Income and Environmental Performance across Indian States and Union Territories: A Regression Analysis

Rakesh Saxena
Institute of Rural Management,
Anand-388001 (Gujarat) India

Outline

1. Introduction
2. Methodology
3. Income and Environmental Performance
4. Income and Inequity
5. Income and poverty ratio
6. Conclusion

1. Introduction

- India is a lower middle income country. It consists of 29 States and 7 UTs. There is large divergence in economic and environmental performance across these States and UTs.
- For the year 2012-13, the average per capita income of India was Rs. 38,856 at constant 2004-05 prices. It varied from Rs. 14,904 in Bihar to Rs. 145,923 in Goa.

- The Environmental Performance Index by the Planning Commission of India was estimated as 0.5773 (EPI-PC) for 2012. It varied from 0.2925 in Lakshadweep (UT) to 0.7696 in Andhra Pradesh.
- As per data available for 2011-12, 21.92% of the people in India lived below Poverty Line. This ratio varied from one percent in A & N Islands (UT) to 39.93% in Chhattisgarh.

- For 2011-12, the Gini Coefficients for rural and urban areas were estimated as 0.2803 and 0.3673, respectively. For rural areas, it varied from 0.1723 in Meghalaya to 0.3345 in Arunachal Pradesh. For urban areas, it varied from 0.1980 in Sikkim to 0.4063 in Karnataka.
- This study explores a relationship between income and environmental performance across different States and UTs of India. Two associated dimensions of income, namely, inequity and poverty, have also been analysed in this context.

2. Methodology

- A regression analysis has been done by using the cross section data across different States and UTs to find out the relationship of income with environmental performance, inequity and poverty.
- Different variables have been defined as follows.
- Income
  - Per Capita Net State Domestic Product for 2012-13 at constant prices (2004-05).

- Environmental Performance
  - Environmental Performance Index and its Sub-Indicators for 2012 as measured by Chandrasekharan *et al*. (2013).
  - As the EPI was calculated for the Planning Commission of India, it has been referred to as PC-EPI.

Indrani Chandrasekharan, R. Sendhil Kumar, Seena Raghunathan and Shweta Chandrasekharan (2013), Construction of Environmental Performance Index and Ranking of States, *Current Science*, Vol. 104, No. 4, 25 February.

- PC-EPI is the simple average of the following five sub-indices: (1) air quality, (2) water quality, (3) forest performance, (4) waste management, and (5) climate change. These sub-indices are based on 16 indicators. The value of each indicator varies between zero and one.

  1. Air quality:

     Average score of 3 indicators given below; individual score of each indicator is based on distance from national air quality standards; the indicators that meet the national standards are given a score of 1.

     1.1 SO_2 (50 µg/m^3)

     1.2 NO_2 (40 µg/m^3)

     1.3 RSPM - Respirable Suspended Particulate Matter (60 µg/m^3)

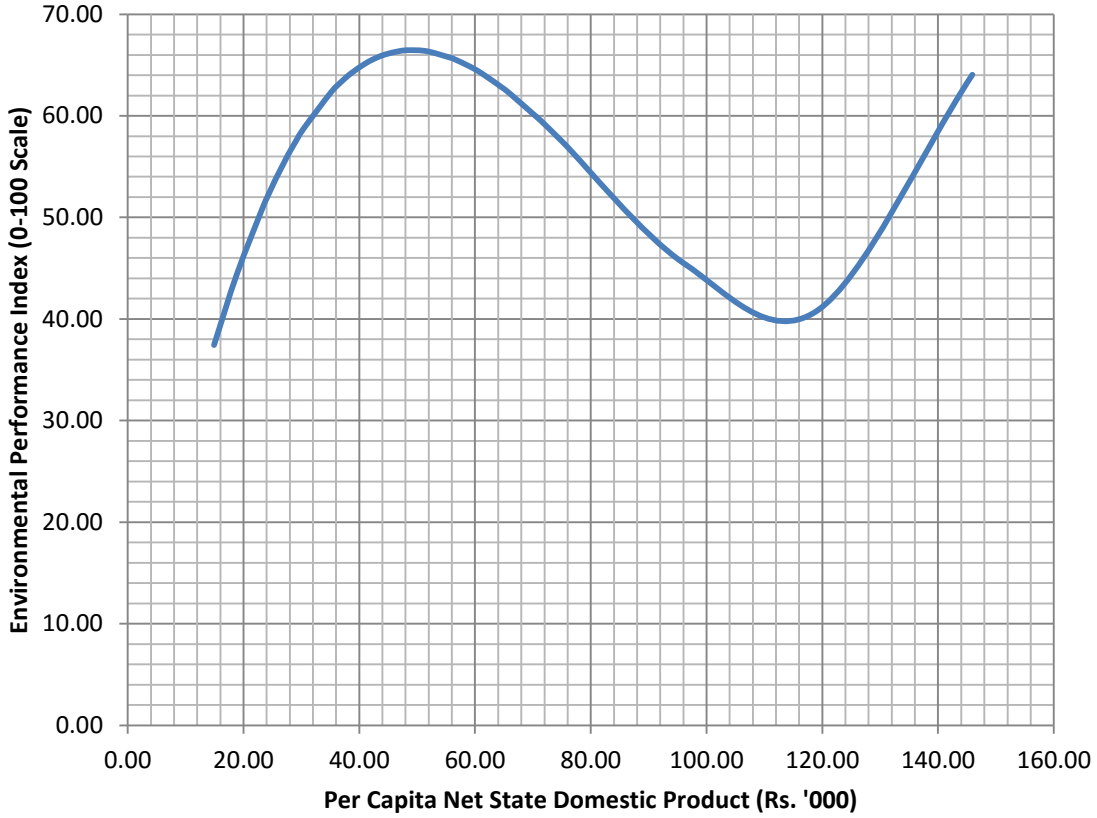
2. Water Quality:
    2.1 Sewage disposal (% treatment capacity for sewage)
    2.2 Water quality of rivers – Standards for dissolved oxygen and total coliform count
    2.3 % of groundwater extraction
3. Forest Performance:
    3.1 Total forest cover as % of geographical area and contribution to the national average
    3.2 % increase or decrease during 2003-09
    3.3 % change in growing stock during 2009-12
    3.4 Yearly average afforestation effort during 2009-12

4. Waste Management:
   - 4.1 Municipal solid waste (MSW) collection efficiency
   - 4.2 Treatment and disposal capacity for MSW
   - 4.3 Capacity set up for treatment of hazardous waste and biomedical waste
5. Climate Change:
   - 5.1 Availability of State Action Plan for Climate Change (SAPCC)
   - 5.2 Renewable energy growth rate including small hydro
   - 5.3 Electricity intensity of State Gross Domestic Product (SGDP)

- Inequity
  - Gini Coefficients estimated for rural and urban areas for 2011-12 by the GOI.
- Poverty
  - % of people living below poverty line for 2011-12 as estimated by the GOI.

3. Income and Environmental Performance

- Third degree polynomial equation is estimated as the best fit equation based on R^2 and the significance of the coefficients.
  - $EPI = 3.15301\ I - 0.04579\ I^2 + 0.00019\ I^3$
  - N= 32
  - $R^2 = 96.44\%$
  - Level of significance of coefficients = 0.005
  - EPI is shifted to 0-100 scale
  - I is measured in Rs. ‘000



EPI across Indian States and UTs as per their Per Capita Income, 2012

Third degree polynomial equation:

EPI = 3.15301 I – 0.04579 I^2 + 0.00019 I^3, N=32, R^2 = 96.44%, α = 0.005

EPI = Environmental Performance Index of a State/UT for 2012 (Scale: 0 to 100)

I = Per Capita Net State Domestic Product for 2011-12 at 2004-05 prices (Rs. '000)

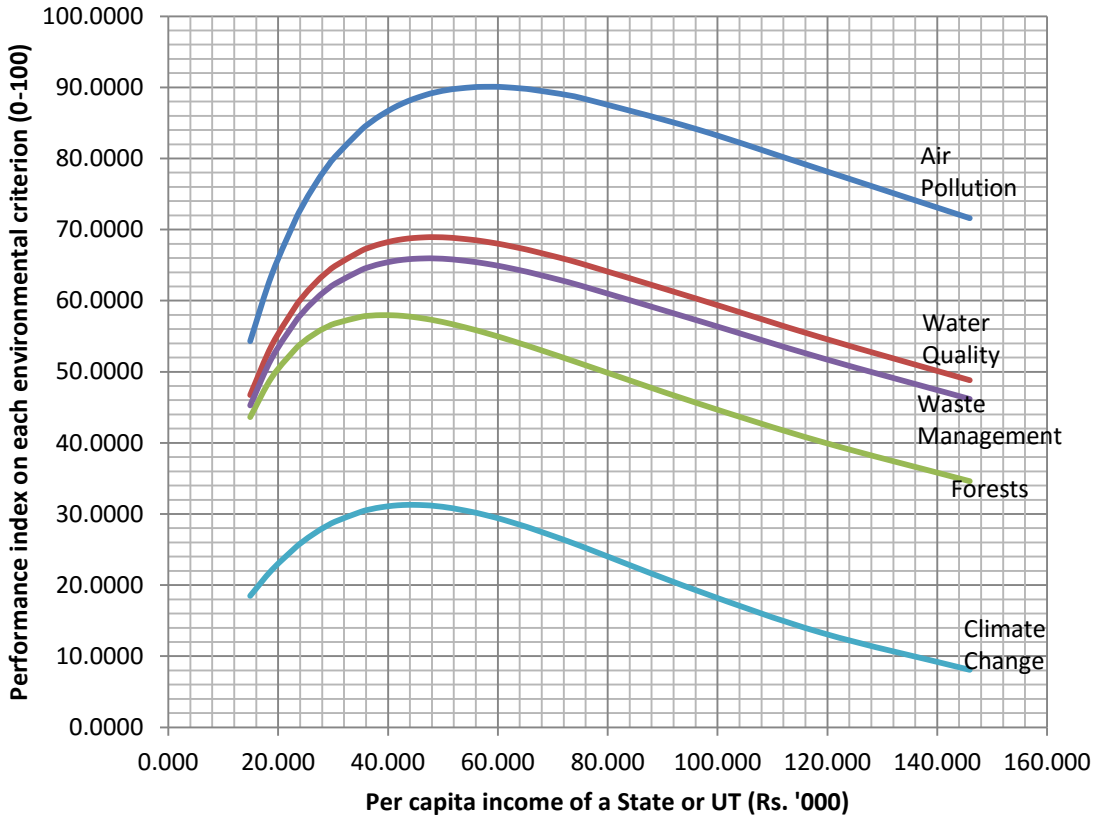
Turning Points of PC-EPI-2012 with respect to Per Capita Income

Turning Point	PCNSDP (Rs. '000)	EPI-2012
First	49.2049	66.4707
Second	114.6103	40.3982

- Environmental performance shows a wave like relationship with income.
  - Close to 60% of the States and UTs located at the lower end of the income show improvement in environmental performance with a rise in per capita income from one State/UT to another.
  - Next 34% of the States and UTs located in the middle with respect to per capita income show lower environmental performance for rise in income.
  - Remaining 6% States and UTs located at the higher end of per capita income show an improvement in environmental performance with a rise in income.

Sub-Indices of PC-EPI and Income

Criteria (Y)	Functional Form (X = PCNSDP)	N	β	γ	α_β	α_γ	R^2
1. Air Quality	$\ln y = \beta \ln x + \gamma (\ln x)^2$	31	2.21456	- 0.27241	0.005	0.005	99.75
2. Forests	$\ln y = \beta \ln x + \gamma (\ln x)^2$	32	2.21022	- 0.30081	0.005	0.005	99.19
3. Water Quality	$\ln y = \beta \ln x + \gamma (\ln x)^2$	32	2.18412	- 0.28173	0.005	0.005	99.63
4. Waste Management	$\ln y = \beta \ln x + \gamma (\ln x)^2$	30	2.17173	- 0.28148	0.005	0.005	99.35
5. Climate Change	$y = x^\beta e^{\gamma x}$	32	1.23294	- 0.02778	0.005	0.005	94.28

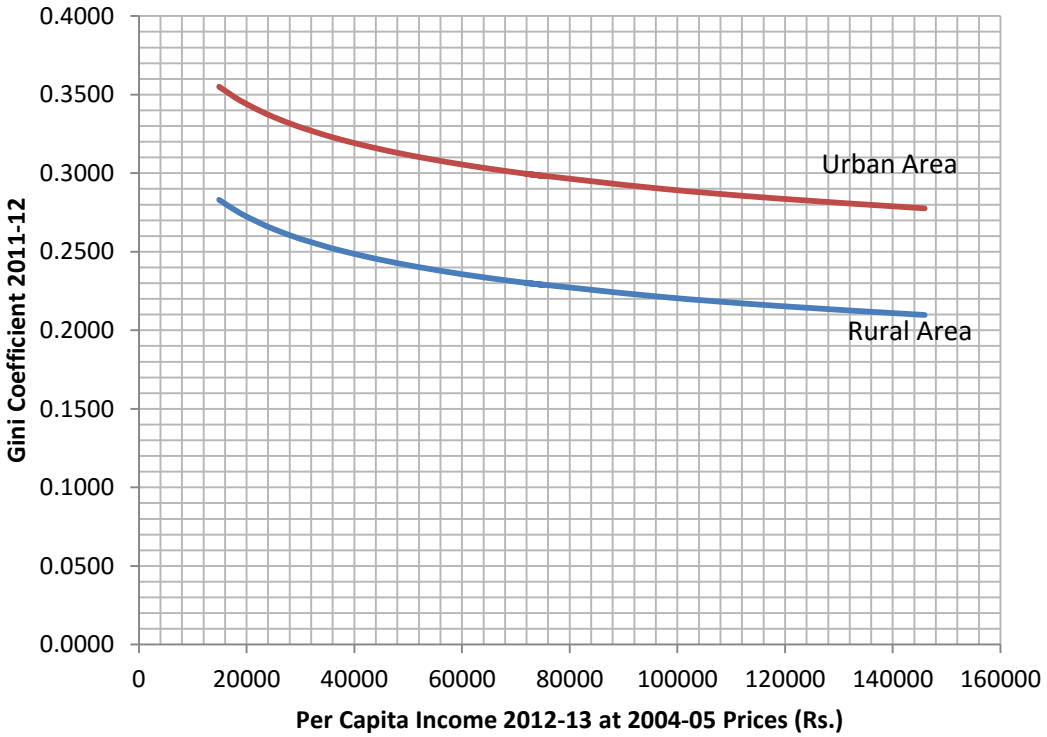


Performance Index on Each Environmental Criterion and Per Capita Income

- All individual sub-indices of EPI show inverted U-shape curves with respect to rise in income from one State/UT to another. The curves are much flatter in the second half.
- For any given per capita income, the order of performance (highest to lowest) by the sub-indices is as follows: 1. Air quality, 2. Water quality, 3. Waste management, 4. Forests, and 5. Climate change.

4. Income and Inequity

- For a relationship between per capita income and Gini Coefficients, the log linear equations are estimated as the best fit equations.
- For Rural Areas:
  - $\ln (Y) = -0.13134 \ln (X)$ or $Y = X^{-0.13134}$
  - Y = Gini coefficient for rural areas of a State or UT
  - X = Per capita income (NSDP) of a State or UT (Rs.)
  - $R^2 = 98.17\%$, N = 32, Level of significance = 0.005
- For Urban Areas:
  - $\ln (Y) = -0.10777 \ln (X)$ or $Y = X^{-0.10777}$
  - $R^2 = 97.04\%$, N = 32, Level of significance = 0.005



Income Inequality and Per Capita Income across States and UTs

Log-linear equation: $\ln (Y_R) = -0.13134 \ln (X)$, $\ln (Y_U) = -0.10777 \ln (X)$

Y = Gini coefficient for rural/urban areas of a State or UT for 2011-12

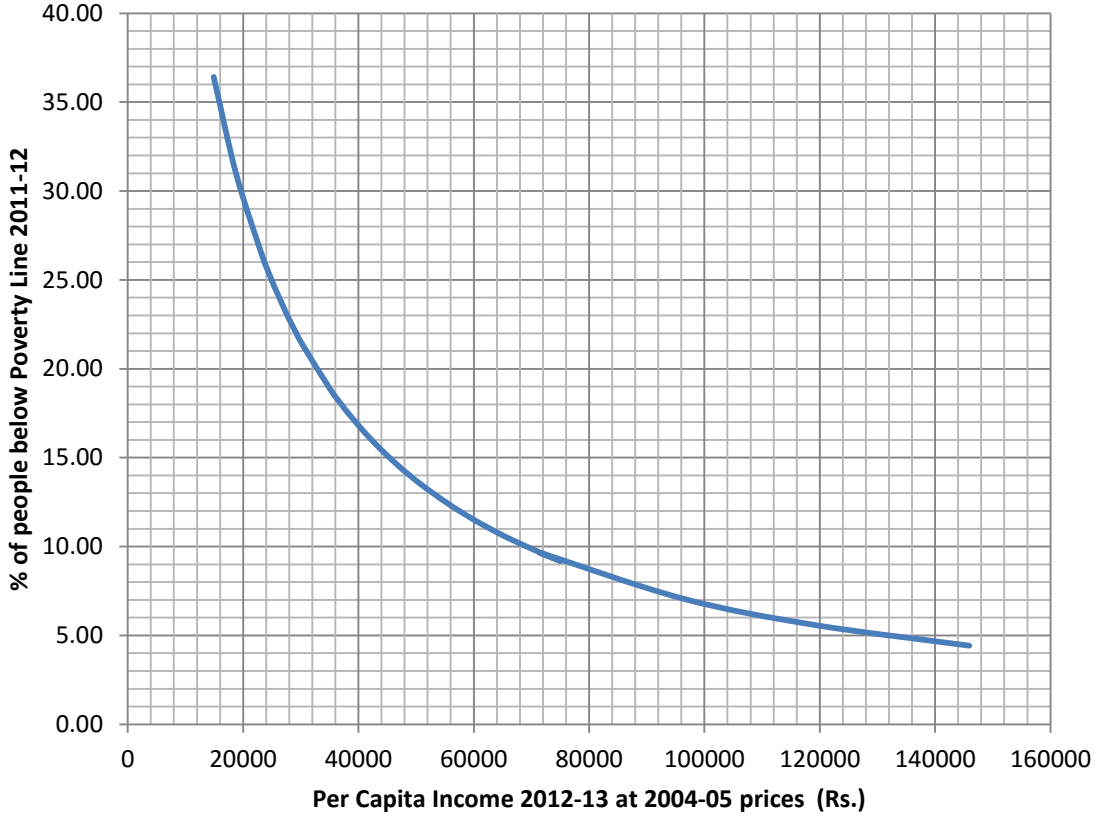
X = Per capita income (NSDP) of a State or UT for 2012-13 at 2004-05 prices (Rs.)

R^2 (R) = 98.17%, R^2 (U) = 97.04% N = 32, $\alpha = 0.005$

- Income inequalities are higher in urban areas than in rural areas for any given level of income.
- Income inequality reduces with a rise in per capita income from one State/UT to another in both rural and urban areas, at a decreasing rate.

5. Income and BPL Population

- For a relationship between income and poverty levels, the log quadratic equation has been estimated as the best fit equation.
- $\ln Y = 1.4232 (\ln X) – 0.10917 (\ln X)^2$
- Y = Percentage of people below poverty line in a State or UT
- X = Per capita income (NSDP) of a State or UT (Rs.)
- $R^2 = 95.78\%$, N = 32
- Level of significance= 0.005



People below Poverty Line and Per Capita Income across States and UTs

Log-quadratic equation: $\ln Y = 1.4232 (\ln X) - 0.10917 (\ln X)^2$

Y = Percentage of people below poverty line in a State or UT in 2011-12

X = Per capita income (NSDP) of a State or UT for 2012-13 (Rs.)

$R^2 = 95.78\%$, N = 32, $SE_1 = 0.20346$, $SE_2 = 0.01891$, $t_1 = 6.9950$, $t_2 = 5.7723$, $\alpha = 0.005$

- The percentage of people living below poverty line declines with a rise in per capita income from one State/UT to another. It reduces very fast in low income zone and at a declining rate thereafter.

6. Conclusion

- It seems that India has a good scope not only for improving both income and environmental performance together but also lowering income inequalities and poverty levels at the same time. It needs to follow a discreet approach across its States and UTs.
- Further studies are required to identify the factors that cause deterioration of EPI after a certain level of income to reverse this trend.

THANKS