advantage

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Pollution & Climate Change Special

In this issue ...

Welcome to the Pollution and Climate Change special issue of *Advantage*

Floods, droughts and wildfires have claimed headlines this summer, re-emphasising the importance of taking bold measures to stop global climate change. Against this backdrop, the 26th UN Climate Change Conference of the Parties will convene in the UK this November. The UK has already set itself as a global leader, pledging to achieve net-zero greenhouse gas emissions (GHG) by 2050. But the path to net zero is uncertain. It will require efforts in all sectors of the economy and a shift in both policy and individual behaviour.

In this issue, we examine the costs of pollution and climate change and discuss the policies designed to tackle them. Stephen Jarvis asks how can we expand renewable wind energy given siting constraints. No one wants wind turbines in their backyards, so they end up in remote, and potentially ill-suited locations, substantially increasing the cost of deploying wind energy. Yet policies to incentivise the use of better locations are possible. Stella Carneiro uncovers loopholes in regulation designed to curb deforestation for cattle raising (a source of GHG) in the Amazon. Better monitoring will be needed to further disincentivise deforestation in the future.

One point of the UK government's 10-point plan for a green industrial revolution is green buildings. Nanna Fukushima shows that replacing house coal with a non-smoke emitting alternative between 1957 and 1973 significantly decreased infant mortality. Similar policies to improve air pollution in low- and middle-income countries could have huge effects.

There is no doubt tackling pollution and climate change will generate large benefits for society. Sonia Bhalotra explores the link between water decontamination and improved cognitive development. Jonathan Colmer investigates the intergenerational spillovers of clean air, while Ludovica Gazze discusses the classroom spillovers of lead exposure. Healthier children have better and more productive lives, and so do their children and grandchildren, as well as the peers they interact with.

And yet, in our Parting Shot, Andrew Oswald reveals sombre data on how much — or better said how little — Europeans care about environmental concerns. The articles in this issue show that action can be taken to tackle pollution and climate change. Encouraging people to act may be the biggest challenge of all.

Ludovica Gazze, Guest Editor

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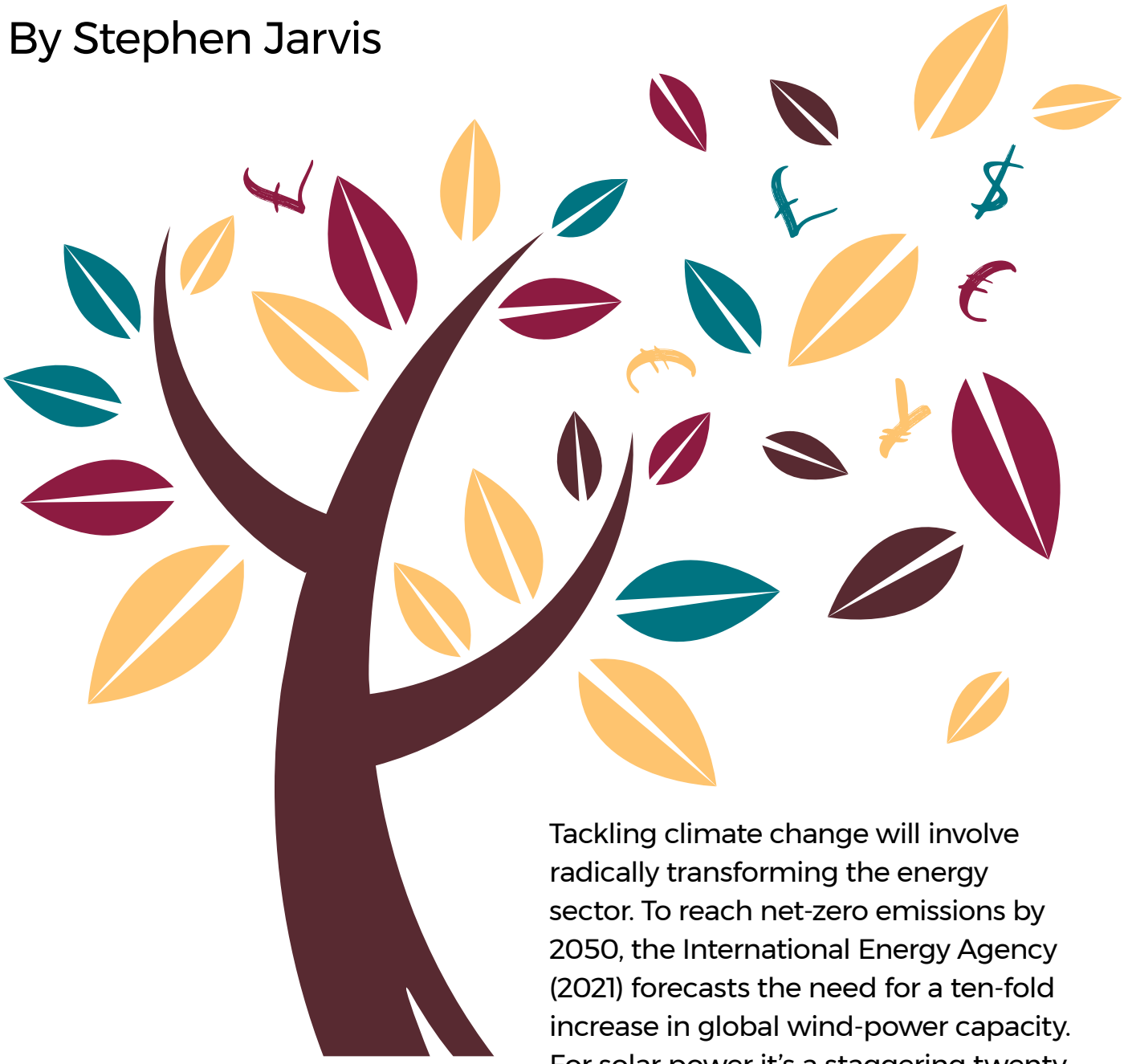
Is NIMBYism driving up the cost of wind energy?

By Stephen Jarvis

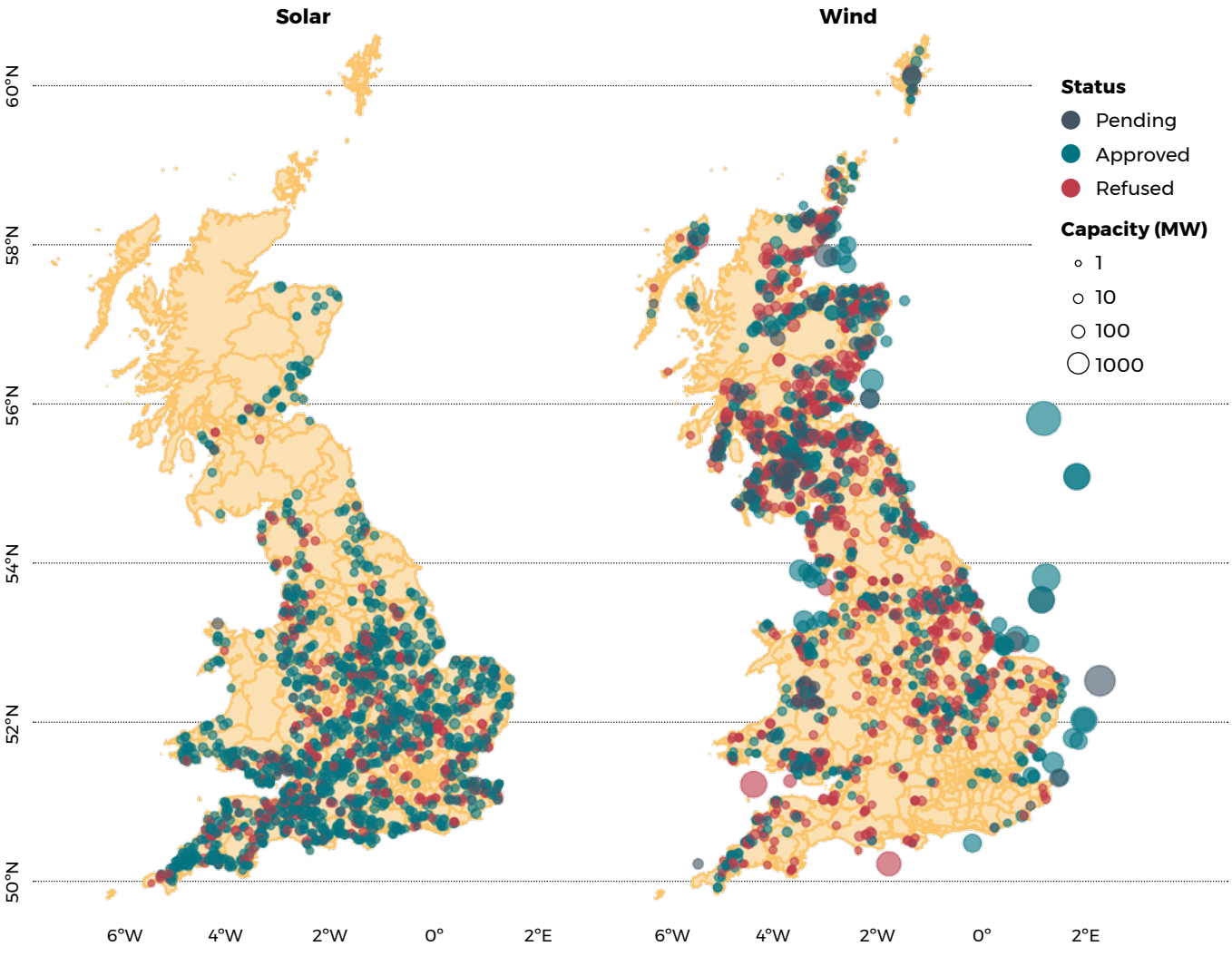


Tackling climate change will involve radically transforming the energy sector. To reach net-zero emissions by 2050, the International Energy Agency (2021) forecasts the need for a ten-fold increase in global wind-power capacity. For solar power it's a staggering twenty-fold rise. Hitting those milestones means adding around 40 million football fields of solar panels and more than half a million wind turbines as tall as the Shard or the Eiffel Tower.

Where, then, is all this going to be located? Fights over infrastructure siting are hardly new, and renewable energy is no exception. In Britain, onshore wind projects have long been contentious (*BBC News*, 2014). Less than half of the wind projects proposed have managed to get planning permission. Even the recent enthusiasm for offshore wind is probably in part because the turbines are located far out at sea — out of sight and out of mind (*The Guardian*, 2020). Solar projects have tended to have an easier time, with four out of five projects proposed getting planning approval. Recently, though, even that has been changing with the emergence of larger solar projects prompting local backlash (*The Economist*, 2021).

It is easy to dismiss opposition to these projects as NIMBYism — the sort of Not In My Back Yard attitude we all love to decry until it is our own back yard under the microscope. In truth, wind farms do appear to impose real external economic costs on nearby residents. One way to quantify this is to look at the impact on nearby property values. I find that the median wind project reduces the value of residential properties within two kilometres by around 4–5%. ▶

Figure 1: Map of wind and solar projects proposed in Great Britain



These effects are concentrated on properties in wealthier, less deprived areas with direct line-of-sight, which is consistent with the main issue being the unwanted visual impacts. For solar projects there does not appear to be much of an effect, although that may change in the future as projects become larger.

While these local impacts are important, what remains unclear is whether the current planning process does a good job of incorporating them into decisions about which projects get built and where. To study this, I examine each of the projects proposed in the UK since 1990, estimating both the local impacts (e.g., on property values) and the wider societal impacts (e.g., the costs of constructing the project and the value of the electricity produced or any emissions abated). I find that there is indeed significant variability in the local costs that wind projects impose. Furthermore, owing to the influential role local planning officials play in the UK, I find evidence that local impacts that are by far the strongest determinant of whether a project is approved.

That local officials pay attention to local factors may be unsurprising — arguably they are just representing the interests of their constituents. The key here is that what may be optimal for a given local area can, in aggregate, create costly outcomes for society. In this case, the misalignment between local and wider societal incentives can lead to the under-provision of renewable energy, or the shift in development to more remote, more expensive projects. This raises the overall cost of climate change mitigation. In fact, I find that the fragmented and localised nature of the planning process has potentially increased the cost of the UK's deployment of wind power by £8–23 billion, or 10–29%.

Some of this can probably be blamed on NIMBYism. There would be significant cost savings from approving more low-cost projects, even when these have significant local impacts. However, that isn't the only issue here. While planning officials are responsive to variations in costs within their local area, they don't appear to pay much heed to how those costs compare with other areas of the country. Finding ways to improve coordination at the regional or national level could therefore yield some real gains, especially where it leads to the beneficial concentration of capacity in the most productive areas.

There are a range of policies that could address some of these misaligned incentives. An obvious one is to try and keep more of the revenues created by a project within the local community. My analysis suggests that a relatively simple system of direct compensation payments could offset most of the local costs experienced by nearby residents, and often do so at a reasonable cost to developers. Schemes like this do exist in many countries, including the UK. However, they tend not to be targeted at individual residents. Moreover, their voluntary nature means provision is patchy, with disadvantaged areas at risk of being left behind. Taking steps to standardise the kinds of benefits local communities can expect from hosting a new renewable energy project could go a long way to helping countries meet their ambitious net-zero goals. ◀

"While these local impacts are important, what remains unclear is whether the current planning process does a good job of incorporating them into decisions about which projects get built and where."

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Investigating environmental loopholes in the Amazon beef supply chain

By Stella Carneiro

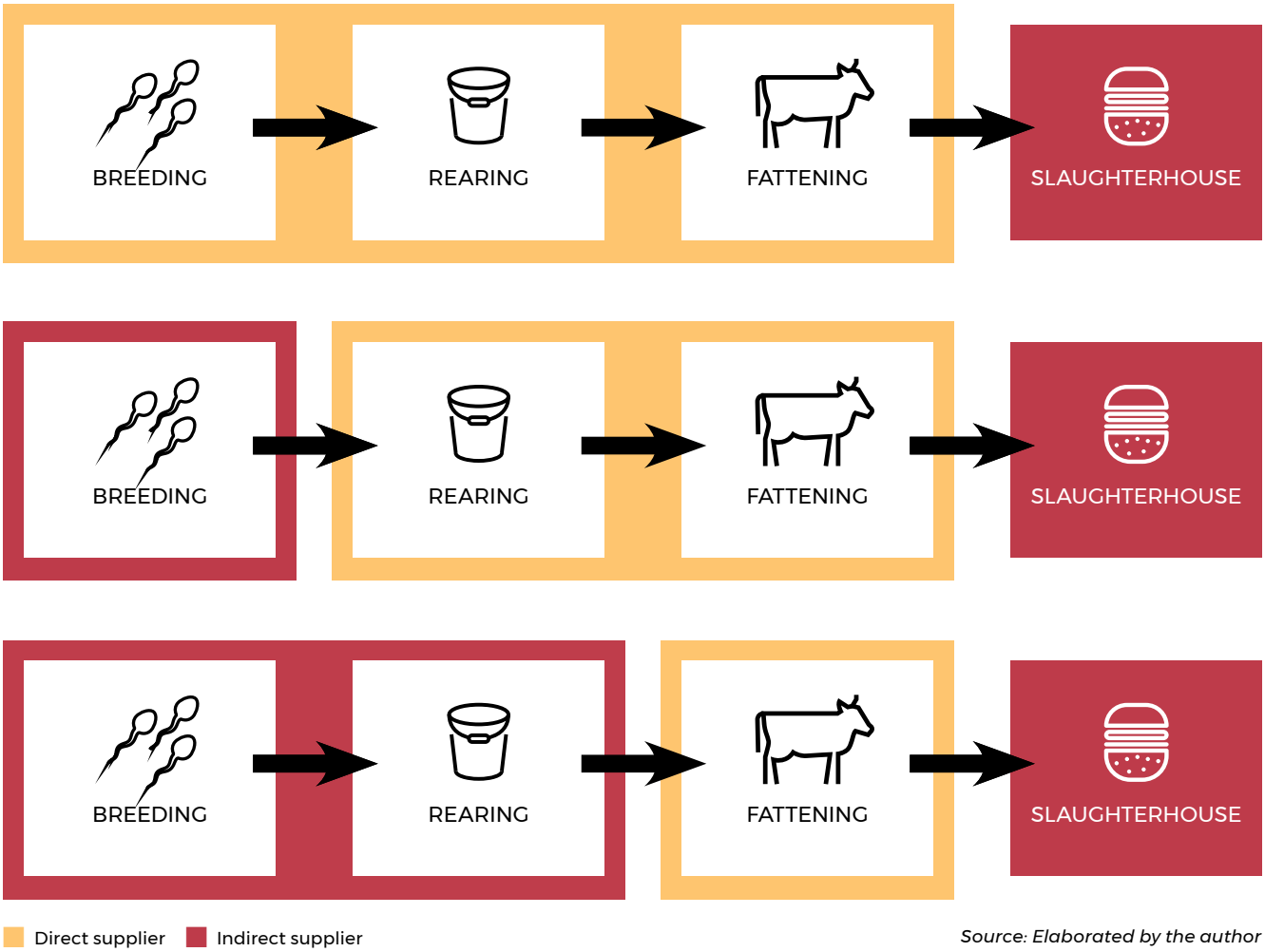
Cattle grazing is the number one activity in newly deforested areas, accounting for 45% of all tree-cover loss associated with agriculture between 2001 and 2015 (Goldman et al., 2020). Much of this deforestation occurred in Brazil (21.8 million hectares: 48% of the total), where pasture expansion into the Amazon's forests is made easy by the region's weak property rights and loose environmental law enforcement. Some argue these features helped Brazil consolidate its position as the largest beef exporter in the world, despite growing backlash from consumer groups and non-governmental organisations (Bowman et al., 2012).

Although the legal limits of deforestation on private properties have been defined since 1965, the tightening of legislation for environmental crimes is relatively recent. Only in 2008 were embargoes of illegally deforested areas made mandatory and fines for whoever acquires animal or vegetable products from embargoed properties established. But some have suggested this regulation has loopholes that can curb its effectiveness (Alix-Garcia and Gibbs, 2017; Gibbs et al., 2016). I investigate this further using a dataset of over 700,000 animal transit permits from the Amazon state of Pará, which lists cattle transactions made between 2014 and 2020.

The cattle supply chain can include multiple intermediaries throughout the stages of animal raising and fattening. When meatpackers purchase cattle from a ranch, they background check only its direct supplier, ignoring if the direct supplier bought cattle from other ranches — so-called 'indirect suppliers' — as described in Figure 1. Animals are bought and sold between multiple ranches in remote areas during their life span before slaughter. The size and complexity of this indirect market hinder law enforcement efforts at this stage in the supply chain.

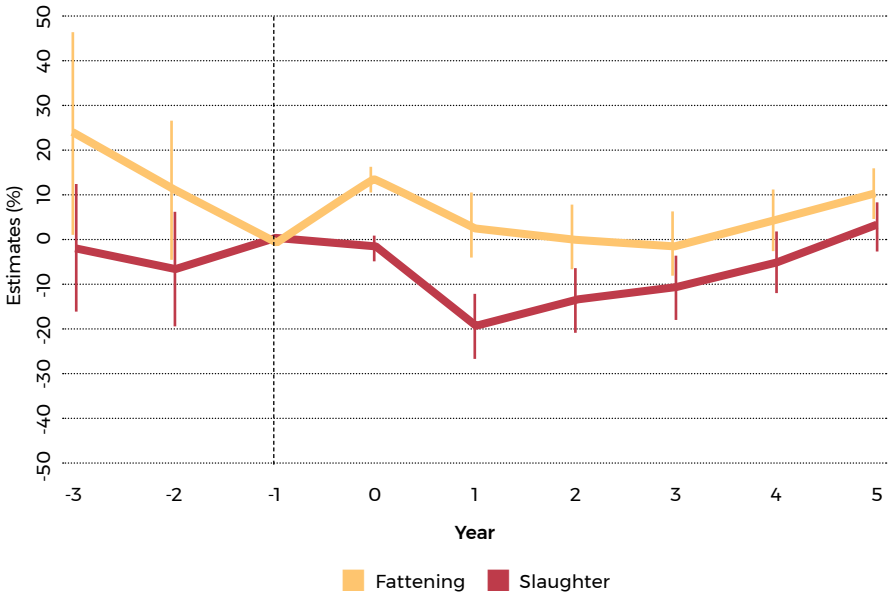
This setup allows the 'washing' of animals grazed in embargoed areas, shifting them from illegal pasture to legal pasture before they are sold to slaughterhouses. Even though anyone who purchases deforestation-linked products is subject to fines, the largest meat processing companies are under greater scrutiny because they control most of the slaughtering capacity in the state. The four largest meat producers in the state buy an average of 30% of the total livestock produced there over the course of a year, according to the data I collected.

Figure 1: Stages of the cattle supply chain: animal raising to slaughtering



Source: Elaborated by the author

Figure 2: Effect of the deforestation trade ban on the sales of cattle for fattening and slaughter in embargoed areas



Source: Animal transit permits from Adepará; embargoed property lists from IBAMA and Semas/PA. Notes: The vertical axis plots the estimated coefficients and their 95% confidence intervals of yearly dummies from an event study regression. The dependent variable is the number of animals sold by ranch.

Matching the animal transit data with the embargoed areas list in a differences-in-differences setting, I find that ranches in embargoed areas continue with their activities during the embargo period (which lasts five years), but switch their roles as direct suppliers to indirect ones. Figure 2 illustrates the effect of the embargoes during their term. Controlling for the buyer–seller travelled distance and seller fixed effect, the impact of the ban is the highest during the first year — when an embargoed ranch sells on average 20% fewer animals for slaughter than in the year before the ban. The trend is reversed in the following years until it becomes positive again in the fifth year, when the embargo expires.

My database consists of a sample of 40,436 ranches, 3,637 of which are in embargoed areas, illegally trading cattle in Pará. But this number corresponds to only a fraction of the deforestation taking place in the state. Although it can be punished, past forestation is hard to detect because once an area has been cleared it becomes a small part of the vast expanse of illegally cleared land in Brazil (Assunção, Gandour and Rocha, 2013).

My results confirm that loopholes in environmental policy have enabled beef farmers and producers to continue to profit from the use of deforested land. They highlight the need to restructure existing policy to increase transparency along the beef supply chain. Policies that tackle only the edges of this complex network end up ignoring the greater share of the market that continues to benefit from the conversion of forest to pasture area. The transition to a sustainable beef industry in the Amazon requires animal-tracing technology, integrated farming and better use of pastures for more intensified ranching that will rely less on continuous area expansion to meet future livestock demand. ◀

“My database consists of a sample of 40,436 ranches, 3,637 of which are in embargoed areas, illegally trading cattle in Pará.”

About the author

Stella Carneiro is an MRes student in Economics at the University of Warwick.

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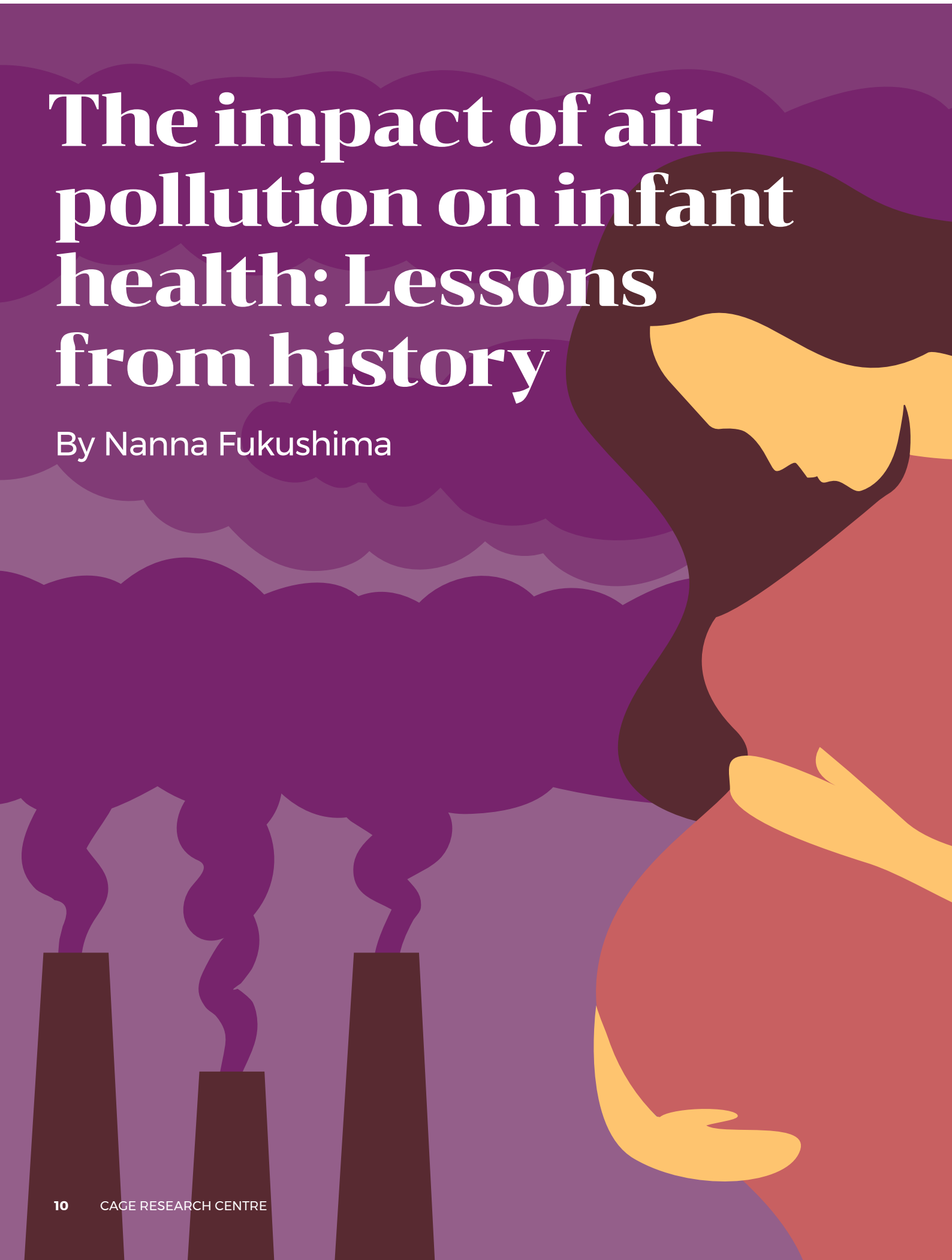
The impact of air pollution on infant health: Lessons from history

By Nanna Fukushima



The Great Smog of London in December 1952, which caused the premature death of thousands of citizens, brought debate about the adverse impacts of air pollution to an abrupt end. The clear evidence linking air pollution to death set aside previous concerns about the importance of coal to produce energy and heat, and the immense popularity of open fires, and led to the swift passing of the 1956 Clean Air Act. Until that point, the population density of the UK and its heavy reliance on coal had made parts of the country some of the most polluted places in the world.

Efforts to reduce pollution coincided with a significant fall in post-war infant mortality. Infant mortality in England and Wales declined from over 40 deaths per 1000 live births at the end of the Second World War to around 7 deaths per 1000 live births four decades later. However, the role of enhanced air quality in the improvement of infant health is not yet fully understood. Moreover, most contemporary research on the effect of air pollution on health comes from developed countries, where air pollution is comparatively low. Understanding the health impacts of improved air quality in the highly polluted, heavily populated, industrialised cities of 1950s Britain, where solid fuel was the primary source of air pollution and individual households were large emitters, could present a useful parallel for many developing countries today.

To investigate the causal effect of high-level air pollution on infant health, I study the impact of a zonal banning of house coal (bituminous coal) on infant mortality in urban areas in England after the passing of the 1956 Clean Air Act. ▶

The Clean Air Act was enacted at the very height of UK coal dependency and prohibited the emission of dark smoke from industries. More importantly, it gave local authorities the mandate to create so-called Smoke Control Areas (SCAs) that banned any smoke emission of any colour from any premises. An owner or an occupier of a building could replace house coal with a non-smoke emitting fuel alternative — such as anthracite and manufactured smokeless fuel — to comply with the regulation. Households were also entitled to receive a reimbursement covering 35–70% of the cost of any building works necessary to comply with the regulation.

To evaluate the effect of the regulation on local air pollution and infant mortality, I first calculate the effect of a gradual expansion of SCAs between 1957 and 1973 for the winter and summer seasons separately. Since the demand for coal was substantially lower in the summer, we would expect the SCA effect to be negligible during the warm season. Indeed, my analysis reveals that SCAs did not affect summer pollution once we control for place and time characteristics. This method, however, does not account for place-and-time-varying factors affecting pollution and infant health. Therefore, next, I compare the local impact of SCAs in the winter season to the summer season to remove the influence of location-specific trends common across the seasons. Figures 1 and 2 show a visual representation of the findings. The pre-regulation levels of smoke-pollution concentration and mortality by season (yellow circles) show how air pollution and infant mortality were much higher in the winter than in the summer. However, after the SCA roll-out, winter pollution and mortality declined, with the post-intervention levels (purple circles) no longer showing any statistical differences across the seasons (95% confidence interval).

"An owner or an occupier of a building could replace house coal with a non-smoke emitting fuel alternative — such as anthracite and manufactured smokeless fuel — to comply with the regulation."

Figure1: The effects of SCAs on smoke pollution

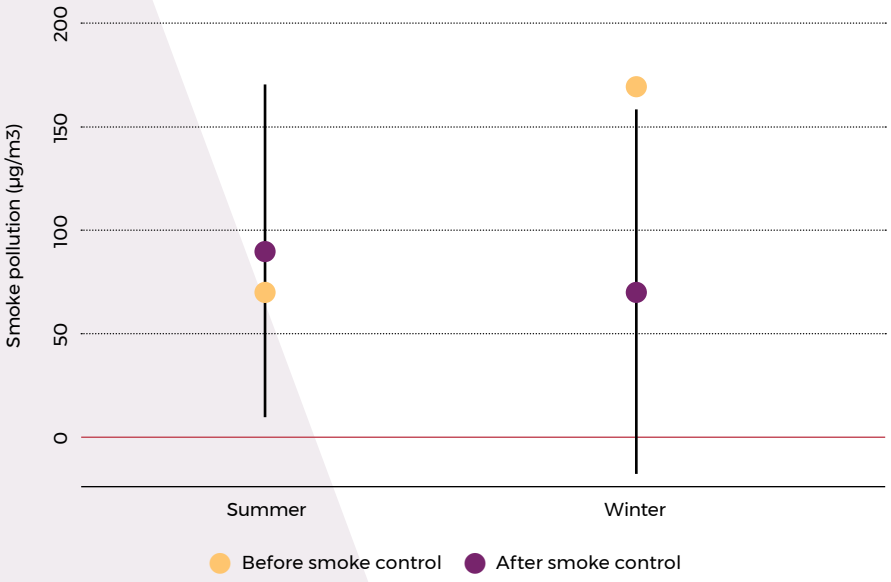


Figure 2: The effects of SCAs on infant mortality

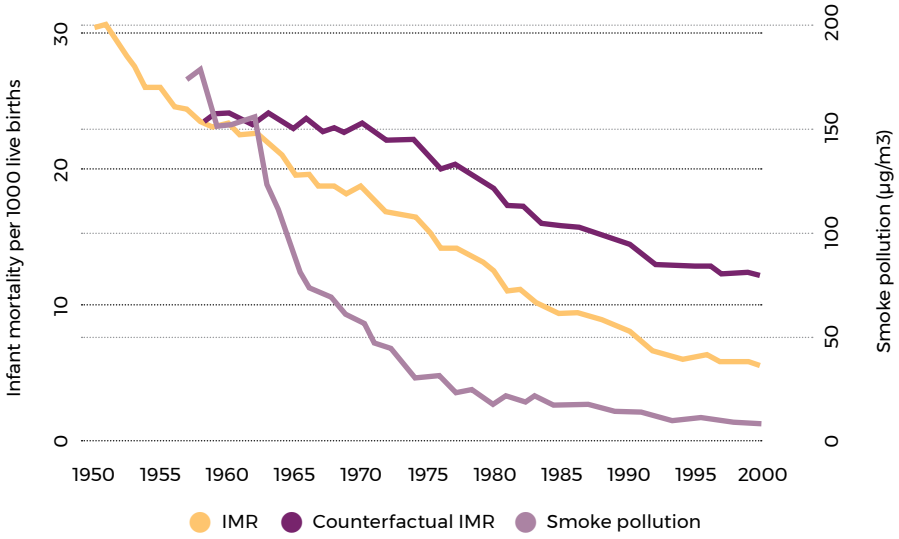
Given the average SCA coverage, the analysis shows that SCAs accounted for 18% of the decline in smoke pollution and 15% of the decline in infant mortality over the period.

In a further step, I link the effect of improved air quality to infant mortality. To separate the effect of pollution from other unobserved factors that may explain the reduction in pollution and infant mortality, I focus on the impacts of improved air quality brought about as a direct result of SCAs.
The method ensures that the estimates are free from the influence of other mortality-reducing effects.
I find that smoke particles released from the burning of coal are directly responsible for infant mortality.
The effect size implies that for every microgram per cubic metre reduction in smoke pollution, infant mortality declined by 0.04 deaths per 1000 live births meaning that it can explain as much as 70% of the aggregate reduction in infant mortality in urban areas in England between 1957 and 1973.

In the study, I also present evidence that the effect of pollution on infant mortality is independent of the initial level of pollution. The findings suggest that we should expect the same change in infant deaths for the same change in air quality irrespective of the location or period of interest. Thus, my results could be used to extrapolate benefits from pollution reduction in developing countries today. To demonstrate the historical role of improved air quality on infant mortality using the study estimates, Figure 3 shows the rate of infant mortality for the whole country had the level of black smoke concentration remained the same as in 1957 (dark purple line).

Other results from the study indicate that the adverse health effects of air pollution are largest for male infants and the youngest infants in particular and that smoke pollution increased the number of miscarriages and stillbirths. Improvement in air quality drove a 10% reduction in prenatal deaths over the sample period and suggests that air pollution's effect on infant mortality is likely a lower bound estimate.

Figure 3: Observed and counterfactual infant mortality in the UK



Source: UNICEF & Heal and Beverland (2017)

My investigation reveals that improved air quality played a significant role in reducing post-war infant mortality in the UK. The findings are particularly policy-relevant for many high-pollution countries to understand better the impact of air pollution on infant health, which has until now remained unknown. ◀

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"In the study, I also present evidence that the effect of pollution on infant mortality is independent of the initial level of pollution."

Clean water programmes can improve cognitive development

By Sonia Bhalotra

Around 2.2 billion people globally do not have access to safe water. A further 1.37 billion people lack handwashing facilities at home. As proper hand hygiene is one of the most effective ways to stop the spread of pathogens — including COVID-19 — these numbers are alarming.

2m+

GLOBAL DEATHS PER ANNUM FROM WATERBORNE DISEASES

The first scientific research on water disinfection proposing chlorination was published in 1894. In 1897, Maidstone in England was the first town to have its entire water supply treated with chlorine. Permanent water chlorination began in 1905, when it was effectively used to stop a serious typhoid fever epidemic in Lincoln. More than a century later, despite the technology being available and the cost of water disinfection being relatively low, millions of people in developing countries do not have access to clean water.

Each year more than 2 million people die from waterborne diseases. Young children are especially vulnerable, and diarrhoea is the second leading cause of child death in the world. The death toll from diarrhoea is widely known and often referenced in public health debates. What is less known is that there are persistent negative impacts on survivors. Our research indicates that infants born into an environment with clean water exhibit stronger cognitive performance in adolescence and earn more as adults. They are also taller as adults — a marker of long-term nutrition. ▶

"...despite the technology being available and the cost of water disinfection being relatively low, millions of people in developing countries do not have access to clean water."

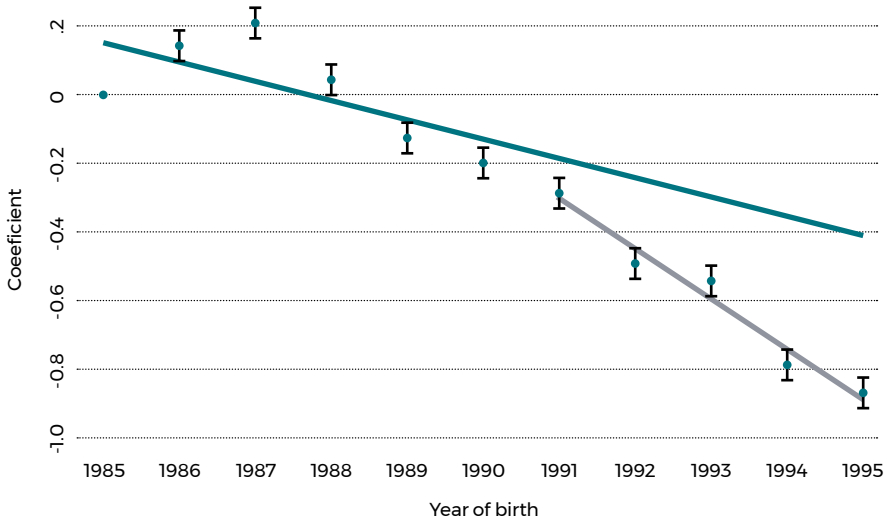
Identifying a link between infectious disease and cognitive development

Infancy is a period of rapid growth. The brain doubles in size in the first year, and by age three it has reached 80% of its adult volume (Nowakowski, 2006). On account of this, brain growth is sensitive to nutrition and infection. It is estimated that 85% of calorie intake in infancy is used to build brains, and severe or repeated infections in infancy may divert nutrients away from brain development (Finch and Crimmins, 2004). The release of inflammatory molecules during infections may also directly impact the developing brain by changing the expression of genes involved in the development of neurons and the connections between them (Deverman and Patterson, 2009).

These biological mechanisms suggest that the higher prevalence of infectious diseases, such as diarrhoea, might explain why children in developing countries tend to perform less well on international intelligence tests. However, the prevalence of infectious disease is correlated with other factors like poverty, making it important to devise a research strategy that purges these other factors and allows us to identify whether there is a causal link between infection and brain development.

Our research strategy leverages a policy experiment. We analysed the impacts of a large-scale municipal water disinfection programme implemented in 1991 in Mexico, which led to water chlorination coverage in urban areas increasing from 58% to over 90% within 18 months. The Mexican government acted swiftly in response to a cholera epidemic raging through neighbouring countries. This helps the research design because the change was sharp, and it was a reaction to conditions outside the country rather than to internal changes.

Figure 1: Trends for diarrhoea mortality rates of children under the age of five in Mexico relative to mortality rates from respiratory diseases



Notes: This plot shows trends for Mexico in diarrhoea mortality rates of children under the age of five relative to mortality from respiratory diseases (which is not directly affected by clean water), adjusted for regional factors and common trends in health and income. While mortality from both conditions was declining over the period, the plot shows that diarrhoeal mortality started to fall far more sharply immediately after the clean water policy was implemented in 1991. The vertical axis (coefficient) plots the estimated marginal effect of the policy (of exposure to clean water at birth) on diarrhoea mortality rates relative to respiratory mortality rates, conditional on municipality and year fixed effects.

Assessing the impact of Mexico's clean water programme

First, we identified the impact of the clean water programme on reducing diarrhoea mortality rates in Mexico. We measured the impact of the reform by cohort of birth — analysing the difference in infection rates between infants exposed to dirty water and those exposed to clean water. We crossed this with variation in the impact of the reform by region — which we proxied with the pre-reform diarrhoea burden — showing that regions with higher initial diarrhoeal disease burdens saw larger declines in diarrhoea after the reform. We used data on respiratory infection mortality rates as a control on the premise that respiratory infections are not a direct result of pathogens in water. We estimate that the program reduced childhood diarrheal disease mortality rates by between 45 and 67% (Bhalotra et al., forthcoming).

Next, we studied the impact of the programme on infant cognitive performance. We found that the reform led to improved cognitive performance measured independently on Raven tests (used to assess abstract reasoning) conducted at age 9–14 in a household survey, and in maths and reading tests at age 15 taken at school as part of the international PISA assessment (Bhalotra and Venkataramani, 2013).

In work in progress, we are re-examining the evidence using more fine-grained, municipality-level data and tracking individual outcomes right from infancy to early adulthood (Bhalotra, Brown and Venkataramani, in progress). We find that access to clean water in infancy led to a 6% increase in cognitive performance scores and a 0.11 standard deviation increase in height during adolescence, and that similarly sized effects persist into early adulthood. Tracking those infants into adulthood (age 17–26), we find evidence that early life access to clean water resulted in significant gains to productivity, as measured by earnings per hour.

Policy implications

The importance of clean water for reducing death from waterborne diseases is well known. However, international organisations and governments evaluating public policy priorities systematically underestimate impacts of clean water for individuals who survive infection. Our research shows that clean water can enhance cognitive skill, improve academic achievement and increase productivity over a long time horizon. Clean water programmes are therefore a good investment not only in health but also in ensuring that individuals attain their cognitive potential and in raising living standards worldwide. ◀

About the author

Sonia Bhalotra is Professor of Economics at the University of Warwick and a CAGE Associate.

Publication details

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Bhalotra, S.R., Brown, R., and Venkataramani, A.S. (2020) Clean Water Policy — Impacts on Cognitive and Physical Development. (Unpublished work in progress).

Bhalotra, S.R., Diaz-Cayeros, A., Miller, G., Miranda, A., and Venkataramani, A.S, (2021). Urban Water Disinfection and Mortality Decline in Lower-Income Countries. *American Economic Journal: Economic Policy*. Forthcoming.

Bhalotra, S.R. and Venkataramani. A.S. (2013). Cognitive Development and Infectious Disease: Gender Differences in Investments and Outcomes. IZA Discussion Paper (No. 7833).

The research is summarised in the video short 'Clean Water; a dirty matter' by Sameera Bhalotra Bowers, available on the CAGE YouTube Channel.

6%

INCREASE IN COGNITIVE PERFORMANCE WITH ACCESS TO CLEAN WATER

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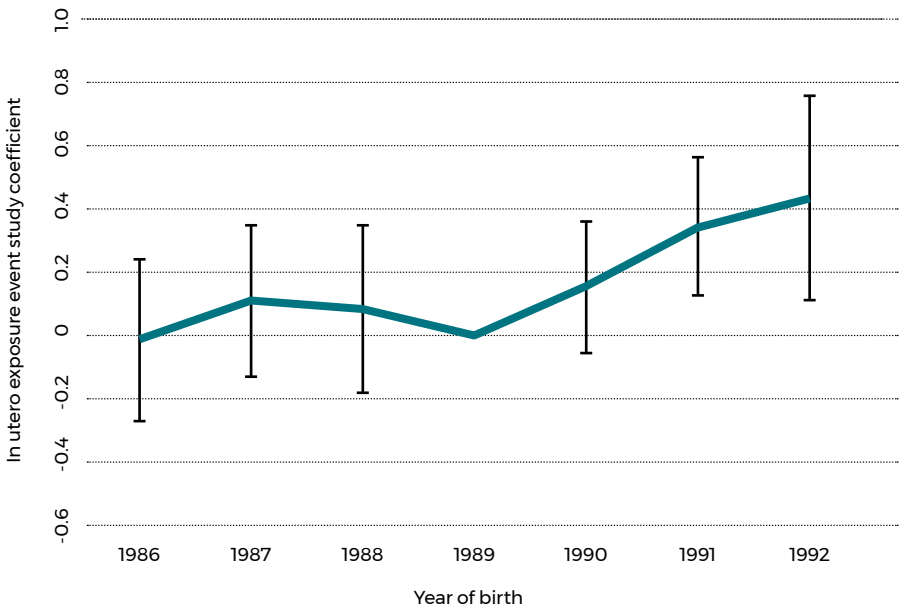
Nowakowski, R. S. (2006). Stable neuron numbers from cradle to grave. *Proceedings of the National Academy of Sciences of the United States of America*, 103(33), 12219–12220.

Figure 2: The effect of clean water exposure at birth on Raven test scores in Mexico (conducted age 9–14)



Notes: The graph shows that Raven test scores (which measure pattern recognition skills) improve among Mexican children born after the water policy reform (1991). The vertical axis (coefficient) plots the estimated marginal effect of the policy (of exposure to clean water at birth) on the Raven test score, conditional on municipality and year fixed effects.

"Infancy is a period of rapid growth. The brain doubles in size in the first year, and by age three it has reached 80% of its adult volume"

The grandkids aren't alright: The intergenerational effects of air pollution

By Jonathan Colmer

When the National Ambient Air Quality Standards were introduced in the United States 50 years ago as part of the 1970 Clean Air Act Amendments, concerns about air pollution were largely focused on respiratory health and visible air quality. In the decades since, academics and policymakers alike have learnt that the impacts of air pollution are more far-reaching, affecting many dimensions of health, economic productivity, and overall economic and social wellbeing.

Children are especially vulnerable to the effects of air pollution. Exposure to pollution and other environmental risks in early childhood can play a critical role in shaping economic opportunity, through persistent effects on health and wellbeing. Fortunately, improvements in air

quality delivered by the Clean Air Act have been shown to bring significant benefits to those directly affected, reducing infant mortality, and increasing wealth, productivity and later-life earnings.

Investments in clean air could have even broader and more systematic effects on economic opportunity and inequality if these benefits propagate across generations. Over time we have learnt that disadvantaged communities are disproportionately exposed to pollution, indicating that differences in environmental quality may play an important role in driving and proliferating economic disparities. Poor environmental quality leads to worse economic outcomes for individuals, which directly shapes the economic opportunities of their children, as well as their children's exposure to environmental risks through the neighbourhoods that they can afford to live in. Investments to improve environmental quality and reduce environmental disparities could break the cycle, bringing economic benefits and reducing environmental, health and economic disparities both within and across generations.

We measure the intergenerational benefits of investments in environmental quality. Using newly available administrative and survey data from the US Census Bureau, which allowed us to construct more than 150 million parent-child links, we find that the introduction of the 1970 Clean Air Act not only benefitted those who directly experienced regulatory reductions in prenatal exposure to air pollution, but also shaped the educational outcomes of their children 40–50 years later. We estimate that a 10% reduction in prenatal exposure to particulate matter for individuals born around 1970 is associated with a 2.5 percentage point increase in the likelihood that the second-generation attends college 40-50 years later.

How do the effects of prenatal exposure cross from one generation to the next? In addition to measuring the intergenerational effects of air pollution, we also explore the mechanisms through which intergenerational transmission arises.

On the one hand, the health improvements associated with lower prenatal pollution exposure may have been inherited from one generation to the next — a biological transmission pathway. On the other hand, improvements in health may have translated into increased productivity and earnings as adults, providing a household environment that offered greater resources and opportunities. Using information on whether children are biological, adopted or stepchildren, we find little evidence that the effects are likely to have been driven by any inherited benefits. Instead, supporting evidence suggests that the intergenerational transmission mechanism appears to be driven by increased parental resources and investments.

Our findings have several important policy implications. First, in considering the efficacy of current and future environmental regulations, it is important to account for broader economic considerations, such as effects on education, productivity and earnings. To date, environmental agencies almost exclusively focus on direct health effects. Doing so misses important dimensions through which pollution affects society. Cost-benefit analyses of environmental regulations should incorporate these benefits for a more complete accounting of how reducing air pollution will affect society.

Second, our findings point to the importance of environmental quality in shaping economic opportunity. Our results underline the importance of ensuring that disadvantaged communities benefit from improvements in environmental quality. Not only do reductions in air pollution reduce disparities today, but these benefits are propagated from one generation to the next. Further examination of the links between environmental quality, economic mobility, and inequality should be explored. Investments in environmental quality should be included alongside traditional economic-mobility mechanisms such as investments in education, transportation and labour market opportunities. ◀

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Exposed: The widespread societal costs of lead contamination

By Ludovica Gazze

The air we breathe, the water we drink, the soil our children play in — all of these can expose us to pollution and toxins with the potential to cause immediate and persistent harm to our bodies. Lead is one such harmful pollutant that has been used extensively over time, for example in plumbing, paint, car batteries, and petrol. Like exposure to other forms of pollution, exposure to this toxic metal can lead to increased incidence of diseases, affect brain development and damage the nervous system. Its effects are particularly serious in children.

Higher lead exposure levels have been linked to a lower ability to perform in schools and even a lower ability to control one's impulses, leading to increased interpersonal conflict and even delinquency. Although much has been done across the world to reduce the use of this heavy metal in everyday products, lead does not decay. Therefore, its current levels in the environment are much higher than natural levels, including in the United Kingdom. A recent UNICEF study (2020) estimates that about 200,000 British children are likely to be affected by lead exposure. ▶

"The effects of lead contamination from the air, water and soil are particularly serious in children."

What are the societal costs of lead pollution?

One unexplored factor in determining the societal costs of pollution is the role of interactions. Aristotle famously said, 'man is by nature a social animal'. So, in the case of lead contamination, could it be that your cognitive and non-cognitive loss due to pollution is also my loss, if we spend time learning together? Losses in schools could be due to learning disruptions, or to teachers having to adapt their teaching to accommodate lead-poisoned children. Alongside Dr Claudia Persico and Sandra Spirovska, I tackled this question by examining the performance of students who did not test positive for lead exposure in early childhood but went to school with someone who did. We analysed unique anonymised student-level records for every student in North Carolina. The records detailed test scores, disciplinary actions, absences, high school graduation, and whether the student took a standardised test that is often necessary when applying for college. We had these data linked, securely, to blood lead levels measured during routine paediatric visits.

Lead exposure is widespread and affects educational attainment

We were shocked to see that virtually every child in our sample, even those who never tested positive themselves, went to school with at least one peer in their school-grade year who had tested positive for lead exposure. For more than half the children, over 10% of their peers had been exposed to lead in early childhood. These numbers show how widespread lead exposure is. Figure 1 shows that, in our sample, children with high blood lead levels (BLLs) are more likely to receive out-of-school suspensions and less likely to graduate from high school. We show only correlations here, but other scholars (e.g., Aizer et al., 2018; Billings and Schnepel, 2018; Hollingsworth et al., 2020) have established a causal connection between lead exposure and school outcomes by exploiting data on lead clean-ups and the de-leading of regular and racing gasoline. Given that almost every student in North Carolina interacted with at least one of these lead-exposed children in the classroom or during lunch or recess, could everyone else also be affected by the detrimental impacts of lead exposure?

> **"So, in the case of lead contamination, could it be that your cognitive and non-cognitive loss due to pollution is also my loss, if we spend time learning together?"**

Lead-exposed children affect the education outcomes of their peers

Lead-exposed children might disrupt learning in the classroom or take away teacher time. Lead's effects on behaviour might also mean lead-exposed students are more likely to pick fights with other children, and other children might imitate this misbehaviour. But is this borne out in the data? Figure 2 shows that students with a higher share of peers who had been lead-exposed in early childhood were more likely to receive out-of-school suspensions and less likely to graduate from high school. However, there might be many reasons why we observe these correlations. For example, lead-exposed children are more disadvantaged on average, and so are their peers. To establish a causal link between a student's outcomes and the share of their peers with high blood lead levels, we compare siblings who go to the same school. In this way, we ensure that differences we might find between outcomes are not due to differences in students' backgrounds or school and neighbourhood characteristics. We exploit the fact that there is variation over time in how many children were exposed to lead in early childhood from year to year. With this strategy, we confirm that students who have a higher share of lead-exposed peers are indeed more likely to receive out-of-school suspensions and be chronically absent, and less likely to graduate from high school and take an exam needed to enter college.

The effects of lead pollution are likely exacerbating existing inequalities

Pollution holds people back, preventing them from reaching their full potential. What's more, even those children who escape exposure but live in highly polluted environments will suffer indirectly from interacting with exposed peers. But pollution does not affect everyone equally. In fact, the data shows that it can exacerbate existing social inequalities. The Black students in our sample are more likely both to be lead-exposed and to have more lead-exposed peers. Moreover, we find that they are disproportionally affected by lead-exposed peers. This needs to be taken into consideration when devising policy to tackle the negative effects of a polluted environment. Reducing exposure in minority and poor neighbourhoods could have even larger positive effects than previously thought. ◀

10%

FOR MORE THAN 50% OF THE CHILDREN, OVER 10% OF THEIR PEERS HAD BEEN EXPOSED TO LEAD IN EARLY CHILDHOOD

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Publication details

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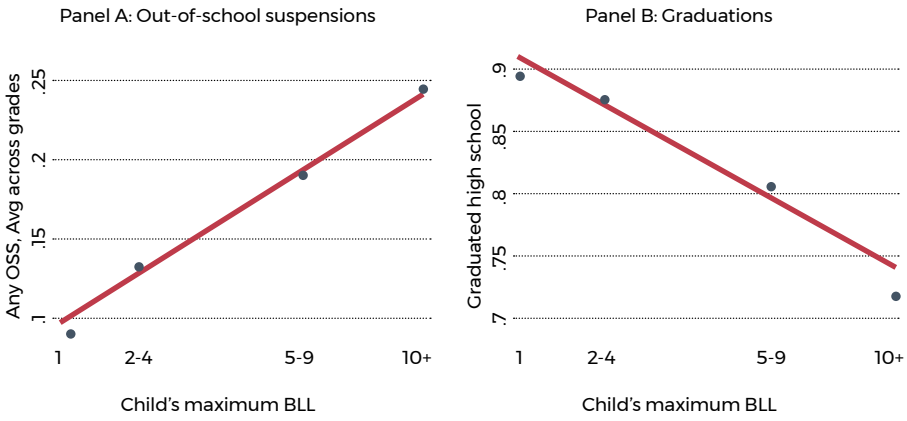
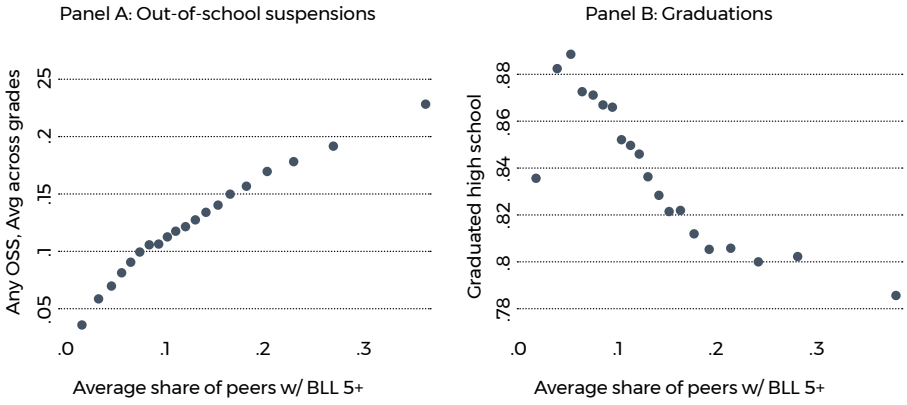
Figure 1: Children with higher blood lead levels are more likely to receive out-of-school suspensions (OSS) and less likely to graduate from high school



Notes: The figure plots out-of-school suspension rates (Panel A) and graduation rates (Panel B) by students' blood lead levels and adds the line of best fit.

Figure 2: Children with a higher share of peers with high blood lead levels are more likely to receive out-of-school suspensions (OSS) and less likely to graduate from high school



Notes: The figure plots out-of-school suspension rates (Panel A) and graduation rates (Panel B) by vigintile of students' share of peers with blood lead levels at or above 5μg/dL.

"Pollution holds people back, preventing them from reaching their full potential."

Parting Shot

Before we can tackle climate change, we first need to convince people to care much more about it.

By Andrew Oswald

The recent flooding in Germany and wildfires in North America are a reminder that if we are to avoid tragedy in the future, society needs to make progress in tackling global warming. Human beings will have to alter how they live. That is likely to be painful. People will not be pleased about having to pay more for their travel, fuel, heating and lighting — and having to alter their lifestyles to do and use all those things less. So, are our citizens ready and willing to make climate change a major priority? Recent data suggests — worryingly — the answer is no.

"...this survey gives us the opportunity to understand how many people see an urgent need for change in environmental policy."

With Adam Nowakowski, I examined data from the Eurobarometer Survey of 2019. This survey asked approximately 30,000 randomly chosen respondents across Europe to choose the two societal issues they consider to be the most important. There is a long list of 13 possibilities to choose from. This dataset has a special advantage because it asks respondents about their ranking of *different kinds* of problems in society. While anyone can say in an abstract sense, 'yes, I think something should be done about climate change', this survey gives us the opportunity to understand how many people see an urgent need for change in environmental policy. The key question is whether citizens will tolerate tackling environmental and climate issues by giving up something else (as will be necessary).

As we might expect, different people prioritise different topics. But the ranking of the results is revealing (Table 1). The most mentioned national problem is that of Health and Social Security: 25.8% of Europeans emphasise this. The least mentioned national problem is that of Terrorism: 4.4% of Europeans emphasise this. Environment, Climate and Energy Issues come only fifth in the ranking of societal importance. It is mentioned by 16.3% of Europeans.

In other words, only approximately one in seven Europeans think of climate change as one of the two most important problems facing society. Climate concerns are ranked lower than priorities about Health and Social Security, Inflation, the Economic Situation, and Unemployment.

For policymakers and environmentalists, this implies that personal economic considerations matter to people much more than environmental and climate concerns. A small percentage of citizens put high weight on the problem of global warming. Yet most Europeans do not. The typical citizen is instead focused on their own economic interests.

To take steps forward in the fight against climate change, policymakers will need to alter people's feelings about it. Right now, European citizens are not ready for policies that might cause upheaval to their daily lives. But education is needed to alter perceptions about the urgency of this environmental crisis. If we fail to encourage individuals to care more about climate change, our grandchildren, and especially their grandchildren, could be in severe peril. ◀

About the author

Andrew Oswald is Professor of Economics and Behavioural Science at the University of Warwick and a CAGE Senior Research Fellow.

Table 1: What do you think are the two most important issues facing (OUR COUNTRY) at the moment?

Societal Issue	Average % mentioned	Mentioned	Not mentioned
Health and social security	25.8	7,447	21,452
Rising prices / inflation / cost of living	23.6	6.833	22,066
Economic situation	18.4	5,330	23,569
Unemployment	18.3	5,276	23,632
The environment, climate and energy issues	16.3	4,720	24,179
Immigration	15.5	4,468	24,431
Pensions	14.4	4,173	24,726
Crime	11.3	3,264	25,635
The education system	11	3,192	25,707
Housing	10.4	3,019	25,880
Government debt	9.52	2,751	26,148
Taxation	8.12	2,348	26,551
Terrorism	4.35	1,256	27,643

Notes: Eurobarometer Data, 2019. The answers are ranked according to the frequency they were mentioned in response to the question. Each respondent was permitted to give a maximum of 2 answers. The sample size is 28,899. Some answers are omitted from the table: 'Don't know', 'Other (SPONTANEOUS)' and 'None (SPONTANEOUS)'.

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