Efficiency and Equity Impacts of Energy Subsidies

Hahn and Metcalfe. (2021)

Enviromental Reading Group session 3

Aug 9, 2023

Motivation and Research Question

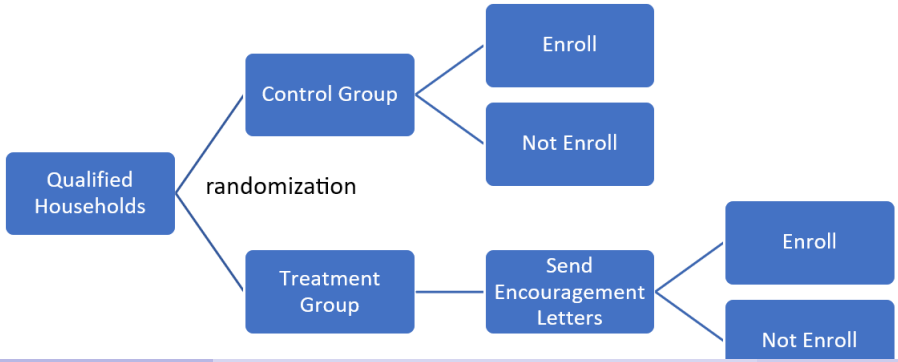
- What is the economic and environmental impact of energy subsidy?
  - on consumers' energy consumption?
  - on emissions?
- What is the net benefit of energy subsidy?
  - It might be good for people who enjoy this subsidy.
  - However, it decreases welfare for non-subsidy consumers and might lead to more air pollution.

California Alternate Rates for Energy (CARE)

- This is a subsidy program that offers a 20% discount on gas price and 30-35 % price discount on power price. (Not everyone is eligible)
- To qualify for this program, a household has to send an application form and the authority should verify the eligibility. $\Rightarrow$ traceable.
- 4.5 million households enrolled. For the gas only program, 1.6 million.

Experiment Design

- Target Program: Southern California Gas (SoCalGas).
- Target People: CARE customers that failed to re-enroll in time (10% of total population).



Experiment Design Cont.

TABLE 1—EXPERIMENTAL GROUPS AND DETAIL

Group	Detail	Sample size
Experiment 1, 2014		
T0 (Control)	No letter	7,366
T1	Business as usual letter asking to enroll in CARE	7,329
T2	T1 + personalized information on benefits	7,363
T3	T2 + loss framing on benefits	7,368
T4	T3 + social norms	7,370
Experiment 2, 2015		
T0 (Control)	No letter	8,496
T1	Rebranded letter	8,499
T2	T1 + thank you for being a customer	8,496
T3	T1 + more information on gas efficiency	8,497

LATE Estimate

$$\hat{LATE} = \frac{\bar{G}_1 - \bar{G}_0}{\bar{D}_1 - \bar{D}_0} \tag{1}$$

Enrollment Decision is endogenous, so we should use randomization as an instrument.

$$\mathbf{1}(CARE)_{imt} = \phi T_{imt} + \theta_m G^b_{im} + \pi_m + \gamma_j + \mu_{imt} \tag{2}$$

$$G_{imt} = \beta T_{imt} + \theta_m G^b_{im} + \pi_m + \gamma_j + \mu_{imt} \tag{3}$$

Encouragement and Enrollment

TABLE 2—OVERVIEW OF ENROLLMENT BEHAVIOR: LINEAR PROBABILITY MODEL

	Enrollment exp 1 (1)	Enrollment exp 2 (2)	Enrollment exp 2 (3)
Treatment 1	0.0895	0.1114	0.1114
	(0.0046)	(0.004)	(0.004)
Treatment 2	0.1008	0.1091	0.1091
	(0.0047)	(0.004)	(0.004)
Treatment 3	0.1031	0.1109	0.1109
	(0.0047)	(0.004)	(0.004)
Treatment 4	0.1011		
	(0.0047)		
Constant	0.0430	0.0232	0.0406
	(0.0024)	(0.0016)	(0.0035)
Wave fixed effects	No	No	Yes
R^2	0.015	0.024	0.025
Observations	36,796	33,988	33,988

Note: Column 1 contains results for experiment 1, the other columns for experiment 2.

LATE and Arc Elasticity

TABLE 3—ITT AND LATE ESTIMATES OF CARE (ALL DATA)

	Take-up CARE (FS) (1)	Gas consumption (ITT) (2)	Gas consumption (LATE) (3)
Receive encouragement	0.0772	0.1513	
	(0.0014)	(0.0729)	
Monthly usage control	0.0001	0.7110	0.7108
	(0.0000)	(0.0145)	(0.0145)
Enrolling in CARE			1.9090
			(0.9198)
Control usage (therms)	21	21	21
F-statistic in first-stage	1,441		
2015 data for wave 1			
R^2	0.063	0.53	0.464
Observations	515,017	499,274	499,274

$$E_{gas} = \frac{22.91 - 21}{(21 + 22.91)/2} \Big/ \frac{0.9 - 0.7}{(0.7 + 0.9)/2} = -0.35.$$

Heterogeneity

TABLE 5—HETEROGENEOUS TREATMENT EFFECTS AND ELASTICITIES

	LATE		Elasticities	
	Yes (1) to characteristic (1)	No (0) to characteristic (2)	Yes (1) to characteristic (3)	No (0) to characteristic (4)
(1) Low-income household	2.918	1.31	0.52	0.24
Observations	219,693	640,951		
(2) High gas user	2.2731	0.6794	0.41	0.13
Observations	435,854	424,790		
(3) Opower treatment group	1.917	1.889	0.35	0.34
Observations	89,181	771,463		
(4) Paperless billing	1.329	1.718	0.25	0.31
Observations	235,467	625,177		

Welfare Effect

Change of welfare effect:

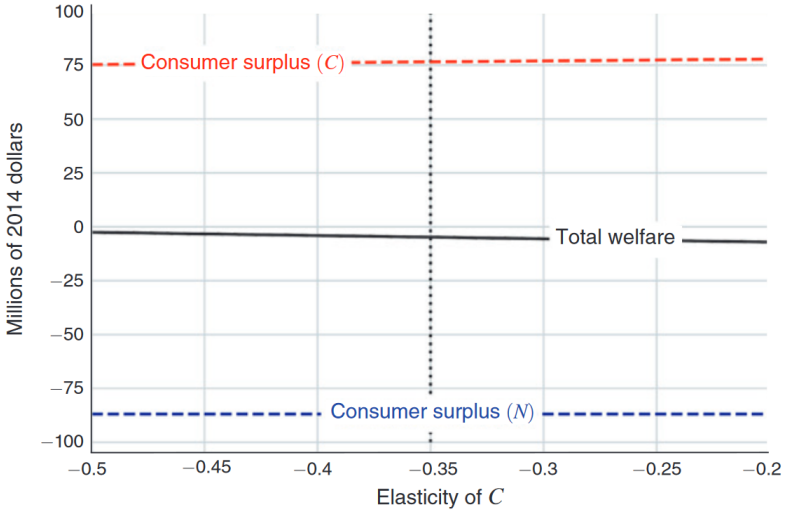
$$N_n \int_{Q_{0n}}^{Q_{1n}} (P^n(Q) - MSC)dQ + N_c \int_{Q_{0c}}^{Q_{1c}} (P^c(Q) - MSC)dQ - A \tag{4}$$

Derive P_0 by assuming that the net transfer is zero:

$$N_n(P_{1n} - P_0)Q_{1n} = N_c(P_0 - P_{1c})Q_{1c} + A \tag{5}$$

Derive Q_0 by demand function.

Welfare Effect Cont.



Welfare Effect Cont.

- Total welfare is negative.
- Total welfare can be positive if administrative costs is lower.
- The welfare benefit for CARE Consumer decreases with demand elasticity.
- The total welfare loss decreases with demand elasticity.

Conclusion

- Energy subsidy significantly increases energy consumption for customers who enjoy the program.
- Overall, the subsidy decreases total social welfare as large administrative cost and social carbon cost.

Reference

Hahn, R. W., & Metcalfe, R. D. (2021). Efficiency and equity impacts of energy subsidies. American Economic Review, 111(5), 1658-1688.