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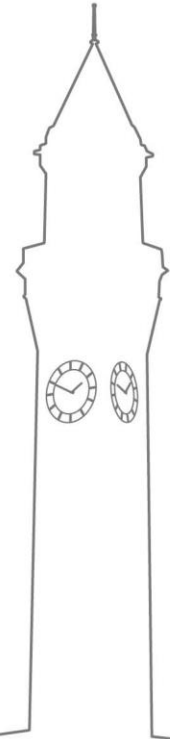


Air Quality Policy Evaluation Toolkit (AQ-PET)

Evaluating the impact of air pollution: A new Defra+ damage Toolkit

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Determining the effectiveness of urban air pollution control policy - challenging:

1. Observed pollution levels are co-influenced by **weather conditions**

“weather normalisation” method - Atmospheric Scientist (Grange and Carslaw, 2019)

2. **Other confounding factors** (natural emission changes, socio-economic factors)

“causal inference” method – Economist (Greenstone and Gayer, 2009)



Air Quality Policy Evaluation Toolkit (AQ-PET)

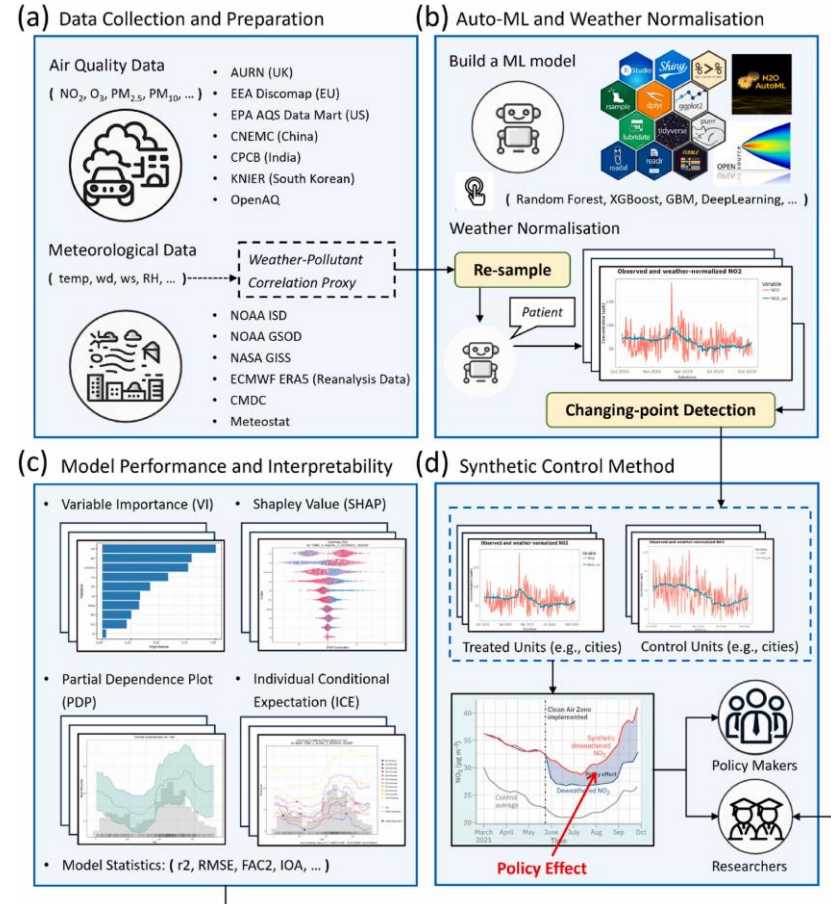
- An Open-source R package “aqpet” (Dai et al., 2024):

1. Data collection and preparation
2. Auto-ML and weather normalisation
3. Model performance and interpretability
4. Causal policy evaluation

User-friendly (Software Platform)



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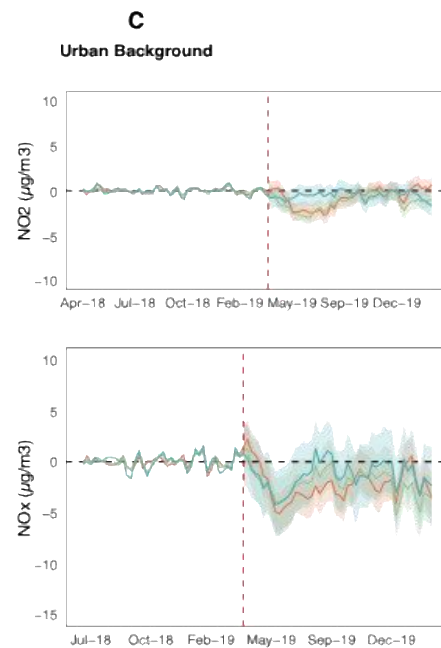
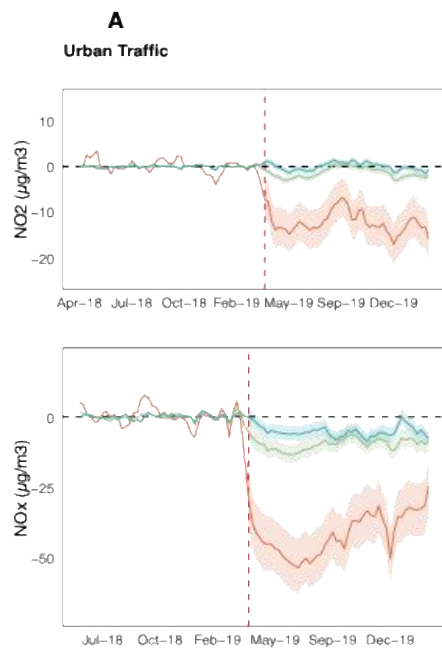
AQ-PET - Applications & Impacts

- Birmingham Clean Air Zone (Liu et al., 2023)
- London Ultra Low Emission Zone (preparing)
- Glasgow Low Emission Zone (preparing)
- Global Covid lockdown (Shi et al., 2021)
- China lockdown (Cole et al., 2020)
- Clean winter heating program in China (Song et al., 2023)

- Effective collaboration and co-creation with WMCA and BCC
- Knowledge Exchange & Capacity Building – via workshops and training for 40+ participants
- Research England: policy support funding: £77.5k
- 30+ Media coverage for Birmingham CAZ analysis



ULEZ impacts (preliminary)



Defra method: Air quality appraisal- impact pathways approach

Three key channels for estimating the monetary impacts of air pollution:

- Human health (physical)
- Productivity (worker, agriculture, industry) and Wellbeing
- Natural environment (ecosystem service, natural capital, biodiversity)

Selection of pathways and indicators: **"there is at least reasonable evidence of an association with exposure to air pollutant concentrations."**



Towards an “Experimental” but more “Comprehensive” approach

We reviewed over 100 papers:

1. Published in leading natural and science journals (within recent 6 years)
2. Employing rigorous “causal impact” of air pollution
3. Global sample

| Key variable | Authors | Study Region / Period / Estimation method | Key findings | Journal |
|--|------------------------|--|--|----------------------------|
| Happiness (sentiment from social media) | Zheng et al (2019) | 144 Chinese cities; 2014; Instrument Variable (IV) | “A one standard deviation increase in the PM2.5 concentration (or Air Quality Index) is associated with a 0.043 (or 0.046) standard deviation decrease in the happiness index” | Nature Human Behaviour |
| Dementia (Alzheimer diagnosis or related dementias) | Bishop et al (2023) | 2.7 million US individuals; 2001-2013; IV | “A 1 µg/m3 increase in decadal PM2.5 increases the probability of a new dementia diagnosis by an average of 2.15 percentage points (pp)” | Review of Economic Studies |
| Life expectancy | Ebenstein et al (2017) | 161 Chinese counties; 2004 to 2012; OLS, IV, Regression Discontinuity (RD) | “A 10-µg/m3 increase in PM ₁₀ reduces life expectancy by 0.64 years (95% confidence interval = 0.21–1.07). ” | PNAS |
| Biodiversity (bird population) | Liang et al (2020) | US nationwide; 1980-2020; Fixed effects model / IV | “Air quality improvements over the past 4 decades have stemmed the decline in bird populations, averting the loss of 1.5 billion birds, ~20% of current totals.” | PNAS |

Air Pollution

Defra

Human health Productivity Natural environment

1. Physical

1. Worker
2. Agriculture
3. Industry

1. Ecosystem service
2. Natural capital
3. Biodiversity

Defra+

Human health Productivity Natural environment Compensatory behavior Under-explored

2. Mental
3. Happiness
4. Cognitive Ability
5. Dementia

4. Social security
5. criminal activity
6. Migration
7. Labour allocation

1. Avoidance / Defensive expenditure
2. Household location choices / household sorting
3. Social care cost
4. Education choice
5. Tourism choice

1. Financial sector (financial intermediation, stock market performance, investor behavior)
2. Firm performance
3. Sleeplessness
4. Body weight and obesity
4. Politician productivity
5. Future income
6. Willingness to pay - clean air
7. School attendance,
8. Exam performance
8. Human capital

Economy

Selected References:

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Q&A