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Forest cover increase in India: The role of policy and markets

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ABSTRACT

Contrary to trends in many countries, forest cover in India has increased in recent times. Using a step wise time series cross section regression analysis on state–level panel data over 1990–2008, we examine two hypotheses to explain this increase: Forest cover is influenced by policies as well as the timber market. While appropriately controlling for economic and structural influences, we find that implementation of joint forest management is positively correlated with forest cover, implying that community participation is key to effective afforestation; and the timber and fuel wood market demands are positively correlated with forest cover, implying that demand-driven growth is conducive to forest growth, especially in presence of complementary policies. Our results suggest that policies, by supporting individual interests, can increase forest cover more effectively.

1. Introduction

1.1. Motivation

Recognition of the critical ecosystem goods and services provided by forests as well as the significant role played by them in carbon storage and sequestration has increased their importance in climate change mitigation strategies (Bouwman and Leemans, 1995; Schlamadinger and Marland, 1996; Brown, 1997; ICFRE, 2009). This leads to the question of what influences forest cover changes in different geographies.

The focus of this study is on forest cover change in India. With a forest cover of 692,027 km^2 (FSI, 2011) – 21.05% of the geographic area of the country – India ranks 10th in the list of most forested nations in the world (FAO, 2010). What makes this study particularly compelling is that, as opposed to the forest cover decreases observed in many parts of the world (Flint, 1994; Salam and Noguchi, 1998; Laurance, 2007a,b), the forest cover in India has increased by 1.56% of geographic area in the last two decades (Fig. 1).

Though modest, this increase should be looked at in the global context. Table 1 compares the forest cover change in the top ten forested countries. Most countries show either deforestation or no net change during this time period (FAO, 2010). Only three countries show an increase in forest cover (i.e., China, India, and the United States of America). The top spot is claimed by China, where the forest cover increase is well studied by Song and Zhang (2010), who attribute the phenomenon to large scale government sponsored plantation forests. India showed the second largest annual net gain, which raises the question: what factors have contributed to the forest cover increase in India?

Empirical studies on temporal variation in deforestation and its population or development correlates, particularly in low-income countries such as India, are limited (Salam and Noguchi, 1998; Foster and Rosenzweig, 2003; Jha and Bawa, 2006). Majority of the studies evaluating economic reasons for forest cover change have looked at data at the national level (Flint, 1994; Kauppi et al., 2006; Laurance, 2007a,b). In addition, very few studies have examined forest cover change in India at the sub-national level and even these have focused on very specific landscapes or limited regions (Jha et al., 2000; Baland et al., 2006; Davidar et al., 2010). Furthermore, all these studies take only one or two time periods into consideration and, therefore, do not capture trends in forest cover change. Foster and Rosenzweig (2003), using village level data, is the only study that has done rigorous empirical analysis on the forest cover increase in India. However, their study focuses largely on economic factors contributing to forest cover increase during an earlier period (1971–1999) and, furthermore, does not evaluate the role played by policy.

1.2. Our study

There is a need for an empirical study that examines the forest cover increase in India in the first decade of the 21st century (Fig. 1). This is what our study intends to establish, via detailed panel regression analysis of the change in forest cover in India over time, using recent (1990–2008) nationwide data at the state level from 9 different years.

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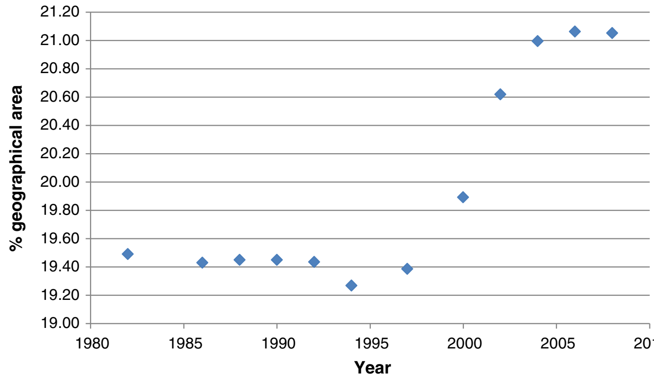

Fig. 1. Change in total forest cover in India over time showing a subtle increase (1.56%) in forest cover.

We recognize that many factors can result in positively influencing forest cover. In India, millions of people depend upon forest products. The requirements of these households determine the nature and extent of forest cover change (Davidar et al., 2010). In view of the deteriorating forest resources and their importance to the national economy and environment, the Government of India has been emphasizing the sustainable development of forest resources (MoEF, 1999). Based on an extensive literature review and examining a number of variables and pathways impacting forest cover in India, we chose to examine two main hypotheses for this study.

1.2.1. Joint forest management hypothesis

Hypothesis 1. The implementation of joint forest management is positively correlated to forest cover.

The primary hypothesis is that, governments and local communities, facing critical shortages of wood and other forest products, engage in plantation efforts through the creation of community forestry (Rudel et al., 2005; Laurance, 2007a,b; Meyfroidt and Lambin, 2008; Nagendra, 2010), via Joint Forest Management (JFM). JFM is a concept of developing partnerships between fringe forest user groups and the state forest departments on the basis of mutual trust and jointly defined roles and responsibilities with regard to forest protection and development (MoEF, 1990).

1.2.2. Demand driven growth hypothesis

Hypothesis 2. The demand in the forest produce markets namely of timber and fuel wood, is positively correlated to forest cover.

Table 1
Ten countries with largest forest area showing annual net change in forest area 1990–2010 (FAO, 2010).

Country	Forest area (million ha)	Annual change (%)	
		1990–2000	2000–2010
Russian Federation	809	0	0
Brazil	520	−0.5	−0.5
Canada	310	0	0
United States of America	304	0.1	0.1
China	207	1.2	1.6
Democratic Republic of Congo	154	−0.2	−0.2
Australia	149	0	−0.4
Indonesia	94	−1.7	−0.5
Sudan	70	−0.8	−0.1
India	68	0.2	0.5

Increasing population increases the demand for timber and fuel wood. In absence of afforestation, if the effective demand goes down it reduces pressure on forest cover; but, if the effective demand goes up, it may increase pressure on forest cover. In this context, a related phenomenon is demand-driven forest increase: rising timber and fuel wood yields from managed forests, for example, plantations and agroforestry, help to not only meet their demand with fewer disturbances to natural forests (Kauppi et al., 2006; Meyfroidt and Lambin, 2008; DeFries and Pandey, 2010; Nagendra, 2010) but also increase the effective forest cover (Foster and Rosenzweig, 2003).

2. Materials and methods

2.1. Empirical model

We construct an econometric model to analyze the impact of the implementation of joint forest management and volume of timber extracted on total forest cover, represented as percentage of geographic area, in India. We use variation in space – i.e., across states for a fixed time period – as well as in time – i.e., across years for a fixed state – for our estimation.

We use a pooled time-series cross-section (TSCS) model that estimates the forest cover in state *s* at time *t* as (Parks, 1967):

$$Y_{st} = \beta_0 + \beta_y X_{st} + \beta_p P_{st} + \beta_z Z_{st} + \alpha_s + \gamma_t + \varepsilon_{st} \quad (1)$$

where Y_{st} is the dependent variable, measuring the total forest cover (as a percentage of geographic area) in state *s* at time *t*. β_0 is a constant, *X* represents the timber market value, and *P* is the implementation of joint forest management. *Z* represents many control variables, including economic and demographic factors that could influence forest cover.

This model relates “levels” of independent variables to “levels” of the dependent variable — the forest cover, which is in % terms. Thus, the coefficients β_y and β_p capture changes in the forest cover per unit change in corresponding independent variables. In our model, we use dependent and independent variables from similar time periods, for two reasons. First, this is common practice in published literature (Foster and Rosenzweig, 2003; Salam and Noguchi, 1998). Second, total forest cover includes fast growing forest plantations, which can be detected by the satellite imageries even in early stages of growth (FSI, 2003). A step wise regression analysis was run to test the robustness of the results for the main independent variables being tested in the aforementioned two hypotheses to the inclusion of other potential drivers.

The distribution of all independent variables was tested using the Skewness–Kurtosis tests, such as Kolmogorov–Smirnov as well as Shapiro–Wilk (Shenton and Bowman, 1977). If a variable was found to be normally distributed – i.e., the null hypothesis that the variable distribution is different from normal is rejected with 95% confidence – it was used in the linear form. If the variable was not found to be normally distributed it was log transformed and, after ensuring normality, used in the panel.

The proper estimation of this model requires addressing several econometric issues given that standard OLS estimation yields inconsistent or inefficient estimates for panel data (Stimson, 1985). Since we exploit a panel of individual states over a fixed time period, unobserved heterogeneity is likely to be present in both state and time domains. Not controlling for this heterogeneity yields inconsistent estimates as the error term becomes correlated with independent variables. Therefore, we use a fixed effects model controlling for state fixed effects, α, and time fixed effects, γ. Our use of fixed effects is further supported by Hausman (1978) tests, which reject random effects, suggesting that a fixed effect specification is more appropriate from a statistical perspective as well.

Finally, controlling for these effects and using clustered robust standard errors on the remaining error term, ε, accounts for heteroskedasticity, likely to be present due to state-size-differences.