Beliefs, Information Trust, and Air Pollution

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Motivation

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- **Questions:**
  - To what extent do agents rely on official disclosures?
  - How much do agents value information quality?

This Paper: Waste Incineration and Housing Location Choices

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$Australia$: $500m$

$Japan$: $200m$

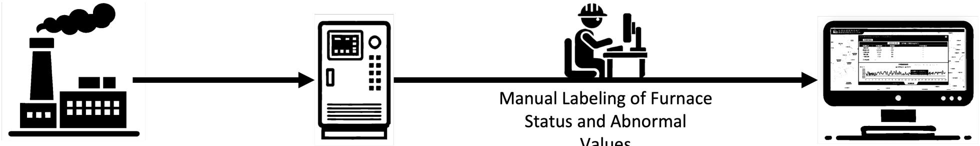
[1] "Areas within 10 kilometers of large waste incineration plants are contaminated with dioxins, posing significant health risks, especially to children."

[2] "The old waste incineration plant was built less than 20 kilometers from residential areas. How can 350,000 residents live under such conditions?"

[3] "Qionghai City plans to build an incineration plant within 3 kilometers of residential areas... Could the government consider relocating it to an uninhabited area 20 kilometers away?"

This Paper: Waste Incineration and Housing Location Choices

- **Novel Setting - China:**
  - largest number of waste-to-energy plants (918 plants, 2056 incinerators)
  - first nationwide platform for WtE pollution disclosure (since Jan 2, 2020)
  - plant details, daily incinerator-level emission records, labels for abnormal records
- By 2021, the platform had recorded over **60 million** visits



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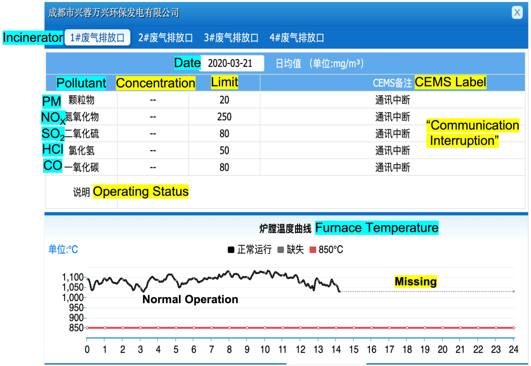
The data is not always valid: 15% of daily records exhibit flaws



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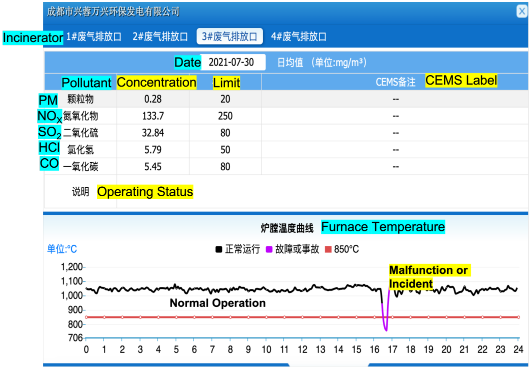

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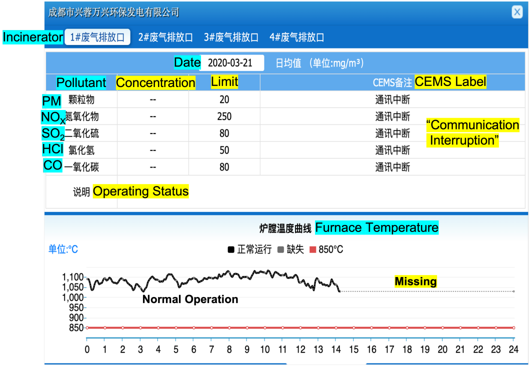

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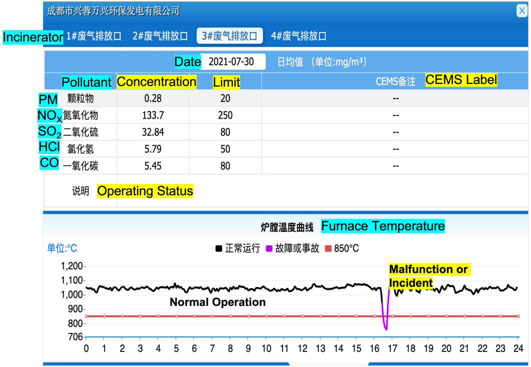

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⇒ Despite strict regulations, a few plants still falsely label to hide over-emissions

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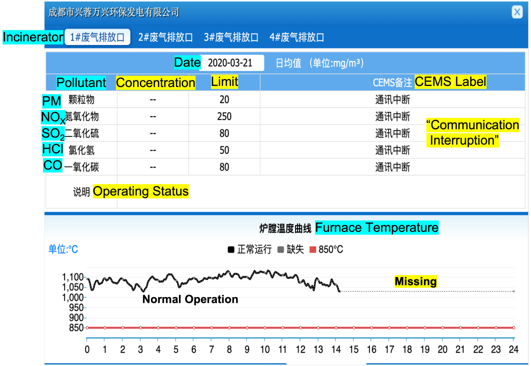

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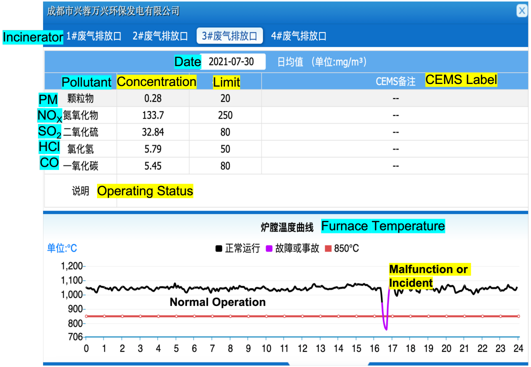

Faulty

⇒ Despite strict regulations, a few plants still falsely label to hide over-emissions

⇒ Household beliefs about emission should reflect interpretations of pollution levels

Empirical Methodology

Estimate the beliefs using a Residential Sorting Model

- *Main ingredients:*
  - Household belief about plant emissions, influenced by information quality
  - U (Pollution at house k, Consumption, Housing services), budget constraint
- *Step 1:* Map plant emissions to pollution levels at all house locations
  Gaussian plume model: perceived emissions $\rightarrow$ perceived pollution at house k
- *Step 2:* The expected indirect utility V_k
  - Integrate U w.r.t. belief $\rightarrow$ expected utility
  - Maximize w.r.t. consumption and housing services at house $k \rightarrow V_k$
- *The observation level:* Household chooses houses which maximizes V_k
  $\Rightarrow$ a discrete choice model
  $\Rightarrow$ ML estimation of parameters

Empirical Methodology - Emissions Beliefs

- **Overall emissions:** Pollution Index combining pollutants and furnace temperature.

$$\begin{tikzcd} & {[\log Q^o + \varepsilon^o] \sim \mathcal{N}(\log Q^o, \sigma_o^2)} \\ \log Q \arrow[ur, "\text{valid}"] \arrow[dr, "\text{flawed}"'] & \\ & \log Q^u \sim \mathcal{N}(\mu_u, \sigma_u^2) \end{tikzcd}$$

- **Assumption:** no systematic (log) bias in beliefs when records are valid
  - manipulating data is costly and difficult (Greenstone et al., 2022)
  - government values public reporting of emissions violations (Buntaine et al., 2024)

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- **Information quality**: valid rate in the reference period (Info)

$$\log Q = \mathrm{Info} \cdot [\log Q^o + \varepsilon^o] + (1 - \mathrm{Info}) \cdot \log Q^u$$

variation

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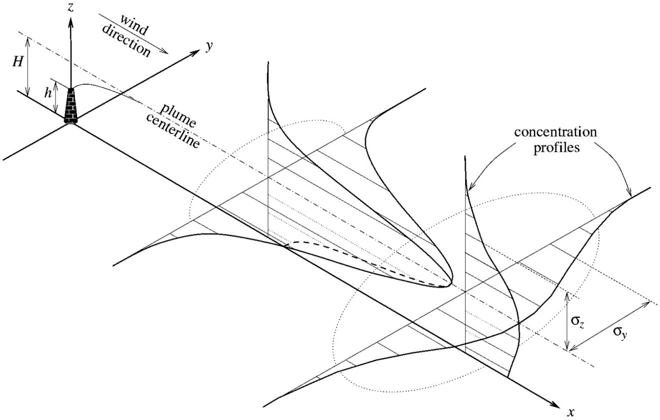
Empirical Methodology - Gaussian Plume Model



Source: Stockie (2011)

$$\kappa(x, y, 0) = \frac{Q}{W} \exp\left[f(d)\right]$$

- W: wind speed
- $f(d)$:
  decays with plant-house distance d, affected by angle relative to wind direction θ
- $\boldsymbol{W}, \boldsymbol{\theta}$: weighted by frequency in the downwind region ▸ wind

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Main Data Sources

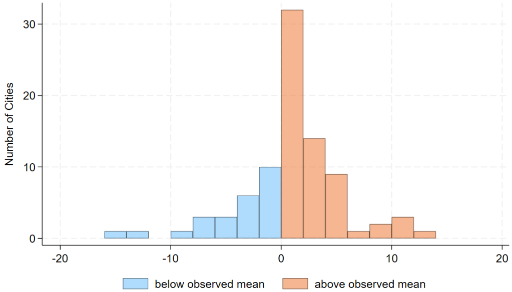
- **Emissions from WtE Plants (2020-2022):**
  - plant details: geo-location, capacity, and start date
  - [daily] concentrations of five pollutants + [every five minutes] furnace temperature
  - 918 plants, totaling 2,056 incinerators by 2022

- **Secondhand house sales and listed properties in 92 cities:**
  - collected from *Beike*: largest platform for integrated online and offline real estate transactions and services in China
  - include list prices, supply dates, transaction prices and dates, locations, and characteristics (e.g., surface area, floor level, green space ratio)
  - 6 million

- **Household income:** *county-level*
  - per capita disposable income $\times$ average household size
  - 2021–2023 city-level statistical yearbooks and the 2020 Population Census.

Results - Pollution Beliefs and Information Trust

City-level divergence in pollution beliefs: $\widehat{\Delta}_{\mu_u} = \widehat{\mu}_u - \overline{\log Q^o}$

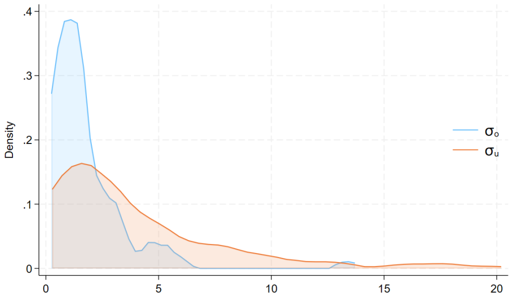


- 67/92 cities: perceive pollution as higher under flawed records
- **43** cities: statistically significant over-perceptions at the 5%

$\Rightarrow$ **"over-perception" cities**

Results - Pollution Beliefs and Information Trust

City-level uncertainty in pollution perceptions: $\widehat{\sigma}_u$ and $\widehat{\sigma}_o$



- uncertainty exists even with reliable information
- $\widehat{\sigma}_o$: concentrated around smaller values
- $\widehat{\sigma}_u$: broader with a larger mean

$\rightarrow$ greater uncertainty in the absence of valid records

Results - Potential sources of “over-perception”

- **Plant manipulation**
  - external sources of $PM2.5$
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- **Fundamental distrust**
  - socio-economic and political factors

    $\Rightarrow$ Over-perception cities: $\Uparrow$ NIMBY protests, $\Downarrow$ local leadership, $\Downarrow$ fines etc.

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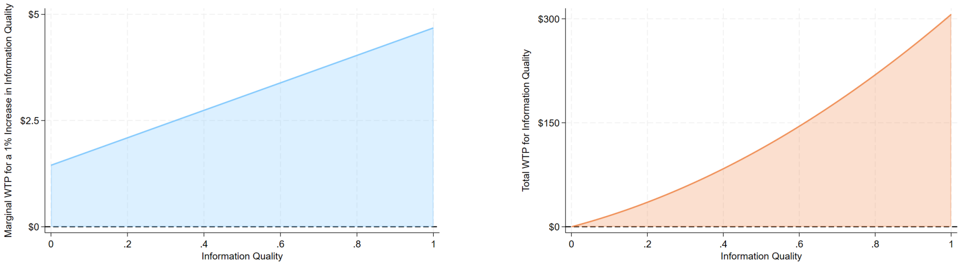
- Divergence level: negatively correlated with long-term information quality

  $\Rightarrow$ Information trust

Results - Willingness-to-Pay for Information Quality

$$\text{MWTP}_{i,k} = \frac{\frac{\partial V}{\partial \text{Info}}}{\frac{\partial V}{\partial M}} = \underbrace{r_k^{dw}}_{0.51} \frac{\beta_Q\left(\mu_u - \log Q_k^o\right) - r_k^{dw}\beta_Q^2\sigma_u^2 + r_k^{dw}\beta_Q^2\left(\sigma_o^2+\sigma_u^2\right)\text{Info}_k}{\beta_C+\beta_H} \underbrace{M_{i,j(k)}}_{\$18,752}$$



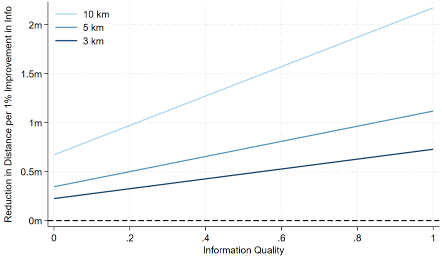
(a) MWTP for 1% Increase in Info

(b) TWTP

$\Rightarrow$ MWTP for current level (0.85) = \$1.23 $\rightarrow$ TWTP for increasing to 1 = \$19.54

Results - Substitution Effects Between Info and Distance

$$|\mathrm{MRS}_{\mathrm{d,Info}}| = \frac{\frac{\partial V}{\partial \mathrm{Info}}}{\frac{\partial V}{\partial d}} = \frac{\beta_Q \cdot (\log Q^o - \mu_u) + r^{dw} \cdot \beta_Q^2 \cdot \left[\sigma_u^2 - \left(\sigma_o^2 + \sigma_u^2\right) \cdot \mathrm{Info}\right]}{\beta_d \cdot f^{(1)}(d)}$$



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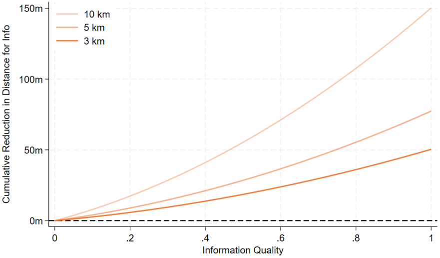


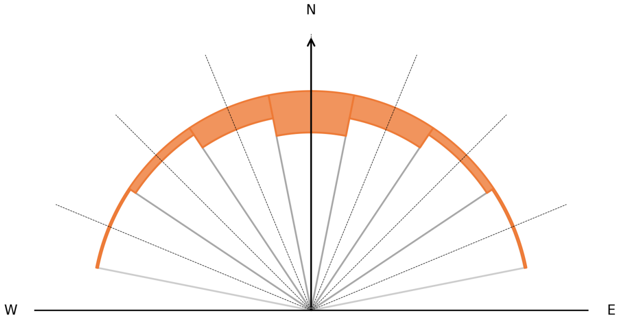
(b) Cumulative Substitution Effects

$\Rightarrow$ if located exactly 5 km downwind from the plant
MRS for current level (0.85) $=$ 1.06m $\rightarrow$ CSE for increasing to 1 $=$ 16.82m

Results - Substitution Effects Between Info and Distance

If wind consistently blows true north, for houses 5 km from the plant

$\Rightarrow$ reduction in surface area $= 86,648\,\mathrm{m}^2$



Inward Shift Under Improved Info

Conclusion

- **Main results**
  - Flawed records increase perceived pollution and uncertainty, even with technical explanations
  - Distrust is rooted more in institutional factors than in deliberate manipulation by plants
  - Degrading information quality generates sizable economic costs
- **Implications**
  - Households do not take disclosures at face value
  - Poor-quality records can erode trust and weaken, or even reverse, intended policy effects

References I

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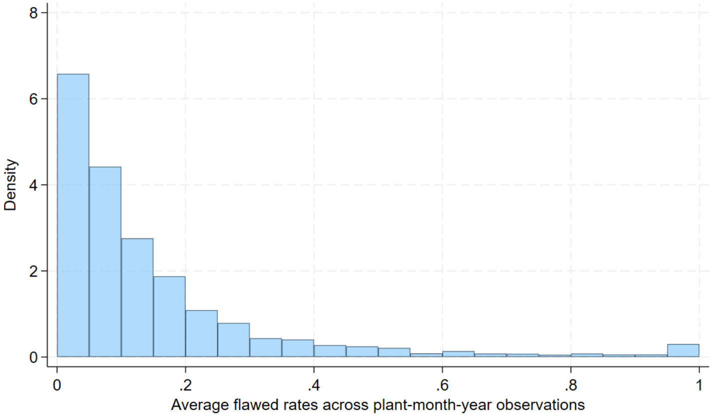
Empirical Methodology - Emissions Beliefs



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