Impact of PM2.5 and CO on Air Quality Index (AQI): A Panel Data Analysis of Indian Cities

1. Introduction

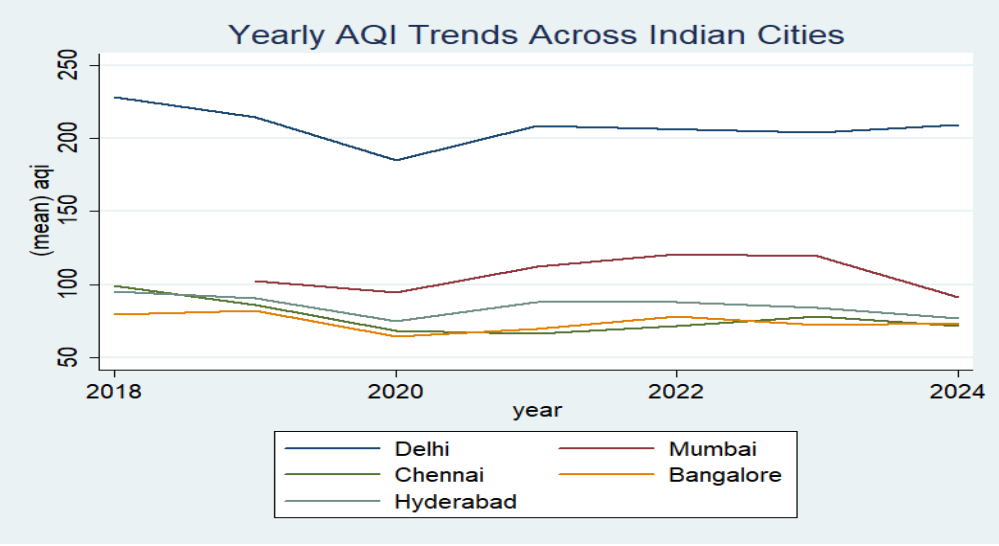
   Air pollution poses a significant challenge in Indian cities, particularly due to rising levels of particulate matter (PM2.5) and carbon monoxide (CO). This mini project investigates the relationship between PM2.5, CO, and AQI using panel data from five major Indian cities between 2018 and 2024.

2. Objective

   To quantify the impact of PM2.5 and CO levels on AQI using panel data econometrics and determine the appropriate model specification through the Hausman test.

3. Data and Methodology
   a. Cities Analysed: Delhi, Mumbai, Chennai, Bangalore, Hyderabad, Years: 2018–2024
   b. Variables:
      Dependent Variable- AQI
      Independent Variable- PM2.5, CO
   c. Method: Panel Data Regression using Fixed Effects (FE), Random Effects (RE), and Hausman Test in STATA

4. Descriptive Graph



5. Regression Results
   a. Fixed Effects Model (xtreg aqi pm25 co, fe)

Variable	Coefficient	Std. Err.	T	P>|t|	[95% Conf. Interval]
PM2.5	2.268	1.084	2.09	0.046	[0.040, 4.496]

CO	-23.514	56.779	-0.41	0.682	[-140.225, 93.198]
_cons	-0.051	0.085	-0.60	0.554	[-0.226, 0.124]

b. Random Effects Model (xtreg aqi pm25 co, re)

Variable	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]
PM2.5	2.881	0.996	2.89	0.004	[0.929, 4.833]
CO	-55.696	52.166	-1.07	0.286	[-157.940, 46.548]
_cons	0.033	0.025	1.33	0.185	[-0.016, 0.081]

c. Hausman Test
The Hausman test was used to decide between FE and RE models. Result: chi2(2) = 2.42, Prob > chi2 = 0.2984. This indicates that the difference in coefficients is not systematic, suggesting the RE model is appropriate.

6. Interpretation
PM2.5 significantly increases AQI, as expected. CO shows a negative but statistically insignificant coefficient. Since the Hausman test fails to reject the null hypothesis, the Random Effects model is considered appropriate.

7. Conclusion
This project demonstrates that PM2.5 has a significant positive impact on AQI in Indian cities. Although CO's effect is statistically insignificant, its negative sign warrants further investigation. The results emphasize the need for PM2.5-focused pollution control.

8. Skills Demonstrated
   a. Panel data regression (Fixed & Random Effects)
   b. Model selection using the Hausman test
   c. Data visualization in STATA
   d. Applied econometric analysis