Subsidizing cleaner products

- Fixed gov't revenue R
- Want to subsidize adoption of new class of cleaner products. Multiple products on the market.

Goal: want to maximize total quantity of product sold while keeping in mind equity concerns with who is receiving the benefit of the subsidy.

We have:

- Estimated demand for products in this class (with cleaner tech.)
- Demand est. separately for each product and by demographic group (e.g., income)

Focus of paper:

- Theory model
- Demand estimates
- Policy simulations that use demand estimates to shed light on theory

Model: should give principles for how subsidies should be structured to maximize diffusion of cleaner products.

To develop concepts, I'm going to start with a simple model, modified slightly from Sarah Armitage's JMP[1], where the demand estimation is a modification of the BLP-style discrete choice modeling.[2] I also use Nevo (2000) as a helpful guide.[3]

Setup:

- Start with static model – 1 period
- This is a nice setup for discrete choice since many consumer products that policy makers may want to incentivize are large appliances that you would only buy one of.
- product $j \in J$ in market $t \in T$, with observed & unobserved product characteristics $\boldsymbol{x_{jt}}$, $\boldsymbol{\xi_{jt}}$
- consumer $i \in I_t$, with vector of demographics $\boldsymbol{D_i}$
- Indirect utility for individual i purchasing one unit of product j in market t:
  $U_{ijt} = \boldsymbol{x_{jt}}\boldsymbol{\beta} - \alpha \boldsymbol{p_{jt}} + \boldsymbol{\xi_{jt}} + [-\boldsymbol{p_{jt}} \quad \boldsymbol{x_{jt}}] \cdot (\Pi \boldsymbol{D_i} + \Sigma \nu_i) + \varepsilon_{ijt}$
  $\boldsymbol{p_{jt}}$ market price (can be replaced with $\boldsymbol{p_{jt}} + t_j$, where t_j is the tax (subsidy) on good j)
  $\alpha, \boldsymbol{\beta}$ all-consumer taste parameters (estimated)
  Π demographic taste parameters (estimated)
  Σ idiosyncratic random coefficients
- Consumers can also choose the outside option to not purchase any thing this period (and stay

[1] Armitage, Sarah. "Technology Adoption and the Timing of Environmental Policy: Evidence from Efficient Lighting." Job Market Paper, November 14, 2021. https://scholar.harvard.edu/files/sarmitage/files/armitage_jmp_harvard.pdf.

[2] Berry, Steven, James Levinsohn, and Ariel Pakes. "Automobile Prices in Market Equilibrium." Econometrica 63, no. 4 (1995): 841–90. https://doi.org/10.2307/2171802.

[3] Nevo, Aviv. "A Practitioner's Guide to Estimation of Random-Coefficients Logit Models of Demand." Journal of Economics & Management Strategy 9, no. 4 (Winter 2000): 513–48. https://doi.org/10.1162/105864000567954.

with their already-owned dirty good?); utility of outside option normalized to zero.

- Only can choose one product in the period.
- The products have per-unit externalities e_j such that $e_D > e_{C2} \geq e_{C1} \geq 0$
- Q_j = total quantity of good j sold
- Production functions:
- Assume x and y are perfect substitutes to start.
- Budget constraint: i has income $y_i = p_x x_i + p_y y_i + z_i$
- $X = \sum_i x_i$ = total quantity of product x sold (same for y and z)

In estimating demand though the BLP framework, we get estimates of the average and demographic-specific price sensitivity (*alpha*, first row of Π). We can use these to understand how people will react to the subsidies – estimating shares of the population, by demographics, that will switch to the different products given a vector of subsidies (negative taxes).

We want to maximize the social welfare function over the choice of subsidies, subject to our revenue R budget constraint.

Questions:

- How will subsidizing these different products affect market structure? We probably care about the long-run effects of this (Armitage, 2021)
- What does the social welfare function look like?