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Impact of private forest ownership on deforestation and poverty

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Abstract We analyzed the impact of private forest ownership on deforestation and poverty. Using multivariate cross-section models, we identified a statistically significant negative correlation between private forest ownership and deforestation and a statistically significant negative correlation between private forest ownership and poverty. Our study presents the importance of privatization in the forest sector and stimulation of private forestry to combat deforestation and poverty.

Keywords Deforestation · Poverty · Privatization · Heteroscedasticity

JEL Classification C21 · C23 · L33 · Q23

1 Introduction

Although deforestation rate have reduced during 2000–2005 period (7.3 million hectares per year) compared to 1990–2000 period (8.9 million hectares per year), deforestation rate is still alarmingly very high (Food and Agriculture Organization 2005). As seen in Table 1, forests disappear particularly rapidly in Africa and South America.

Besides other remedies, promoting privatization can also contribute to preventing deforestation in the forest sector. Tenure of forest resources and security of tenure may reduce deforestation. If ownership is insecure or poorly enforced, an agent will convert the forest area into agricultural land in order to secure property rights. On the other hand, when ownership is secure, an agent's inter-temporal income flows from forested land will increase. This may

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Table 1 Deforestation in terms of annual change (ha/year)

Regions	1990–2000	2000–2005
Africa	−4,375,000	−4,040,000
Asia	−792,000	1,003,000
Europe	877,000	661,000
North and Central America	−328,000	−333,000
South America	−3,802,000	−4,251,000
Oceania	−448,000	−356,000
World	−8,868,000	−7,317,000

Source Adapted from Food and Agriculture Organization (2005)

ensure his/her commitment to sustainable forest management (Bohn and Deacon 2000). However, when relative prices change adversely for forestry, farmers may choose alternative land uses such as cattle ranching or agriculture. Strictly enforced land use regulations may eliminate this risk of deforestation (Karsenty et al. 2008).

Country experiences indicate that security of tenure and clearly defined ownership rights play an important role in sustainable forest management. Insecure property rights increased deforestation in Brazil and Paraguay. Private ownership of forests without legal titles in Brazil, private ownership of forests without rights in Pakistan, and ambiguous and unstable ownership rights in forest management in China exaggerated deforestation of forests. On the other hand, secure ownership rights given to individual poor households improved forest conditions and prevent degradation in Nepal and Vietnam (FAO 2006).

In regard to forest tenure, there can be a total privatization and a partial privatization in the forest sector. In the case of total privatization, complete property rights of forested area are transferred from public sector to individuals, families, private co-operatives, corporations, industries, religious and educational institutions, pension or investment funds, and other private institutions. In the case of partial privatization, use rights of forested area are transferred from public sector to private groups and individuals through concession contracts. An agent can sell the forest land in the form of total privatization while an agent can't sell the forest land in the form of partial privatization.

According to Food and Agriculture Organization (2005), 84.4% of forests are publicly owned while 13.3% of forests are under the private property. As seen in Table 2, private ownership is higher in North and Central America, Oceania, South America, and Oceania than other regions. Although most of the forests are mainly owned by the state, state ownership of forests has declined and private ownership has started to increase in recent years in such countries as Sweden, Australia, New Zealand, Finland, Chile, South Africa and China. For example, 94% of plantation forests are privately owned in New Zealand.

Private ownership in the forest sector can reduce not only deforestation but also poverty. Secure tenure rights can contribute positively to forest conversation and poverty alleviation. Private ownership and secure tenure rights in forest sector can lead owners to develop the forest resources, protect their forest and invest in tree planting in their private land.

Under private property system in Vietnam, forests are managed by individual households whereby forest area is allocated to forest owners for 50 years with a land use certificate. Owners of certificates (a) can utilize the allocated forest area in joint production and commercialization activities to maximize their profit (b) are required to pay taxes (c) exchange, transfer, lease, inherit and mortgage their certificates (d) are obliged to protect their forest allocations against unauthorized use (e) plant trees where needed. Observers report that under

Table 2 Worldwide ownership of forests in the year 2000

Regions	Public (%)	Private (%)	Other (%)
Africa	97.6	1.8	0.6
Asia	94.4	5.0	0.6
Europe	89.9	10.0	0.1
North and Central America	66.2	29.9	3.9
South America	75.9	17.3	6.9
Oceania	61.3	23.7	15.0
World	84.4	13.3	2.4

Source Adapted from Food and Agriculture Organization (2005)

this system, local households achieved higher economic benefits, improve forest conditions and invest in tree planting (FAO 2006).

In regard to addressing the needs of the poorest and promoting equity and empowerment, community management of the forest area seems to best practice. Twenty percent of total forest area in Nepal is community forests. Under the community forest system in Nepal, the forest area is allocated for a community through community forest agreements on the basis of renewable 5-year operational plans. Rights and responsibilities related to community forests are clearly defined by the 1993 Forest Act. Observers report that forest conditions improved considerably, degraded forests are regenerated, and community's welfare increased since the beginning of the programme (FAO 2006).

In some countries concessions are used as a tool to alleviate poverty and thus deforestation in communities neighboring to concessions (Karsenty et al. 2008). (a) Some countries such as Cameroon and Brazil transfer some part of taxes and payments received from concessionaires to neighboring local public bodies and villages to allocate to local development projects. (b) Concessionaires in some countries are obligated to fulfill environmental and social responsibilities at neighboring communities whereby concessionaries have to prepare a management plan with sections on wildlife management and social responsibilities (investments) such as building schools and health centers, maintaining roads and bridges, setting up transformation units to provide jobs locally. (c) Local populations in Gabon and Cameroon receive a voluntary cash contribution from some concessionaires to maintain a peaceful relationship with neighboring communities.

We hypothesized that privatization could reduce both deforestation and poverty. Using cross section multivariate models, we found highly statistically significant negative correlation between private forest ownership and deforestation across countries. We also test the relationship between private forest ownership and poverty. We found highly statistically significant negative correlation between private forest ownership and deforestation across countries.

In our study, we investigated the impact of private forest ownership on deforestation and poverty for the year 2000. The reason for using just 1 year cross section data in our analysis is due to the fact that the only officially collected data on the ownership in forest sector is reported by Food and Agriculture Organization (2005) for the year 2000.

In the next section, we explain data and methodology as well as we reported and discussed the estimation results for the relationship between deforestation and private forest ownership. Data, methodology, and estimation results are reported and discussed for the relationship between poverty and private forest ownership in Sect. 3. The last section concludes.

2 Privatization and deforestation: data, methodology, and estimation results

In order to test the relationship between private forest ownership and deforestation, we estimated the following multivariate model:

$$\begin{aligned}\text{DEFORESTATION}_i = {} & \beta_1 \text{PRIVATE}_i + \beta_2 \text{POPDEN}_i + \beta_3 \text{CROPLAND}_i \\ & + \beta_4 \text{GDPPCGR}_i + \varepsilon_i\end{aligned}$$

where i stands for i-th country and ε_i is error term for the i-th country.

In our study, we investigated the impact of private forest ownership on deforestation for the year 2000. The reason for using just 1 year cross section data in our analysis is due to the fact that the only officially collected data on the ownership in forest sector is reported by Food and Agriculture Organization (2005) for the year 2000. Thus, we used the year 2000 value of other independent variables in the model.

In addition to private forest ownership (PRIVATE) variable, we introduced three more determinants of deforestation to analyze the association between deforestation and privatization: population density (POPDEN), permanent cropland as a percentage of total land area (CROPLAND), and annual gross domestic product per capita growth (GDPPCGR). All those variables come from World Development Index (WDI). The variables used in our analysis were chosen in the light of previous studies found in the literature, the availability of the data and our main hypothesis. The following further describes the independent variables and discusses their expected signs.

PRIVATE is the private ownership in the forest sector. Private forest ownership data is taken from FAOs Global Forest Resource Assessment 2005—Ownership of Forest and Other Wooded Land 2000 (Food and Agriculture Organization 2005). The coefficient on the PRIVATE is expected to be negative.

POPDEN is the per square km and represents population density. Population pressure forces slash-and-burn farmers and small cattle rangers to clear forest cover in order to meet their basic needs. Also population pressure forces poor households in cities to clear forests in order to meet their housing space. We expect to have POPDEN contribute positively to deforestation.

CROPLAND is the permanent cropland as a percentage of total land area. CROPLAND is a proxy for the agricultural land demand. In most of the developing countries the amount of arable land for farming is limited and there is increasing pressure on forest land for alternative land uses. Thus, we expect a positive relationship between CROPLAND and deforestation.

GDPPCGR is the annual gross domestic product per capita growth. The coefficient on the GDPPCGR variable is expected to be negative. As a nation becomes more developed, deforestation tends to decrease.

In the sample selection process, we included those countries having the forest land at least 50,000 km^2 into our analysis. This cut-off point left us with the sample size of 128 countries. To analyze the sensitivity of the results, we form sub-samples. The main sample is divided into groups of countries based on having the forest land: countries having the forest land more than 3, 6, 9, and 12 million km^2.

Estimation results for the five samples (the entire sample, countries having the forest land more than 3 million km^2 sample, countries having the forest land more than 6 million km^2 sample, countries having the forest land more than 9 million km^2 sample, and countries having the forest land more than 12 million km^2 sample) are reported in Table 3 for multivariate models. The table also provides information on estimation techniques. It is possible to come across with heteroscedasticity problem in cross-section data. Hence if we detected

Table 3 Cross-section estimation results on the relation between deforestation and private forest ownership

	Entire	>3 Mil.	>6 Mil.	>9 Mil.	>12 Mil.
CONSTANT	−0.0861	0.4806	0.4882	0.6492	0.5858
Standard error	0.3400	0.1910	0.1811	0.1702	0.1830
P value	0.800	0.014	0.010	0.000	0.003
PRIVATE	−0.0281	−0.0106	−0.0144	−0.0135	−0.0151
Standard error	0.0058	0.0041	0.0046	0.0041	0.0048
P value	0.000	0.013	0.003	0.002	0.004
POPDEN	0.0102	0.0001	−0.0001	−0.0018	−0.0001
Standard error	0.0018	0.0014	0.0013	0.0014	0.0016
P value	0.000	0.925	0.944	0.213	0.969
CROPLAND	0.0303	0.0433	0.0361	−0.0227	−0.0053
Standard error	0.0174	0.0330	0.0321	0.0325	0.0385
P value	0.084	0.194	0.266	0.488	0.890
GDPPCGR	−0.4528	−0.0208	−0.0075	0.0003	0.0105
Standard error	0.0474	0.0309	0.0335	0.0298	0.0330
P value	0.000	0.504	0.824	0.990	0.751
Estimation method	WLS	OLS	OLS	OLS	OLS
R^2	0.8447	0.1152	0.1967	0.2642	0.2458
Number of observations	132	71	56	49	36
Breusch–Pagan statistics	1.51	2.04	2.25	0.10	0.37

heteroscedasticity in the model, we corrected the model by rescaling variables with appropriate weight factor and in turn re-estimated the model with WLS (weighted least square) method[1].

As shown at Table 3, we found highly statistically significant negative correlation between privatization and deforestation: the estimated coefficient of PRIVATIZATION variable has positive sign and is statistically significant at least at 5% level in all models. Thus, this finding suggests a negative relation between privatization in forest sector and deforestation. Whenever POPDEN, CROPLAND and GDPPCGR variables are statistically significant, they take prior expected signs.

3 Privatization and poverty: data, methodology, and estimation results

In order to test the relationship between privatization and poverty, we estimated the following multivariate model:

$$\mathrm{HDI_i} = \beta_1 \mathrm{PRIVATE_i} + \beta_2 \mathrm{GRINVEST_i} + \beta_3 \mathrm{ORERATE_i} + \beta_4 \mathrm{EDUCATION_i} + \varepsilon_i$$

where i stands for i-th country and ε_i is error term for the i-th country.

In our study, we investigated the impact of private forest ownership on poverty for the year 2001 and used 1 year lag value of private forest ownership variable (PRIVATE).

[1] For this model we assumed that error variance is proportional to square of exports of goods and services (constant 2000 US$) and therefore we rescaled each variable by $1/(Exports)^2$. The data is taken from WDI.

We used 1 year cross section data in our analysis since the only officially collected data on the ownership in forest sector is reported by Food and Agriculture Organization (2005) for the year 2000. We also used lag value of private ownership variable since observation of the impact of private forest ownership on poverty may take some time.

In this part of the study, we use the Human Development Index as the indicator of the poverty and four independent variables to analyze how privatization in the forest sector affects poverty in a country. The data on human development indexes come from Human Development Reports of UNDP. The independent variables are private ownership in the forest sector (PRIVATE), physical capital endowment (GRINVEST), natural resource endowment (ORERATE), and human capital endowment (EDUCATION). The variables used in our analysis were chosen in the light of previous studies existing in the literature, the availability of the data and our main hypothesis. The following further describes the independent variables and discusses their expected signs.

PRIVATE is the private forest ownership. Private forest ownership data is taken from FAOs Global Forest Resource Assessment 2005—Ownership of Forest and Other Wooded Land 2000 (Food and Agriculture Organization 2005). The coefficient on the PRIVATE is expected to be positive.

GRINVEST is the ratio of gross fixed capital formation to GDP. The ratio of gross fixed capital formation to GDP is used as the proxy for the physical capital endowment. Data on gross fixed capital formation (% of GDP) is collected from WDI). In our model capital-GDP ratio is expected to be positively correlated with human development index and thus be negatively correlated with poverty.

ORERATE (natural resource endowment) is the share of natural resource (ores and metal) exports in total exports. We use the share of natural resource (ores and metal) exports in total exports as the proxy for natural resource endowment. The data on total exports and ores and metal exports are from UNCTAD.

The sign of the coefficient on the ORERATE is expected to be ambiguous. While natural resource exports may increase GNP per capita, it may decrease human development index due to natural resource curse. According to natural resource curse hypothesis natural resources may adversely affect growth and human development through channels such as Dutch Disease, economic volatility, trade structure, depletion, and rent-seeking (Pineda and Rodríguez 2010). This is due to high capital intensity, ownership is highly concentrated ownership, and low complementary between capital and labor in this sector (Gupta et al. 1998).

EDUCATION (human capital endowment) is the share of primary school enrollment in total education enrolment. Primary level education enrolment is used as the proxy for human capital endowment. Primary level education enrolment data are collected from United Nations Common Database.

Improving education level may increase income earning potential of the poor, whereby a higher educational endowment may decrease the poverty. In our model higher capital endowment is expected to be associated with lower poverty and thus be associated with higher human development index.

In the sample selection process, we included those countries having the forest land at least 50,000 km^2 into our analysis. This cut-off point left us with the sample size of 128 countries. In order to test the robustness of our results, we form subsamples: countries having the forest land more than 3, 6, 9 and 12 million km^2.

Estimation results for entire sample and other four sub-samples are reported at Table 4 below. The table also provides information on estimation techniques. It is possible to

Table 4 Cross-section estimation results on the relation between poverty and private forest ownership

	Entire	>3 Mil.	>6 Mil.	>9 Mil.	>12 Mil.
CONSTANT	0.2171	0.1822	0.0833	0.0137	0.1248
Standard error	0.1012	0.1277	0.0993	0.0990	0.1402
P value	0.034	0.160	0.407	0.891	0.384
PRIVATE	0.0019	0.0027	0.0039	0.0042	0.0042
Standard error	0.0004	0.0006	0.0005	0.0005	0.0008
P value	0.000	0.000	0.000	0.000	0.000
GRINVEST	0.0016	0.0025	0.0008	0.0056	0.0001
Standard error	0.0024	0.0035	0.0027	0.0034	0.0042
P value	0.505	0.472	0.759	0.112	0.996
ORERATE	−0.0023	−0.0014	−0.0015	−0.0016	−0.0016
Standard error	0.0010	0.0013	0.0009	0.0009	0.0013
P value	0.021	0.264	0.120	0.112	0.228
EDUCATION	0.0044	0.0041	0.0054	0.0050	0.0051
Standard error	0.0009	0.0011	0.0008	0.0009	0.0011
P value	0.000	0.001	0.000	0.000	0.000
Estimation method	OLS	OLS	OLS	WLS	OLS
R^2	0.4320	0.5318	0.7605	0.7904	0.7761
Number of observations	108	56	46	39	26
Breusch–Pagan statistics	1.82	2.11	0.0668	0.1411	0.1845

come across with heteroscedasticity problem in cross-section data. Hence if we detected heteroscedasticity in the model, we corrected the model by rescaling variables with appropriate weight factor and in turn re-estimated the model with WLS method[2].

As shown at Table 4, we found highly statistically significant negative correlation between privatization and poverty: the estimated coefficient of PRIVATIZATION variable has positive sign and is statistically significant at least at 1% level in all models. Thus, this finding suggests a negative relation between privatization in forest sector and poverty.

In regard to other variables, the estimated coefficient on human capital endowment (EDUCATION) indicator is positive and significant at least at 1% level. The coefficients on physical capital endowment (GRINVEST) is not significant in all models. The coefficients on natural resource endowment (ORERATE) is significant in one model (entire sample model) and takes negative sign indicating that natural resource exports decrease human development index and thus increase poverty.

4 Conclusion

We analyze the effect of privatization on deforestation and poverty. We identified a statistically significant negative correlation between privatization and deforestation and a statistically significant negative correlation between private forest ownership and poverty.

[2] For this model we assumed that error variance is proportional to square of gross capital formation (measured as % of GDP) and therefore we rescaled each variable by $1/(gcap)^2$. The data is taken from WDI.

In the first part of the study, we examine how privatization affects deforestation. Using multivariate models, we found highly statistically significant negative correlation between privatization and deforestation.

One of policies to fight poverty is privatization of state forests (and private forest ownership). In the second part of the study, we investigate the influence of privatization on poverty. We identified a negative correlation between privatization and poverty.

Our study presents the importance of privatization in the forest sector and stimulation of private forestry to combat deforestation and poverty. However, how much of the forests in a country are to be privatized depends on the environmental and socio-economic conditions of the country concerned since the process of privatization is itself sensitive to corruption. Privatization of state forests requires a clear and just strategy. Privatization of forests should also be taken into consideration with other remedies combating against deforestation. The experiences of countries in where privatization of forests took place successfully show that the country should reach a certain level of income.

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