Household Vehicle Bundle Choice and Gasoline Demand

A Discrete-Continuous Approach

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Resources for the Future

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Elasticity of Demand for Gasoline

- Consumer response to changing gasoline prices
- Important in policy settings
  - Environmental concerns
  - Welfare outcomes
  - Distributional Concerns

CORRECT ESTIMATION IS CRUCIAL!!

Elasticity of Demand for Gasoline

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  1. Reduced Form: Regress prices and quantities
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- Methods for estimating elasticity:
  1. Reduced Form: Regress prices and quantities
     - Cross-sectional data; Panel data
       - Schmalensee and Stoker (1999)
  2. Structural: Understand underlying parameters
     - Can incorporate many issues of concern unavailable to reduced form methods
       - Bundle choices, substitutability: West (2004); Goldberg (1998); Berkowitz (1990)
       - Joint estimation of extensive/intensive margin: Feng, Fullerton & Gan (2005); Bento, et.al. (2008)

Proposed Approach

- Structural, cross-sectional analysis – 2001, 2009 National Household Transportation Survey
- Revealed preference
- Can minimize number of simplifying assumptions that impact elasticity

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3. Don't include *vehicle specific fixed effects*
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4. *Aggregate* choice set for easier estimation
   - Doesn't capture subtle changes in vehicle purchase decision

Impacts on Elasticity, Benefits of Method

- Allows me to test impact of assumptions 2-4 on elasticity
  - Bundles, disaggregation, vehicle fixed effects

- Not accounting for these complexities can have significant impacts on elasticity!

Elasticity can be underestimated by 66%

Why This is Difficult

1. Bundles + disaggregate choice set ≈ ∞ choices!
2. VFE + dis. choice set = too many parameters!

Need a method that allows for

very large choice set,

vehicle specific fixed effects

Proposed Method

- Revealed preference approach:
  - Observed household bundle is optimal, provides maximum utility
  - Any deviation from chosen bundle results in lower utility
    - Thus, can compare the utility levels:

    Utility(bundle choice) ≥ Utility(deviation from choice)
  - Search for parameters that make this inequality hold, use these to calculate elasticity
- Allows for unconstrained choice set

Estimation: Revealed Preference

- Routine:
  - Form preference inequality for each household

$$U_{iJ_i^*} \geq U_{iJ_i}$$

J_i^*: Bundle chosen by household i

J_i: One alternative bundle **not** chosen by household i

  - Maximize likelihood that chosen bundle was best choice (preference inequality holds).

Proposed Method : Adding Vehicle Specific Fixed Effects

- Unilateral comparisons *do not allow* inclusion of vehicle FE!

Household 1 owns vehicle A: $U_{1A} + \theta_A \geq U_{1B} + \theta_B$

  - Too many θ_j to estimate in this manner.

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$$U_{1A} + \theta_A + U_{2B} + \theta_B \geq U_{1B} + \theta_B + U_{2A} + \theta_A$$

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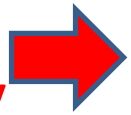
Final Pref. Inequality  $U_{1A} + U_{2B} \geq U_{1B} + U_{2A}$

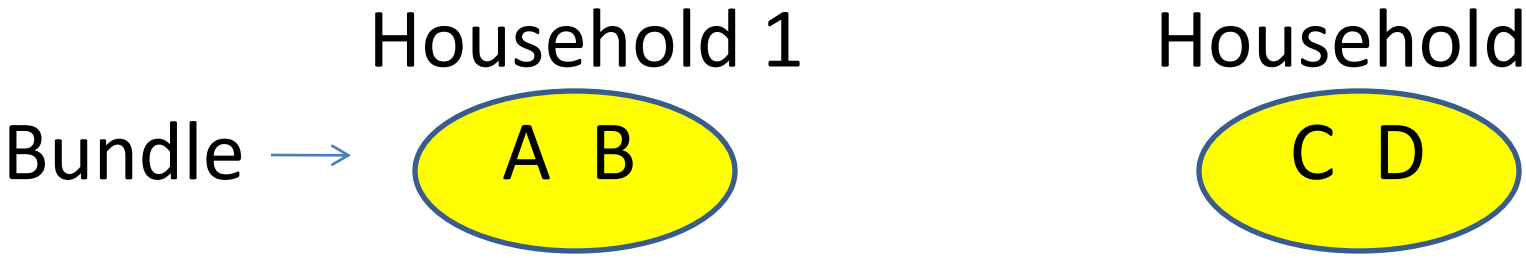
NEED TO DO A "SWAPPING" ESTIMATOR!!

Swapping Estimation: Bundles with >1 vehicle

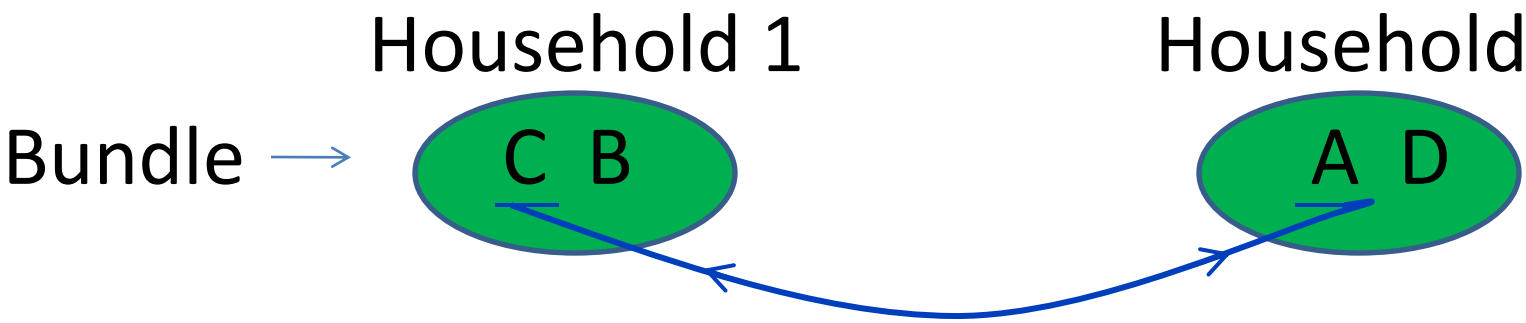
- "Swap" = proposed deviation from bundle.
  - Choose one purchased vehicle from two households' observed bundles, swap them

Proposed Deviation: "Swap" with Bundles

- Original Scenario (*Data Observation*)



- Proposed Deviation (*Swap*)



Revealed Preference: both HH better under data observation!

Estimation Technique

1. Randomly swap two vehicles between two households.
2. Run maximum likelihood that any random swap makes both households worse off.
3. Find parameters that maximize likelihood.
4. Use these parameters to calculate elasticity.

Revealed Preference -> Elasticity

- VMT* = f (Z_i: HH characteristics;
  X_j: vehicle characteristics;
  $Z_i * X_j$: interactions;
  $\hat{\beta}$: estimated parameters;
  gasoline price)

- Elasticity = $(\Delta VMT / \Delta price) * (price_0 / VMT_0)$

Results

	Baseline	1	2	3	4	5
Fixed effects	No	No	No	Yes	Yes	Yes
Bundles	No	Yes	No	No	No	Yes
Disaggregation	No	No	Yes	No	Yes	Yes
Elasticity estimate (std. err.)	**-0.30 (0.08)**	**-0.32 (0.09)**	**-0.43 (0.12)**	**-0.52 (0.15)**	**-0.62 (0.17)**	**-0.89 (0.25)**
% Underestimated	66%	64%	51%	41%	29%	-

Conclusion

- Elasticity is underestimated if
  - Ignore bundle effects
  - Aggregate the choice set
  - Exclude vehicle fixed effects
- Swapping Revealed Preference method
  - Allows researcher to model more complex consumer behavior
  - Minimizes distortions on elasticity

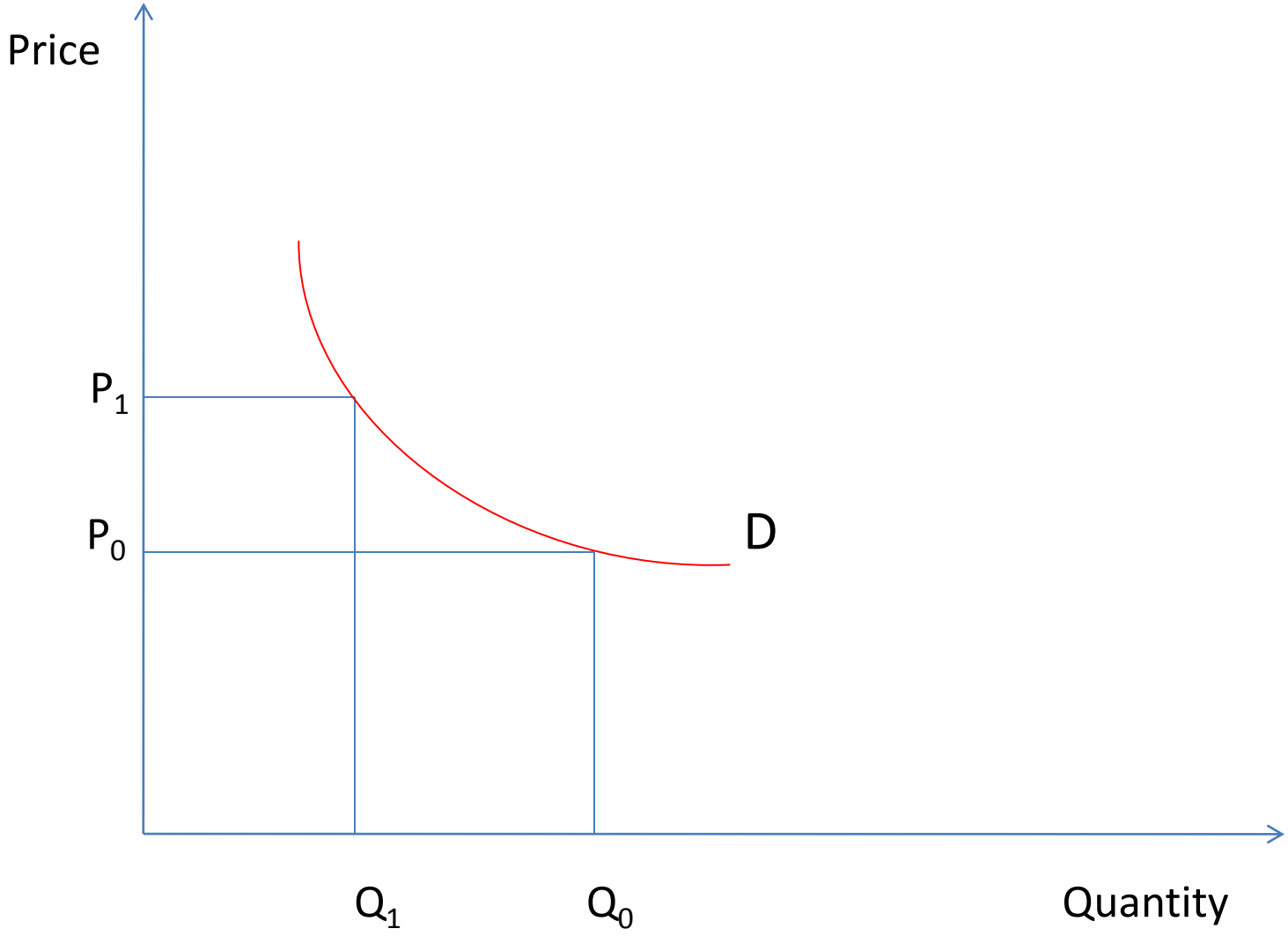
Thank you!

Any Questions?

Benefits of Structural, Cross Sectional Analysis

- Reduced form: cannot predict impact of various policy changes
  - Intensive margin: Does not capture technological change, substitution within household
  - Policy makers won't understand how individuals make changes when faced with higher gas prices
- Time series data: hard to pinpoint change in demand due ONLY to gasoline prices
  - Preferences, demographics, income, economy may change along with prices

Misidentification: Reduced Form



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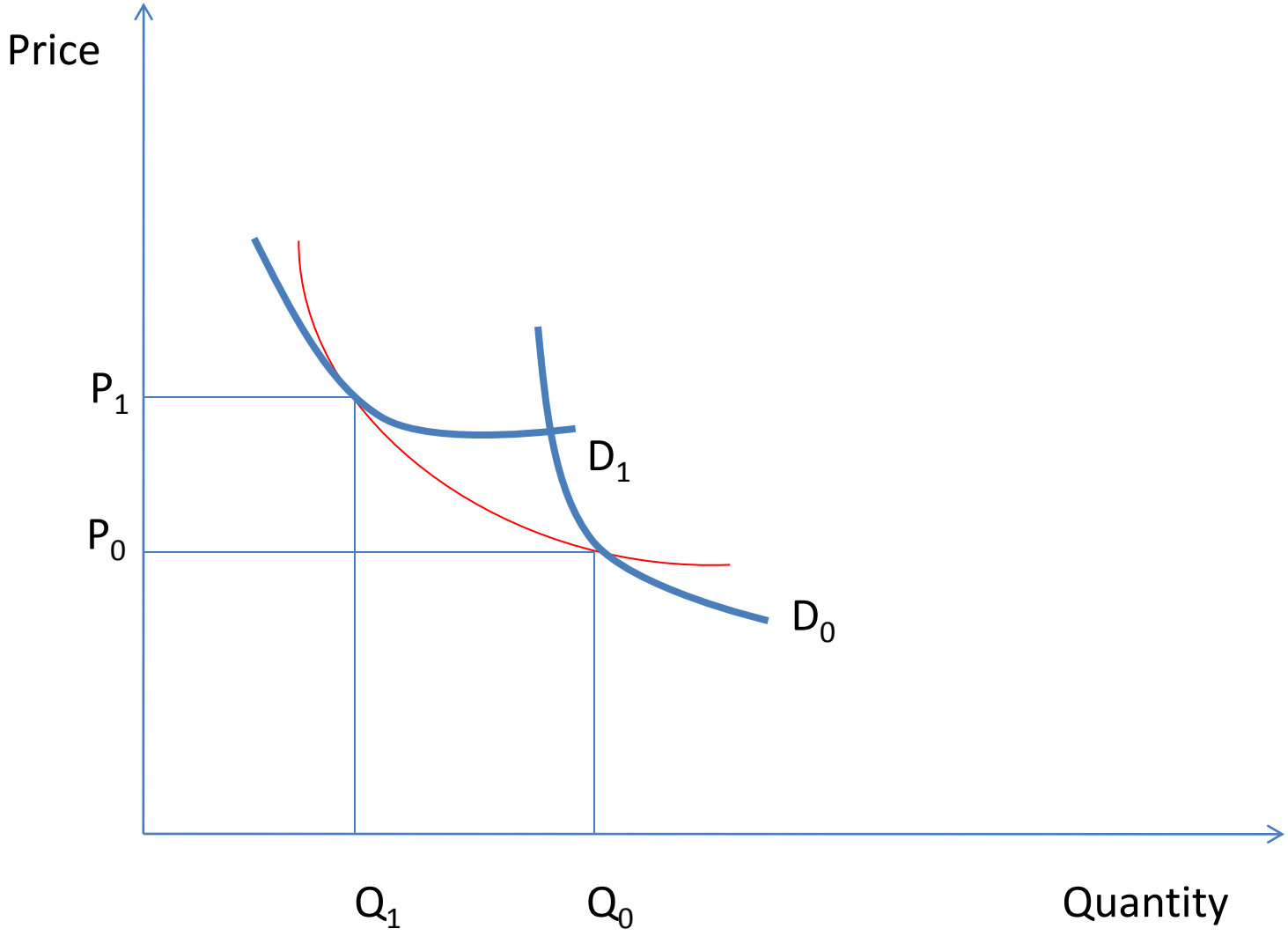

Benefits of Structural Method

- Structural: Allows for the actual identification of demand curve!
- Revealed Preference: Want to allow for more complex consumer behavior