Introduction

- Commercial buildings: 18% of US energy consumption → Potential for energy savings
- Debate around rebound effect → Energy efficiency increases energy consumption?
  - Most studies do “engineering estimate” or assess “technical potential” → Hard to tell the net energy savings after rebound effect
  - Very rare empirical work using econometrics to evaluate the actual energy savings, net of all social factors
- Energy price elasticity estimates
  - Rare in commercial sector

Research Questions

- What is the net impact (net of rebound effect) of the adoption of energy efficient technologies on electricity consumption?
- What are the price elasticities of electricity consumption of commercial buildings?

Technical Challenges

Endogeneity among energy price, adoption of energy efficient technologies and electricity consumption

1. Positive correlation between energy intensity/consumption and the adoption of energy efficient technologies (Andrews and Krogmann, 2009 a) → Rebound effect really that strong? SAMPLE SELECTION BIAS
2. Average energy price is a function of energy consumption → Deep literature in residential, very few in commercial

Models

- Structural models
  - Average price equation
    \[ P_v = \frac{1}{\phi} \int \left( q(C_v,C_f,U,U) \right) dq \]
  - Technology adoption equation (probit model)
    \[ T_j = 1 \text{ if } S_j = E_j, F_j = 1 + \tau(C_j). E_j, F_j = 0 \]
- Electricity demand equation (reduced form)
  \[ \ln Q_j = \mu \ln \beta \ln \pi_j + \rho \ln \eta_j + \delta Z_j + \theta_1 \theta_2 + \epsilon_j + \epsilon_P \]

Selection bias ← Modified Heckman model

\[ E_i(Q_j) = E_i(E_j) E_i(F_j) = 1 \text{ if } (T_j = 1) \text{ and } (E_i(Q_j) = 0) \]

Average price ← Two stage least squares

Data

- Energy Demand of U.S. Commercial Buildings: An Econometric Approach
  - Lucy Yueming Qiu
  - Ph.D Candidate, Stanford University

Data Contd.

Detailed Model Results

- Detailed Model Results
  - Model number
  - LHS=ln (electricity consumption / area)
  - No technology
  - EMCS
  - Economizer
  - VAV system
  - Technology adoption
  - buildings
  - Regional characteristics
  - Owner type
  - Size of the building
  - Building usage
  - Principal building activities
  - Technology
  - Building age (Base case: 2000-2004)
  - Wall construction material
  - Roof construction material

- Data
  - Commercial Buildings Energy Consumption Survey (2003); Technologies Analyzed → HVAC, 51% of energy use

- Conclusions
  - After rebound effect, there are still net energy savings of adopting energy efficient technologies for commercial buildings → Promote energy efficiency
  - Commercial buildings are price sensitive in terms of their electricity consumption → Pricing or tax policies will be effective

Without correcting the bias, misleading the rebound effect leads to negative energy saving!