Household behaviour related to indoor and outdoor water conservation

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Outline

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Motivation

- What factors motivate households' decision-making regarding water conservation?
- Are indoor and outdoor conservation decisions jointly determined?
- How significant are external forces (prices, government programs) and household characteristics?

Literature (1)

- Renwald and Archibald (1998)
  - Indoor water-conserving technologies and adoption of new irrigation methods in a drought setting
  - Price and non-price factors both matter
- Millock and Nauges (2010); Grafton (2011)
  - OECD Data
  - Estimate probits/ordered probits to explain water conserving choices/intensity
  - No prices but presence of home water meters and presence of volumetric charge ↑ adoption

Literature (2)

- Dupont and Renzetti (2013)
  - Bivariate probit for two indoor water conservation choices
  - Bivariate ordered probit for two types of outdoor water frequency
  - Canadian households survey
  - Test for jointness of indoor/outdoor decisions
  - Test for endogeneity of prices and non-price programs
  - Prices influence indoor water conservation choices but DSM policies don't
  - Prices less important for outdoor water conservation choices

Model (1)

- Household makes discrete choice decisions pertaining to optimal behaviour sets of decisions (four)
  - Indoor – utility maximizing choice of having a low volume toilet and/or a low flow shower
  - Outdoor – utility maximizing choice of frequency of lawn watering and/or garden watering
- Allow for independent correlations across four decisions

Data and Estimation (1)

- Statistics Canada's 2006 Households and the Environment Survey (N=28,334)
  - Microdata on adoption of low flush toilets and low flow showerheads
  - Outdoor water frequency for lawns and gardens
  - Household characteristics (income, education, children, size of household)

Data and Estimation (2)

- Use only metered homeowner observations from CMA's (N=8400)
  - CMA – census metropolitan area
  - Link to municipal water prices: including "marginal price", dummy for increasing volumetric price, %Δ real price of water 2001-2005 and information about use of non-price conservation measures
  - Link to weather variables (rainfall, degree days)
  - Link to electricity prices

Data and Estimation (3)

- Problem: 3 of the explanatory variables (whether volumetric pricing, marginal price, and existence of non-price conservation measures) may be endogenous
- Why? Municipal jurisdiction may have responded to local conditions and water choices
- Solution: Instrumental variables for potentially endogenous variables
- Jointly estimate equations for each of the three explanatory variables with the four choices of interest

Data and Estimation (4)

- System of 7 equations:
  - Eqtn 1: IV for price structure (probit yes/no volumetric pricing)
  - Eqtn 2: IV for marginal price (OLS level of price)
  - Eqtn 3: IV for non-price policies (probit yes/no policy)
  - Eqtn 4: probit for low volume toilet
  - Eqtn 5: probit for low flow shower
  - Eqtn 6: ordered probit for lawn watering
  - Eqtn 7: ordered probit for garden watering

Data and Estimation (5)

- Allow for correlations across equations
  - Test for potential endogeneity
  - Test for jointness of decisions
- Stata using CMP routine (conditional mixed process)
- Recursive system of 7 SUR
  - Variables used as explanatory in IV equations
    - Electricity prices, provincial dummies, access to recycling programs, awareness of local air quality problems

5. Results

- What drives indoor conservation choices?
  - Higher marginal prices increases likelihood of low volume toilet
  - Presence of increasing volumetric price structure increases likelihood of low flow showerhead
  - Non-price conservation policies have not impact
  - Household characteristics (income, education, household size) increase likelihood of both
  - But, presence of kids reduces likelihood of both

Results (2)

- What drives outdoor conservation choices?
  - Higher water prices and presence of volumetric price structure encourages LESS frequent garden watering
  - BUT encourages MORE frequent lawn watering
    - Problem – variable we have is frequency of lawn watering in a week – this does not tell us how much water is used
    - Higher prices may reduce overall consumption (which we do not observe) but households compensate by watering more frequently
  - Non-price conservation encourages LESS frequent lawn and garden watering
  - Higher incomes and education lead to MORE watering
  - Children lead to LESS!

Results (3)

- Toilet and shower decisions are correlated (positively)
- Garden and Lawn decisions are highly correlated (positively)
- Garden is positively correlated with Toilet and Shower
- Lawn is not at all correlated with Toilet and Shower

- Endogeneity of prices/policies not present