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A Double-Edged Sword: Impact of Covid-19 on the Environment

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About the authors

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In a nutshell

- *The COVID-19 pandemic represents one of the largest economic shocks to world economies in recent decades. Its negative effects on income losses, rising unemployment, declining consumption, mental health deterioration, and increased domestic violence have been documented.*
- *Despite all the negative economic, social, and health-related consequences, COVID-19 offers an opportunity to causally identify and quantify the effect of economic activity on the environment.*
- *Due to the lockdowns, improvements in the levels of greenhouse gas emissions and air and surface water quality may be expected. In this study, we causally examine the effect of reduced mobility and economic activity on the environment.*
- *Our results demonstrate that ambient air quality has significantly improved following the announcement of the first COVID-19 case and the consequent precautions implemented in Turkey.*
- *Statistically, particulate matter (CO, NO2, and NOX) concentrations significantly declined, while O3 and SO2 concentrations remain unchanged.*
- *We also provide suggestive evidence that water pollution has diminished during the lockdown period.*
- *Our results quantify human-induced environmental pollution and magnify the need for designing policy alternatives that harmonize sustainable growth objectives with public health and environmental concerns.*

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COVID-19 in Turkey

As a populous and emerging market, Turkey is among the countries hit hardest by the pandemic economically, and among those with the highest number of cases. As of December 2020, Turkey has the ninth highest number of cases with over 2.9 million cases, 1.6 million recoveries, and 29,696 deaths. Turkey provides a unique setting to study the effect of the COVID-19 pandemic on the environment, as it is one of the fastest countries to impose measures and tight restrictions against it. After the reporting of the first official COVID-19 case on March 10, 2020 and the first death on March 15, 2020, the Turkish government closed schools until further notice on March 16, 2020, Starting March 15, 2020, public places such as malls, bars, restaurants, cafes, theaters, cinemas, and hairdressers were gradually closed. The operating times and capacities of supermarkets and groceries were regulated. Moreover, partial curfews were imposed for individuals over the age of 65 and under the age of 20 on March 22 and April 4, respectively. Since these precautions did not provide the desired decline in case numbers, general curfews were imposed in 31 provinces on weekends between April 11 and May 3, in 23 provinces between May 9 and May 10, in 15 provinces between May 16 and May 19, in 81 provinces between May 23 and May 26, and, finally, in 15 provinces between May 30 and May 31. These restrictions and lockdowns were abolished in June 2021.

The effect of economic slowdown on air quality

We use air quality data from the Turkish Ministry of Environment and the Urbanization Air Quality Monitoring Stations. These data provide several air quality measures including PM2.5 and PM10, inhalable particles with diameters that are generally 2.5 and ten micrometers, respectively, and NO2, which is primarily released from emissions from cars, trucks, buses, power plants, and off-road equipment. We also examine the concentrations of SO2, CO, and O3. From these seven pollutants, we also create an aggregate air quality index using principal component analysis.

We have air quality indicators from 314 stations in 81 provinces in Turkey between January 1, 2018 and July 27, 2021. Table 1 provides summary statistics of the daily concentrations of air pollutants in 314 stations. It reveals that there is too much daily variation that can be attributed both to the seasonality characteristic of the air pollution as well as province-specific differences such as urbanization, industry, population, weather… etc. This variation is especially substantial for PM2.5 and CO concentrations. Therefore, in our estimation framework, we incorporate controls for seasonality and time-invariant city characteristics to account for such potential differences.

Table 2 provides city-level descriptive statistics for the years 2018, 2019, and 2020, respectively. It is hard to detect a single trend across years; while for some pollutants there is an improvement between 2018 and 2020, for others, concentrations display an increasing trend. According to WHO's guidelines for air pollution, interim targets for annual concentrations of PM10 and PM2.5 are 20 μg/m3 and ten μg/m3, respectively. According to Table 2, both pollutants are above the target concentrations. The WHO estimates that reducing the annual average PM2.5 concentrations from 35 μg/m3, common in many developing cities, to the WHO guideline level of ten μg/m3 can reduce air pollution-related deaths by around 15 percent. For NO2, WHO's interim annual target is 40 μg/m3 on average through 2018-2020. NO2 concentrations in Turkey satisfy this limit.

Table 1. Daily concentration of air pollutants

	Number of Obs	Mean	Std. Dev.	Min	Max
PM10 (μg/m^3)	241,571	45.55	38.07	0	1591.74
PM25μgm3	101,126	619,45	124708	.02	3.40e+07
SO2 (μg/m^3)	233,218	12,60	30.91	.03	3658.12
CO (μg/m^3)	111,540	1015.93	33334.51	.09	8695796
NO2 (μg/m^3)	184,693	31.55	25.79	0	594.76
NOX (μg/m^3)	180,814	58.97	77.96	.01	4396.95
O3 (μg/m^3)	130,820	45.015	30.67	.42	1002.74

Notes: Table summarizes daily pollutant levels from 314 stations between January 1, 2018 and July 27, 2021.

Table 2. Annual average concentration of air pollutants in cities

Panel A: 2018

Variable	Obs	Mean	Std. Dev.	Min	Max
PM10 (µg/m^3)	77	50.38	18.66	18.22	129.38
PM2.5 (µg/m^3)	43	24.28	11.96	11.78	86.46
SO2 (µg/m^3)	79	13.46	9.47	4.623	51.61
CO (µg/m^3)	42	1027.02	840.16	416.98	3954.34
NO2 (µg/m^3)	52	28.99	12.56	6.72	68.02
NOX (µg/m^3)	52	51.33	41.29	6.95	289.15
O3 (µg/m^3)	49	43.51	15.41	14.87	78.89

Panel A: 2019

Variable	Obs	Mean	Std. Dev.	Min	Max
PM10 (µg/m^3)	77	46.77	17.06	13.24	136.38
PM2.5 (µg/m^3)	46	22.39	8.25	6.12	53.55
SO2 (µg/m^3)	78	12.88	8.94	3.35	57.99
CO (µg/m^3)	44	735.07	240.43	282.89	1229.41
NO2 (µg/m^3)	57	33.55	18.29	6.94	122.46
NOX (µg/m^3)	57	53.37	28.64	13.19	184.42
O3 (µg/m^3)	56	42.80	19.04	14.50	118.17

Panel B: 2020

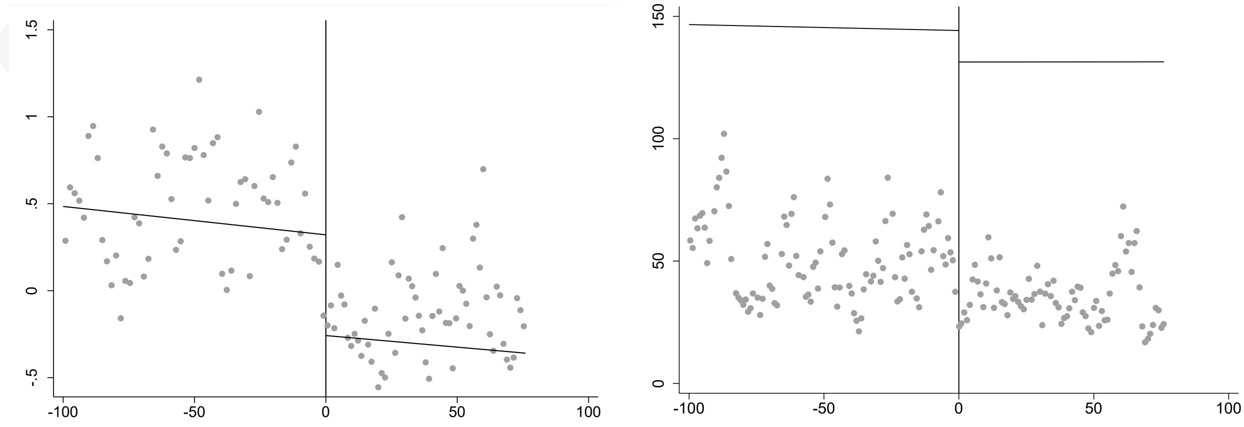
Variable	Obs	Mean	Std. Dev.	Min	Max
PM10 (µg/m^3)	79	46.98	15.06	15.30	109.31
PM2.5 (µg/m^3)	54	23.61	11.82	7.81	85.81
SO2 (µg/m^3)	79	14.96	20.32	3.44	175.48
CO (µg/m^3)	51	916.74	938.43	329.83	7034.91
NO2 (µg/m^3)	62	33.50	14.00	8.93	66.73
NOX (µg/m^3)	62	58.98	30.28	17.34	163.49
O3 (µg/m^3)	61	39.87	15.15	9.54	69.26

Notes: Table summarizes annual pollutant averages by city.

Figure 2. Regression discontinuity plots (air quality indicators)

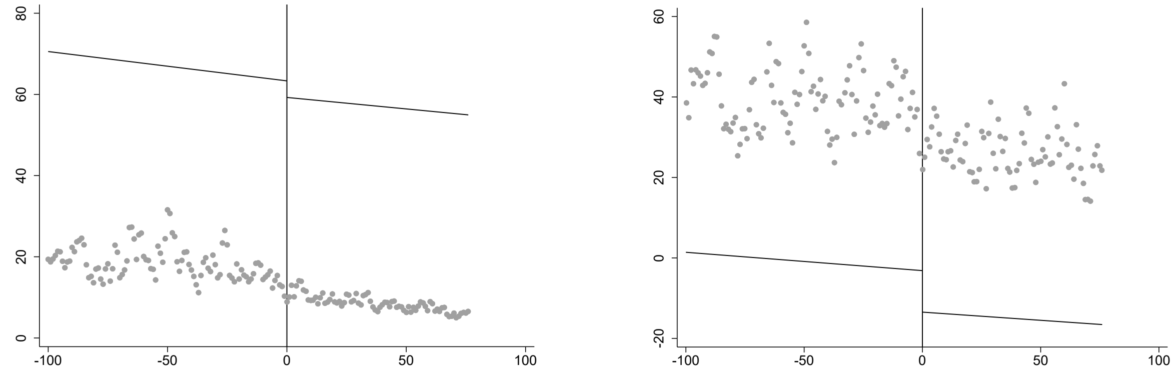
a) AQI

b)PM10



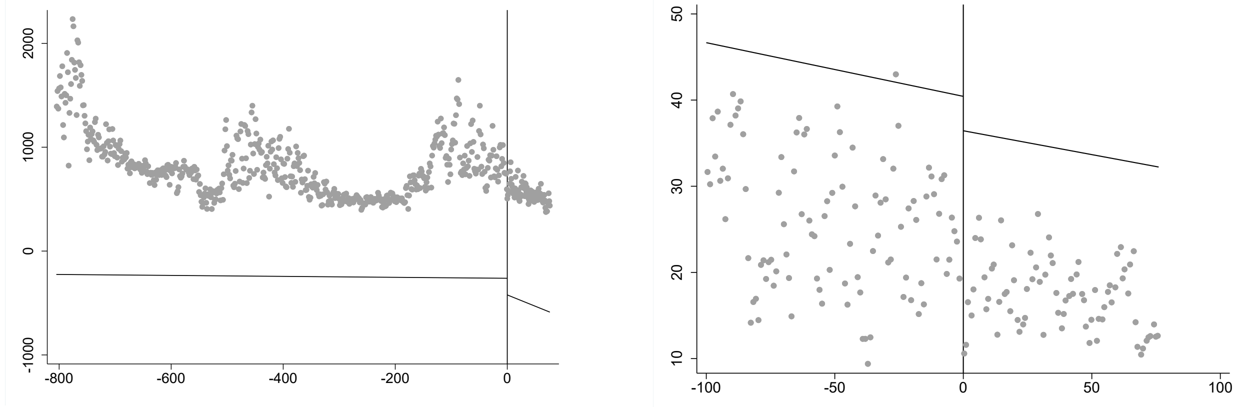
c) NO2

d) NOX



e) CO

f) PM2.5



Nationwide restrictions and lockdowns were first imposed on March 16, 2020, which we take as a cut-off date in our analysis. These figures visually demonstrate the significant and negative impact of COVID-19-related slowdowns on air pollutant concentrations.

For the causal identification of the potential pollution effects of the pandemic, we explore the length of curfews as an exogenous shock to air quality and employ a difference-in-differences design. In this effect, we exploit the temporal and provincial variation in the implementation and length of the curfews to causally quantify the environmental effects of declining mobility and economic activity. Our difference-in-differences analysis assumes that COVID-19 had a disproportionately larger impact on air quality in provinces with curfews and longer curfews than provinces without the curfews.

In addition to the difference-in-differences analysis, we further supplement our analysis with a Regression Continuity (RD) Design by exploring the clear cut-off day in the implementation of the curfews.

Our results show that ambient air quality was improved during COVID-19-related lockdowns and decreased economic activity. Particulate matter (CO, NO2, NOX) concentrations statistically significantly declined, while O3 and SO2 concentrations remain unchanged. We also provide some suggestive evidence that surface water quality was also improved, possibly due to mobility restrictions, air quality improvements, and reduced industrial activity.

Policy implications

Obtaining a better understanding of the impact of economic activities on the environment and climate change is a steppingstone to promote green alternatives that minimize risk to human health and the environment without sacrificing economic efficiency. In such, the results of this study provide policymakers with invaluable information to develop environmentally sustainable economic development strategies.

Quantifying the causal association between economic activity and air quality is particularly important for the countries in the MENA region. This region has the second-highest air pollution levels in the world and, according to the World Health Organization (WHO), air pollution levels are four or five times higher in most of the MENA cities (WorldBank, 2020). Yet, air pollution in the region is currently understudied. The economic costs of the health effects from air pollution include premature deaths and people suffering from respiratory and cardiovascular diseases, among many others, as well as reduced labor productivity. Therefore, it is of academic and policy concern to examine the effects of economic activity on air pollution levels and incentivize the inclusion of green and sustainable practices in the post-COVID-19 era.

Due to high population growth rates and rapid urbanization, water demand has been increasing rapidly in the MENA region. The overexploitation of surface and groundwater and the uncontrolled discharge of domestic and industrial wastewater, pesticides, and fertilizer-derived plant nutrients into the water resources all contribute to water pollution and exacerbate the already alarming water stress in the region. Future development scenarios are expected to further aggravate these challenges, especially given that the MENA region is among the most vulnerable to the impacts of climate change (IPCC, 2013). As such, it is crucial to study the effects of human-induced changes in pollutants on water pollution, and the COVID-19 slowdown provides an unintended controlled experiment to do so.

In this regard, our results highlight the human-induced environmental impact and its indirect effect on human health. They also provide further empirical evidence supporting the need for governments to design sustainable economic policies that acknowledge public health and environmental concerns.

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