RESEARCH SUMMARY

Can Technology Solve the Principal-Agent Problem? Evidence from China's War on Air Pollution

by Michael Greenstone, Guojun He, Ruixue Jia, Tong Liu

KEY TAKEAWAYS

1. The central government of China awards local officials who are able to achieve economic and social targets with incentives such as promotions. Such an incentive system can be effective in achieving targets, but also creates opportunities to underreport data that could stand in the way of achieving incentives—pollution data being one example.

2. In an effort to increase transparency and improve data quality, the central government installed an automatic pollution monitoring system that publishes air pollution information in real time to the public.

3. Comparing pollution data from before and after the installation of the technology, the researchers find that air pollution concentrations were significantly underreported by the local governments prior to the automation—reported pollution concentrations increased 35 percent immediately after automation. Importantly, satellite measurements indicate no change in true air quality before and after the installation.

4. Those cities with higher GDPs were less likely to underreport the data, while cities with high pollution levels were more likely to underreport the data.

5. With improved air pollution data indicating higher levels of pollution, individuals appeared to respond by taking greater measures to protect themselves from air pollution. Specifically, online searches—a high correlator for purchasing behaviors—tripled for "face masks" and increased by 20 percent for "air filters." The implication is that the manipulated data led people to have a false sense of security and insufficiently protect themselves from air pollution's dangers.

6. Improved data thanks to the automatic monitoring contributed to the Chinese government's successful "war on pollution," as well as individual efforts to protect against harmful pollution.

Introduction

In China, the central government awards local officials who are able to achieve economic and social targets with incentives such as promotions. While such an incentive system can be effective in achieving targets, it also creates opportunities to underreport data that could stand in the way of career advancement. The case of air pollution data is one example where such a situation could occur given that reducing pollution comes with high local economic costs and it is difficult and costly to verify local reporting.

As China experienced rapid economic growth over the last several decades, the demand for better air quality and better data on air pollution increased. The central government launched a "war on pollution," established the Air Quality Index (AQI), and automated a nationwide monitoring network to collect and report pollution information. The system directly collects pollution data from local stations and publicly publishes the data in real time. It is also able to detect data anomalies through built-in algorithms.

Before automation, local environmental bureaus collected data and submitted the data to the central authority without validation. This created possibilities for local governments to underreport the air quality data by, for example, excluding readings from very polluted hours and days, or simply reporting a lower number than was accurate. By underreporting pollution data, the public is unable to take steps necessary to protect their health and the central government is unable to ensure compliance of pollution rules.

With the new system, concentrations of different air pollutants from more than 1,600 monitoring stations are updated on an hourly basis and are available simultaneously on the central government's Ministry of Ecology and Environment website, provincial and municipal environmental bureaus websites, as well as a large number of mobile apps and third-party websites. This real-time sharing of data with the central government and the public enables data to be cross-checked, making it difficult for local governments to underreport and easier for the central government to identify where more stringent local pollution policies are needed.

Research Design

How has the introduction of automatic pollution monitoring contributed to China's successful "war on pollution"? The researchers sought to answer this question.

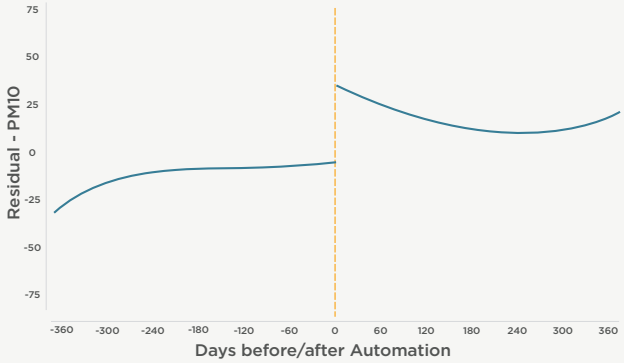
They collected pollution data from before and after automatic monitoring was implemented in 123 cities with 654 monitoring stations to test whether data had been underreported and to what degree reporting improved after the automatic monitoring. The automatic monitoring program was implemented in waves from January 2013 to November 2014.

The researchers also measured the public's response to new, and often higher, pollution readings. They did so by monitoring online searches for face masks and air filters, noting that these searches highly correlate with sales.

Findings

1. The installation of automatic pollution monitors immediately led to significantly higher reported pollution concentrations and improved the quality of pollution data being reported. The researchers discovered that reported particulate matter (PM_{10}) concentrations increased by 35 percent immediately after automatic monitors were installed, though satellite measurements suggest no change in air quality immediately before and after the start of the technology. This suggests air pollution concentrations were being underreported by local government officials prior to the installation of the automatic monitors.

Figure 1 · Reported PM_{10} Concentrations Before and After Automation



Note: This figure illustrates changes in reported PM_{10} concentration before and after automation. Monitoring station fixed effects, month fixed effects, and weather conditions are absorbed before plotting the figure.

> "This study demonstrates the critical role greater transparency and improved data quality played in China's efforts to reduce the harms of air pollution. Unpacking what is allowing China to win its war on air pollution is important in its own right but also very useful for other countries considering taking up this challenge."
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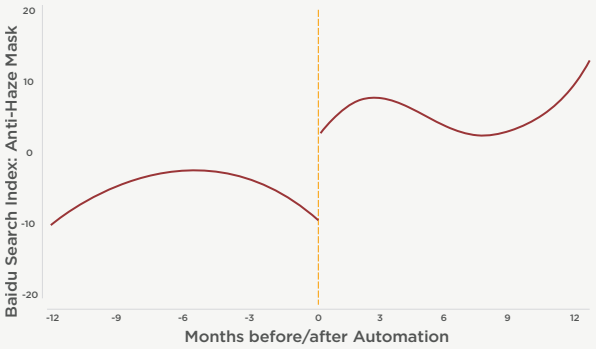
> **MICHAEL GREENSTONE, THE MILTON FRIEDMAN DISTINGUISHED SERVICE PROFESSOR IN ECONOMICS, THE COLLEGE, AND THE HARRIS SCHOOL; DIRECTOR, EPIC**

2. Cities where the quality of pollution data improved the most had higher pollution levels overall and lower GDP. The researchers discovered that nearly half of the cities they studied had underreported pollution data to the government prior to the installation of automatic monitors—some reporting concentrations that were more than 75 $\mu g/m^3$ lower than monitors were reporting (the WHO guideline on annual average PM_{10} is 20 $\mu g/m^3$). Those cities with higher GDPs were less likely to underreport data, while cities that suffered from high pollution were more likely to underreport data. In the case of the latter, the improved data quality is particularly important to pollution rule compliance efforts.

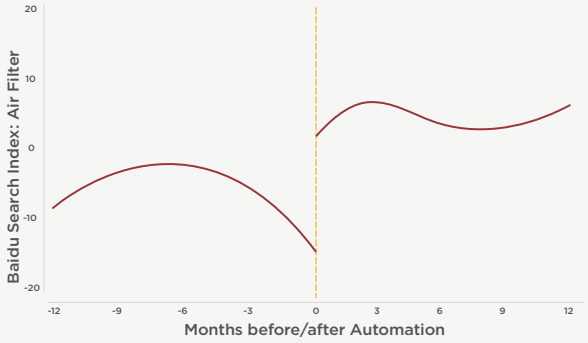
3. The introduction of automated monitoring likely led individuals to purchase more air filters and face masks to protect themselves from heavy pollution. Monthly online searches for "face masks" tripled after automation and searches for "air filters" increased by 20 percent. The implication is that the manipulated data led people to have a false sense of security and insufficiently protect themselves from air pollution's dangers. This finding underscores the human costs of inaccurate data, as well as the central role that people play in protecting themselves from air pollution.

Figure 2 · Baidu Searches for 'Anti-Haze Mask



Note: This figure illustrates changes in Baidu search index for anti-haze face masks before and after automation. City fixed effects, month fixed effects, and weather conditions are absorbed before plotting the figure.

Figure 3 · Air Filter' Before and After Automation



Note: This figure illustrates changes in Baidu search index for air filters before and after automation. City fixed effects, month fixed effects, and weather conditions are absorbed before plotting the figure.

"While the fight against air pollution continues to be an ongoing priority for the central government, the installation of automatic pollution monitors has played an important role in improving data quality, increasing compliance, and ultimately reducing pollution across the country,. Along with government actions, an accurate picture of pollution has led more Chinese people to take important steps to protect their own health through the purchase of pollution masks and air filters."

GUOJUN HE, DIRECTOR OF RESEARCH, EPIC-CHINA; ASSISTANT PROFESSOR, HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY.

Policy Recommendations

The Chinese government's successful "war on pollution" has led to improved air quality across the country. Countrywide, particulate pollution (PM2.5) declined by about 43 percent from 2013 —before the "war on pollution" had been declared —to 2019. This improvement is due to a number of strong government actions. This study demonstrates that the central government's work to increase transparency and improve data quality through the installation of automatic pollution monitors was a central part of its "war on pollution." These findings are useful in understanding the roots of China's success, but also for other countries considering policies to reduce air pollution, which the Air Quality Life Index (AQLI) finds is the world's greatest current threat to public health.

The Energy Policy Institute at the University of Chicago (EPIC) is confronting the global energy challenge by working to ensure that energy markets provide access to reliable, affordable energy, while limiting environmental and social damages. We do this using a unique interdisciplinary approach that translates robust, data-driven research into real-world impacts through strategic outreach and training for the next generation of global energy leaders.