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THE IMPACT OF SMOG/AIR QUALITY ON ECONOMIC ACTIVITIES, HEALTH CONDITIONS, AND ENVIRONMENTAL QUALITY IN PAKISTAN

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Abstract:
Public health; economic size, and quality of environment is significantly changing due to spread of Smog in Pakistan. This is becoming a critical challenge which requires immediate policy actions to overcome it. Many cases of flue and breathing congestions have been reported which reflect falling health conditions of people in Pakistan. The bad health is also affecting the workers productivity which is hurting overall production of goods and services. Due to high air quality index, quality of environment is also getting worse off. Considering this notion in mind, this research has obtained empirical results which state that smog has negative impact on economic activities; human health and quality of environment in Pakistan. In order to combat this increasing challenge, sustained policies that may control pollution, promoting usage of environmentally friendly energies, spreading awareness among the mass, increasing installation of air purifier machines at public places for all the public instead of public of selected areas, detection of air quality index meters to all places instead of selected places, and improving health infrastructure in the country. The proposed steps will help improving health and environmental quality in the country on the one side and on the other side it will help in achieving goals 3 and 13 of Sustainable Development Goals (SDGs).

Keywords: Smog; Health Conditions; Economic Activities; Environmental Quality and Pakistan

Introduction:

The combination of sulfur dioxide, nitrogen oxides, PM2.5- matter of fine particulate and some additional dangerous contaminants form smog. The sum of “London Smog” and “Los Angeles Smog” may provide one aspect of understanding the base of this issue. London smog refers to the smog which emerges due to the burning of sulfur rich substances while Los Angeles smog comes into being due to burning of photochemical substances. In recent times, among many challenges of environment and public health, smog has appeared as the most vibrant and significant issue in Pakistan. During winter season, the severity of this issue increases especially

in urban hubs such as Karachi and Lahore. The index of air quality of both cities is witnessed as highest in the entire South Asia which is badly affecting health, economic and environment related activities. According to World Health Organization (2018) report, more than 4.2 million people died around the world due to the widespread of air pollution.

Over the recent years, the urban cities have become more populous in Pakistan which has increased the utilization of private transport on roads. Workers in rural areas also switched to industries in cities. Due to lack of awareness peasants in rural areas have not reduced burning of waste of crops. This has escalated vehicular, industrial and agricultural pollution in the air. All has caused smog and due to this, diseases related respiratory system, heart and mortality of premature are increasing. This leads to affect human health. Moreover, workers ability to work efficiently falls due to bad health conditions, consequently leading to decrease in overall production during peak time of smog in the country. Another argument is that due to expansion in smog severity, index values of $PM_{2.5}$ or black carbon stimulates. Consequently, quality of water; air and soil is badly affected in any economy. It is intuited that when air quality becomes worse off, then it escalates degradation of soil, resultantly level of production in the agriculture sector deteriorates. This reflects negative impact of smog on productivity level in the country. We have witnessed many studies such as Hanif and Gago-de Santos (2017); Hanif et al. (2014); Nazli et al. (2018); Huang et al. (2020); Alharthi and Hanif (2020); Hanif et al. (2020); Wang et al. (2022) in providing evidence upon the changing patterns of economic activities due to many other macroeconomic indicators. The smog is also contributing to environmental degradation by releasing more vehicular emissions, burning of waste of crops and industrial pollution leading to reduce quality of environment in the country. The role of various macroeconomic indicators was also inquired upon environmental quality for various sample economies by the scholars like Li et al. (2022); Luo et al. (2023); Liu et al. (2023); Fei et al. (2023); Huihui et al. (2024) and Jia et al. (2024). On the basis of these arguments, the aim of this research is to demonstrate the empirical impact of smog on three socio-economic indicators such as a economic growth, life expectancy and environmental quality in Pakistan. The research has considered an annual data from 2010 to 2023 and applied simple OLS technique to obtain empirical results. The results are supporting our wisdom.

The rest of the study is structured by explaining empirical literature in the next section. The methods are going to discuss in the third section. Results and their discussion is going to be presented in the fourth section. The last section is going to highlight the conclusion and policy implications.

Some Empirical Evidences:

The contribution of Razzaq et al. (2018) highlighted the link between respiratory health and tobacco smoke in adults in case of Karachi. They provided evidence that people over age 38 with low socio-economic status who were exposed to tobacco smoke having 5 packs or more per year were suffering respiratory health issues. The role of SO_2 on economic growth was inquired by Xu and Yang (2020). The study utilized structural VAR for 108 cities of China by taking period from 2008 to 2015 and reported accelerating impact of SO_2 on economic growth at a national level. In another research, we witnessed Raza et al. (2021) in presenting a systematical literature in which they highlighted that after 2013 the severity of smog had increased and it was getting worse over time in Lahore. They exposed that due to expansion in smog, challenges to human health were increasing in Lahore, Pakistan. Later on, Malhi et al. (2023) provided measurement

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of six measures of air pollution such as O_3; PM_{10}; NO; $PM_{2.5}$; SO_2; NO_2 for the city of Lahore. They suggested that during the whole year the levels of $PM_{2.5}$ and NO remained higher than the standards of environmental quality of Punjab. The both indicators showed important source of pollutant environment in Lahore city.

Aslam et al. (2023) conducted their research for Lahore and reported that the measures of ambient air pollution like $PM_{2.5}$ and PM_{10} are significantly escalating asthma diseases among elders during winter time. After this, Lin et al. (2024) explored a case study of Karachi in which they highlighted the impact of PM2.5 on respiratory health. After considering quasi-Poisson technique on 13827 patients, their findings exposed that smog has badly influenced the older or male patients having tuberculosis, chronic disease related to obstructive pulmonary or any other diseases related to pulmonary. The study conducted by Mushtaq and Mahmood (2024) suggested that due to expansion in smog or air pollution, individuals in Lahore were suffering from health issues related to respiratory like breathing and coughing problems, cardiac issues, skin allergies and pneumonia. This concluded that exposure to smog led to badly affect health conditions of individuals in Lahore. Later on, another study conducted by Malik et al. (2024) considered various indicators of air quality such as PM_{10}; CO; $PM_{2.5}$; SO_2; NO_2 for the case of Lahore. The study suggested that before smog period the index values were low but during highly intense smog period all the indices of air quality followed upward trend. During high smog period, the health indicators such as admissions to hospitals, heart diseases, asthma patients were increased significantly. They concluded that increase in smog severity expanded health issues in Lahore. After this, sample and methods are discussed in the next section.

Sample and Methods:

This research considers the role of smog on economic growth, life expectancy and environmental quality by taking an annual data from 2010 to 2023. The data is obtained from World Bank (2024) data bank. The following models are used for obtaining empirical results.

$\ln GDPPC_t = f\ (\ln PM_{2.5t})$	1
$\ln LE_t = f\ (\ln PM_{2.5t})$	2
$\ln ME_t = f\ (\ln PM_{2.5t})$	3

Table 1: Defining Variables

Representation	Names	Construction
$\ln GDPPC_t$	Economic Growth	ln [GDP / Population]
$\ln LE_t$	Life Expectancy	ln [Total Life Expectancy at Birth]
$\ln ME_t$	Environmental Quality	ln [Methane Emissions in Energy Sector]
$\ln PM_{2.5t}$	Smog or Air Pollution	ln [$PM_{2.5}$]

This research is going to apply least square regression for the above three proposed functions to see how smog is going to influence per capita GDP which is taken as proxy for economic growth, longativity of life which is taken as proxy for human health and methane emissions which is taken as proxy for environmental quality. The results are provided as below:

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Results and Discussion:

This part carries details about empirical results for our proposed models. Initially the summary statistics are provided as below:

Table 2: Summary Stats

Tests/Variables	$lnGDPPC_t$	$lnLE_t$	$lnME_t$	$lnPM_{2.5t}$
Mean	11.9314	4.1859	10.0438	4.1619
Standard Deviation	0.0999	0.0116	0.0243	0.0496
Jarque-Bera	1.4555	1.3557	0.6263	0.5528
Probability	0.4830	0.5077	0.7312	0.7585
Observations	14	14	14	14

The summary statistics table shows the averages, deviations and normality status of the selected indicators. Among all the indicators the average value of per capita GDP appears highest while mean value of $PM_{2.5}$ remains at minimum. The insignificant JB test confirms the normality of all the selected indicators of this research. After this, status of unit root is also tested by using KPSS unit root test at level and first difference specifications.

Table 3: KPSS Unit Root Test

At Level		**At First Difference**	
Variables	**KPSS-Test**	**Variables**	**KPSS-Test**
$lnPM_{2.5t}$	0.1259	$\Delta lnPM_{2.5t}$	0.2216
$lnGDPPC_t$	0.4461	$\Delta lnGDPPC_t$	0.1970
$lnLE_t$	0.4189	$\Delta lnLE_t$	0.2889
$lnME_t$	0.2676	$\Delta lnME_t$	0.0990

The results provided in the above table at level shows that all the variables in natural log form like $PM_{2.5}$, GDP per capita, life expectancy and methane emissions have LM-stats below than 1% percent critical value of 0.739. This allows us to accept null hypothesis of stationary series at level. Similarly when we apply KPSS test at first difference specification, we may observe that the LM stats for all the selected indicators in the study are less than the one percent critical value of 0.739 which confirms that all the data series have no unit root at first difference. This concludes that all the selected series have I(0) order of integration. This sets up the base of applying simple regression for obtaining the impact of explanatory variable like smog on economic growth, life expectancy and environmental quality. From the results we may see that smog in the form of natural log of $PM_{2.5}$ shows adverse and significant impact on economic growth in Pakistan. The coefficient size is more elastic as it is below than negative unity but greater than negative infinity. As air pollution in the form smog increases by one percent, then it significantly reduces domestic production by 1.3984 percent.

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Table 4: Regression Estimates

Variable	Dependent Variable		
	$lnGDPPC_t$	$lnLE_t$	$lnME_t$
	Coefficients [Probability Values]		
LNPM2.5	-1.3984 [0.0139]	-0.1502 [0.0120]	0.2669 [0.0436]
C	17.7912 [0.0000]	4.8159 [0.0000]	8.9331 [0.0000]
Diagnostics			
Adjusted R2	0.4168	0.4327	0.2392
F-Test [Probability Value]	8.8598 [0.0139]	9.3912 [0.0120]	5.0874 [0.0436]

After this, the impact of smog is also captured on life expectancy which reveals average total life of the people in a country and it is taken as proxy for human health. Due to expansion in smog, life expectancy of people is declining. The coefficient is negative and significant which shows that if natural log of $PM_{2.5}$ increases by one percent then life expectancy significantly declines by 0.1502 percent. This concludes that smog has deteriorating effects on human health in Pakistan. The results further reveal that methane emissions significantly escalate by 0.2669 percent due to one percent increase in natural log of $PM_{2.5}$. This also confirms that smog has adverse impact on environmental quality. The significant F-stats reveals that overall model is good fit. These results support our concept and the literature that we have carried out in the previous sections that smog leaves deteriorating effects on economic activities; human health and environmental quality.

Conclusion:

This research is structured to capture the adverse and deteriorating implications of smog on human health, economic activities, and environmental quality in Pakistan. For this purpose, this study considers an annual data ranging from 2010 to 2023 from World Bank (2024) data bank and applied OLS estimator. The OLS estimator is applied because KPSS (1992) unit root test confirms that all the data series has I(0) order of integration. Moreover, the empirical results suggest that smog in the form of $PM_{2.5}$ indicator significantly squeeze economic activities. It is also evident that smog is badly influencing human health and it is further found that smog is reducing environmental quality in Pakistan. These findings are in accordance to our intuition. Based on these results, serious measures must be attained by the administration to combat increasing challenges of smog in Pakistan. Otherwise it will have consequences far beyond these selected indicators.

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