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RESEARCH ARTICLE

DOES AIR POLLUTION IMPACT CONSUMER SENTIMENT IN PAKISTAN: A CITY-LEVEL ANALYSIS*

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Abstract

Over the past few years, air pollution has been a rising concern in Pakistan. Apart from a direct bearing on the health of households and a significant risk to the environment, it is hypothesized that poor air quality has an impact on consumer sentiment in Pakistan. In this study, the impact of air quality on consumer sentiment is estimated for major cities in Pakistan. A consumer confidence survey conducted by the State Bank of Pakistan is a leading indicator of economic activity. This survey primarily reflects consumers' perceptions of the current and expected economic conditions. Consumer sentiment is measured by the diffusion index, whereas the air quality index is used to capture the magnitude of air pollution. Using the city fixed effects model on balanced panel data of ten cities and 36 time periods, the findings suggest that air pollution has a negative impact on consumer sentiment in Pakistan. The coefficient of air pollution is statistically significant and consistent in all specifications, reflecting that air pollution impacts consumer sentiment. The reverse causality test confirms that consumer sentiment does not impact air pollution. Control variables, such as dummies for floods, terrorist attacks, and household characteristics for each city, are included in this study to gain an improved model fit. The Pakistani government needs to acknowledge the severity of air pollution and its impact on consumer sentiment, which is a leading indicator of economic activity

Keywords: Air Pollution, Consumer Sentiment, Diffusion Index, Balanced Panel, Environment
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1. Introduction

Being categorized as an emerging financial market – an economy transitioning into a developed market economy–Pakistan's economy is the 24th largest based on GDP using purchasing power

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parity (PPP). [1] Pakistan holds the position of the fifth most populous country in the world. [2] A surge in urbanization, along with a proportional increase in vehicular loads, has adverse consequences (Anjum, et al., 2021). Pakistan is ranked second in the world in terms of pollution (Figure 1.1). Persistent poor air quality reduces life expectancy by almost 4 years in Pakistan (The Air Quality Life Index, 2023). In Pakistan, outdoor air pollution leads to twenty-five deaths per 100,000 people, while indoor air pollution is responsible for almost 30 deaths per 100,000 people. [3]

Air pollution is considered a key environmental issue since the 1970s (The World Bank, 2019). The main causes of air pollution are fossil fuel burning, industrial processes, transportation, and agricultural activities. Furthermore, anthropogenically generated climate change increases the threat of exposure to air pollutants (Ministry of Finance, 2022). There are frequent episodes of hazardous levels of air quality emanating from crop burning stubbles, deforestation, and industrial and vehicle emissions (IQAir, 2023). The worsening situation compels the government to impose strict restrictions such as closure of public places and restriction of unnecessary movement (Bukhari & Shahid, 2024).

The consequences of pollution are not only limited to the environment, chronic diseases, and depression, but also has an impact on macroeconomic indicators, such as high government expenditures and surges in housing prices in areas with better air quality. The hypothesis that air quality impacts consumer sentiment is formulated and tested in this study. Consumer sentiment about the current and expected economic conditions of a country is a reflection and leading indicator of economic activity. In this study, the year-on-year growth of the confidence index is used to examine the impact of air pollution on consumer sentiment.

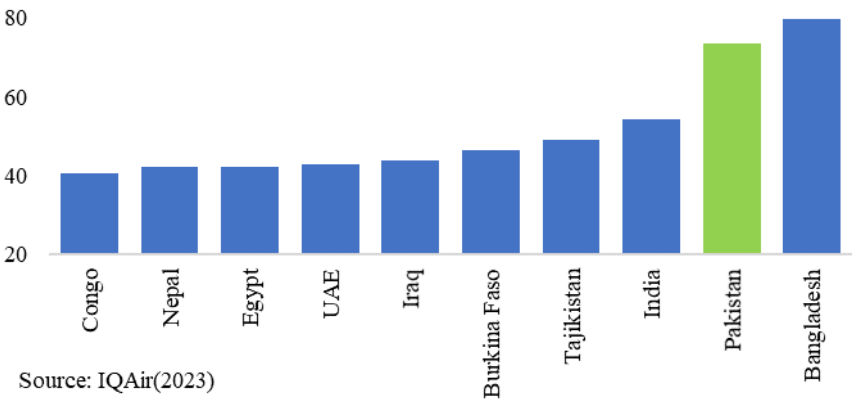

Figure 1. 2023 Country Ranking Population weighted PM 2.5 concentration

1 DAWN News. https://www.dawn.com/news/1704774. Retrieved on 1st December 2024.

2 UN Women. https://asiapacific.unwomen.org/en/countries/pakistan/about. Retrieved on 5th December 2024.

3 World Health Organization. https://www.emro.who.int/pak/programmes/environmental-health.html. Retrieved on 1st December 2024.

2. Literature Review

Air pollution is a byproduct of urbanization and industrial development over the past few decades. Air pollution is a serious environmental issue in cities, particularly in developing economies (Mayer, 1999). Tagged as the greatest environmental threat, air pollution is responsible for roughly 7 million deaths worldwide every year. Air pollution adversely impacts child growth and development (Balietti et al., 2022). The harm caused by air pollution extends to both physical and mental health (Xue et al., 2021). Air pollution further impedes consumer choice (He et al., 2022). The credibility of local government is also compromised due to air pollution (Yao et al., 2022). In some cases, air pollution may lead to social conflicts, aggressive behaviour, and violent crimes (Li and Meng, 2023). Sleeplessness is another implication of air pollution (Heyes and Zhu, 2019).

The consequences of air pollution on health seems clear, and several studies have estimated the association between air pollution and health issues. A study of six cities in the United States of America (US) reveals that long-term exposure to air pollution leads to respiratory diseases, and air pollution and mortality are highly correlated (Dockery et al., 1993). Air pollution contributes in the development lung cancer (Loomis et al., 2013). Air pollution has an adverse impact on children's health. Premature birth, low birth weight, and developmental disorders are also a consequence of bad air quality (Perera, 2008). Another major consequences of climate change is the high extinction of specific species and the possible loss of biodiversity (Bellard et al., 2012).

The macroeconomic challenges related to air pollution are alarming. The foremost macroeconomic cost to economies worldwide is health-related expenditures. Air pollution-related costs alone account for over US$ 5 trillion globally (The World Bank, 2016). The adverse impact of air pollution is substantial in the airline industry. A study in China showed higher PM2.5 concentration levels and a high probability of flight delays and/or cancellations (Chen et al., 2023). The migration to areas with cleaner air is also an outcome of pollution (Pan, 2023).

Another macroeconomic implication of air pollution is the loss of labor productivity. A study conducted at two industrial locations in China reveals that the output per worker is reduced in proportion to severe air pollution (He et al., 2019). Environmental protection must be treated as an investment in human capital because ozone pollution leads to a loss in agricultural worker productivity (Zivin and Neidell, 2012). The link between air pollution and mental health is well established. Air pollution is one of the contributing factors to mental health disorders, and high exposure to PM2.5, is associated with a high risk of depression (Power et al., 2016). Lim et al., (2012) emphasize that high levels of and exposure to air pollution are correlated with a high suicide rate. A meta-analysis reveals that exposure to air pollution negatively impacts mental health, mood swings, anxiety, and depression. Air pollution also limits consumer choices, and its impact of air pollution is disproportionate in different economic sectors. Air pollution leads to a slowdown in movie theater market sales in China (He et al., 2022). Brain drain and loss of firm productivity is one of the consequences of air pollution (Xue et al., 2021).

Air pollution affects mental health. The important question is whether the impact also affects consumers' decision-making. There are a number of studies emphasizing that air pollution influences

consumer behavior, including preferences, spending habits, and lifestyle choices. Air pollution reduces recreational activities, which hampers overall demand in the economy (Zivin and Neidell, 2009). Consumer spending patterns change due to air pollution. Consumers can swap outdoor activities and expenses related to indoor activities. Subjective well-being is also influenced by air pollution (Welsch, 2006). Dynamics of the housing market changes due to air pollution. Areas with clean and high-quality air have high demand, and property prices rise in such areas (Chay & Greenstone, 2005).

The impact of air pollution on health, infrastructure, and the overall economy in Pakistan has been estimated to some extent. However, we find no study previosuly which directly assesses the impact of air pollution on consumer sentiments in Pakistan. This study fills this gap by analyzing the impact of air quality on ten major cities in Pakistan from January 2018 to December 2023. At least one city is selected from each province (state) of Pakistan. [4]

3. Methodology

The hypothesis formulated and tested in this study is as follows:

H_0 : There is no impact of air pollution on consumer sentiment in Pakistan

H_a : There is an impact of air pollution on consumer sentiment in Pakistan

In this study, panel linear fixed effects models are employed to test the null hypothesis for 10 cities and 36 time periods. Panel variable is city, and it is strongly balanced.

$$CS_{it} = \beta_0 + \beta_1 AQI_{it} + \alpha_i + \mu_{it} \qquad (1)$$

CS = Consumer Sentiment measured by diffusion index

AQI = Air quality index

α_i = city fixed effects

i= 10

t = 36

In equation (1), *i* is cross sectional units, *t* is time units, consumer sentiment (CS) is the dependent variable, and the air quality index (AQI) is the main explanatory variable that varies over time. The year-on-year growth of consumer sentiment and air quality index is used in the estimations to avoid any seasonality. β_0 is the intercept that may differ for each period. As mentioned earlier, city fixed effects are employed in this specification. The two terms α_i and μ_{it} (the error term) behave somewhat differently. There is a different μ_{it} for each city at each point in time, but α_i only varies across cities and not over time (Allison, 2009). However, μ represents purely random variation at each point in time.

The State Bank of Pakistan (SBP), in collaboration with the Institute of Business Administration (IBA), organizes the Consumer Confidence Survey. The responses received through this survey are

4 These cities are Abbottabad, Faisalabad, Gujranwala, Islamabad, Karachi, Lahore, Mirpur Khas, Rawalpindi, Peshawar and Quetta

used to construct (i) current economic conditions, (ii) expected economic conditions, and (iii) the consumer confidence index. For the data on air quality, Air Quality Index (AQI) by IQAir is used. [5]

In addition, several control variables (Z) for the robustness check are included in equation (2). These control variables are (i) *Education* – the average level of education of the respondents in a city, (ii) *income*–the average level of income of the respondents in a city, (iii) dummy for *Floods* in a city, (iv) *household size* – number of people in a house and (v) dummy for *Terror incidents* in a city.

$$CS_{it} = \beta_0 + \beta_1 AQI_{it} + \beta_2 Z_{it} + \alpha_i + \mu_{it} \quad (2)$$

For robustness, the time fixed effect is also added to the above specification. The inclusion or exclusion of the time-fixed effect does not significantly impact the results. Moreover, previous consumer sentiment is included as a control variable to check whether lagged sentiment influences current consumer sentiment.

Clustered (by city) standard errors are used in all specifications. Clustered standard errors, such as normal or robust standard errors, are not underestimated and they provide unbiased standard error estimates.

4. Data Description

Consumer sentiment is the leading indicator of economic activity. The perception of economic indicators such as inflation, interest rates, and employment are important for an emerging economy such as Pakistan, in which forward-looking policy formulation is followed. The SBP, in partnership with IBA conducts the Consumer Confidence Survey largely following the University of Michigan Consumer Sentiment Survey. [6] Each wave of this survey roughly covers about 1800 households contacted through fixed line telephone across Pakistan starting from January 2012 on a bi-monthly frequency, but from January 2023, it is conducted monthly. It covers all regions of Pakistan. The questionnaire is administered in different regional languages to ensure maximum outreach. The population of Pakistan is divided into 59 strata, and each stratum is represented in the sample according to its population.

In addition, household characteristics such as the number of households, age, income, occupation, and qualification of the respondents are also part of the survey. These household characteristics are used as the control variables in this study. The SBP reports the results of this survey in the form of a Diffusion Index (DI). The DI reflects the overall trend in respondents' perspectives on a specific aspect of a given survey. The questionnaire offers five options to the respondents for each question.

Very positive= Increase/improve significantly.

Positive = Increase/improve.

5 This index constitutes 120 major cities worldwide. The figure presented for each major city represents the average AQI calculated from all monitoring stations within that city at the specified time. Focusing on major cities rather than an extensive list of all cities allows for a clear, insightful, and impactful comparison of air quality in urban centers across the globe (IQAir, 2023).

6 State Bank of Pakistan. http://www.sbp.org.pk/research/CCS.asp. Accessed 15 May 2024.

E = Unchanged/neutral.

Negative = decline /deteriorate and

Very negative= decline/deteriorate significantly.

The Diffusion Index is then computed as follows:

Step 1: Net Response (NR) is computed as below:

NR = (1.00*PP) + (0.50 × P) + (-0.50 × N) + (-1.00*NN).

Step 2: Diffusion Index (DI) is calculated as follows: DI = (100 + NR) / 2

Where DI ranges from 0 to 100; interpretation of which is as follows:

DI > 50 indicates that Positive views are more than Negative views.

DI = 50 indicates that Positive views and Negative views are equal.

DI < 50 indicates that Positive views are less than the Negative views.

Table 1. Summary Statistics of Consumer Sentiment and Air Quality Index

Variable	Mean	Min	Max	*s.d*
Consumer Confidence Index	37.43	17.0	58.0	*4.11*
Current Economic Conditions Index	34.23	16.0	61.0	*4.85*
Expected Economic Conditions Index	40.66	19.0	61.0	*4.75*
Education	Graduate	Primary	Post-Graduate	-
Income	300-500$	100-200$	1000-2000$	-
Household size	7	2	12	*1.1*
Air Quality Index	64.98	14.1	261	*48.1*

Source: Author's Calculations

The Consumer Confidence Survey (CCS) data used in this study covers the period from January 2018 to December 2023. Due to the limited available data on the Air Quality Index, ten major cities of Pakistan – at least one from each province (state)–are analysed in this study. Thirty-six surveys, comprising almost 100,000 households, are included in the analysis.

Summary statistics related to consumer sentiment and air pollution are provided in Table 4.1.

Table 2. Air Quality Index – Categories

Category	AQI level	PM 2.5 (ug/m^3)	Recommendation
Good	0-50	0-9.0	Air quality is satisfactory.
Moderate	51-100	9.1-35.4	Outdoor activities to be avoided by sensitive individuals.
Unhealthy for sensitive groups	101-150	35.5-55.4	General public and sensitive individuals face risk to experience irritation and respiratory problems.
Unhealthy	151-200	55.5-125.4	Increased likelihood of adverse effects and aggravation to the heart and lungs among general public.
Very unhealthy	201-300	125.5-225.4	General public will be noticeably affected. Sensitive groups should restrict outdoor activities.
Hazardous	301+	225.5+	General public at high risk of experiencing strong irritations and adverse health effects.

Air pollution is proxied by the AQI. The AQI quantifies the concentration of air pollutants in the surrounding environment and the related health risks (IQAir, 2023). This index assigns a

numerical value corresponding to different air quality categories. As pollutant levels increase within each category, the associated health risks also rise accordingly. The air quality index ranges from 0 to 500, although air quality can be indexed beyond 500 when there are high levels of hazardous air pollution. Good air quality ranges from 0 to 50, whereas measurements over 300 m are considered hazardous. Table 4.2 provides information on the different categories of AQI.

5. Results and Discussion

Table 5.1 provides the result of the air quality index and overall consumer confidence index. The coefficient of the air quality index is statistically significant with a negative sign in all specifications, which intuitively makes sense. If the air quality index rises (implying more air pollution), consumer sentiment is likely to deteriorate. This coefficient of the air quality index is approximately equal to one-half of the standard deviation of the dependent variable (consumer confidence index), which implies that a considerable amount of variation in consumer sentiment is influenced by air quality.

Table 3. Impact of Air Quality Index on Consumer Confidence Index

	(1)	(2)	(3)	(4)
AQI[a]	-0.06**	-0.09**	-0.100**	-0.09**
	(0.027)	*(0.028)*	*(0.024)*	*(0.033)*
Control Variables				
Education		0.044	0.045	0.043
Income		0.142**	0.156**	0.133**
Household size		0.032	0.031	0.033
Floods			-0.210**	-0.231**
Terror incidents			-0.126**	-0.123**
Lag of Sentiment			0.002	0.001
City Fixed Effect	***Yes***	***Yes***	***Yes***	***Yes***
Time Fixed Effect	No	No	No	***Yes***
Observations	360	360	360	360
Number of cities	10	10	10	10
R-squared	0.64	0.67	0.72	0.72

Notes: Clustered (by city) standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

a: Year-on-year growth rate of air quality index.

In Column (2) of Table 5.1, several control variables are added for robustness purposes. The results show that the higher the level of income, the response of consumer gets stronger (more optimistic). However, the coefficient of education level is not statistically significant. Even when these two control variables are added, the coefficient of our main explanatory variable remained statistically significant. Regarding the size of the coefficient, it is still equal to half the standard deviation of the dependent variable (consumer sentiment).

In the last two columns of Table 5.1, additional control variables such as a dummy for floods and a dummy for terrorist incidents in a city are added. In addition, the time dummy variable is included; the result of this specification makes our main variable of interest significant. Hence, all specifications are consistent, and we reject our null hypothesis that air pollution has no impact on consumer sentiment.

The results validate the hypothesis that cities with higher air pollution levels tend to have more pessimistic sentiments. In columns 3-4, the lag value of the dependent variable (consumer sentiment in the previous period) is also used as a predictor for the current value of the dependent variable (current sentiment), and the results indicate that previous sentiment does not impact current sentiment.

Table 4. Impact of Air Quality Index on Current Economic Conditions Index

	(1)	(2)	(3)	(4)
AQI[a]	-0.07**	-0.10**	-0.11**	-0.09**
	(0.025)	*(0.026)*	*(0.023)*	*(0.031)*
Control Variables				
Education		0.040	0.042	0.042
Income		0.120**	0.119**	0.125**
Household size		0.030	0.029	0.031
Floods			-0.210**	-0.201**
Terror incidents			-0.130**	-0.125**
Lag of Sentiment			0.002	0.001
City Fixed Effect	***Yes***	***Yes***	***Yes***	***Yes***
Time Fixed Effect	No	No	No	***Yes***
Observations	360	360	360	360
Number of cities	10	10	10	10
R-squared	0.63	0.66	0.71	0.73

*** p<0.01, ** p<0.05, * p<0.1

a: Year-on-year growth rate of air quality index.

Table 5.2 and Table 5.3 provide the result of the air quality index on the current economic condition index and expected economic condition indices, respectively. These results are consistent with the overall consumer confidence index. The coefficient of air quality index is statistically significant, with a negative sign in all specifications. The Wooldridge test for autocorrelation is used to detect serial correlations. The p-value is greater than 0.05, which implies that the null hypothesis of no serial correlation is not rejected, i.e., errors are not serially correlated. It is also important to highlight that clustered standard errors are used at the panel level, which is a common fix for autocorrelation.

One possibility is that air pollution itself is due to high economic activity in Pakistan. To verify this, the reverse causality test is also estimated. The reverse causality results indicate that consumer sentiment does not impact air pollution in Pakistan. Even during the COVID-pandemic period, when smart lockdowns are imposed and the industrial sector is completely shut down, air quality in Pakistan remained poor. It appears, and to some extent, validated by the reverse causality test, that air pollution is largely exogenous and probably due to global climate change.

Results of this study are consistent with previous empirical studies mentioned in the section on literature review. Air pollution has a negative impact on consumer sentiment which effects households spending behaviour, individual's recreational activities etc.

Table 5. Impact of Air Quality Index on Expected Economic Conditions Index

	(1)	(2)	(3)	(4)
AQI[a]	-0.06**	-0.09**	-0.10**	-0.09**
	(0.026)	*(0.027)*	*(0.024)*	*(0.030)*
Control Variables				
Education		0.039	0.036	0.039
Income		0.122**	0.121**	0.127**
Household size		0.031	0.030	0.033
Floods			-0.200**	-0.213**
Terror incidents			-0.128**	-0.126**
Lag of Sentiment			0.003	0.002
City Fixed Effect	***Yes***	***Yes***	***Yes***	***Yes***
Time Fixed Effect	No	No	No	***Yes***
Observations	360	360	360	360
Number of cities	10	10	10	10
R-squared	0.65	0.66	0.72	0.72

a: Year-on-year growth rate of air quality index.

6. Conclusion

Pakistan is facing problems such as premature death, respiratory diseases, and a reduction in life expectancy due to air pollution. Agricultural productivity also suffers as crops become damaged owing to pollutant exposure. A visible fall in tourism is also a byproduct of pollution. As pointed out in previous studies, air pollution can lead to depression and anxiety. Another possible impact of air pollution on consumer sentiment related to current and expected economic conditions is estimated in this study. Consumer sentiment is a leading indicator of economic activity, and the consumer confidence index is treated as an important variable during monetary policy formulation. Using the city fixed effects model on balanced panel data of ten cities and 36 time periods, the main findings indicate that air pollution has an adverse impact on consumer sentiment. The impact is significant for all three indices used in this study. The coefficient of the air quality index is roughly equal to one standard deviation of the consumer confidence index. The reverse causality test shows that consumer sentiment or economic activity does not impact air pollution, and this relationship is only one-way. Control variables such as dummies for floods, terrorist attacks, average level of education, and average level of income for each city are included in this study to gain an improved model fit. The results are consistent for all the specifications. Given the significant impact of air pollution on consumer sentiment – a leading indicator of economic activity–stakeholders, particularly the government of Pakistan, need to tackle the surging issue of air pollution.

Competing Interests: The author declare that no conflicts of interest exist.

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Ethical compliance: This study does not require ethical approval because it does not involve human participants and is based on secondary data analysis.

Declaration: I hereby declare that the ideas, concepts, and research presented in this work are entirely my own. I used AI tools solely for purposes of enhancing articulation, grammar, and rephrasing, ensuring clarity and coherence. The original intellectual content, analysis, and findings remain the product of my independent effort.

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