# Determining Environmental Quality in a Federal Setting: An Empirical Analysis of Subnational Governments in India

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# Determining Environmental Quality in a Federal Setting: An Empirical Analysis of Subnational Governments in India

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## Abstract

Against the analytical backdrop of environmental federalism, the paper examines the impact of fiscally decentralized public policy stance on environmental quality in India. Unlike many studies which analysed the fiscally decentralized determination of environmental welfare from *tax-side* through modeling interjurisdictional competition and 'race to bottom', this paper attempts to look at the link from *public expenditure side* in a Kuznets' U specification. The paper does not refute the widely explored Kuznets U phenomenon between economic growth and the environmental quality, rather it emphasizes that it does substantially through conscious public policies on reforestation and pollution abatement with adequate public expenditure decisions. Using GSLS and fixed effects model of pooled least squares for the late 1990s, the analysis of the link between decentralized environmental expenditure in per capita terms and the environmental quality indicators for the forestry sector revealed that there is a positive functional relationship between the variables. The models also revealed the effectiveness of economic growth variables in creating the Kuznet's U effect on environmental quality. However, the panel estimates showed that fiscal policy has a stronger impact on environmental quality than the Kuznets U-impact of economic growth. This result is in confirmation with the trend that fiscal policies on environmental capital formation gets transformed to the end results of better environmental quality indicators, despite the constraints of initial negative impacts of economic growth on ecology.

Key words: environmental federalism, fiscally decentralized public policy stance, Kuznets' U specification.
JEL Codes: H5, C33, E62

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# Introduction

Fiscal policy stance is a key policy instrument to ensure sustainable environmental development, which rests on the fact that the functioning of the market cannot, by itself, activate the signaling, response and mobility of economic agents to achieve efficiency in both static (allocative efficiency) and dynamic (shift in the production frontier) terms. The role of fiscal policy stance in environmental development proceeds from market failures of one kind or another. In the context of interjurisdictional environmental regulatory competition that exists in the economies of federation, the impact of fiscal policy stance on environmental quality is a highly complex and unresolved issue. It raises an important issue of assigning appropriate role of various tiers of government in provision of public goods, setting the environmental standards and designing regulatory measures to attain these standards, rather than confining to debate on centralization versus decentralization of environmental management.

The emerging literature on *environmental federalism* deals with the fiscally decentralized determination of environmental quality and the dangers of 'race to bottom' that can emerge due to interjurisdictional competitiveness to attract mobile capital (mobile firms) by excessively lax environmental standards, which will result in sub optimal outputs of local public good including the environmental quality. However, the empirical treatment of the topic is still challenging.

Despite the global recognition of fiscally decentralized determination of environmental quality and its gaining prevalence in the public policy making, there have been relatively few empirical studies on this topic. Specifically, the empirical treatment of *environmental federalism* from fiscal policy perspective is scarce; a few related studies we could find were Pashigan (1985) and Crandall (1983) which examined the link between Reagan's fiscally decentralized policy of environment in the 1980s (in substantially reducing the Federal involvement in environmental issues and simultaneously cut *federal grants* to states, which

had supported local pollution control efforts at the subnational government level) and environmental quality in the context of USA; List and Gerking (2000) which examined the same empirical question using fixed effects model for the determination of environmental quality and abatement expenditure in the pre- and post-decentralized environmental regime in the context of USA and found that the shift in the environmental policy under Reagan has not resulted in 'race to bottom' in 1980s; and Millimet (2000) which provided further assessment of the impact of Reagan's fiscal policy of environmental decentralization of eighties through environmental Kuznets U curve specification in panel data framework from US states[2].

This paper aims to take on this rare gamut of empirics by examining the link between fiscally decentralized public policy stance and environmental quality. It is a challenging task as theoretical and empirical literature which revolves around environmental federalism is heavily skewed towards the discussion on *environmental regulations* and ignores the *fiscal policy content* in it to a great extent. This paper is a nascent attempt to empirically capture the impact of fiscal policy in a federal economy on the environmental quality using *Kuznets' U* specification. This paper does not refute the widely explored *Kuznets U phenomenon* between economic growth and the environmental quality, rather to emphasize that it does substantially through conscious public policies at the subnational levels of government, viz., reforestation, pollution abatement etc, with adequate public expenditure decisions. The crucial question thus is that *does fiscal policy stance make an impact on environmental quality*. Since there is a contemporaneous transformation of many socio-economic and policy variables that result in the environmental quality, it is a difficult task to establish a bivariate link between the two. However, an analysis of macroeconomic link between decentralized fiscal policy stance and environmental quality would enable us to realise whether the money spent by the subnational government on afforestration or pollution abatement is transformed to the end results of better environmental quality indicators.

[2] These studies are discussed in detail in Section III.

This paper aims to empirically examine the fiscal policy dynamics of environmental federalism in India, with special reference to forest sector. The paper is divided into four sections. Apart from the introduction, section II deals with the theoretical framework of environmental federalism while section III translates this framework into some theoretical and empirical issues related to fiscal policy stance and environmental quality. Section IV interprets the data and deals with the specification of the model and econometric estimation. Section V interprets the results and draws conclusions.

## 1. Theoretical Framework of Environmental Federalism

In the contemporary global restructuring, the rationale of applying *'principle of subsidiarity'* to environmental management is a matter of debate. According to principle of subsidiarity, the responsibility for providing a particular service should be assigned to the smallest jurisdiction whose geographical scope encompasses the relevant benefits and costs associated with the provision of services. Such decentralization of public decision making in environmental issues allows outputs of public services to be tailored to the particular circumstances - the tastes of the residents, the costs of production and any other particular local features- of each jurisdiction[3] (Oates, 1998).

Simultaneously, there is a complex component of the choice of regulatory jurisdiction involving the potential for regions to compete one another to attract mobile capital by lax environmental standards. Oates and Schwab (1988) examined the interjurisdictional competition over environmental regulation in a model in which many states compete to attract mobile capital to a polluting industry. In literature, the *'race to bottom'* and *'pollution haven hypothesis'* often address these issues of trading lower environmental quality for more mobile capital[4].

[3] In the context of heterogeneity in preferences, the advantages of assigning allocation function to the sub national governments have been dealt extensively in the theory of fiscal federalism. The genesis can be traced back to Oates (1972). Musgrave's three-fold categorization of the functions of the government- allocation, distribution and stabilization – also argues that allocation issues are motivated largely through heterogeneity in preferences (Musgrave, 1959).

[4] Empirical evidences revealed a continuous tension between 'principle of subsidiarity' and 'one size fills all' paradigms. Maaschrict Treaty for European Union states that action at the jurisdictional-level is justified "only and insofar as the objectives of the proposed action, be better achieved by the Member States and can

In a federal setup, Oates (2001) envisions three benchmark cases under which ambient environmental standard to be met in each of the jurisdictions that make up the whole nation. *Three standard-setting functions* of environmental quality have been developed within the intergovernmental hierarchy. The first case considers environmental quality as a *pure public good* for the nation as a whole; the second prototypical case considers environmental quality as a *pure local public good* and the third case, which is most common in practice, deals with the effects of interjurisdictional externalities and Coasian-type negotiations.

*(1). Environmental Quality is a Pure Public Good: Centrally determined standard-setting function*

This benchmark case considers that the vector of environmental quality ($Q_i$) is a function of aggregate level of emissions from all sources in the nation (E).

$$Q_i = f\{E\} \qquad (1)$$

The critical property of this function is that a unit of polluting emissions has the same effect on the vector of national environmental quality regardless of where it takes place; a unit of emissions in jurisdiction *i* is a perfect substitute in this sense for a unit of emissions in jurisdiction *j*. In other words, there exists a standard sort of interjurisdictional externality (as emissions in any given jurisdiction spill over and degrade the environment in other jurisdictions).

Global warming and depletion of ozone layer falls under this category. For these matters, environmental quality is a *global public good*. For instance, a unit of CFC or $CO_2$

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therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community[4]". In US, there exits an inconsistent amalgam of decision structures related to environmental management. For instance, the standards for setting ambient air quality in terms of permissible concentrations of pollutants is a *centrally determined* by U.S Environmental Protection Agency (EPA) under Clean Air Act (Amendment), 1970; while U.S Congress directed the States to set standards for water quality within their own jurisdictions under Clean Water Act (Amendment), 1972.

emissions has the same effect on global environmental quality irrespective of its location; and these issues require a global solution.

*(ii) Environmental Quality is a Pure Local Public Good: Decentralized Determination of standard-setting function*

This prototypical case considers the level of environmental quality in the $i^{th}$ jurisdiction as a function of level of emissions of pollutants ($e_i$) in that jurisdiction alone.

$$Q_i = f \{ e_i \} \qquad (2)$$

The 'principle of subsidiarity' is directly applicable to this case; envisioning a decentralized determination of environmental quality. Each jurisdiction is expected to set its own appropriate standard for environmental quality.

Theoretical and empirical literature, however, suggests that in decentralized determination of environmental quality, the dangers of 'race to bottom' can emerge due to interjurisdictional competitiveness to attract mobile capital (mobile firms) by excessively lax environmental standards, which will result in sub optimal outputs of local public good (including environmental quality).

*(iii) Environmental Quality as a function of interjurisdictional Spill Over Effects*

This most recurring case considers environmental quality as a function of local emission of pollutants and also the emissions from external polluting activities that flow across boundaries from other jurisdictions.

$$Q_I = f \{ e_i , e_{2,\ldots\ldots\ldots\ldots} e_n \} \qquad (2)$$

For instance, both air and water pollution flow across jurisdictions; sometimes over long distances as acid rain.

Under this case, one solution is to invoke central intervention, though the centrally determined uniform ambient national standards for environmental quality is not an optimal solution. Yet another solution is to prescribe a set of emission taxes that internalize the social damages, which is a less practical solution in an intergovernmental setting. In other words, an effluent charge per unit of waste emissions equal to the marginal external damages, which would be a differentiated tax across jurisdictions, is difficult for a central authority to determine or politically to impose.

Yet another solution is Coasian[5] sort of resolution of jurisdictional spill over effects through regional co-operations. But such co-operations are not easy to come as the cases of spill over effects across jurisdictions spurt a complex set of policy alternatives[6]. It is also to be noted that there exists a dichotomy in the nature of interjurisdictional externalities, whether emission of pollution flows is unidirectional or bidirectional[7].

This paper is confined to Oates' decentralized determination of standard setting functions of environmental quality in concomitant with the *principle of subsidiarity*. However, unlike many studies which tried to analyse the fiscally decentralized determination of environmental welfare from *tax-side* (modeling interjurisdictional competition and 'race to bottom'), this paper attempts to look at the link between fiscal decentralisation and environmental quality from *public expenditure side*.

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[5] Contrary to Pigou's theory that only governments, by means of taxes and subsidies, can "internalize" externalities in economic exchange or production, Coase argued that, when one considers opportunity cost in its full meaning, no such devices are necessary: private losers and winners in such cases can "internalize" these externalities themselves through negotiation and that the result will be identical regardless of which party has rights of ownership over the cause of the externality. In short, the manner in which a property right is initially assigned will not affect the efficiency of resource allocation. The only exception, Coase granted, is when there are transactions costs to negotiation.

[6] The basic idea here is that so long as the polluting activities that are the source of the spillovers are not at their efficient levels, there exist potential gains from trade from an interjurisdictional program to regulate these activities. The costs, in such cases, of pollution abatement are less than the benefits accruing to residents of both the home and the neighboring jurisdictions (Oates, 2001).

[7] For detailed discussion, Baumol and Oates, 1988.

## III. Theoretical and Empirical Literature on Environmental Federalism: A Synoptic View

In the theoretical and empirical literature, *'race to bottom'* is the most recurrent issue in environmental federalism. In other words, studies are heavily skewed to *tax-side* analysis of the determination of environmental welfare in a federal setting through modeling interjurisdictional competition. Thorsten (1999) is an exception, which tried to analyse the link between fiscal policy and environmental welfare from tax and public expenditure sides in a model of interjurisdictional competition. Given this limitation, this section briefly reviews the existing literature on environmental federalism.

Oates and Schwab (1988) explained *'race to bottom'* in a model where many jurisdictions compete to attract a fixed amount of mobile capital. Capital confers benefits on the jurisdictions in the form of increased local wages and this in turn imposes costs in the form of local environmental degradation. To limit pollution costs, regulators set emission caps that reduce the return to capital. This lowers the quantity of capital attracted to the jurisdiction, in turn lowering the local wages. Levinson (1997) noted that faced with a trade-off between environmental quality and wage income, regulators maximize local welfare by setting regulations so that the marginal gain from attracting capital equals its marginal environmental cost. This decentralized outcome is then shown to be socially efficient from the perspective of all jurisdictions (Levinson, 1997).

Oates and Schwab model revealed that interjurisdictional environmental regulatory competition for mobile capital between communities of homogeneous immobile workers is efficient. This efficiency result depends on the implicit internalization of the pollution externality. Workers suffer from pollution and earn wages from polluters simultaneously. The result is analogous to the fiscal federalism literature, genesis can be traced back to Oates (1972), under assumptions sufficient to turn pollution abatement into a local public good and environmental regulations into benefit taxes and regulatory competition can be shown to be efficient in the same way as tax competition[8].

[8] Levinson (1997).

Contrary to Oates and Schwab model, Markusen, Morey and Olewiler (1995) model revealed the efficiency implications of interjurisdictional environmental regulatory competition in a Nash equilibrium framework. Their model revealed that two jurisdictions competing on the basis of pollution taxes to attract polluting manufacturers face transaction costs between the regions and the resulting discrete location choice problem depends on the tax rates in the jurisdictions. Their model argued that centralised regulation of local environmental problems is necessary to avoid market failures.

Yet another study by List and Manson[9] have explored the interjurisdictional environmental regulatory competition in a dynamic game-theoretic model with asymmetric players to characterize outcomes in a setting with transboundary pollutants. They examined two subefficient policy alternatives: decentralized standard setting and a centrally determined uniform standard. Their numerical simulations of the model indicate that the decentralized setting of standards can dominate a centrally determined uniform standard if there are significant differences across the jurisdictions and if initial levels of pollution are not too high. Otherwise, central setting of standard yields a better outcome[10].

The theoretical literature is thus *inconclusive* on the issue of 'race to bottom'. On one hand, studies showed that subnational governments cannot be entrusted with the responsibility of setting environment standards because in the tug of war between ecology versus economy, they prefer economic development at the cost of environmental quality. Thus 'race to bottom' takes the form of suboptimal provision of local public goods, one of which is environmental quality (Oates, 2001). On the other hand, studies showed that interjurisdictional competition for environmental regulation is efficiency-enhancing. These studies showed that greater decentralization of environmental regulations may lead to a NIMBY (not-in-my-backyard) phenomenon, whereby local governments raise environmental regulations above the optimal level in order to discourage polluting firms from locating with their jurisdiction.

[9] (forthcoming, cited in Oates, 2001)
[10] This discussion is drawn from Oates, 2001.

If there is 'race to bottom', we are left with a choice of two alternatives: suboptimal local decisions on environmental quality or inefficient uniform national ambient environmental standards (Oates, 2001). Theoretically it is difficult to arrive at a conclusion on which of these choices leads to higher level of social welfare. As rightly pointed out by Oates (2001), empirical studies on alternative regimes are required to shed light on this issue.

Another set of studies on environmental federalism looked into the issue of 'race to the bottom' within the framework of *firm location decisions*. Following the econometric model of location choice of new firms developed by Carlton (1983), several studies estimated the impact of different variables on firm's profit as reflected in firm location decisions (Levinson, 1995; Bartik, 1988). Levinson (1995) found that new branch plants of larger multiplant firms locate in states with least stringent environmental regulations. In the context of developing country, one of the pioneering work on environmental 'race to bottom' in the framework of plant location decision has been done by Mani et al (1997) in the context of India. The study noted that since new firms are not restricted in their choice of location by sunk costs, varying environmental stringency could be an important factor in determining the new firm location across jurisdictions. Using conditional logit model, the study found that number of proposed new plants in different states of India does not appear to be adversely affected by the stringent enforcement of environmental regulations at the state level and therefore no evidence for environmental 'race to the bottom' in India.

Empirical literature on environmental federalism has largely been confined to USA. Some *recent econometric studies* looked into Reagan's policy of environmental decentralization in the 1980s and its implication on the 'race to the bottom' issue. Reagan substantially reduced the Federal involvement in environmental issues and simultaneously cut federal grants to states, which had supported local pollution control efforts. A study by Pashigan (1985) found that northern US states benefited from Federal air regulations, while another study by Crandall (1983) argued that these same states were not in favour of Reagan's policy of environmental decentralization in the eighties (cited in Millimet, 2000). Millimet (2000) further reviewed a study by List and Gerking (2000) using the state level data of US and found that the shift in the environmental policy under Reagan has not resulted in 'race

to bottom' in 1980s. This study estimated a fixed effects model for the determination of environmental quality and abatement expenditure in the pre- and post-decentralized environmental regime in the context of US. Millimet (2000) provided further assessment of the impact of Reagan's policy of environmental decentralization of eighties; using panel data from US states on nitrogen oxide and sulphur dioxide emissions from 1929-1994 and per capita pollution abatement and control expenditures (PACE) and PACE per unit of manufacturing output.

Millimet (2000) model provides a methodological improvement over the study done by List and Gerking (2000). He performed Chow tests to test for structural breaks in data; and the tests reject pooling of the data prior to and after Reagan's policy of environmental decentralization. Millimet (2000) further estimated the effect of Reagan's decentralized environmental policy on emission levels and abatement expenditure through simulation. By projecting environmental quality using data prior to Reagan's policy shift and comparing the predicted levels with actual levels showed no consistent evidence for 'race to bottom' as the environmental quality did not deteriorate with Reagan's policy shift. The model specification of Millimet can be compared to the models specified to test for environmental Kuznets curve[11]. The overwhelming conclusion from his study is that environmental quality yields no statistically significant negative impact of environmental decentralization.

Another set of studies addressed the question of devolution of environmental regulations in a *cost-benefit analytical framework*. These studies are mostly *case studies*, which illustrates the cost and benefits of environmental devolution. For instance, a study by Kerry et al (1997) evaluated how environmental devolution affects the development of benefit cost analyses for regulations and the role of economic versus environmental factors in defining the extent of the regulatory market, using a case of nutrient control for the Neuse River in California.

[11] Kuznets curve in environmental economics depicts the relationship between environmental quality and economic development. See for details, Grossman and Kruger (1995).

The review of theoretical and empirical literature on fiscal stance and environmental quality based on tax-side and interjurisdictional competition throws that the studies have been highly inconclusive and partial. Yet another limitation is that the existing studies on environmental federalism is heavily skewed towards the discussion *on environmental regulations* in the economics of federalism and ignores the fiscal policies to a great extent.

The 'race to the bottom' issues addressed in the context of environmental federalism also heavily ignores the fiscal variables. The determinants of environmental quality in the context of economics of federalism have not been evolved perfectly under these studies. In the theoretical literature, economic development, population and public policy stance including fiscal policies have been the major determinants of environmental quality. The studies is meager in literature, which analyses the link between environmental quality and the supply of public services, generally it is widely ignored in the literature. This paper is an attempt, which belongs to this category. In the studies on economic-environment relationships, studies have covered inverted U-shaped relation between environmental degradation and percapita gross domestic product (Grossman and Kruger, 1995; Seldon and Song, 1994, Shafik, 1994; Cropper and Griffiths, 1994, Suri and Chapman, 1998).

The paper attempts to analyse the link between fiscal policy stance and environmental quality in a model specification, which can be compared to Kuznets U specification, incorporating the determinants of environmental quality such as economic growth along with the fiscal variable.

## IV: Interpreting Data with Special Reference to Forestry Sector

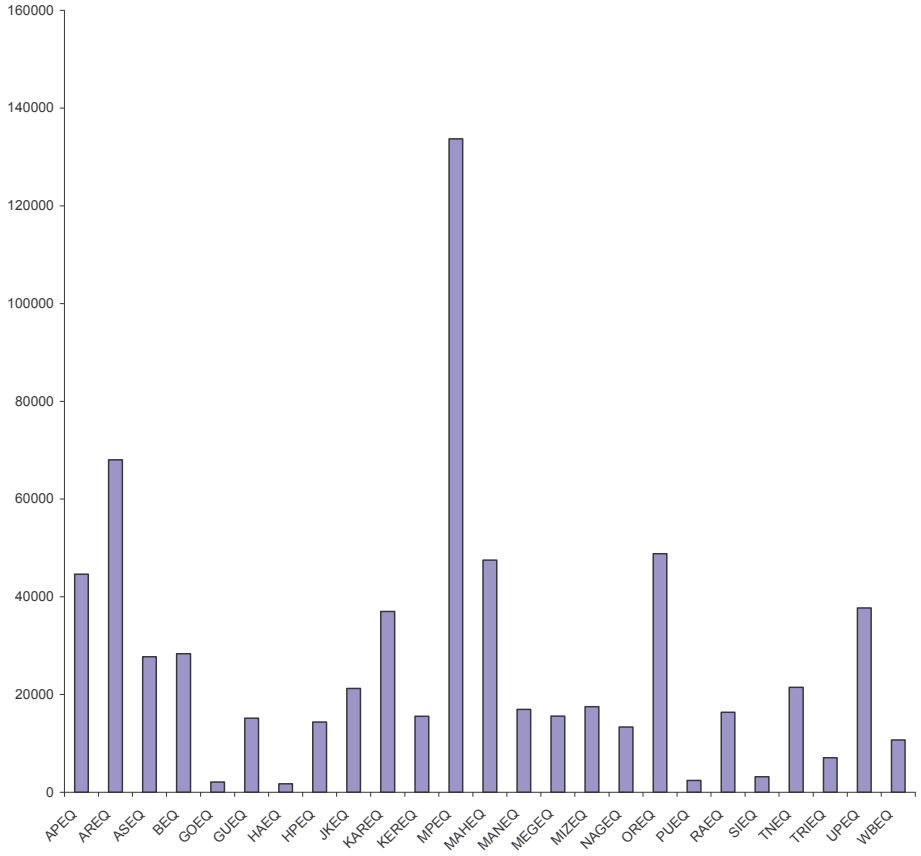
Data for the study has been taken from the Statistical Abstract of India, subnational budget documents compiled by Reserve Bank of India and Central Statistical Organization. The environmental variable across 25 States have been culled out from Statistical Abstract, the revenue and capital expenditure figures allocated for environment across subnational governments are compiled from various issues of RBI State Finances; while data on

population and revised series of gross state domestic product (GSDP) across 25 States have been given by Central Statistical Organization.

Environmental quality indicators encompass not only water and air, but significantly forest too. Ideally the link between fiscal stance and environmental quality has to be analyzed for water, air and forest either through constructing a composite indicator with appropriate weights to these three elements across subnational governments or through analyzing these through three separate element-specific models. This paper attempt only the link between fiscal stance and aspects of deforestation due to data constraints of lack of transparent budget heads in the documents on the budgetary allocation relates to containing air and water pollution at the decentralized levels of governance.

Yet another point to be noted is that Government of India has been concentrating on efforts to increase forest cover through reforestation and considerable expenditure has been allocated across State governments to meet this commitment. It is noted that India's forests are in a devastated condition, with less than 18 per cent of India under forest cover in 1997 and to ensure ecological stability, 30 per cent of the nation should be under adequate forest cover. The figure 1 provides the interstate differences in the net forest cover in India; which revealed that Haryana has the least forest cover and Madhya Pradesh has the highest forest cover.

**Figure 1: Net Forest Cover Across States in India**




In this context, an impending digression is taken to explain the significance of budgetary allocation for reforestation in India, before going into the econometric estimation of analysing whether the public spending on reforestation is translated into better environmental quality indicators across 25 States in India. Forests have traditionally been grown for timber, pulpwood and other wood products, but they also provide a range of environmental benefits such as soil protection and improved biodiversity, if compared with improved pasture. A market is now developing for another environmental benefit. This benefit is the capture of carbon dioxide. This new role of forests capturing carbon dioxide is also known as *'carbon sequestration'*. Forest growers could potentially receive income from their trees capturing such greenhouse gases, but this is dependent on a market developing for 'carbon credits'. As governments work to reduce greenhouse gas emissions

and to expand the use of greenhouse sinks such as increasing the forest cover, such actions can be registered as credits.

*Carbon credits* (often referred to as Offsets) are emission reductions that an emitter has achieved in excess of any required reductions. The excess amount is the credit and can be sold on the market[12]. *Carbon trading* deals in forestry is a new concept which gained attention after the Kyoto protocol, 1997, by which all countries are required to reduce their greenhouse gas emissions by 5% - from 1990 level s- in the next ten years, i.e. 2012 - or pay a price (carbon credits) to those that do. The Convention on Climate Change negotiated at the Rio Earth Summit in 1992 also recognized the need for target levels to reduce greenhouse gas emissions world wide[13].

Ropert (1997) discussed the link between macroeconomic policies and deforestation in detail, especially how macroeconomic policies have pervasive influences on the use and conservation of forest resources. However he further noted that there exist no macroeconomic models or analytical frameworks that effectively link forest exploitation and forestland conversion to the array of sectoral and macroeconomic (mainly fiscal and trade policies) policies.

[12] The amount of carbon captured by trees is estimated from the volume of the trees, calculated from the heights and diameters. The tree volume is then converted to tonnes of dry wood. The weight of dry wood is then divided into the weight of carbon and other elements such as hydrogen and oxygen. For example, a fast-growing eucalypt plantation averaging a stem growth rate of 20 cubic metres of wood per hectare may yield 500kg of dry wood per cubic metre, that is 10 tonnes per hectare and contain 50 per cent carbon, that is 5 tonnes per hectare of carbon in one year.

[13] This discussion is drawn from http://www.emissierechten.nl/climate_change__monitoring_inter.htm http://www.co2e.com/carbon/carbon_credits_trading.htm and http://www.newcrops.uq.edu.au/

## V: Specification of Model and Interpretation of Results

The methodology adopted for the study is panel analysis across 25 States of India to analyse the link between fiscal expenditure and environmental quality in a specification inclusive of quadratic of per capita GSDP. This model specification is able to test the hypothesis of whether economic growth or public policy stance has greater impact on environmental quality as well as the hypothesis of U-phenomenon discussed by Kuznets. The model specification is expressed as follows.

$$eq_{it} = \alpha + \beta_1 \, pubexp_{it} + \beta_2 \, pci_{it} + \beta 3 \, pci^2_{it} + \mu_{it}$$

| | |
|---|---|
| $eq_{it}$ | = environmental quality indicator. |
| $pubexp_{it}$ | = subnational public expenditure on environment |
| $pci_{it}$ | = per capita GSDP |
| $pci^2_{it}$ | = squared term of per capita GSDP, which explains U |
| $\mu_{it}$ | = surrogate of omitted explanatory variables |

Using panel data for late nineties across 25 States in India, two models have been attempted in the paper. Model 1 is the generalized least square method of assuming cross section intercept as same for all 25 States and Model 2 is a fixed effects model which allows to differ across cross-section units by estimating different constants for each cross-section through computing the fixed effects by subtracting the "within" mean from each variable and estimating OLS using the transformed data.

The results of Model 1 and 2 are discussed as follows.

Model 1

$eq_{it} = 431.13 + 7.622\ pubexp_{it} - 0.053\ pci_{it} + 6.95E\text{-}07\ pci^2_{it}$

[5.483581] [ 13.51527] [-7.34291] [4.755737]

$R^2 = 0.63$

DW = 0.16

In model 1, the environmental quality is proxied by net forest cover is significantly determined by fiscal policy stance and economic growth. It is found that U-curve is operating across 25 State in India that per capita economic growth initially decreases and then increases the forestration. The results also showed that the coefficient of fiscal policy stance, in terms of public expenditure across subnational governments on forest, has more impact than the quadratic term of economic growth.

The link between economic and environmental variables is also estimated in Fixed Effects Model (model 2), where State-level specificities are taken into consideration. In this model, we estimate a simple linear model as follows:

$y_{it} = \alpha + x_{it}\beta + u_{it}$

for $i = 1, 2, \cdots, N$ and $t = 1, 2, \cdots, T$

$y_{it}$ = environmental quality variable for province $i$ in period $t$.

$x_{it}$ = vector of exogenous variables, viz. fiscal policy stance variable, economic growth variable including the U-term for province $i$ in period $t$.

Where $\alpha$ is a scalar and $\beta$ is a $K \times 1$ vector of coefficients to be estimated. For our sample $N = 25$ and $T = 4$ . Note that we assume that the coefficients are fixed and constant. For this model the ordinary least squares estimates will be consistent and efficient if $E(x'_{it}u_{it}) = 0$.

To take into consideration the possibility of heteroskedasticity and autocorrelation, models are adjusted for White Heteroskedasticity consistent standard errors and covariance; and also autocorrelation is allowed for with panel specific AR (1) coefficients estimated. Given the spatial diversity among provinces, a more realistic model is one with fixed effects. Specifically, we postulate that;

$u_{it} = \mu_i + v_t$ for $i = 1, 2, \cdots, N$ and $t = 1, 2, \cdots, T$

Where $\mu_i$ is the province specific unobserved fixed effect. The standard assumptions of the model are:

1. $v_{it} \sim IID(0, \sigma^2)$ and

2. $x_{it}$ is independent of $v_{it}$ for all $i$ and $t$.

To estimate this model we use the *within* estimator:

$\hat{\beta} = (X'QX)^{-1} X'Q_y$

Where Q is a transformation, that subtracts the time mean for all provinces from each observation. For example $Q_y$ has the typical element $(y_it-y_{i.})$, where $y_{i.}$ refers to the mean of $y$ for province $i$ over all time periods.

The results that signify the impact of fiscal policy stance on environmental quality remain positive and significant in the Fixed Model and U-curve is also operating when the State-specific intercepts were incorporated in the Model. In other words, the results showed that as economic growth increases, environmental quality decreases and then increases. The results are given in Table 1.

**Table 1: Fixed Effects Model with White Heteroskedasticity-Consistent Standard Errors & Covariance (Model 2)**

| Variable | Coefficient | t-Statistic |
|---|---|---|
| fiscal policy stance | 0.019565 | 1.820578 |
| economic growth | -0.000597 | -1.444439 |
| squared term of eco-growth | 2.23E-08 | 2.483425 |
| Fixed Effects | | |
| AP--C | 42.99161 | |
| AR--C | 6506.267 | |
| AS--C | 88.20330 | |
| B--C | 30.94294 | |
| GO--C | 26.61638 | |
| GU--C | 4.742456 | |
| HA--C | -21.91400 | |
| HP--C | 209.1892 | |
| JK--C | 205.4892 | |
| KAR--C | 48.26217 | |
| KER--C | 18.27774 | |
| MP--C | 219.0202 | |
| MAH--C | 20.17486 | |
| MAN--C | 751.8438 | |
| MEG--C | 699.6323 | |
| MIZ--C | 2123.500 | |
| NAG--C | 772.0691 | |
| OR--C | 124.6784 | |
| PU--C | -22.91858 | |
| RA--C | 14.43845 | |
| SI--C | 612.8075 | |
| TN--C | 8.326364 | |
| TRI--C | 181.4545 | |
| UP--C | 13.83630 | |
| WB--C | -3.688249 | |

R2 = 0.99; DW = 1.56

The results from Model 1 and 2 reinforces that fiscal policy stance has significant impact on environmental quality relative to the negative impacts of economic growth across 25 States in India. The results suggest the government intervention through increasing budgetary allocation for reforestration measures, especially in the context of market failures arising from the macroeconomic policy related impacts of population, technological development and in turn economic growth, especially at the decentralized units of governance.

## VI. Conclusion

The paper examines the impact of fiscal policy stance on environmental quality at 25 subnational government levels in India. Using GSLS and fixed effects model of pooled least squares for the late 1990s, the analysis of the link between per capita public expenditure on environment and environmental quality for the forest sector revealed that there is a positive functional relationship between the variables. This result emphasizes on the fiscal policy stance, in terms of public expenditure on environmental capital formation in enhancing environmental quality across subnational governments in India.

The Fixed Effects model also revealed the effectiveness of economic growth in terms of per capita income at subnational levels in creating the Kuznet's U effect on environmental quality. The panel estimates confined to the forestry sector showed that fiscal expenditure has a stronger impact on environmental quality than the squared term of per capita income, which signifies the Kuznets U-impact. The GSLS results translated that one per cent increase in fiscal expenditure on environment improves the quality of environment by 7.6 percentage points at Provincial level in India. This result is in confirmation with the trend that fiscal policies on environmental capital formation gets transformed to the end results of better environmental quality indicators, despite the constraints of initial negative impacts of economic growth on ecology.

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