

**Problem Set 2 Part 1**  
**ARE 261**

**Part 1: Conditional logit model, welfare analysis, and counterfactual choice simulation**

This part of the assignment asks you to replicate the results reported in the paper, interpret these results, and then use the estimated model to simulate home heating choices under efficient (versus observed) retail energy prices.

The data file titled `Davis_data.csv` contains household-level information about household/house characteristics collected the U.S. decennial Census and ten waves of the U.S. American Community Survey (ACS). This data set spans 1992-2018. The data dictionary is included at the end of this assignment. I have constructed all the variables you will need, although you might want to play around with these to get a feel for the variables. Data are described in detail in Davis (2021).

- i. Estimate the conditional logit model summarized by equations (2)-(4) in Lucas's 2021 paper. Make sure you can replicate the coefficient estimates and associated marginal effects he reports in Table 5.
- ii. The estimated coefficient on annual energy expenditures is -1.40. How should we interpret this estimate, exactly? Please relate your explanation to the latent utility parameters in equation (1).
- iii. Calibrate the willingness to pay to avoid an electrification mandate for each household (replicating the exercise described in section 4.3 of the paper). Focusing on California, summarize the implied distribution of WTP estimates for these California households. What generates variation in these WTP estimates in this conditional logit model?
- iv. Recall that regulated retail energy prices in California are higher than social marginal cost (SMC) so as to recover fixed/legacy costs. In recent years, Borenstein and Bushnell have estimated that the social marginal cost of natural gas production is about \$9/1000 cu ft. Borenstein, Fowlie, and Sallee have estimated that the social marginal cost of electricity consumption is about 10 cents per kWh.

Focus on the period 2010-2018 in the data and assume that the SMC is \$9/000 cuft for natural gas and \$0.10/kWh (nominal) over this entire period. Use Lucas's model to first predict heating choices for households in California survey respondents over the period 2010-2018 using observed nominal prices. Report the predicted share of households choosing electric heat. Then, for these same households, predict how electrification rates would likely have differed if prices were set at SMC values over this period.

Based on your simulation results, are California's relatively high retail electricity prices slowing the transition to building electrification? If yes, by approximately how much?

<b>variable name</b>	<b>variable label</b>
sample	sample_lbl IPUMS sample identifier
serial	Household serial number
numprec	Number of person records following
hhwt	Household weight
division	region_lbl Census region and division
statefip	statefip_lbl State (FIPS code)
ownershpd	ownershpd_lbl Ownership of dwelling (tenure) [detailed
hhincome	Household Income, 1000s
builtyr	builtyr_lbl Age of structure
builtyr2	builtyr2_lbl Age of structure, decade
fuelheat	fuelheat_lbl Home heating fuel
year	
statecode	StateCode
hdd	Heating Degree Days, 1000s
cdd	Cooling Degree Days
statefips	State fips code
region	region    Census Region
elec	
D2	division==Middle Atlantic Division
D3	division==East North Central Div.
D4	division==West North Central Div.
D5	division==South Atlantic Division
D6	division==East South Central Div.
D7	division==West South Central Div.
D8	division==Mountain Division
D9	division==Pacific Division
bedrooms4	Four Bedroom Home
bedrooms5	Five+ Bedroom Home
rental	Rented, i.e. not owner-occupied
units_mobile	Mobile Home
units_attached	Single Family Home, Attached

units_2to4	Multi-Unit Home, 2-4 Units
units_5plus	Multi-Unit Home, 5+ Units
ngprice	Natural gas retail price
elecprice	Electricity retail price
annualkwh2015	(mean) annualkwh2015
annualkwh	(mean) annualkwh
annualkwhMore~i	(mean) annualkwhMoreMulti
annualkwhLess~i	(mean) annualkwhLessMulti
annualkbtu2015	(mean) annualkbtu2015
annualkbtu	(mean) annualkbtu
annualkbtuMor~i	(mean) annualkbtuMoreMulti
annualkbtuLes~i	(mean) annualkbtuLessMulti
id	group(sample serial)
alternative	choice alternative
choice	choice indicator
elec expenditure	$\text{annualkwh} * \text{elecprice} / 100$
gas expenditure	$\text{annualkbtu} * \text{ngprice} / 1000$ (converting btu to cu ft)
expenditure	annual energy expenditure (\$000)