RESEARCH SUMMARY

Willingness to Pay for Clean Air: Evidence from Air Purifier Markets in China

by Koichiro Ito and Shuang Zhang

KEY TAKEAWAYS

1. Air pollution leads to about 6.5 million deaths each year and serves as a major impediment to economic progress. Emerging economies experience the highest levels and worst impacts of this pollution. With a clear link between air pollution, health problems and economic costs established, governments are now proposing and implementing ways to combat air pollution.

2. Optimal environmental regulations depend on the extent to which individuals value air quality improvements—that is, their willingness to pay for clean air. This study provides some of the first evidence for citizens' willingness to pay for cleaner air in emerging economies.

3. The researchers used monthly air purifier sales, monthly average prices paid and detailed product attributes such as effectiveness in reducing pollution, combined with pollution and demographic data. They also took advantage of a natural experiment rooted in the Huai River policy, which subsidized coal-based central heating for people living north of the river.

4. The study found that pollution is 30 percent higher in cities north of the Huai River compared to cities in the south, and the market share for air purifiers with the strongest filters (HEPA)—which reduce almost all of indoor air pollution—is substantially higher in the north. This reveals that the higher the pollution the more likely people are to buy air purifiers that mitigate indoor air pollution.

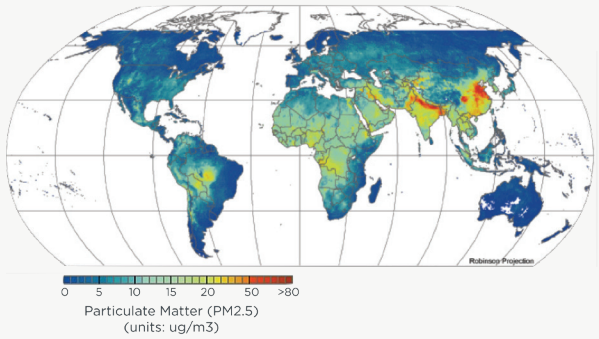
5. From the data analysis, the researchers conclude that on average people are willing to pay $5.46 to remove one microgram per cubic meter (ug/m3) of pollution out of the air. But, how much people are willing to pay varies widely depending on their income, with a range of zero to $15.

6. People's willingness to pay is a key barometer for policymakers trying to determine which rules and regulations are most effective in enhancing welfare. It further sheds light on the degree to which citizens prioritize economic growth over environmental regulations—a subject of constant debate and importance in both emerging and industrialized economies.

Introduction

Air pollution leads to about 6.5 million deaths each year, making it the world's fourth-largest threat to human health, according to a 2016 report by the International Energy Agency. Emerging economies experience the highest levels of pollution, particularly cities in India and China where growth in energy demand and pollution has gone hand-in-hand with economic growth.

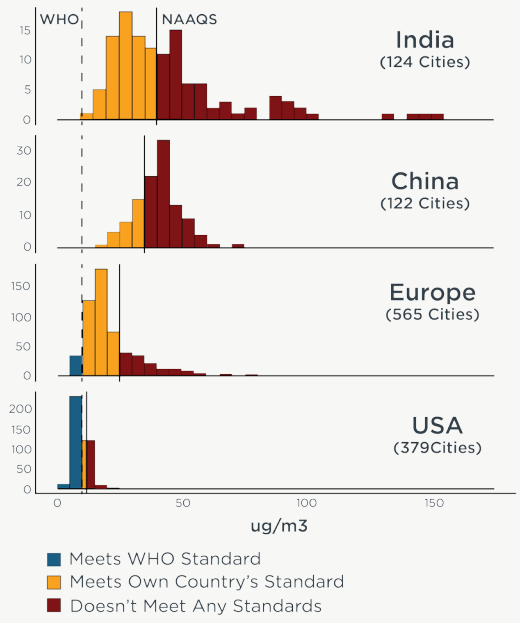
Figure 1 · Global Annual Particulate Pollution (PM2.5)



Source: CIESIN Columbia University, April 2013

Annual average exposure to fine particulate matter pollution in China was more than five times higher than that of the U.S. in 2013. Further, 97 percent of the population in China breathes air considered unsafe by the World Health Organization (WHO), and 66 out of the 74 major Chinese cities subject to air quality monitoring don't meet China's own air standards, according to China's Ministry of Environmental Protection. Industrial centers such as Beijing and Hebei province face the highest levels of pollution. There, rapid growth has made pollution an unfortunate part of everyday life.

Figure 2 · Annual Average PM2.5



Because emerging economies have some of the highest levels of pollution, they also face the highest risks. A study by University of Chicago economist Michael Greenstone and his colleagues found that fine particulate matter pollution has shortened the lifespans of 500 million people living in northern China, which contains the worst pollution, by 5.5 years compared to the south. China is not alone. Greenstone and colleagues used the same metric derived from the China study and applied it to India. They found 600 million residents in the most polluted regions there are seeing their lives cut short by 3.2 years due to air pollution.

This pollution also has major impacts on the economy. Dirty air increases rates of sickness, in turn increasing heath care costs and decreasing the amount of time spent at work. Shorter lifespans also mean fewer years a citizen can contribute to the economy. According to a 2007 World Bank study, the economic costs of air pollution in China were between about $85-$280 billion in 2003. Economists now consider air pollution to be one of the foremost obstacles to economic development.

With a clear link between air pollution, health problems and economic costs established, governments are now proposing and implementing ways to combat air pollution. In China, Premier Li Keqiang went as far as to declare a "war against pollution" in 2014. China has since enforced tougher fines on polluters and begun upgrading coal-fired power plants to cut pollution from the plants by 60 percent by 2020.

But even if these policies would improve the health of citizens and the overall economy, do they improve the general welfare of citizens? Optimal environmental regulations depend on the extent to which individuals value air quality improvements relative to other goods—that is, their willingness to pay for clean air. If citizens are not willing to pay much for clean air, it may be because they prioritize economic growth instead. Therefore, citizens' willingness to pay for clean air is a key barometer when considering the trade-offs between economic growth and environmental regulation. This trade-off is the essential question regulations in emerging economies must contend with each day.

> "Knowing people's willingness to pay for clean air can help leaders determine which energy and environmental policies are most effective in improving welfare at a critical time."
>
> **KOICHIRO ITO**
> **ASSISTANT PROFESSOR, UNIVERSITY OF CHICAGO**

Research Design

This study provides some of the first evidence of citizens' willingness to pay for cleaner air in emerging economies. The approach is based on the idea that if households value clean air, then they would buy air purifiers to clean the air in their homes.

The researchers collected data on HEPA air purifiers sold in retail stores in 81 Chinese cities from January 2006 through December 2012. Air purifiers with a HEPA filtering system reduce almost all indoor air pollution. From this data they were able to learn how many air purifiers were sold each month, the average price paid and other product attributes such as each purifier's effectiveness in reducing air pollution. They also collected pollution data from air pollution monitors and demographic information from the Chinese census.

In order to compare buying patterns in an area that is highly polluted to a cleaner area, the researchers took advantage of a natural experiment created by a unique Chinese policy. In the 1950's, China introduced the Huai River policy, which provided free coal-based heat to those living north of the Huai River while those in the south were not provided with free coal heating systems. This policy caused pollution in the north to be substantially worse than in the south. And while the heating subsidies ended in 2003, the basic system remains in place, as does the heavy pollution (read in more detail about the Huai River policy and subsequent reforms in the Policy Lessons section).

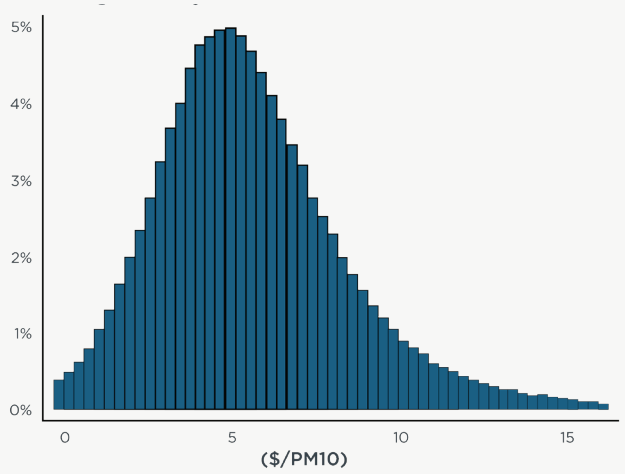
Because of another policy that banned or discouraged mobility from one city to another, the people living in these highly-polluted cities were forcibly exposed to it for decades. This provided the researchers with data that showed how people respond to long-run exposure rather than just short bouts of heavy pollution.

Findings

1. More people purchase air purifiers in cities with high air pollution. Pollution is 30 percent higher in cities north of the Huai River compared to cities in the south. This finding is consistent with other studies. The air purifier data shows that cities that experience a higher level of pollution also sell more HEPA air purifiers. In the south, the market share of HEPA purifiers was around 50 percent. In the north, the share was over 70 percent. So, the 30 percent increase in pollution resulted in about a 20 percentage point increase in the market share for HEPA purifiers.

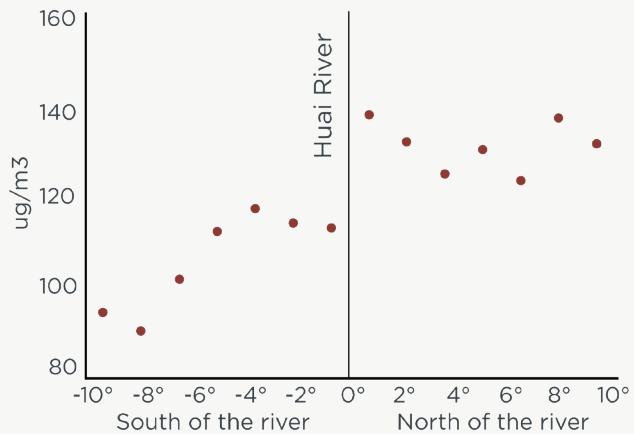
2. People are willing to pay on average $5.46 per microgram per cubic meter (ug/m3) of pollution to clean up their air. On average people are willing to pay $5.46 to remove one unit of pollution out of the air. Because the Huai River policy results in 39 units of fine particulate matter pollution (PM10), people's willingness to pay to remove the pollution caused by the policy would come to about $200 over five years. The average willingness to pay in emerging economies is lower than the willingness to pay in developed countries.

Figure 4 · Willingness to Pay for Clean Air

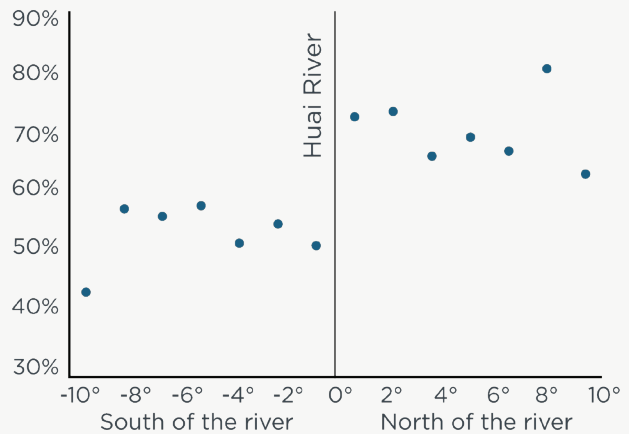


3. The more money people have, the more they are willing to pay for clean air. The above data represents an average across income levels. But how much people are willing to pay to reduce pollution in the air they breathe varies widely depending on income. The researchers found that higher-income households would pay up to $15 per microgram per cubic meter of pollution over five years to reduce pollution, while low-income households were willing to

Figure 3 · Level of Air Pollution (PM10)



Market Share of HEPA Air Purifiers



pay little to nothing for that clean air. This finding, that income highly impacts people's willingness to pay for clean air, is consistent with the finding that people in emerging economies are on average willing to pay less for clean air than people in developed countries.

Policy Lessons

Armed with a greater understanding of the problems that come with increasing levels of air pollution, leaders in emerging economies are rapidly proposing new policies to confront pollution. Having a barometer that indicates people's willingness to pay for clean air can help these policymakers determine which rules and regulations are most effective in enhancing welfare.

This is especially important knowledge to have in these countries because they have the greatest need to effectively reduce pollution at the least cost, given their limited amount of resources. Further, this barometer sheds light on the degree to which citizens prioritize economic growth over environmental regulations—a subject of constant debate and importance in emerging economies.

To demonstrate how people's willingness to pay can influence environmental reforms, the researchers conducted a case study using the reforms to the Huai River policy.

Prior to 2005, the Huai River policy had created a system that was both inflexible and inefficient. While the burden for paying for heat largely shifted from the government to the consumer in 2003 as the country underwent a transition to a market economy, consumers still had little control over their heat or a way of measuring their consumption. Most of the heat was being generated and controlled by large boilers within apartment complexes and households paid a flat fee.

In 2005, the Chinese government and the World Bank initiated pilot reforms to improve the system in seven northern cities. In order to save energy and reduce pollution, the reforms introduced household metering and consumption-based billing under which consumers could control their own heat and paid for the heat they consumed.

Using back-of-the-envelope calculations, the researchers found that the willingness to pay for the reforms is $1.88 million per city per year. This represents the total benefits of the reforms for households. Because the benefits are substantially larger than the costs of $13,000 per city per year, the researchers determined that the reforms were cost-effective. Further, they drew from this that the expansion of the heat reforms to other northern cities could enhance household welfare.

This case study shows how the willingness to pay can be used to take into account the benefits of reforms, and compare those benefits to the costs. This would be vital knowledge for policymakers to have in order to assess whether to implement certain environmental reforms over others. Further, this knowledge comes at an opportune time as policymakers in emerging economies ramp up efforts to reduce pollution.

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