Are Perceptions of Air Quality More Negative for Those Who Live Close to Coal-fired Power Stations?

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Transitioning towards green energy by phasing out coal power for less-polluting alternatives, such as wind and solar energy is one of the key changes that is required to fight against climate change. Renewable technologies are now sufficiently scalable to replace much of the capacity generation of coal-fired power plants and fast-growing R&D investments in energy storage technology are helping address challenges of variable grid demand. Thus, a green energy transition looks more technologically feasible now than ever.

For this to happen, citizens of countries that use coal-fired power have to put pressure on their governments to act. As well as being a fossil fuel, coal-fired power is also highly polluting form of energy production with detrimental consequences for air quality. But it is far from obvious that even those who experience this are aware of it. And, if that is not the case, political forces seem less likely to be unleashed (Besley and Persson, 2022).

To investigate whether perceptions are affected by proximity to coal-fired power stations, we make use of global attitudes data on ambient air quality perception from the Gallup World Poll, a nationally representative annual survey covering roughly 99% of the world's adult population living in more than 160 countries. We focus on measuring local effects, exploiting spatial granularity at the geocode level i.e., latitudes and longitudes of survey respondents. We are therefore able to detect whether they are located within 40 km of an operational coal-fired power plant. We have sufficient data and coverage to perform this exercise for 51 countries around the world, a sample which is generally focused on low and middle-income countries.

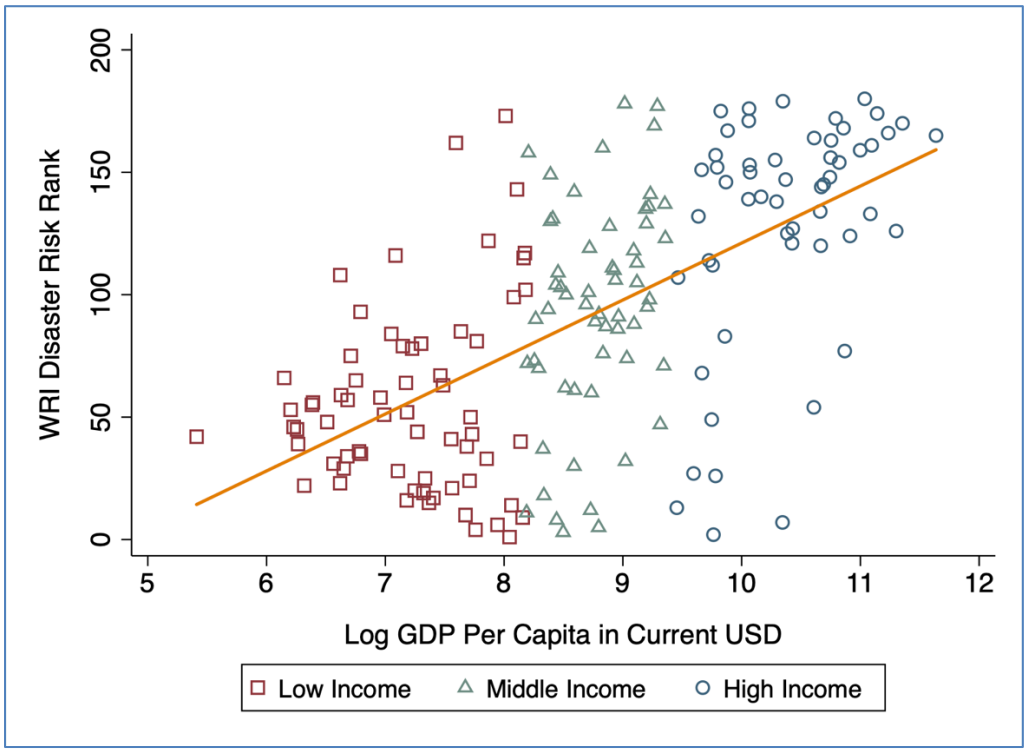
- **The Need to Study Low- and Middle-Income Countries**

Despite the technological feasibility, while high income countries in Western Europe and the United States have ramped-up investments in renewables and pushed most of the existing coal-fired power plants either for retirement or conversion into natural gas, coal power continues to see strong investments in fast-growing economies of the world, including China and India. Given that these countries are expected to see tremendous growth in energy demand in future, they warrant utmost attention from researchers and policymakers.

For a variety of reasons, including data availability and the focus of most researchers, much prior research on environmental damage and climate change has concentrated on the developed world, primarily the United States and the Europe. However, the damages due to global warming are predicted to be disproportionately higher in the global south (Cruz and Rossi-Hansberg, 2021). There is scope therefore for studies that close this knowledge gap by being representative of low- and middle-income countries. New research in Besley and Hussain (2022) on which this brief draws makes a stride in this direction.[1]

[1] We are grateful to the British Academy for support under the Shared Understandings of a Sustainable Future programme and to Gallup Inc. for granting access to the World Poll data.

Figure 1: Relationship Between World Risk Index Disaster Risk Rankings and GDP Per Capita for Low-, Middle-, and High-Income Countries in 2019



Notes: This chart presents a scatterplot of the WRI country-level disaster risk rankings and country-level GDP per capita in 2019. Rankings are in decreasing order i.e., countries with lower ranks are at higher risk of damages caused by disaster events. The ranking considers exposure, vulnerability, susceptibility, coping capability, and adaptive capacity of the overall country. This data is generated and maintained by the United Nations University. Low-, middle-, and high-income country classification is done by partitioning the countries in three quantiles based on their 2019 GDP per capita numbers as reported in the World Bank national accounts data. The chart suggests that low- and middle-income countries are placed at lower values in ranking, thereby are at higher risk of disasters unfolding due to climate change.

- **Linking Location and Perceptions**

Environmental psychologists are increasingly engaging with research on understanding the role of individuals' characteristics, beliefs, and incentives and location attributes such as past events, risks projections, urbanicity, etc. on adaptation and mitigation of climate change damages (Whitmarsh, 2008; Poortinga et al., 2019; Diekmann and Preisend¨orfer, 2003). Domestic and international policies to reduce carbon emissions are likely to be encouraged if citizens, firms, and civil society demand change. It is important to know about the factors that lead people to demand change and studying drivers of their perceptions about the environment around them is a good starting point for studying this.

There is robust relationship between location of individuals relative to an operational coal-fired power plant and their dissatisfaction with the ambient air quality highlights that a group of citizens, in this case those living within 40 km distance band from coal plants, are more eager to demand climate change mitigation than others. This relationship is qualitatively robust to various location characteristics, such as vegetation cover, urbanicity, etc., perturbation in the distance band considered, and individual-level attributes, such as gender, age group, etc. This is an important finding because it uncovers citizens' incentives in place,

which among many others could be better health for themselves and their children, to get rid of coal power and support a clean energy transition.

Whether this is a causal relationship is moot. For example, people choose their residential location and that could be affected by their willingness to tolerate air pollution. Governments may also sanction locations where they perceive that opposition will be lowest i.e., where people are less concerned about pollution. Thus, we can never hope to get an ideal experimental setting where it is as if individuals are randomly allocated to locations, some of which are near and others far away from the coal-fired power plants.

To worry about this, we look at factors that affect the location of coal-fired power stations independently of the attitudes of residents. We conjecture that the distance of a location from railroads and waterbodies are candidates for creating such variation. There is a compelling argument for this since railways and waterbodies constitute important transportation links for procurement of raw materials, with waterbodies providing additional advantages, such as reliability of water supply and ease of waste treatment, for plant operation. And we do find that these measurable locational factors are strongly predictive of coal-fired power station locations, while not affecting perceptions of air pollution directly. (To offer further credence to the argument, we also include an array of additional variables as controls.) Using this argument, we get "as-if" random variation in location of individuals with respect to operational coal plants. This allows us to claim that we pin down a causal effect. And we show that the results are indeed robust when we use this source of "as if" random variation.

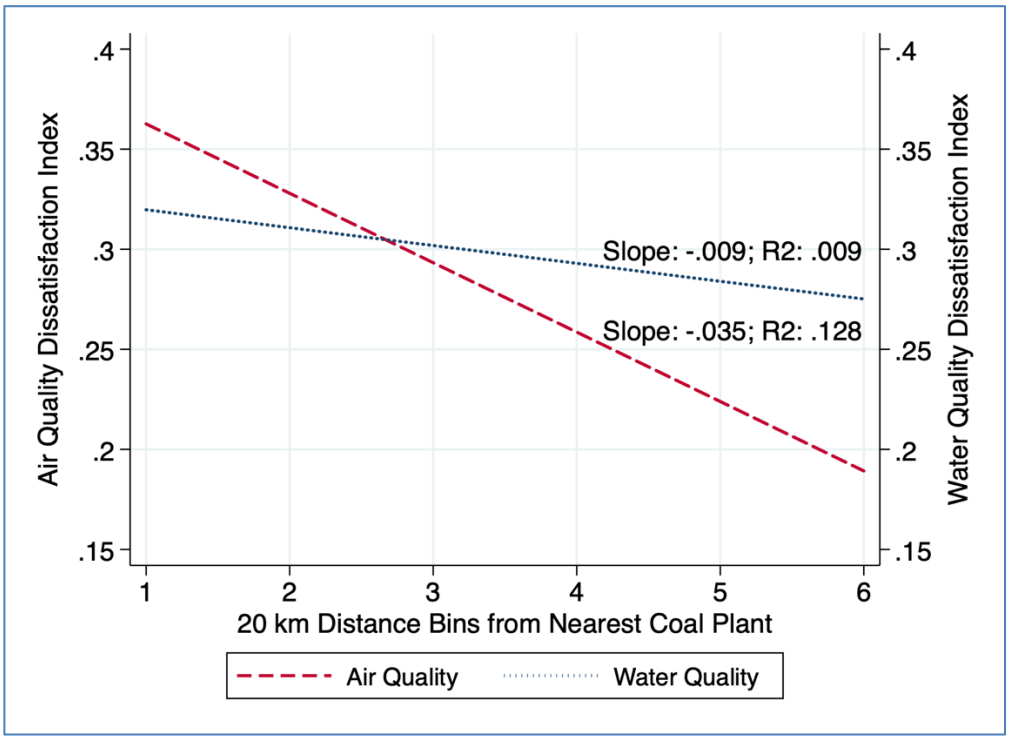
- **A Placebo Test**

The core finding that air quality dissatisfaction is negatively correlated with distance from nearest coal plant does not hold for locations that are in 40-80 km or 80-120 km distance bands, thereby highlighting that the effect is "local". In addition, we do not find any effect of *future* plants i.e., plants that are planned but are not operational in 2019 and *retired and mothballed* plants, which are plants that have been closed, on individuals' air quality dissatisfaction. Though carbon-dioxide is a major air pollutant that is also present in significant proportions in coal plants exhausts too, the total annual plant-level emissions do not affect perceptions on air quality.

- **Risk Perceptions**

When it comes to risk perceptions, we draw on the Lloyd's Register Foundation World Risk Poll, which includes questions on climate change. We then find that being located near to coal plants affects pollution risk perceptions but is not correlated with risk perception towards climate change damages. This focuses attention on how creating negative perceptions of air quality can translate into concerns about future climate risk. For this, more research is needed that studies how to anchor narratives and policy discussions on local manifestations of externalities, so that citizens make the connection between observable manifestations of activities that produce carbon and their concerns about climate change. Only then, is it likely that they will be eager to support policies to mitigate them.

Figure 2: Relationship Between Air/Water Quality Dissatisfaction and Households Distance from Nearest Coal-fired Power Plant for 51 Sampled Countries in 2019



Notes: This chart presents best linear-fit lines of country-level air (left axis) and water (right axis) quality dissatisfaction with respect of 20 km distance bins from nearest operational coal-fired power plant for the 51 countries in the main sample. Each distance bin only considers those survey observations that qualify based on the distance restriction from the coal plant. For example, bin 3 only uses survey observations, which are in 40-60 km distance band from an operational coal plant. The graph shows that the air quality dissatisfaction goes down with increasing distance from a typical working coal plant but, as expected, perceptions on water quality do not change much with distance.

- **Who Cares?**

When we look at differences in the population, there are string links to educational attainment. Educated elites i.e., those with higher levels of education, are comparatively more dissatisfied with ambient air quality. This divorce between the concerns of elites who may have been exposed to a lot more discussion of climate change concerns is a common feature of studies using survey data (Dechezleprˆetre et al., 2022). While they may have more sway in the political process, increasing the breadth of concern could potentially have consequences for how policymakers respond. This is especially true when there are economic sacrifices to be made to make a green transition.

- **Estimating Willingness to Pay for Clean Air**

Scientific evidence has robustly championed concerns about the detrimental effects of coal power. But there are people who benefit from the status quo through employment opportunities both directly in the plants and indirectly in coal mining and associated activities, support for local public amenities maintenance, etc. Shutting down coal plants or replacing

them with renewables would have distributive effects. Looking at these distributional consequences is an important topic for further research.

Previous work on calibrating the willingness to pay (WTP) for clean air has used "objective" measures of air pollution such as lead and NOx content in air (Welsch, 2006). However, the correlation between objective and subjective measures of air quality is not always strong and the perceived air quality seems to matter more for economic decision-making (Chasco and Gallo, 2013). By looking at perceptions of air quality, we can however, gain some insight into how people value air quality and hence what would be the implicit "willingness to pay" for moving away from coal-fired power. Of course, this does not mean that people will actually pay in practice, but we can still calibrate how perceptions of air quality affects their well-being and hence how it compares to the effect of income on well-being (Layard et al., 2008).

Our findings suggest significant effects of both income and air quality dissatisfaction on overall life satisfaction. Using the quantitative relationship between the well-being indicator, which is measured on a 10-step Cantril ladder, and income and air quality dissatisfaction level, one can calibrate an "exchange rate" between air quality and money to arrive at a measure of the willingness pay for clean air, i.e., amount of income that an average individual needs to be given to compensate them for an increase in pollution. This can be used to inform policies through a kind of cost-benefit analysis. For example, we could see whether transition from coal power to green energy is feasible, given the benefits and the costs. And we could look at this for different countries across the world.

Looking at differences in our measure of willingness to pay across education groups, the educated elite group again stands out; being nearly two to three times of other education groups. In terms of differences across space, we estimate that Indians are less concerned on average. This is perhaps not surprising given that India is a middle-income country where people care more about income than air quality for achieving greater life satisfaction.

The numbers are far from definitive and there are many caveats. For example, we have only looked at changing the generation mix away from coal-fired power, but there are important issues around maintaining a balanced system using storage technology, which gives some insurance against days when the sun does not shine sufficiently and/or there is insufficient wind. So, a more sophisticated calculation would have to take this into consideration, but this research is certainly a step towards thinking on how to plan and evaluate clean energy transition projects, which are going to be common in the near future.

- **Take Away Messages**

Research with survey data is an important part of studying the forces that can shape a green transition towards lower carbon energy sources. Although our research gives some insight that could inform the policy debate, it is not able to tackle all the issues that matter. However, our findings do illustrate the power of research using geo-coded data.

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