How Well is the Relationship Between Poaching and Education Understood?

Biswo N. Poudel, Ph.D.
Assistant Professor
Kathmandu University School of Management
Post Box No:6250
Lalitpur, Nepal
Phone: +977-1-5548891
Fax: +977-1-5533814
Email: ghamkapailaharu@gmail.com

Krishna P. Paudel
Professor
Department of Agricultural Economics and Agribusiness
Louisiana State University (LSU) and LSU AgCenter
Baton Rouge, LA 70803
Phone: (225) 578-7363
Fax: (225) 578-2716
Email: kpaudel@agcenter.lsu.edu

Selected Poster prepared for presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, San Francisco, CA, July 26-28.

How Well is the Relationship Between Poaching and Education Understood?

Biswo Poudel, Kathmandu University
Krishna P. Paudel, Louisiana State University (LSU) and LSU AgCenter

Introduction

Poaching has been a serious concern in many developing countries. It has been also a well discussed topic during the last few decades (Heltberg, 2001; Kremer and Morcom 2000; Lopes 2014; Taylor 2011). Kremer and Morcom (2000) studied elephant poaching and found that the prospect of future scarcity of storable goods (such as elephant ivory) increases poaching. Taylor (2011) found that technical innovation in the sector that uses wildlife produce (such as buffalo hide) lead to the increased incidence of poaching. Over exploitation of common property resource and the need to protect such resources with government induced regulation (or other relevant taxes when imposing such tax is feasible) has been the major topic of discussion since Gordon (1954).

Poaching is a phenomenon related to the management of renewable resource. Often, when growth rate is less than harvest rate, species may extinct so they are offered protection. Society may also suddenly find itself with the information that a particular species of animal has the population lower than socially desired level thereby imposing some artificial measure to raise the population. In some instances, such measures are not strong enough to deter strong willed individuals from attempting to harvest the species. At the core of poaching is therefore heterogeneity among the population's skill in poaching. If some people find that the expected cost they incur by attempting to poach is less than the expected benefit they derive, they are likely to poach. Since expected net benefits of poaching is inversely related to the prevalent wage, in that net benefit of engaging in poaching includes the expected benefits of successful poaching minus the foregone wage as well as expected penalty. The dominant attitude in conservation circle is to encourage investment in education of local population to decrease poaching rate. Furthermore, Mincerian return to education studies consistently show that return to education is positive; recent studies such as Acemoglu (1998) in the relationship between wage and return to education show that the wage gap between educated and uneducated are mainly driven by skill biased technological changes. These observations have led to the general expectation that investments in local education and infrastructure will translate to increased wage which will be compatible with the policy maker's goal of reducing incidences of poaching.

Recent news reports from countries such as Nepal, which has made progress in education, show disturbing trends on poaching. Local media has reported on rising trends in poaching. Several of these poachers are uneducated, but hail from districts adjacent to the national parks. Since these districts are actually making progress in education fronts, the rise poses question on whether the assumed relationship between education and poaching is valid. Some previous studies on the impact of education on participation in forest resources management groups had also found inconclusive evidence regarding the role of education in conservation. For example, Agarwal et al. (2005) found negative relationship between education and participation in community level management groups.

Objectives

Our objective is to provide a new approach in studying the incidences of poaching and advance the notion that focus on education (and hence income) promoting policies alone won't be sufficient to protect wildlife. We developed an economic theory on poaching and then test the importance of education on poaching using data on wildlife poaching from Nepal, the home of one of the largest concentrations of endangered species such as tigers, one horn rhinoceros, wild elephants and Gharial crocodiles.

Model

- Proposition 1: Less people will be involved in poaching when some fractions of population gets education than when no one gets education .
- Proposition 2: Suppose probability of an educated man getting arrested is λ< 1 fraction of the probability of an uneducated person getting arrested if they both go to poaching. (i.e. education helps survival skills of poachers.) Let $\pi = \frac{K}{\alpha p}$.Then, there will be more poaching when fraction of the population is educated than when no one is educated if $\gamma < 1 - W_\beta \pi$. Proofs of these proposition can be obtained from one of the coauthors.

Method

We present our model of interest as follow:

$$y = Y\pi + x\beta + \gamma W y + u$$
$$u = \rho M u + \varepsilon$$

Here, y is a dependent variable which is the difference in poaching rate in a given district from Kathmandu, Y is endogenous variable which is literacy rate in our model, X is exogenous variables in the model (buffer, police, rangers, road, population, unemployment rate) W and M are spatial weighing matrices with zero diagonal elements and W y and $M\,u$ are spatial lag variables, u and ε are error terms. The parameters of the model are $\pi, \beta, \gamma,$ and ρ. The error term in equation 10 is thus modeled as spatial error. This model is consistent with the formulation provided by Kelejian and Prucha (1998, 1999, 2004, 2010), Arraiz et al. (2010), and Drukker et al. (2010).

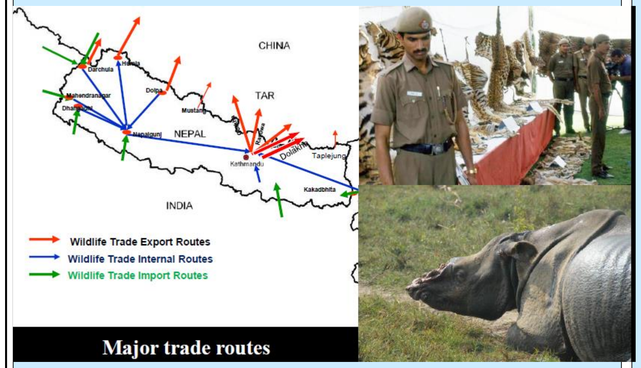

Figure 1. Poaching and major trade routes in Nepal [Photo Source: World Wildlife Fund]

Data

Data for this study come from official records of various authorities in Nepal. The poaching numbers by districts came from the annual publication of Wildlife Conservation Nepal and Department of National Park, Department of Forestry, and the records of the Nepal Police Headquarter. We compared several sources of information for accuracy. Poaching is attributed to a particular district based on the police report of such incidence. The poaching number represents the number of all protected wildlife killed illegally.

The number of active forest rangers were collected from internal statistics of Department of Forest (Ban Bibhaag), Kathmandu. These are active duty rangers who are stationed in the district. Unemployment rate is from the Nepal Census of 2011 published by the Central Bureau of Statistics(CBS). The road length in each district is collected from data published by Department of Local Infrastructure Development and Agriculture Roads (DOLIDAR), Nepal, from its record titled Graamin Sadak Abhilekh published in September 2012. The roads included in the analyses are both gravel and concrete roads. The number of police personnels in each district is collected from the Internal Statistics of Janapad Police Headquarters. The number reflects number of active duty personnels. Similarly, population of districts are collected from CBS record. Buөer zone data was collected from the records of National Park authorities and distance from Kathmandu was calculated by using various sources. For districts for which road connectivity is still not established, we used an arbitrary value (10 kilometers plus the distance to district center) for an analysis purpose.

Results

We present the descriptive statistics of the variables in the model in Table 1. One important thing to mention based on the information presented in the table is that we found the highest number of poaching arrests in Kathmandu which is also the district with the highest literacy rate. We estimated the spatial IV regression based on the equation provided in the econometric model section. In this and Poisson model output shown in Table 2, we consider literacy as an endogenous variable and distance as the instrument to estimate the literacy rate. We also estimated the exact formulation of equation 10 using the feasible least square method.

Since we found the spatial effect present in the model, we describe the results from that model in the text. To estimate the spatial IV regression model, we used distance as an instrument variable for the literacy rate variable. We also created a spatial matrix based on the longitude and latitude of the district head quarter. As shown in Table 2, the Rho coefficient is not significant, so we fail to find the spatial error present in the model. However, we find the coefficient associated with a spatial autoregressive component (lambda) significant so we interpret the model accordingly. All parameter significances are measured at a 10% level.

Our results indicate that difference in literacy rate from KTM makes that district vulnerable to poaching. As this value increases by 1%, the poaching rate also increases and the coefficient is 0.16. Although the coefficient sign associated with this variable is consistent with our a priori belief, it did not appear significant in the model. The negative coefficient variable in unemployment indicates that as the difference in unemployment rate with KTM increases by 1%, the poaching rate decreases by 0.77. Although this may seem contradictory, the sign is perfectly explainable in Nepal's situation. The highly unemployed districts in Nepal have seen working adults moving to gulf countries for employment which leaves a few people in home for poaching behavior. Every one kilometer higher road surface from Kathmandu increases the poaching number by 007. This is perhaps because it is easier for individuals to transport poached animals to nearby suppliers. If there are more rangers in a given district, then it decreases the poaching rate which is also consistent with our a priori belief. In fact, we see the difference in number from Kathmandu goes up by one ranger, it decreases the poaching difference by 0.7. However, we see that more number of police population increases the poaching rate. Our guess is that it could be the result of an indication that police force may be corrupt and thus might have been facilitating the poaching process. These two results show that increasing the number of rangers is a good way to prevent poaching as those rangers have some attachments with national park and animals. District with buffer has more poaching indicating perhaps the easy availability of animals in the buffer zone.

Table 1. Descriptive Statistics

Variable	N	Mean	SD	Minimum	Maximum
Poaching (Number of arrest incidents)	75	7.49	13.99	0.00	77.00
Unemployment rate (%)	75	4.61	2.82	0.80	16.90
Road (Km)	75	680.58	518.76	26.00	2254.15
Rangers (Number)	75	4.28	2.57	0.00	11.00
Police (Number)	75	586.45	370.12	198.00	2899.00
Populations (Number)	75	353306	283892	6541	1745567
Distance from Kathmandu (km)	75	219.6	139.4	0.00	508.7
Literacy Rate (%)	75	50.97	11.70	26.60	77.10

Conclusions

We established the relationship between poaching and education using both theoretical and empirical models. We found that more people will be involved in poaching if wage earned by educated people is very low. Results from spatial IV regression indicated that increase in road surface area, increase in number of police, and increase in buffer zone increase poaching. It is perhaps wise to create well paying jobs adjacent to national park situating districts to reduce overall poaching rate. This has been validated as evidenced from Chitwan where poaching rate was zero last year because of high income generating business activities around Chitwan National Park and vicinities.

Table 2. Regression results relating difference in poaching rate to different explanatory variables

Variables	Coefficients (Standard Error)	
	Spatial IV	IV Poisson
dLiterate	0.165	0.062
	(0.278)	(0.052)
dUnemployment	-0.777*	0.030
	(0.327)	(0.042)
dRoad	0.007*	-0.000
	(0.002)	(0.000)
dRangers	-0.729*	0.032
	(0.420)	(0.046)
dPolice	0.011*	0.000
	(0.004)	(0.001)
dBuffer	5.758*	0.256
	(2.445)	(0.167)
Lambda	-0.006*	
	(0.003)	
Rho	0.061	

Notes: Variable definitions: All the variables listed in the regression include the value that shows the difference in value from Kathmandu. Kathmandu is the capital of the country. It is also a district with the highest literacy rate. So dLiterate is a variable that shows the difference in literacy rate in a given district compared to Kathmandu literacy rate. The spatial IV regression model is estimated using SPIVREG command and IV Poisson is estimated using IVPOIS command.

References

Acemoglu, D. (1998). Why do new technologies complement skills? Directed technical change and wage inequality. *Quarterly Journal of Economics*, 113(4) 1055-1089.
Agrawal, A., and K. Gupta. (2005). Decentralization and participation: the governance of common pool resources in Nepal's Terai. *World Development*,*33*(7), 1101-1114.
Arraiz, I., D. M. Drukker, H. H. Kelejian, and I. R. Prucha. (2010). A spatial Cliff-Ord-type model with heteroskedastic innovations: Small and large sample results. *Journal of Regional Science* 50(2): 592–614.
Drukker, D. M., P. Egger, and I. R. Prucha. 2010. On two-step estimation of a spatial autoregressive model with autoregressive autoregressive disturbances and endogenous regressors. Technical report, Department of Economics, University of Maryland.
Gordon, H. S. (1954). The economic theory of a common-property resource: the fishery'. *The Journal of Political Economy*,*62*(2), 124-142.
Heltberg, R. (2001). Impact of the ivory trade ban on poaching incentives: a numerical example. *Ecological Economics*, *36*(2), 189-195.
Johannesen, A. B., & Skonhoft, A. (2005). Tourism, poaching and wildlife conservation: what can integrated conservation and development projects accomplish?. *Resource and Energy Economics*, *27*(3), 208-226.
Kelejian, H. H., and I. R. Prucha. 1998. A generalized spatial two-stage least squares procedure for estimating a spatial autoregressive model with autoregressive distur-bances. *Journal of Real Estate Finance and Economics* 17(1): 99–121.
Kelejian, H. H., and I. R. Prucha. 1999. A generalized moments estimator for the autoregressive parameter in a spatial model. *International Economic Review* 40(2): 509–533.
Kelejian, H. H., and I. R. Prucha. 2004. Estimation of simultaneous systems of spatially interrelated cross sectional equations. *Journal of Econometrics* 118(1–2): 27–50.
Kelejian, H. H., and I. R. Prucha. 2007. The relative efficiencies of various predictors in spatial econometric models containing spatial lags. *Regional Science and Urban Economics* 37(3): 363–374.
Kelejian, H. H., and I. R. Prucha. 2010. Specification and estimation of spatial autoregressive models with autoregressive and heteroskedastic disturbances. *Journal of Econometrics* 140(1): 53–130.
Kremer, M., and C. Morcom. (2000). Elephants. *American Economic Review*, 90: 212-234.
Lopes, Adrian A. "Civil unrest and the poaching of rhinos in the Kaziranga National Park, India." *Ecological Economics* 103 (2014): 20-28.
Messer, Kent D. "Protecting endangered species: When are shoot-on-sight policies the only viable option to stop poaching?." *Ecological Economics* 69.12 (2010): 2334-2340.
Taylor, M. Scott. "Buffalo Hunt: International Trade and the Virtual Extinction of the North American Bison." *American Economic Review* 101.7 (2011): 3162-95.