental organizations and trade groups seek to incorporate explicitly measures to foment the better governance of forest resources, for example Transparency International's Forest Integrity Network, the International Tropical Timber Organization's policy forum on criminal activity in the forest sector, the U.S. Government's Congo Basin Initiative, and the Center for International Forestry Research's newly-created forest governance division. The World Bank also emphasizes the role of good governance within its forest sector strategy as well as more broadly in its poverty reduction programs. The objective of checking the abuse of power by officials is laudable. And the United States's Millennium Challenge account is beginning to link the process of good government with environmental measures in deciding how to allocate its portfolio of foreign aid.

But what are we talking about when speak of corruption? Are these "bad" officials politicians, bureaucrats, some combination of the foregoing groups, or something else? Do the bad officials occupy national, regional, or local offices? In a recent summary of lessons learned in natural resource conservation activities in Africa, the United States Agency for International Development (2002) emphasizes the importance of good governance at the local level. Yet most studies of corruption use national level indicators since they are compiled by organizations concerned largely with central government functioning (often relation to urban-based commerce and multinational agencies). The potential mismatch of actors and scales of analysis should be cause for concern. Further, do all of these officials have the same amount of power to affect resource stocks? Does the nature of the laws of a country, or even its physical characteristics facilitate corruption? Given all the possible sub national variation, a single measure of corruption at the national level seems highly unlikely to capture the true relationship between corruption and resource outcomes.

Empirical research using cross-country data to explore the government-related causes of deforestation in particular has grown rapidly since the early 1990s. Earlier case study research found that weak property rights were associated with loss of forest cover (Gillis 1980; Repetto & Gillis 1988; Vincent 1990; Southgate et al. 1991; Alston et al. 1996; Godoy et al. 1996; Pinchon 1997). Using panel data, cross national studies substantiated this claim (Deacon 1994, 1999; Bohn & Deacon 2000). These studies did not measure corruption per se, but rather factors directly affected by governments that might affect forests.

However, modeling the relationship between forests and an *attribute* of a government at the national level – like corruption – rather than a *policy output* – like property rights – is a far more difficult endeavor. Attributes may or may not affect any single policy area: a corrupt government may be less corrupt in one sector -- or at one level -- than another. More importantly, attributes do not reveal the mechanism by which it becomes observable on the forest. There are dozens of strategies through which officials can transfer the benefits of natural resources from the state to themselves, i.e., act corruptly (Callister 1992; Contreras-Hermosilla 1997; de Bohan et al. 1996; Krishnaswamy & Hanson 1999). Politicians and bureaucrats can sell or exchange the resource; give permits to friends, family, and political supporters; cut off a person's legal right to a resource; and intentionally under-enforce laws that conserve resources (Ascher 1999). Further, a corrupt action may have the same observable effect on a forest as an honest action: intentional under-enforcement due to corruption may have the same outcome on a resource as unintentional under- enforcement due to lack of government resources, i.e. in both cases lots of trees may be cut or elephants killed. Thus any theory about the connection between corrupt behavior and resource outcome needs to specify the causal mechanism(s) precisely in order to test the causal mechanism of the hypothesized relationship if empirical results are to lead to robust findings. Simple correlation tests between two variables measured at the national level will be hard pressed to capture these different mechanisms.

In trying to account for the mechanism by which corruption causes changes in biodiversity, Smith et al. (2003) offer four reasons to expect that corrupt officials subvert conservation: conservation project funding is easy to misappropriate, bribery is common, conservation departments have little enforcement capability, and oversight is difficult. These are all plausible theories, and each may indeed be associated with a different, malfunctioning set of institutions. But the authors neither specify nor test these arguments. Instead, they employ correlation and regression analysis to test the association between governance and standard national level measures of human welfare. As we demonstrate in the next section, these sorts of ad hoc empirical specifications are not robust to even modest adjustments through the incorporation of additional observations or other plausible explanatory variables. As a result of the absence of clearly articulated and directly tested causal channels and the fragility of the resulting statistical findings, it becomes difficult to know what to make of results purporting to link corruption causally to conservation outcomes.

Testing for corruption

Even disregarding the conceptual problems of these approaches, tests such as Smith et al.'s offer few grounds to be persuaded that national level measures of governance have any robust relationship with environmental outcomes. In their investigation of forests, for example, Smith et al. use two different dependent variables, change in total forest cover and change in natural forest cover from 1990 to 1995, to estimate the correlations between forests and governance. The authors compute bivariate Spearman correlation coefficients of change in forest cover on the means of national governance scores (on which, more below), per capita gross domestic product (GDP), Human Development Index (HDI) score, and population density. They find that change in *total* forest cover correlates positively with per capita GDP and governance, but change in *natural* forest cover does not correlate with governance. The authors therefore suggest that the "result for total cover was driven by the establishment of new plantations in wealthier, better-governed countries" (p.68).

These conclusions are not robust. Simple and desirable changes to the statistical methods used completely change their outcomes. First, if we are to isolate the effect of corruption on forest cover across countries, a test must control for change in other variables that are likely to be correlated with both corruption and forest cover. Second, the comparison of natural and total forest covers is simply invalid because it uses different samples. The United Nations Food and Agriculture Organization (FAO) reports forest cover for all countries, but reports natural forest cover only for developing nations. Thus a correct test of the difference between determinants of natural forest cover versus total forest cover must restrict the total forest cover to developing countries. Otherwise the results may simply reflect different samples. If we restrict total forest cover to developing countries and use multivariate tests to control for all of Smith et al.'s factors (the sample size can easily accommodate multivariate tests) we find that neither per capita GDP nor governance have any statistically significant relation to changes in total forest cover, while HDI is now negatively related to forest cover and barely statistically significant at the 10% level (Table 1).[1]

We can reveal the effect of sample selection bias graphically (Figure 1). The graph reveals two clusters of countries, (1) a relatively large group with low governance scores

[1] Data for change in forest cover, corruption, per capita GDP, Human Development Indicators, and population density are precisely those used by Smith et al. (available online at http://www.nature.com/nature/journal/v426/n6962/extref/nature02025-s1.pdf). Because we have one observation per country, we estimate the model using ordinary least squares and correct for heteroskedasticity.

and negative changes in forest cover (marked with Xs) and (2) a relatively small group with high governance scores and positive forest cover change (marked with circles). The Xs represent developing countries; the circles represent developed countries. The graph also shows two best fit lines. The thick line is the best fit for developing countries; the thin line is the best fit for all countries. The slope of line for developing countries is statistically indistinguishable from the zero-slope line at conventional significance levels. Thus, the only defensible inference to draw is that forest cover tended to increase in developed countries and decrease in developing countries between 1990 and 1995. There are few policy implications from such a result.

Third, the authors correlate the change in forest cover with mean governance score over a single period. The implications one can draw from such tests are unclear. An average cannot identify whether conditions are improving, deteriorating, or unchanged, so one cannot infer that improvements in governance would lead to increased forest cover. A more policy oriented research design would at least test the change in the stock of a natural resource on changes of governance, or levels of resource at time (t) and (t+1) on governance levels at (t) and (t+1). If we revisit Smith et al.'s data changes in forest cover and in governance, rather than levels, the correlation between the change in governance and change in forest cover is -0.21, neither positive nor statistically significant. Simple correlations of levels cannot adequately capture the relationship between biological, economic, and political factors.

Smith et al. use similar techniques to analyze the relation between corruption and populations of African elephants and black rhinoceroses. As in their study of forests, they test the effects of governance, per capita GDP, mean HDI, and mean population density, as well as a measure of spending per km^2 of protected area within countries, on changes in African elephant populations. In these tests the authors use stepwise regression, and find that only mean governance scores for the period 1987 - 1994 explain the change in these populations. The authors conclude that "These results suggest that political corruption may play a considerable role in determining the success of national strategies to conserve these two flagship species, despite the international attention they both attract" (p.68).

But once again, these results are not robust. For the sake of brevity, we focus here just on the inferences with respect to African elephants. By adding more data from the same series to their study, and including the appropriate controls due to their omitted relevant variables, Smith et al. results change completely.

Data exist for African elephants over three periods from the same data series, the African Elephant Database 1987 (Burrill & Douglas-Hamilton 1987), 1994 (Said et al. 1995), 1997 (Barnes et al. 1999), and 2002 (Blanc et al. 2003), although Smith et al. only use two. The numbers Smith et al. use for the 1987 elephant numbers do not correspond to the African Elephant Database. By email communication, Dr. Smith wrote that he received new data from someone within the IUCN: Ghana (3,900), Kenya (35,000), Tanzania (100,000), and Uganda (3,000). It turns out that the correlation between change in elephant population and national level corruption is highly sensitive to specific time periods: the correlation is 0.40 between 1987 and 1997, but changes to -0.32 between 1997 an 2002. And the inclusion of appropriate control variables completely changes the results. By simply including a country's latitude changes the results; latitude in fact *better* explains change in elephant populations than does the national corruption measure. Using the Smith et al.'s data, a regression of the change in elephant population on governance and latitude yields the following equation (p-value in parentheses): change in elephant = -73.8 (<.01) + 10.1* Governance (0.14) + -2.4*Latitude (<.01); R-squared = 0.78; N = 20.

Further, the specific features of each specific resource must be considered before trying to model the relationship between corruption and biodiversity. The set of factors that account for elephant population change, for example, are highly unlikely to account for changes in forest cover. In studying elephants we would argue that factors regarding basic anthropogenic and biophysical factors likely affect to elephant fertility and mortality should be included. So as a simple check on the Smith et al. study's robustness, we regressed the annual growth rate in national elephant population on the natural logarithm of the lagged elephant population – the coefficient on which then reflects the effect of a one percent change in base period population on the rate of growth, also measured in percentage terms – and rainfall, as two basic variables likely to affect population growth rates. (We estimate the annual average (compound) growth rate in elephant population between survey periods using the formula $POP_{s+t}= (1+r)^t POP_s$ where t is years between counts, r is the annual growth rate, and s is the initial period. Because we would expect forest and savannah elephants to respond differently at the same levels of rainfall, given the stark difference in their habitats, we use deviations from country-specific mean average annual rainfall levels as our explanatory variable, from 1987-2002. Source: Global Historical Climatological Network (2004).)

Since it is obvious that human activity have a great deal to do with elephant numbers, we employ two anthropogenic factors in our analysis: the presence of civil war, and tourists per hectare of protected area. The civil war data counts the existence of civil war in a country (by convention, intrastate conflict with more than a 1000 human deaths) (Gleditsch & Ward 2004). Tourist data come from the World Bank (2004). Finally, we include a measure of corruption. Standard measures of corruption, like the ones used by Smith et al., provide a single, national level of corruption for a country annually. They employ use the Corruption Perceptions Index (CPI) measure (CPI website: http://www.transparency.org/surveys/index.html). But CPI data does not cover the years for which they have data on their dependent variables, so they construct their measure of corruption using another well- measure of corruption, International Country Risk Guide. These two measures of corruption are highly correlated and widely known. We use the latter as it covers the entire period under investigation and is thus more precise.

Our hypotheses about these factors and their associated measures are in Table 2. Data for elephant populations are from all periods covered by the African Elephant Database. We must add the caution, however, that the editors of the elephant database specifically warn against empirical studies like Smith et al.'s or the results we now present, because contributors to these reports make clear that different counting methods over space and time were used, making comparisons between counts tenuous.[2]

With that important caveat in mind, we regress the growth rate of national-level elephant population on its lagged level and our explanatory variables (Table 3). We estimate the model using panel data-corrected standard errors since lagged variables are included and we wish to account for possible heteroskedasticity in the regression errors. The results suggest that two anthropogenic factors – civil war and tourists per protected area – are significant predictors of African elephant population change. Civil wars reduce elephant populations through mortality (more humans with guns in these zones seek meat and cash) and elephant outmigration. Since no data exist on the actual spatial dispersion of tourists or on conservation enforcement levels over the sample frame, we use tourists per protected area as a proxy, since the presence of tourists can increase elephants through both the informal enforcement effect of tourists, increased government agents in the field due to tourists, and the incremental revenue tourists provide for conservation activities.

Biophysical factors also matter to elephant population stocks. Population dynamics appear to be convex over the sample range in that estimated growth rates are positively and significantly related to the lagged stock level. Stocks are also increasing in rainfall,

[2] The sampling error of the most widely used counting protocols – e.g. dung count and aerial surveys – are also different, and they are also used in different ratios from year to year in different countries. In some cases, more accurate protocols for counting would lead to a decline in the number of elephants reported, regardless of other factors (R. Barnes, editor of 1995, 1998, 2002 African Elephant Databases, personal communication, December 2003).

which others have attributed to rainfall's effect on elephant fecundity, infant mortality, and local labor supply for poaching (Barrett & Arcese 1998). Once we control for these plausible anthropogenic and biophysical conditioning factors, however, corruption levels no longer have any explanatory power (and using level rather than the change in elephant population as the dependent variable yields similar results). This once again underscores how fragile apparent statistical relationships between measures of central government corruption and conservation outcomes such as forest cover or the population of a protected species. Although anecdotal and simple statistical evidence leads observers to hypothesize about connections between corruption and conservation, without careful and explicit modeling of the pathways through which such effects might occur, empirical exercises such as those popularized in recent years are likely to generate fragile, even misleading results.

Conclusion

There is growing interest in explaining conservation outcomes through political processes. This is certainly an appropriate direction in which to push research; no resource is immune from the direct or indirect forces resulting from government policy or the political process (Ascher 1999). But studies of the links between corruption and outcomes on the landscape will need more careful modeling and testing than has been the norm to date. We discussed the many ways that corruption may be linked to overexploitation, each representing a different causal path from human action to environmental outcome. And we showed the fragility of simple studies. The links between national governments and natural resources are many and tangled. Additional work attempting to bridge the social and natural sciences is clearly needed to better explain these important and complex relationships.

Literature Cited

Alston, L.J., G.D. Libecap, and R. Schneider. 1996. The determinants and impact of property rights: land titles on the Brazilian frontier. Working Paper 5405. National Bureau of Economic Research, Cambridge, Massachusetts.

Ascher, W. 1999. Why governments waste natural resources: policy failures in developing countries. Johns Hopkins Press, Baltimore, Maryland.

Barnes, R., C. Craig, H. Dublin, G. Overton, W. Simons, and C. Thouless. 1999. African elephant database 1998. International Union for Conservation of Nature, Gland, Switzerland.

Barrett, C., and P. Arcese. 1998. Wildlife harvest in integrated conservation and development projects: linking harvest to household demand, agricultural production and environmental shocks in the Serengeti. Land Economics **74**: 449-65.

Barrett, C.B., K. Brandon, C. Gibson, and H. Gjertsen. June 2001. Conserving tropical biodiversity amid weak institutions. BioScience **51**: 6, 497-502.

Barro, R.J. 1997. Determinants of economic growth. MIT Press, Cambridge, Massachusetts.

Blanc, J., C. Thouless, J. Hart, H. Dublin, I. Douglas-Hamilton, C. Craig, and R. Barnes. 2003. African elephant status report 2002. International Union for Conservation of Nature, Gland, Switzerland.

Bohn, H., and R.T. Deacon. 2000. Ownership risk, investment, and the use of natural resources. American Economic Review **90**: 3, 526-549.

Burrill, A. and Douglas-Hamilton, I. 1987. African elephant database. United Nations Environment Programme, Nairobi, Kenya.

Callister, D.J. 1992. Illegal tropical timber trade. TRAFFIC International, Cambridge.

Contreras-Hermosilla, A. 1997. Country sector planning. Proceedings of the XI World Forestry Congress **5**: 279-284. Antalya, Turkey.

De Bohan, V., N. Doggart, J. Ryle, S. Trent, and J. Williams. 1996. Corporate power, corruption and the destruction of the world's forests. Environmental Investigation Agency, London.

Deacon, R. T. 1994. Deforestation and the rule of law in a cross-section of countries. Land Economics **70**: 4, 414-430.

Deacon, R. T. 1999. Deforestation and ownership. Land Economics **75**: 3, 341-359.

Durlauf, S. and D. Quah. 1999. The new empirics of economic growth. In J. Taylor and M. Woodford editors. Handbook of macroeconomics. Volume 1A. North Holland, Amsterdam.

Gibson, C. 1999. Politicians and poachers: the political economy of wildlife policy in Africa. Cambridge University Press, Cambridge.

Gibson, C., Ostrom, E., and J. Williams. 2005. Local enforcement and better forests. World Development **33**: 2, 273-284.

Gillis, M. 1980. Fiscal and financial issues in tropical hardwood concessions. Development discussion paper No. 110. Harvard Institute for International Development, Cambridge, Massachusetts.

Gleditsch, K. and M. Ward. 2004. War and peace in time and space: the role of democratization. International Studies Quarterly **44**: 1, 1-29. The data on civil war can be found at http://weber.ucsd.edu/~kgledits/expwar.html.

Global Historical Climatology Network. 2004. http://iridl.ldeo.columbia.edu/SOURCES/.NOAA/.NCDC/.GHCN/.v2beta/.
Godoy, R., J.R. Franks, D. Wilkie, M. Alvarado, G. Gray-Molina, R. Roca, J. Escobar, and M. Cárdenas. 1996. The effects of economic development on neotropical deforestation: household and village evidence from Amerindians in Bolivia. Development discussion paper No. 540. Harvard Institute for International Development, Cambridge, Massachusetts.
Hecht, S. and A. Cockburn. 1989. The fate of the forest. Verso, New York.
Kaimowitz, D. and A. Angelsen. 1998. Economic models of tropical deforestation: A review. CIFOR: Bogor, Indonesia.
Krishnaswamy, A. and A. Hanson. 1999. Summary report: World Commission on Forests and Sustainable Development. World Commission on Forests and Sustainable Development, Winnepeg.
Myers, N. 1979. The sinking ark. Pergamon, New York.
Pichón, F. J. 1997. Colonist land-allocation decisions, land use, and deforestation in the Ecuadorian Amazon frontier. Economic Development and Cultural Change **44**: 4, 127-164.
Repetto, R., and M. Gillis editors. 1988. Public policies and the misuse of forest resources. Cambridge University Press, Cambridge.
Ross, M. 1996. Timber booms and institutional breakdown in Southeast Asia. Cambridge University Press, Cambridge.
Said, M., R. Chunge, C. Craig, C. Thouless, R. Barnes, and T. Douglass. 1995. African elephant database 1995. International Union for Conservation of Nature, Gland, Switzerland.
Smith, R.J., R.D.J. Muir, M.J. Walpole, A. Balmford, and N. Leader-Williams. 6 Nov 2003. Governance and the loss of biodiversity. Nature **426**: 67-70.
Southgate, D., R. Sierra, and L. Brown. 1996. The causes of tropical deforestation in Ecuador. World Development **24**: 7, 1151-60.
Tendler, J. 1997. Good governance in the tropics. Johns Hopkins University Press, Baltimore, Maryland.
United States Agency for International Development (USAID). August 2002. Nature, wealth and power: emerging best practice for revitalizing rural Africa. Environment and Natural Resources Team, Sustainable Development Office, Africa Bureau, USAID, Washington, D.C.
Vincent, J.R. 1990. Rent capture and the feasibility of tropical forest management. Land Economics **66**: 2, 212-223.
World Bank. 2004. World Development Indicators 2004. World Bank, Washington, D.C.

Table 1: Forest cover for all countries and developing countries

	Forest Cover (All countries) [Smith et al.]			Forest cover (Developing countries only)		
Population density	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.52)	(0.19)	(0.89)	(0.42)	(0.49)	(0.52)
governance	0.232			0.135		
	(7.03)[c]			(1.03)		
HDI		1.956			-1.263	
		(4.08)[c]			(1.77)[a]	
Per capita GDP			0.000			0.000
			(6.54)[c]			(1.47)
Constant	-1.702	-1.930	-0.954	-1.507	-0.307	-1.166
	(9.46)[c]	(6.09)[c]	(8.03)[c]	(3.36)[c]	(0.82)	(8.31)[c]
Observations	94	88	93	66	60	65
R-squared	0.28	0.12	0.22	0.02	0.05	0.02

Robust t statistics in parentheses
[a] significant at 10%; [b] significant at 5%; [c] significant at 1%

Table 2: Hypotheses, variables, and measures for elephant analysis

Hypotheses	Measures
Previous level of elephants to control for potential nonlinear elephant population dynamics.	Lagged elephant population level, from African Elephant Database (various years).
Rainfall affects fecundity/infant mortality as well as local labor supply for poaching	Change in three year average of rainfall before elephant count (elephants have 24 month gestation). Source: Global Historical Climatology Network (2004)
Civil war increases elephant poaching	Occurrence of civil war in country at time of count. Source: Gleditsch (2004)
Increased conservation enforcement decreases elephant poaching	Change in number of tourists per hectare of protected area. Source: World Bank (2004).
Corruption decreases elephants due to increased, unsustainable (potentially illegal) offtake.	Change in ICRG measure of corruption

Table 3: Panel-Corrected standard errors model for growth rate of elephants

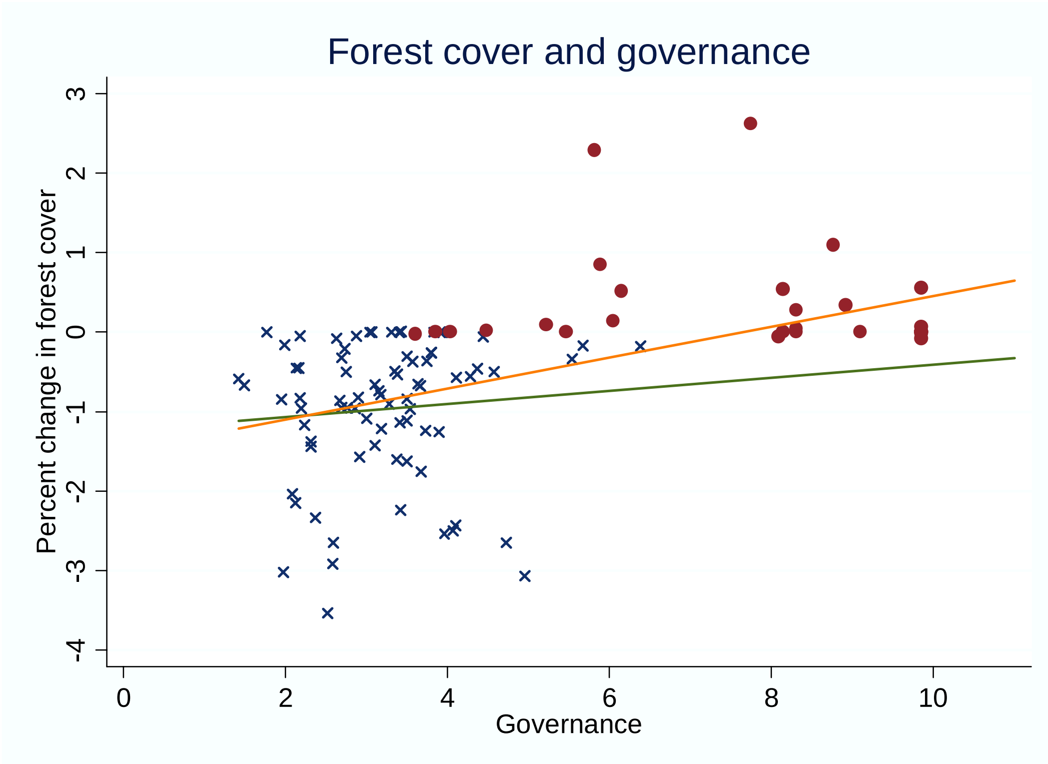
Log of lag level of elephants	0.02
	(2.26)[b]
Civil war	-0.10
	(3.95)[c]
Change in tourists per hectare of protected area	0.03
	(2.22)[b]
Change in rainfall	0.08
	(1.74)[a]
Change in corruption	0.03
	(1.19)
Constant	-0.18
	(2.39)[b]
Observations	45
R-Squared (overall)	0.37

Absolute value of z statistics in parentheses
[a] significant at 10%; [b] significant at 5%; [c] significant at 1%

Figure Legends

The cluster of Xs represents developing countries and the cluster of circles represents developed countries. The thick line with the relatively flat slope is the best fit line for developing countries; the thin line with the positive slope is the best fit for all countries.

Figure 1.


Forest cover and governance
Percent change in forest cover
-4
-3
-2
-1
0
1
2
3
0
2
4
6
8
10
Governance

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