

**Relationship between
environment degradation (emission of SO_2
& NO_2) and Social Inequality**

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ENVIRONMENT KUZNETS CURVE

Grossman and Krueger (1995) ,discovered an inverted-U shaped relationship between per-capita income and environmental degradation.
(Grossman & Krueger, 1995)

The effect of income on environment can be seen by three kinds of effect:

- **Scale effect:** If pollution per unit income is a fixed coefficient, it is a scale effect. This means higher income directly leads to environmental degradation.

ENVIRONMENT KUZNETS CURVE

- **Composition effect:** If the rise in domestic product is due to less pollution intensive sectors, such as service sector, the level of environment degradation reduces, it is referred to as Composition Effect.
- **Technological effect:** If the development of pollution-reducing innovations reduces the overall environmental pollution, although domestic product rises, it is referred to as Technological Effect.

SOCIAL INEQUALITY AND POLLUTION

- Princen, 1997 in his paper highlights, consumers of goods and services produced from pollution intensive industries are different from bearers of impact from these industries. (*Princen, 1997*)
- Pollution- reducing technologies require political approval for implementation.
- Similarly, every factory has to be registered and approved by political authorities.
- Pollution intensive factories are outsourced to lower income states.
- Individual demands of environment quality rise with increase in income. (*Vornovytsky & Boyce, n.d.*)

SIGNIFICANCE

- Sulphur and nitrogen dioxide are harmful life threatening gases.
- Most papers highlight political rights and literacy as power inequality variables. (*Torras & Boyce, n.d.*)
- However, the results of policies, i.e., the target achieved is not highlighted.
- Hence, it is understood that income and power inequality variables are both relevant for environment degradation. (*Laurent, n.d.*)

Dependent Variables

- **S02:**
 - Caused by:
 - Burning coal and oil
 - Power plants
- **N02:**
 - Caused by:
 - Burning of fossil fuels
 - Motor vehicles such as cars, trucks etc

INDEPENDENT VARIABLES

Income Inequality

- State Domestic Product:
 - The per capita domestic product of each state.
 - **Micro Level :** Individuals have more access to pollution intensive resources.
 - **Macro Level:** Increase in number of industries
- **GINI :**
 - Distribution of income or wealth over the citizens of the state.
 - How many people incur benefit from pollution-intensive activities while how many bear the cost of the same.

INDEPENDENT VARIABLES

Power Inequality

- **Target achieved by policies:**
 - Percentage of target achieved by **Special Central Assistance** to distribute funds to SC families.
 - **Special Central Assistance:**
 - Central scheme under which 100% grant is given to the States/UTs as an additive to their Scheduled Castes Sub Plan (SCSP).
 - The **main objective** is to give a thrust to family oriented schemes of economic development of SCs below the poverty line, **by providing resources for filling the critical gaps**.
 - Better target achieved, more access to resources, hence, less power inequality, leading low levels of SO₂ and NO₂.

INDEPENDENT VARIABLES

Power Inequality

- **Margin of Win:**
 - Margin by which the ruling party won in each state.
 - High win margin, less pressure from opposition to make policies for environment, hence, high power inequality, high pollution.

INDEPENDENT VARIABLES

Control Variables

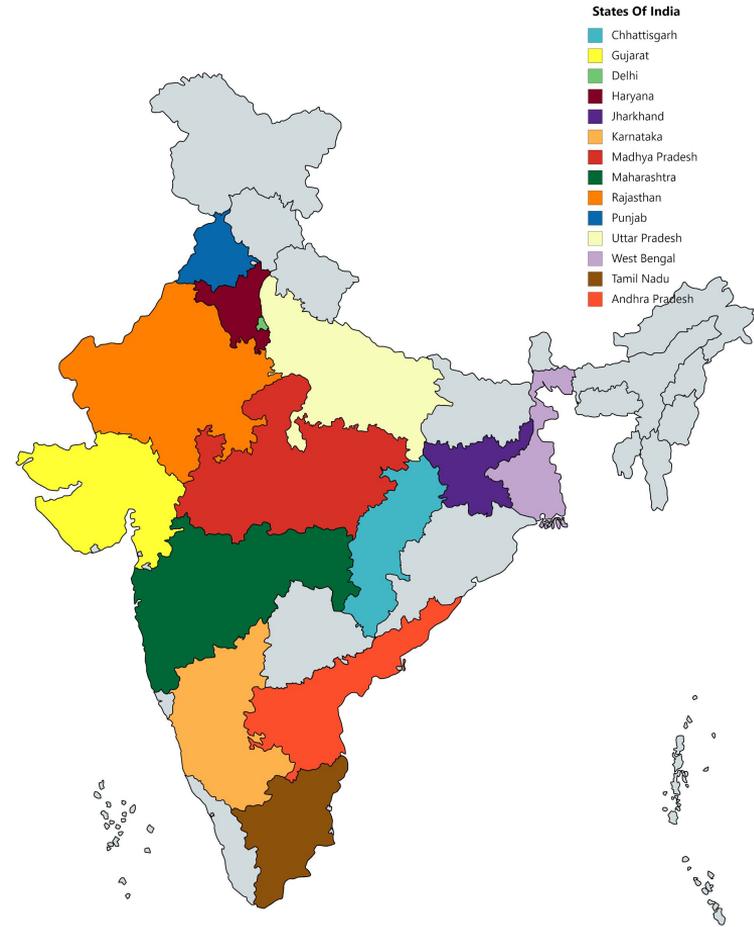
- **Share of manufacturing sector:**
 - The ratio of manufacturing sector in overall SDP of the state.
 - Higher the contribution of manufacturing sector, higher production of goods, more the pollution
- **Number of motor vehicles:**
 - The number of registered motor vehicles in each state.
 - More the motor vehicles, higher emission of NO₂.

VARIABLES AND DESCRIPTION

Variable	Description	Acronym
Income level	SDP: Per capita tate domestics Product	sdp
Income square	squared SDP	sdp2
Income Cube	cubic SDP	sdp3
Income Inequality	GINI Index	GINI

Variable	Description	Acronym
Margin of election victory	The win -margin in state elections of govt formed.	elections
Percentage of target of assistance achieved	Percentage of target achieved to provide assistance under SCA funds	fam_assisted
Manufacturing	Ratio of sdp of manufacturing sector to State domestic product	Manufacturing
motors	log of number of registered motor vehicles	lmotor

DATASET-STATES



DATA SUMMARY

Variable acronym	N	mean	Median	Std.Dev	Max	Min
so2	84	9.971	10.117	4.60	23.33	2.00
no2	84	23.68	20.07	12.98	66.78	2.00
sdp	84	74246	65637	39061.3	18.83	23122
sdp2	84	7.0e+09	4.3e+09	8.2e+08	4.9e+10	5.3e+08
sdp3	84	8.2e+14	2.8e+14	1.6+e15	1.0e+16	1.2e+13
GINI	84	5.86	5.85	0.026	5.90	5.79

Dataset: 84 points of 14 states and 6 years

DATA SUMMARY

Variable acronym	N	mean	Median	Std.Dev	Max	Min
elections	14	0.38	0.29	0.19	0.84	0.20
targetfam	84	132.0	109.0	20.97	303.0	15.54
lmotor	84	8.94	8.93	1.45	12.06	6.44
manufacture	84	0.14	0.14	0.053	0.93	0.29

REGRESSION MODEL

SO₂:-

$$so2_i = \beta_0 + \beta_1 sdp_{i,1} + \beta_2 sdp2_{i,2} + \beta_3 sdp3_{i,3} + \beta_4 gini_{i,4} + \beta_5 manufacturing_{i,5} + \beta_6 election_{i,6} + \beta_7 targetfam_{i,7} + \varepsilon_i$$

NO₂:-

$$no2_i = \beta_0 + \beta_1 sdp_{i,1} + \beta_2 sdp2_{i,2} + \beta_3 sdp3_{i,3} + \beta_4 gini_{i,4} + \beta_5 lmot_{i,5} + \beta_6 election_{i,6} + \beta_7 targetfam_{i,7} + \varepsilon_i$$

RELEVANT HYPOTHESES

Income Inequality:

- ***Income per capita:***

H_0 : SDP per capita follows the EKC. This means: $\beta_1 > 0$ and $\beta_2 < 0$

H_a : SDP does not follow EKC. That is: $\beta_1 < 0$ or $\beta_2 > 0$

- ***GINI coefficient:***

H_0 : $\beta_4 = 0$

H_a : $\beta_4 > 0$

RELEVANT HYPOTHESES

Power Inequality:

- *Margin of election victory*

$$H_o : \beta_6 = 0$$

$$H_a : \beta_6 > 0$$

- *Percentage of target of assistance achieved*

$$H_o : \beta_7 = 0$$

$$H_a : \beta_7 < 0$$

RELEVANT HYPOTHESES

Control Variables:

- *Share of manufacturing sector: (SO2)*

$$H_o : \beta_5 = 0$$

$$H_a : \beta_5 > 0$$

- *Number of motor vehicles:(NO2)*

$$H_o : \beta_5 = 0$$

$$H_a : \beta_5 > 0$$

REGRESSION RESULTS: SO₂

The significance level with which a hypothesis is accepted, is 0.05.

Independent variables	Estimate	Std. error	t-value	P-value
<i>intercept</i>	9.563e+00	5.872e+00	1.629	0.1079

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ''

REGRESSION RESULTS: SO₂

Independent variables	Estimate	Std. error	t-value	P-value
sdp	-3.047e-04	1.105e-04	-2.759	0.24
sdp2	2.513e-09	1.103e-09	2.277	0.074
sdp3	-6.176e-15	3.212e-15	-1.923	0.0586

- *Since p -values for both sdp and sdp2 are not significant, we fail to reject the Null Hypotheses. Hence, We cannot comment on EKC.*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ''

REGRESSION RESULTS: SO₂

Independent variables	Estimate	Std. error	t-value	P-value
gini	-5.79e+00	1.510e+01	-0.384	0.7024

- *Since, The p-value is not significant (~1) we fail to reject the null .Hence ,we cannot conclude results for gini index.*

REGRESSION RESULTS: SO₂

Independent variables	Estimate	Std. error	t-value	P-value
manu_contr	4.918e+01	7.921e+00	6.209	3.33e-08***

- *Since the p-value is highly significant, we reject out Null Hypotheses. Moreover , since $\beta_5 > 0$ we accept our alternate hypotheses.*
- *This is true because more contribution of manufacturing sector to SDP would lead to higher pollution levels, and hence, SO₂.*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ''

REGRESSION RESULTS: SO₂

Independent variables	Estimate	Std. error	t-value	P-value
elections	3.694e+00	2.492e+00	1.482	0.01428*

- *Since , the p-value is significant (less than 0.05) , we reject our null hypotheses. Moreover, since $\beta_6 > 0$ we accept the alternate hypotheses.*
- *This is true because, higher the margin of victory of the ruling party, more is inequality of power among parties leading to higher levels of SO₂ in the environment.*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ''

REGRESSION RESULTS: SO₂

Independent variables	Estimate	Std. error	t-value	P-value
targetfam	-5.994e-04	3.081e-04	-1.945	0.0558 .

- *Since the p- value is not significant , we fail to reject the null. So, we cannot conclude about target of families assisted.*

REGRESSION RESULTS: SO₂

Multiple R-squared: 0.47

Adjusted R-squared: 0.422

F-statistic: 9.042 on 7 and 76 DF

p-value:6.699e-08

Residual standard error: 3.419

REGRESSION RESULTS: NO₂

The significance level with which a hypothesis is accepted, is 0.05.

Independent variables	Estimate	Std. error	t-value	P-value
<i>intercept</i>	2.20e+04	1.5e+04	-1.47	0.14

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

REGRESSION RESULTS: NO₂

Independent variables	Estimate	Std. error	t-value	P-value
sdp	-3.611e+03	2.598e+03	-1.39	0.17
sdp2	203.2	149.4	1.36	0.18
sdp3	-3.79	2.86	-1.32	0.19

Since p -values for both sdp and sdp2 are not significant, we fail to reject the Null Hypotheses. Hence, We cannot comment on EKC.

REGRESSION RESULTS: NO₂

Independent variables	Estimate	Std. error	t-value	P-value
gini	-91.99	47.63	-1.93	0.057 .

- *Since the p-value is not significant , we fail to reject the null.Hence, we cannot conclude anything about the gini index.*

REGRESSION RESULTS: NO₂

Independent variables	Estimate	Std. error	t-value	P-value
lmotor	26.94	3.694	7.29	2.44e-10 ***

- *Since the p-value is highly significant , we reject the Null Hypotheses. Moreover, Since, $\beta_5 > 0$ we accept the alternate hypotheses*
- *This is true because more the registered motor vehicles, higher would be emissions of NO2.*

REGRESSION RESULTS: NO₂

Independent variables	Estimate	Std. error	t-value	P-value
elections	31.89	10.66	2.99	0.00374 **

- *Since ,p-value is highly significant we reject the Null Hypotheses. Moreover, since $\beta_6 > 0$ we accept the alternate Hypotheses.*
- *This is true because, higher the margin of victory of the ruling party, more is inequality of power among parties leading to higher levels of SO₂ in the environment.*

REGRESSION RESULTS: NO₂

Independent variables	Estimate	Std. error	t-value	P-value
targetfam	2.980e-03	9.146e-04	3.26	0.00168 **

- *We are able to reject the null. However since $\beta_\gamma > 0$, we are not able to accept alternate hypotheses.*
- *Reason for the same could be, higher the access to resources and funds increases ability of people to purchase pollution intensive goods, leading to higher pollution levels.*

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

REGRESSION RESULTS: NO₂

Multiple R-squared: 0.4631 **Adjusted R-squared:** 0.4136

F-statistic: 9.364 on 7 and 76 DF ; **p-value:** 2.568e-08

Residual standard error: 9.944

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