A comparative analysis of air pollution levels during times of international uncertainty: The financial crisis of 2008 and the COVID-19 pandemic of 2020

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INTRODUCTION

During a crisis, economies stagnate as uncertainty grows about the future state of the world. The financial crisis of 2008 led to a severe recession where the global economy halted for approximately two years, causing unemployment and poverty [1]. Coronavirus disease 2019 (COVID-19), which attacks the respiratory system [2], was first identified in Wuhan, China, in late December of 2019. Within a matter of months, it spread globally causing economies to shut down. As distinct as the financial crisis of 2008 may seem from the COVID-19 pandemic lockdowns, both have had devastating effects on national economies and industrial production, resulting in an overall decrease in air pollutant emissions such as carbon dioxide (CO₂) and nitrogen oxides (NO_x). Therefore, parallels can be made between air pollution levels during each crisis. Given air pollution rates increased after the financial crisis of 2008 [3], it is likely air pollution will also rise in the aftermath of the COVID-19 pandemic. This study aims to support this argument by analyzing air pollution trends outlined in the results of several published papers.

COMPARING TRENDS IN AIR POLLUTION LEVELS

The financial crisis of 2008

During the early 2000s up until 2007, housing prices in the United States market were rising [4]. This created a housing bubble that eventually burst in 2007, resulting in a recession [1]. As the US economy crashed, many places such as the European Union followed in economic decline [1]. By 2008, some researchers believed the recession was as severe as the Great Depression [1].

A study conducted by Pacca et al. (2019) analyzed short-term effects on air pollution from several financial crises that took place in the period of 1970 to 2014 [3]. Pollutants

were chosen based on atmospheric abundance. CO₂ and NO_x emissions were analyzed and data were collected from the World Bank [3]. The time period of the data was split into four decades and the percent changes are shown in Table 1.

Table 1. Percent change in emissions during different decades.

	1970s	1980s	1990s	2000s
CO ₂ -pc growth	-0.010 (0.046)	-0.008 (0.012)	-0.018 (0.012)	-0.041*** (0.006)
SO ₂ -pc growth	-0.027 (0.025)	-0.012 (0.011)	-0.023** (0.010)	-0.014 (0.011)
NO _x -pc growth	-0.027* (0.014)	-0.017** (0.007)	-0.013* (0.007)	-0.038*** (0.008)
PM _{2.5} -pc growth	-0.013 0.009	0.001 0.006	-0.005 0.004	-0.008 0.007

Top values display percent change and bottom numbers represent standard errors) [3]. $p < 0.10 = *$, $p < 0.05 = **$, $p < 0.010 = ***$.

In the 2000s, there was a reduction in CO₂ and NO_x concentrations by 4.1% and 3.8% respectively [3]. The results support the argument that a decline in economic activity is related with a reduction in air pollutants such as CO₂ and NO_x. A stagnant economy in 2008 led to lower industrial production and fossil fuel combustion, and therefore, lower air pollution levels. However, the underlying question is, how long does it stay this way?

Pacca et al. (2019) also examined the mid-term effects of financial crises [3]. Over the span of 11 years, with year 0 being the time during a financial crisis, the changes in the levels of CO₂ and NO_x were found [3]. Table 2 shows NO_x levels also increased as the percent changes from year 6 (p -value < 0.010) and 8 (p -value < 0.10) have statistical significance.

Data from The World Bank on global CO₂ emissions show a steady increase in levels from 2004 and up to 2008, as

Table 2. Mid-term effects of a financial crisis on pollutants.

	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CO ₂	-0.031** (0.014)	-0.019 (0.012)	-0.017 (0.014)	0.033 (0.028)	-0.019* (0.010)	0.006 (0.012)	-0.023** (0.009)	0.022 (0.018)	0.001 (0.012)	-0.004 (0.014)	-0.028** (0.013)
N	5968	5815	5662	5509	5357	5205	5053	4901	4749	4597	4445
SO ₂	-0.034*** (0.010)	-0.034*** (0.008)	-0.006 (0.010)	-0.000 (0.008)	0.009 (0.008)	0.016 (0.015)	0.025* (0.015)	0.008 (0.011)	0.017 (0.012)	0.009 (0.010)	0.002 (0.010)
N	5660	5511	5362	5213	5064	4915	4766	4617	4468	4319	4170
NO _x	-0.022*** (0.006)	-0.023*** (0.006)	0.004 (0.006)	0.002 (0.005)	0.004 (0.006)	0.009 (0.008)	0.015*** (0.006)	0.006 (0.006)	0.019* (0.010)	0.009 (0.007)	0.005 (0.006)
N	5661	5512	5363	5214	5065	4916	4767	4618	4469	4320	4171

Top values display percent change and bottom numbers represent standard errors) [5]. $p < 0.10 = *$, $p < 0.050 = **$, $p < 0.010 = ***$.

Figure 1. Global CO₂ emissions in tonnes (t) [6].

displayed in Figure 1 [6]. During the financial crisis (2008-2009), CO₂ levels dropped as indicated by the dip in the graph. However, after the crisis was resolved in 2009, CO₂ levels increased. The crisis' effect on air pollution was completely reversed and pollution levels continued to rise (Figure 1). This was likely because international trade and other industries had restarted [7]. The environmental effects caused by the financial crisis of 2008 were short-lived and soon reversed [3]. Due to its similar effects on the economy, the aftermath of the COVID-19 pandemic may have similar outcomes.

COVID-19 pandemic

COVID-19 was declared an epidemic and a global health concern by the World Health Organization (WHO) on January 30, 2020 [2]. COVID-19 is believed to have emerged from bats; it attacks the respiratory system and can be fatal for people with compromised immune systems [2]. As COVID-19 spread around the globe, international travel, trade, and economies

Figure 2. Changes in NO₂ levels in the troposphere across China from mid-January to mid-March 2020 [9].

were shut down to reduce the transmission of the disease [8]. As a result, several atmospheric changes have been observed internationally. Therefore, geographically spread-out locations have been analyzed for emission changes caused due to the pandemic.

China

Through a Sentinel-5 satellite NO₂ levels in the troposphere above China were monitored [9]. A week before China went on full lockdown in January 2020, the highest NO₂ levels were observed. Figure 2 shows that as the lockdown progressed, NO₂ levels significantly decreased on a weekly basis [9].

Italy

Comparing the March of 2019 and the March of 2020, emissions of NO₂ were reduced by about 20-30% (Figure 4) [10].

United States of America (USA)

A reduction of 30% in NO_2 emissions has been observed over the USA using the AURA satellite [10]. NO_2 levels have decreased, similar to the reduction observed during the financial crisis of 2008.

Figure 3. Changes in NO_2 levels before lockdown and during lockdown (March 2019 and March 2020, respectively) in Italy [10].

Figure 4. Changes in NO_2 levels above the Northeast USA before (March averages from 2015-2019) and after lockdown (March 2020) [10].

Global carbon emissions

Global carbon emissions have also decreased during the COVID-19 pandemic. A study conducted by Quéré et al. (2020) presented the reduction of CO_2 levels during the COVID-19 pandemic using a confinement index (CI) [11]. By mapping the impact of governmental COVID-19 policies, the CI was used to estimate carbon emissions at a country-wide scale [11]. Annual mean daily emissions of CO_2 from 1970-April 2020 were plotted, with an uncertainty of $\pm 5\%$ [11]. Similar to the financial crisis of 2008, the COVID-19 pandemic caused a

reduction in carbon emissions.

Several other studies have also found that air pollution levels have decreased as a result of the COVID-19 pandemic. One such study, conducted by Venter et al. (2020), analyzes the impact of COVID-19 lockdown policies on NO_2 levels in 34 countries, spanning five continents [12]. By comparing satellite data of pollutant levels during January-May 2020 to the three-year average of pollutant levels calculated during the same time-frame, a decrease of 60% in NO_2 levels was found [12]. Ju et al. (2020) have investigated changes in air pollution levels in Korea caused by the COVID-19 outbreak [13]. Their study concludes that there has been 20.41% reduction in NO_2 in 2020. This was found by conducting a paired T-test between the pollution levels from December 2019 to April 2020 and the previous four-year averages for the same time period.

Figure 5. (a) Global CO_2 emissions from 1970-2019 with an uncertainty of $\pm 5\%$. (b) Emission estimates in the red line [11].

What does this mean?

A pattern can be seen in the air pollution levels when comparing the financial crisis of 2008 and the COVID-19 pandemic. There was a sharp decline in polluting gases such as CO_2 and NO_x during the financial crisis [3, 6]. However, soon after the passing of the crisis, these air pollutant levels rose significantly [3]. A similar dip in air pollutant levels can be observed through satellite images during the COVID-19 pandemic (Fig 2-4). NO_2 levels in countries around the world have decreased and a swift reduction in global CO_2 emissions can be observed. Some even question the reduction in emissions to be a “blessing in disguise” [10]. However, the cause for concern is after the economic crises are over.

Emissions decrease as economic activity slows during times of international uncertainty. Yet, it is likely air pollution levels will skyrocket after the passing of the global pandemic, similar to previous financial crises.

Next steps

Air pollution is one of the major factors leading to climate change. The Intergovernmental Panel on Climate Change estimates that at the current rate of emissions of air pollutants, global warming will reach 1.5 °C between 2030 and 2052 [14]. Experts believe this will result in loss of species, ecological degradation, and a higher spread of invasive species [14]. Integrating low carbon footprint technologies like electric cars and solar-powered airplanes [15] will help reduce emissions. The aftermath of the global pandemic should be viewed as an opportunity to implement drastic changes in global policies and industrial practices, in an effort to reduce global air pollution levels.

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