WILLINGNESS TO PAY FOR CLEAN AIR: EVIDENCE FROM AIR PURIFIER MARKETS IN CHINA

Discussion Slides
IGC Energy Conference
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- Regulation is typically weak and air quality (ambient, indoor) in developing countries is frequently poor.
- However, measures of WTP in developing countries can be much, much smaller than in developed countries.
- Is bad air quality efficient, or are those estimates too low?

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(1) Stated-Preference Methods: Simply ask people what cleaner air is worth to them.

- Question relies on a hypothetical. Hypothetical questions yield hypothetical responses.
- Strategic Responses: understate to free ride, overstate to encourage stricter policy.

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(2) Hedonic Methods: Local amenities (pollution, crime, access to open space, etc.) are capitalized into home values or rents. Disentangle using multivariate regression.

- Housing transactions may not be "arms-length"; housing market may not be "thick".
- Some pollutants vary over wide geographic range, so that tradeoffs occur in both housing and labor markets.
- Complicated by migration frictions (e.g., Hukou system).

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(3) Epidemiology: Calculate health impacts from exposure and multiply by costs of morbidity and mortality (taken from other studies).

- Useful if individuals aren't aware of pollution.
- Does a bad job if individuals take steps to avoid exposure.

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(4) Defensive Expenditures: Look at what people pay to offset exposure to a nuisance.

- Defensive commodities sold in retail markets with well-defined prices.

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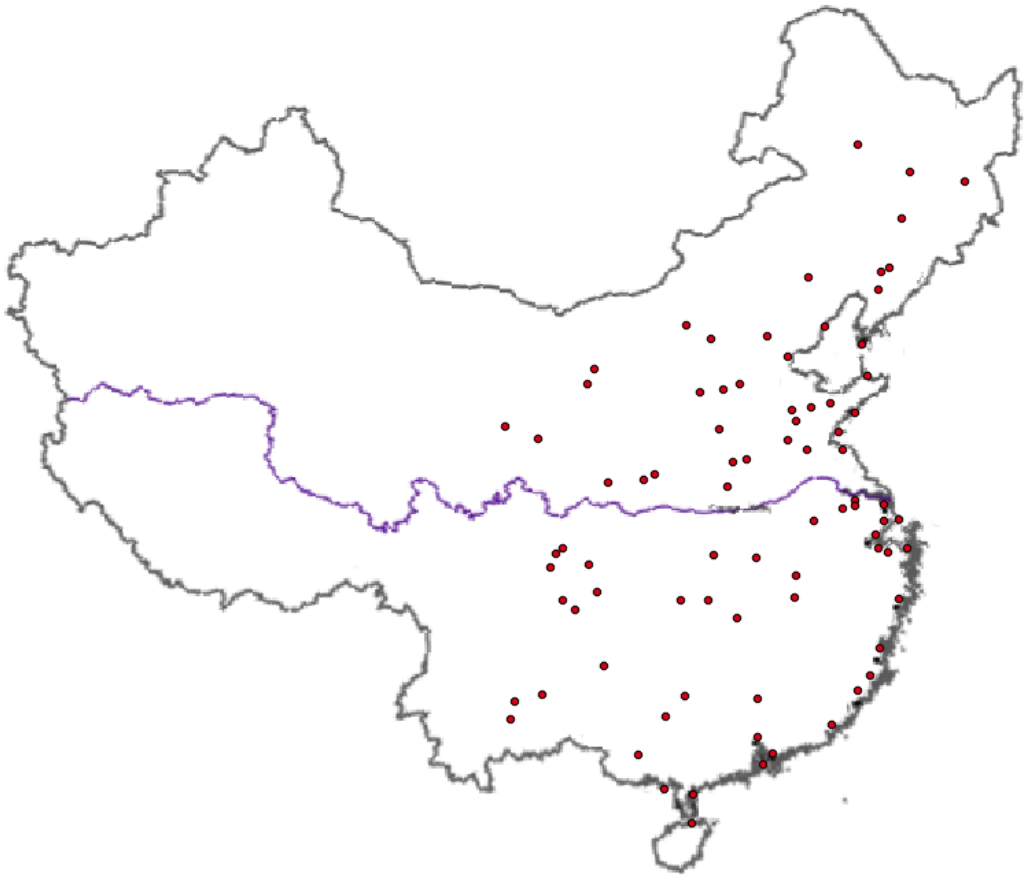
- HEPA air purifiers reduce indoor air pollution levels to zero; non-HEPA filters do not reduce air pollution at all (= outdoor pollution levels).
- Identification based on:
  - Fixed effects and distance-to-production IV for price
  - Spatial RD based on Huai River heating policy

Huai River Spatial RD

- Cities north of Huai River are more likely to have coal-fueled central heating.
- Since 2003, provision of central heat in northern cities no longer subsidized.
- Vestige of policy is in how heat is generated and inability to control it.
- Include flexible function of latitude and instrument for pollution with dummy variable for “north of river”.
- Test sensitivity to alternative bandwidths around river.
- Test for observable differences between northern and southern cities. Sorting?

Figure 2: Huai River Boundary and City Locations



Notes: The line in the middle of the map is the Huai River-Qinling boundary. Each dot represents 1 city. There are 82 cities in our sample.

Results

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- These WTP numbers are large relative to existing literature (although still smaller than what you see in the U.S. and Europe).
- Data describes ambient, not indoor, air pollution. Estimates are lower bounds for true WTP.

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- Would this make bias go in the other direction (i.e., upper bound)?

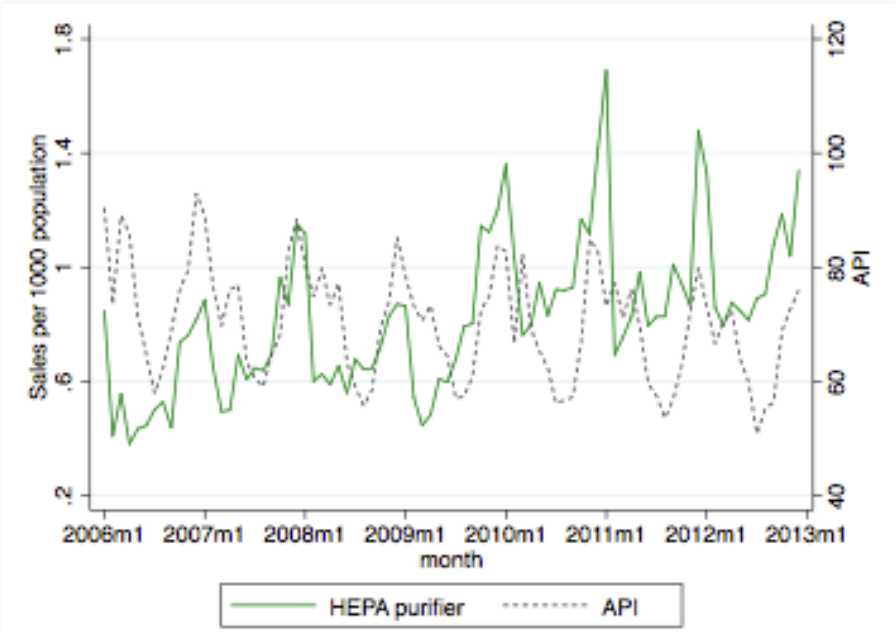
Data: *Air Quality*

- Daily Air Pollution Index (API) measured in 120 cities since 2000 (highest daily average value from PM10, SO2, NO2).

Question: How are different pollution measures normalized for incorporation into the API?

Figure 1: API and Air Purifier Sales

(a) HEPA Purifiers



Data: *Air Purifiers*

- Observe monthly sales at product level for each retail store in 82 cities; 593 products (97 brands)
- January 2006 – December 2012
- Detailed product characteristics (others besides HEPA/non-HEPA?)
- Monthly average price ($390)
- HEPA air filters remove ≈ 100% of all particulates larger than 0.3 micrometers.
- Other filters (e.g., active carbon) take out other pollutants (e.g., VOC's); assumed to result in no change in air quality, as it enters the model.

Air Purifiers

It would be useful to see the time series properties of air purifier quality, prices, and price per unit of quality.

Do these variables move predictably over time?

- If consumers have expectations about these movements, and
- if transaction costs in the re-sale market are non-trivial

…then filters could be treated as consumer durables (otherwise, we should treat them as a period-by-period rental).

Consumer Durables

- Consumer might have expectations about how price, quality, and pollution will evolve.
- Current decisions affect future utility (i.e., if you buy a product you are stuck with it for a while).
- Once a consumer buys, they may exit the market for a while.

Aguirregabiria and Nevo (2013). "Recent Developments in Empirical IO: Dynamic Demand and Dynamic Games." ***Advances in Economics and Econometrics: Theory and Applications. Tenth World Congress of the Econometric Society***

Consumer Durables: *Inclusive Values*

- State space will be very large with so many products to choose from.
- Literature on consumer durables demand relies on inclusive value associated with choice set to summarize the "value of waiting":
- One could…
  - buy purifier today, or
  - wait and get the expected value of being confronted with new choice set tomorrow.
- Model dynamics of that expected value (i.e., logit inclusive value), rather than all of the individual pieces.

Consumer Durables: *Implications*

- Assume:
  - Consumer heterogeneity in WTP is uniformly distributed [0, 1]
  - Total consumer mass of 100
  - Consumer buys if WTP exceeds price and then exits the market
  - Suppose price steadily declines [0.9, 0.8, 0.7, …, 0.1]
- Observed price-quantity pairs: (0.9, 10), (0.8, 10), (0.7, 10), …, (0.1, 10)
- Naïve estimator would assume demand is not responsive (at all!) to price.
- Things get even more complicated if consumers can re-enter the market (e.g., after 5 years).

Consumer Durables

Treating air purifiers as consumer durables can have other implications.

Consumer Durables: *Outside Option*

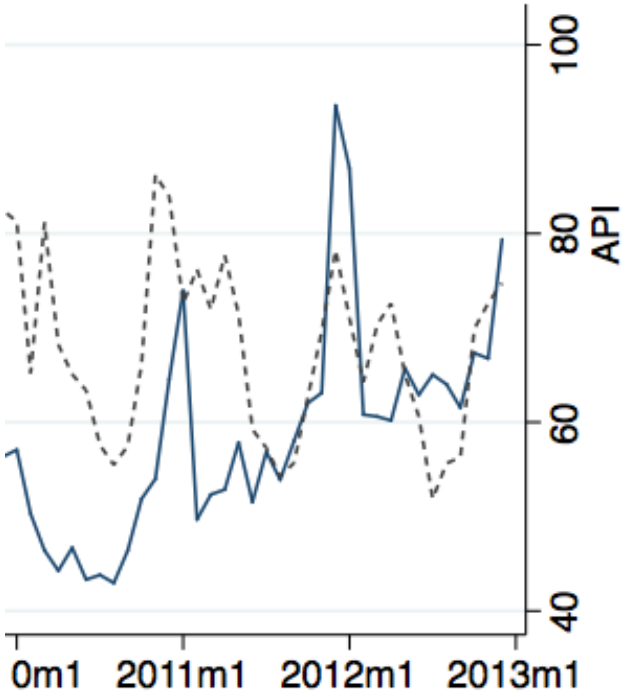
- Share attributed to outside option (s_{0ct}) is defined as

$$\frac{Total\ HH's\ in\ (ct) - \#Purchase\ in\ (ct)}{Total\ HH's\ in\ (ct)}$$

- Required for specifications that do not include city-month fixed effect.
- However, households that had previously purchased a purifier are not likely in the market for a new purifier.
- At later points in time, those who are left in the market likely have weaker preferences for clean air.

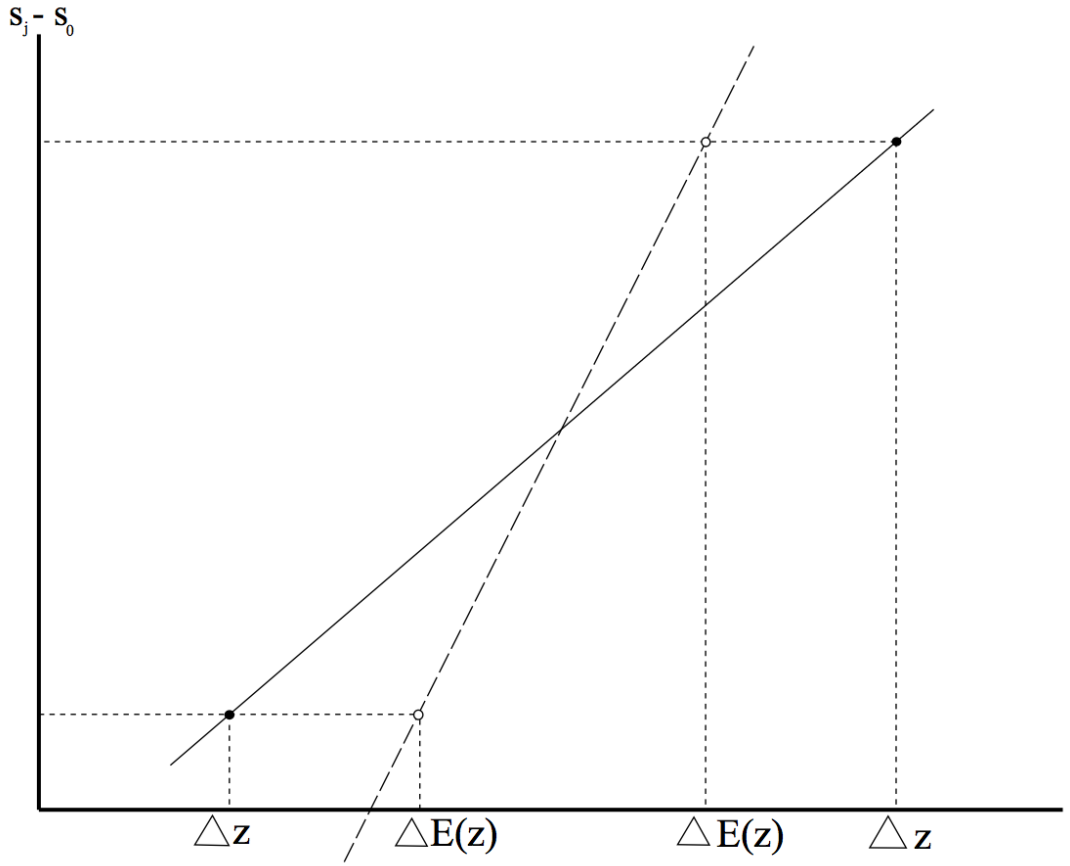
Consumer Durables: *Expectations*

- Presumably no one buys a $390 air purifier expecting it to work for just one month.
- If pollution is high this month, we may expect it to be lower next month (and vice versa).
- Expected total pollution reduction is lower when pollution is high and higher when pollution is low.



Consumer Durables: *Expectations*

We might expect that this would bias downward the estimated relationship between HEPA share and the ambient pollution level.



Price: *Role of Operating Cost*

- Ignoring the consumer durable aspect of air purifiers, we would want to treat the consumer as "renting" the device.
- Assume consumer can sell air purifier at any time and recoup the non-depreciated value.
- Decision should be based on full flow-cost of ownership (i.e., monthly rental rate and monthly operating costs) rather than just cost of purchase.
- Purifier depreciates in 5 years, and filters ($50) need to be replaced every 6 months. Operating costs are larger than purchase price, but do not enter into choice problem?

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- Differences in marginal utility of income.
- How should we use these differences for policy purposes? Allocating resources across countries?
- We do not allow for heterogeneous VSL’s within the U.S.?
- Are WTP’s most useful for setting priorities across different policy objectives within a country?