Is inequality a significant factor in determining environmental degradation?

A comparative analysis between economic and (economic + social + political) factors.

- Group No. 10 -

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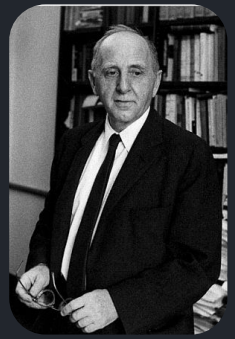
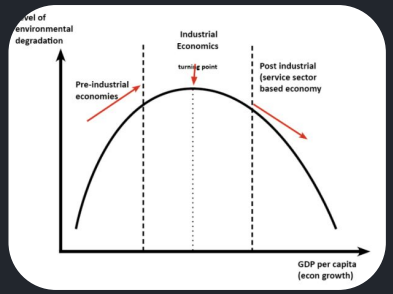
ABOUT THE PROJECT

Simon Kuznets, in the 1950s, advanced the hypothesis claiming that as the **average income** (per-capita income) of the inhabitants increases, so do the **environmental pollutants** (CO2, DDT, plastics, etc.).





The Kuznets Curve.

He projected that with a certain significant increase in the average income of the people, a **turning point** i.e. an increase in the environmental qualities also takes place.

Per-capita income levels of states alone cannot be of the environmental quality. We expect **other noteworthy factors** playing a role -- like literacy rates, economic inequality, industries, **political influence**, population, etc.

We aim to verify the validity of The Kuznets Curve with **Political Inequality** as a factor. We are **comparing the relation between Environmental Degradation vs Income Levels and Environmental Degradation vs Political Inequality(which includes income levels as well)**.

Political influence can be broadly understood as a "**power**" associated with an individual. As a variable, it depends upon the **income level** of the individual, the **income distribution** in his community, and other **non-economic factors** such as race, ethnicity, caste, etc.

For analysing the Power Inequality factors, we used 2 variables :

Electoral Margin of Victory and **Effective Number of Parties**.

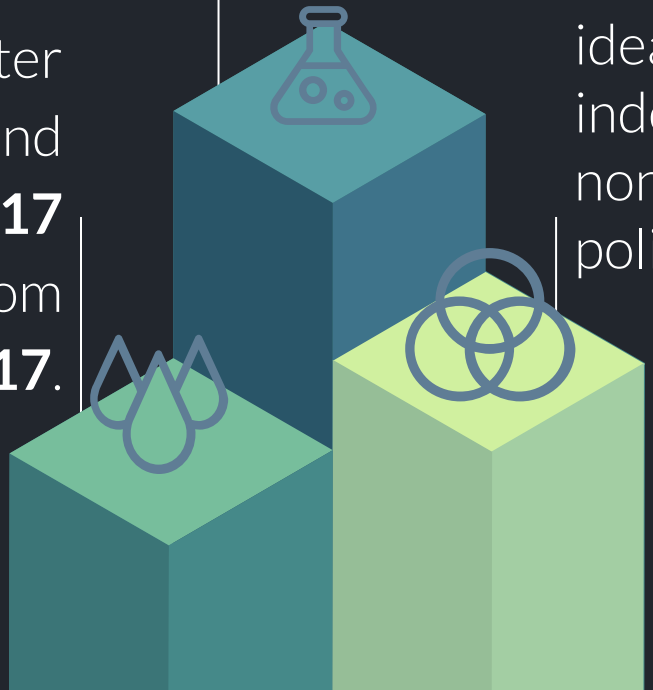
(Both of these will be described later)

METHODS

Used Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) as a measure of **pollution in the water bodies**.

Power inequality as an idea combination of GINI index,landless labourers, non-economic factors, and political factors

Used the data of water quality of medium and minor rivers across **17 states of India** from **2006 to 2017**.



All mentioned factors are described in detail in the following slides.

VARIABLES

Biochemical Oxygen Demand (BOD)

Is the oxygen demanded by microbes, which they use for decomposition. A value **less than 3 mg/L** is a standard for BOD.

Dissolved Oxygen (DO)

When it falls below a certain level, it degrades water quality. DO's **less concentration** leads to **eutrophic conditions** that cause aquatic organisms to die. About **4-5 mg/L** of DO is the generally accepted amount.

VARIABLES

State Domestic Product (sdp)

The **aggregate of the economic value** of all goods and services produced within the geographical boundaries of the State/UT.

GINI Index (gini)

The coefficient measures the dispersion of income or **distribution of wealth** among the members of a population.

VARIABLES

No. of Landless Labourers (landless)

Number of **unorganised agricultural workers** in the state. Socially, a large number of agricultural labourers belong to Scheduled Castes (SCs) and Scheduled Tribes (STs).

Literacy Rate (lit)

Literate persons in a given age group expressed as a percentage of the total population in that age group.

VARIABLES

Electoral Margin of Victory (winGap)

The percentage **difference of vote share** between the winning and the runner-up party.

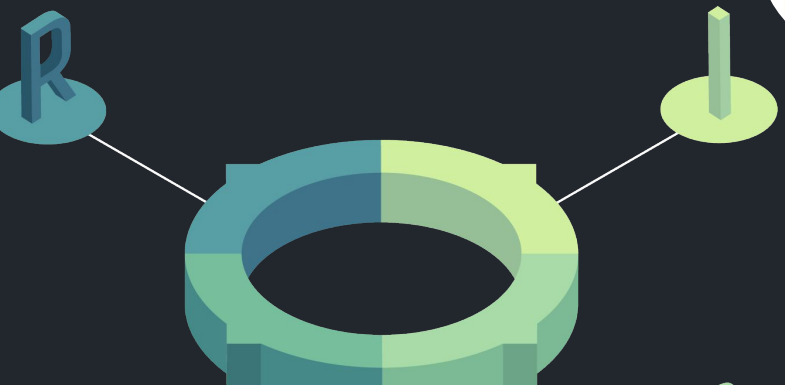
Effective No. of Political Parties (effPol)

The number of equal sized parties competing in an election. Is calculated through **vote/seat shares** of parties in the election.

DATA SUMMARY

For **BOTH** cases :

Variable Acronym	N	Mean	Median	SD	MIN	MAX
BOD	164	6.7	2.55	10.7	0.475	66
DO	163	6.4	6.4	0.9	3.55	8.4
sdp	169	90972.2	74687	55382.6	22820	375550
gini	170	0.30	0.3	0.05	0.161	0.388
landless	170	3861323.04	1528133	4760985.84	26760	16967754
lit	170	76.87	76	8.93	60	94
winGap	170	8.58	8.24	5.45	0.9	25.42
effPol	170	2.8	2.6	1.02	1.35	5.38

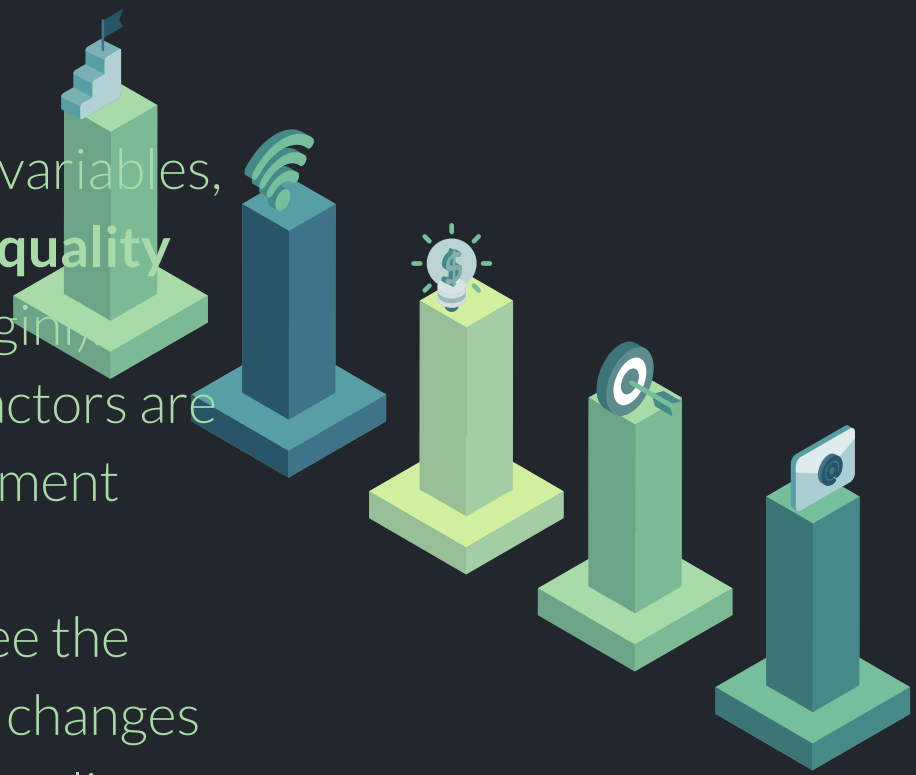


HYPOTHESIS

Null Hypothesis (H_0) : The **environment** variables, DO and BOD are not influenced by **inequality factors** (lit, winGap, effPol, landless, gini).

Alternate Hypothesis (H_a) : Inequality factors are **significant** influencers of the environment variables.

We will use **2 regression models** to see the changes in the economic regressors. The changes that we hope would be brought by inequality factors.



HYPOTHESIS TESTING

For H_o:

$\beta_i = 0$

where β_i is the i^{th} inequality factor's coefficient

For H_a:

$\beta_i \neq 0$

Procedure:

- The first model includes variables which are a measure of economic factors.
- The second model, in addition of the economic variables, includes variables which are a measure of economic and non-economic inequalities to gauge the effect of race, ethnicity, caste etc.
- Find the variable(s) which are significant.

Procedure (continuing)....

- Check the collinearity of the selected variable(s) to ensure that any change(s) in the value of coefficient (β's) of the variable(s) is because of the **improvement of the model** and **not because of collinearity with other variables**.
- Remove the selected variable(s) which are highly correlated with other variables. If all the selected variable(s) are found to be highly correlated, then we would reject our null hypothesis.
- Observe the β_i values of the variables from the two Regression models.

MODELS

Regression Model 1 :

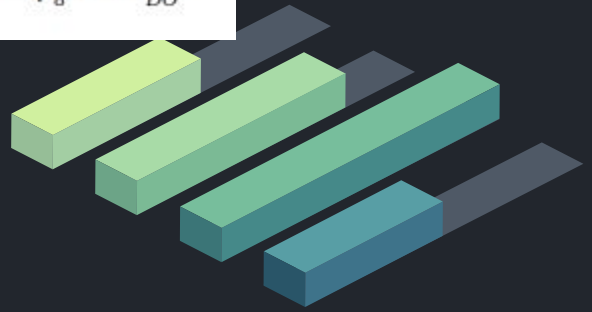
$$BOD_1 = \beta_0 + \beta_1 sdp + \beta_2 (sdp)^2 + \beta_3 (sdp)^3 + \beta_4 gini + \beta_5 landless + \varepsilon_{BOD}$$
$$DO_1 = \beta_0 + \beta_1 sdp + \beta_2 (sdp)^2 + \beta_3 (sdp)^3 + \beta_4 gini + \beta_5 landless + \varepsilon_{DO}$$

First model includes variables which are a measure of economic factors and economic inequality.

Regression Model 2 :

$$BOD_2 = \beta_0 + \beta_1 sdp + \beta_2 (sdp)^2 + \beta_3 (sdp)^3 + \beta_4 gini + \beta_5 landless + \beta_6 winGap + \beta_7 effPol + \beta_8 lit + u_{BOD}$$
$$DO_2 = \beta_0 + \beta_1 sdp + \beta_2 (sdp)^2 + \beta_3 (sdp)^3 + \beta_4 gini + \beta_5 landless + \beta_6 winGap + \beta_7 effPol + \beta_8 lit + u_{DO}$$

Second model along with the economic regressors also includes the variables, which are a measure of power inequality to gauge the effect of race, ethnicity, caste.



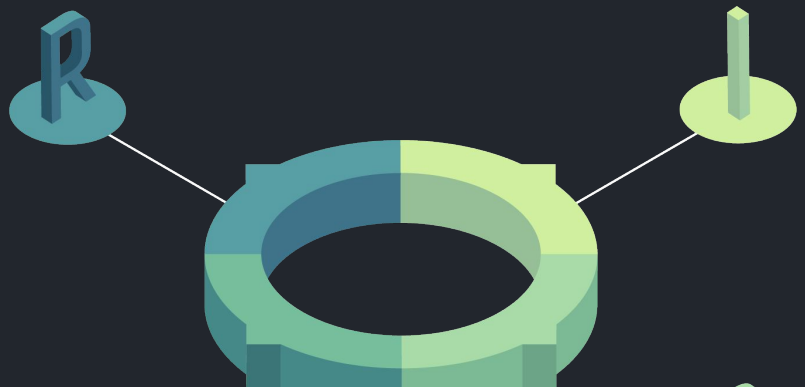
MULTICOLLINEARITY

It is possible to have collinearity between the independent variables. This means that some **regressors might be correlated** with each other. Minimum multicollinearity is favoured as it **increases the precision** of estimate coefficients.

Variables	sdp	$(sdp)^2$	$(sdp)^3$	gini	landless	winGap	effPoli	lit
VIF	82.9	369.95	133.25	2.06	1.72	1.27	1.25	1.80

REGRESSION RESULTS

WITHOUT POLITICAL INFLUENCE :



BOD

	Estimates(β s)	*SE*	*t value*	*Pr(>|t|)*
β_0 (intercept)	-5.17e+00	5.9e+00	-0.877	0.3820
β_1 (sdp)	1.53e-04	1.28e-04	1.194	0.2341
β_2 $(sdp)^2$	-7.13e-10	8.83e-10	-0.807	0.4207
β_3 (sdp3)	7.84e-16	1.64e-15	0.477	0.6340
β_4 (gini)	2.14e+01	2.07e+01	1.034	0.3026
β_5 (landless)	-5e-07	2e-07	-2.564	0.0113 *

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

Residual standard error: 10.45 on 157 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared: 0.07721, Adjusted R-squared: 0.04782
F-statistic: 2.627 on 5 and 157 DF, p-value: 0.02599

DO

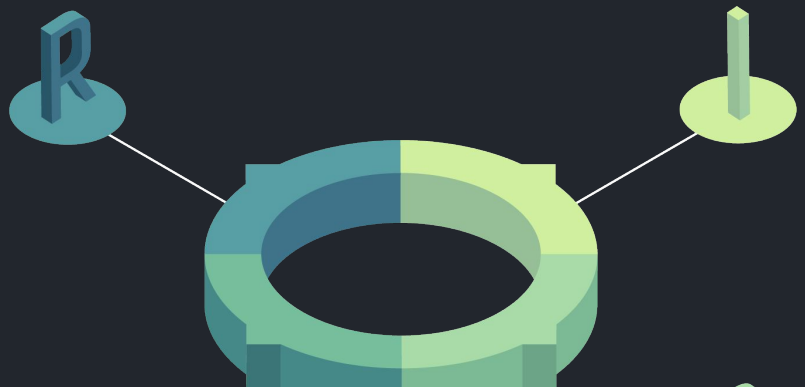
	Estimates(β s)	*SE*	*t value*	*Pr(>|t|)*
β_0 (intercept)	6.91e+00	4.92e-01	14.022	<2e-16 ***
β_1 (sdp)	-1.30e-05	1.07e-05	-1.214	0.227
β_2 (sdp2)	6.28e-11	7.36e-11	0.853	0.395
β_3 (sdp3)	-8.81e-17	1.370e-16	-0.643	0.521
β_4 (gini)	2.32e-01	1.72e+00	0.135	0.893
β_5 (landless)	5.57e-09	1.63e-08	0.342	0.733

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

Residual standard error: 0.8711 on 156 degrees of freedom
(8 observations deleted due to missingness)
Multiple R-squared: 0.03024, Adjusted R-squared: -0.0008421
F-statistic: 0.9729 on 5 and 156 DF, p-value: 0.4362

REGRESSION RESULTS

WITH POLITICAL INFLUENCE :



BOD

	Estimates(β s)	*SE*	*t value*	*Pr(>|t|)*
β_0 (intercept)	2.1e+01	9.11e+00	2.299	0.02283 *
β_1 (sdp)	2.49e-04	1.29e-04	1.927	0.05588 .
β_2 (sdp2)	1.07e-09	8.72e-10	-1.223	0.22335
β_3 (sdp3)	1.24e-15	1.61e-15	0.772	0.44145
β_4 (gini)	4.09e+01	2.2e+01	1.862	0.06444 .
β_5 (landless)	-8.94e-07	2.16e-07	-4.145	5.58e-05 ***
β_6 (winGap)	1.75e-03	1.77e-01	0.010	0.99209
β_7 (effPol)	-7.02e-01	8.63e-01	-0.814	0.41693
β_8 (lit)	-4.44e-01	1.17e-01	-3.798	0.00021 ***

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

Residual standard error: 10.04 on 154 degrees of freedom
(7 observations deleted due to missingness)
Multiple R-squared: 0.1643, Adjusted R-squared: 0.1208
F-statistic: 3.784 on 8 and 154 DF, p-value: 0.0004446

DO

	Estimates(β s)	*SE*	*t value*	*Pr(>|t|)*
β_0 (intercept)	4.21e+00	7.58e-01	5.553	1.21e-07 ***
β_1 (sdp)	-2.47e-05	1.05e-05	-2.342	0.020457 *
β_2 (sdp2)	1.19e-10	7.13e-11	1.669	0.097149
β_3 (sdp3)	-1.69e-16	1.32e-16	-1.281	0.202075
β_4 (gini)	2.08e-01	1.79e+00	0.116	0.907742
β_5 (landless)	3.19e-08	1.78e-08	1.799	0.074060
β_6 (winGap)	4.26e-02	1.45e-02	2.935	0.003854 **
β_7 (effPol)	1.04e-01	7.06e-02	1.471	0.143454
β_8 (lit)	3.29e-02	9.71e-03	3.392	0.000884 ***

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

Residual standard error: 0.8214 on 153 degrees of freedom
(8 observations deleted due to missingness)
Multiple R-squared: 0.1544, Adjusted R-squared: 0.1101
F-statistic: 3.491 on 8 and 153 DF, p-value: 0.0009914

FINDINGS

Number of landless labourers (landless) is the only regressor whose coefficient is significant in both our regression models for BOD.

Extent of collinearity of landless with other regressors is low, i.e. negligibly correlated with other regressors.

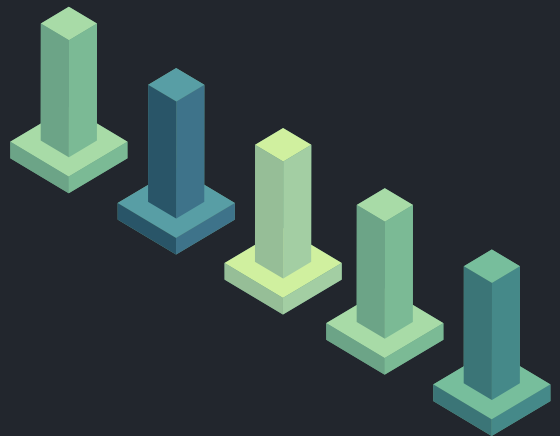
Estimation of the coefficient of sdp improved in the second case for both BOD and DO

For BOD, sdp, gini, landless and lit came out as significant.
For DO, sdp, winGap and lit came out significant.

SOME MORE FINDINGS

>States like Punjab and Haryana showed the most significant results.
>Water degradation has increased in both these states.
>Agriculture intensive states
>Strict government policy on agricultural practices can help improve these states in terms of water quality.

We removed states like Goa, Manipur from our regression models and ran the regression again, finding more significant results. This can be due to their lower numbers of political seats. This suggests a direct relation of environment quality and the equal distribution of political parties



conclusions

- We can conclude that, inclusion of factors like components of Power and Economic Inequality along with economic factors has improved the economic model significantly. This result further strengthens the claim that “Economic and Social Inequalities - based on class, race, ethnicity, gender, age can transform into environmental inequalities” by (Baland et al., 2007).

- If we observe the significance of literacy in Results section tables, we can comfortably conclude that literacy (which by definition, does not guarantee a high school education or a degree) has a direct relationship with Environment Quality. So, for a better environment quality in future, more education policies should be introduced by the government.

- The State Domestic Product (SDP) per capita (which is one of the major regressors for our Regression Model) acquired insignificant values for the first model (can be seen in Table 2 and 3). So, the EKC hypothesis (The inverse U-curve between Environment Degradation and Income levels) stands untested. However, after the introduction of other power variables, the SDP became significant. So, we can conclude that social, political factors when combined with income levels would help us to test the relevance of EKC hypothesis better.

THANKS!

Questions?

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