Tagging and Targeting of Energy Efficiency Subsidies

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December 30, 2014

Abstract

A corrective tax or subsidy is "well-targeted" if it primarily affects choices that are more distorted by market failures. Energy efficiency subsidies are designed to correct multiple distortions: externalities, credit constraints, "landlord-tenant" information asymmetries, imperfect information, and inattention. We show that three important energy efficiency subsidies are primarily taken up by consumers who are wealthier, own their own homes, and are more informed about and attentive to energy costs. This suggests that these subsidies are poorly targeted at the market failures they were designed to address. However, we show that "tagging" can lead to large efficiency gains.

JEL Codes: D03, D12, D83, H21, L51, L94, Q48.

Keywords: Behavioral public economics, energy efficiency, optimal taxation, tagging.

We thank Lucas Davis, Ken Gillingham, Sendhil Mullainathan, and seminar participants at the 2015 ASSA Annual Meetings for helpful insights. We are grateful to the Sloan Foundation for financial support. Code to replicate the empirical analyses is available from Hunt Allcott's website.

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Corrective taxation is a common approach to addressing externalities, internalities, and other market distortions. These distortions are often heterogeneous: for example, some cars pollute more than others, and many people consume alcohol "rationally" even as present biased individuals might over-consume. Such heterogeneity raises the question of whether a corrective tax is "well-targeted": does it primarily affect individuals subject to relatively large distortions? A tax set at the *average* level of the distortion could actually reduce welfare if the *marginal* individuals were already making relatively undistorted decisions.

This paper studies the targeting of corrective taxes and subsidies for energy efficient durable goods such as air conditioners, insulation, and cars. These policies, which in the United States include gas guzzler taxes and subsidies for hybrid vehicles and "Energy Star" appliances, are justified by multiple market failures, primarily including environmental externalities, credit constraints, "landlord-tenant" information asymmetries, imperfect information, and "behavioral" biases such as inattention to energy costs (Allcott and Greenstone 2012, Gillingham, Newell, and Palmer 2009). We document heterogeneity in distortions and show that environmentalists are more attentive to energy costs and believe that energy efficient goods save more money. We then show that three major energy efficiency subsidies are preferentially adopted by consumers who appear to be *less* affected by distortions - wealthier environmentalists who own their own homes and are better informed about and more attentive to energy costs. We show how welfare gains are possible from "tagging" (restricting eligibility) or marketing subsidies towards individuals with larger distortions.

I A Model of Optimal Subsidies and Targeting

Our model is a minor modification of the model in Allcott and Taubinsky ("AT") (2013). A unit mass of consumers make a binary choice, which in our case represents whether or not to purchase an energy efficient good such as insulation or a hybrid car. The good is produced at a constant marginal cost c in a perfectly competitive market. A policymaker can set subsidy

s, which is funded through lump-sum transfers. The good's price is $p = c - s$.

The social value of purchasing the good is v, but consumers have perceived private valuations $\hat{v} = v - d$. The "distortion" d arises from the market failures listed above, such as externalities from pollution and internalities from inattention to energy costs. Positive (negative) d means that consumers are distorted away from (towards) the energy efficient good. To simplify exposition, we assume that there are two distortion types $j \in \{L, H\}$, with population shares α_j and distortions $d_L < d_H$.[1] Consumers purchase the good if and only if $\hat{v} > p$.

Z denotes consumers' initial wealth, F_j denotes type j's cumulative distribution of $\hat{v}$ at subsidy s, $Q_j(p)$ denotes the share of type j consumers who purchase, and $D(p) = \alpha_L Q_L(p) + \alpha_H Q_H(p)$ denotes total demand. The social planner maximizes $W(s) = Z - R(s) + \sum_j \alpha_j \int_{x \geq c-s} (x + d_j - p) dF_j(x)$, where $R(s)$ is the amount of revenue the planner needs to raise from each consumer to fund the subsidy.

I.A Why Targeting Matters for Welfare

Let $\bar{d} = \sum \alpha_j d_j$ denote the population average distortion, and define "targeting" as a measure of whether high-distortion types are more responsive to the subsidy: $\tau(s) \equiv \mathrm{cov}(d_j, -Q'_j(c - s))$. *We refer to a subsidy as well-targeted (poorly-targeted) if $\tau(s)$ is high (low).*

Following the computations in AT (2013), the welfare impact of a small increase in the subsidy s is

$$W'(s) = (s - \bar{d}) \cdot D'(c - s) + \tau(s). \tag{1}$$

Equation (1) implies that welfare gains depend not only on the population average distortion, but also on the covariance between distortion and the responsiveness to the subsidy. This shows that *a poorly-targeted subsidy generates lower welfare gains than a well-targeted*

[1] AT (2014) allow the distortion to depend on $\hat{v}$ and s, and this does not affect the welfare and subsidy formulas below. Allowing d to depend on s accommodates the idea that valuations may be affected by the salience or consumer awareness of the subsidy, which connects to our results in Table 2.

subsidy.

The first order condition for Equation (1) shows that the optimal subsidy must satisfy

$$s^* = \bar{b} - \frac{\tau(s)}{D'(c-s)} \tag{2}$$

Because $D' < 0$, Equation (2) shows that the optimal subsidy is increasing in $\tau(s)$. Thus, *a poorly-targeted energy efficiency subsidy could optimally be small, even if the population average distortion is large.*

I.B Tagging Is More Valuable When Subsidies Are Poorly Targeted

We now study the efficiency gains from "tagging" (Akerlof 1978): explicitly limiting eligibility to individuals subject to greater distortions. To illustrate this simply, we assume that the policymaker observes type L or H and can set type-specific subsidies s_L and s_H. (The results generalize to the case in which the planner only observes a correlate of type.)

Equation (1) shows that the optimal type-specific subsidies must satisfy $s_L^* = d_L$ and $s_H^* = d_H$. Thus, the more heterogeneity there is in the distortions d_j, the more the optimal tagging policy (s_L^*, s_H^*) deviates more from the optimal uniform subsidy, and thus the larger the welfare gains from tagging. Proposition 1 shows that the welfare gains from tagging are also increasing in the absolute value of the covariance term τ(s). Intuitively, the welfare losses from not having a perfectly targeted subsidy are smallest when the optimal uniform subsidy s^* is the average of s_L^* and s_H^*, which occurs when the covariance term is zero.

Proposition 1 *If $Q_L''(p) \approx 0$ and $Q_H'' \approx 0$ for $p \in [s_L^*, s_H^*]$, then the welfare gains from tagging are increasing in $|\tau(s)|$.*

II Empirical Results

We first discuss heterogeneity in distortions. In the context of our theoretical results, this implies both that it is possible for subsidies to be well-targeted or poorly-targeted and that there is scope for efficiency gains from tagging. We then provide suggestive evidence that correlates of lower distortions are associated with higher responsiveness to three different subsidies, which would imply that these subsidies are poorly-targeted.

II.A Distortions Are Heterogeneous on Observables

In the context of energy efficiency, two covariates of distortions are already clear: high-income individuals are likely less subject to credit constraints, and people who own their own residences are less subject to "landlord-tenant" asymmetric information problems. Imperfect information and inattention are two additional distortions that could justify energy efficiency subsidies. Table 1 documents that these are also heterogeneous, and that environmentalists tend to have less positive (or more negative) d from these two distortions. Although the exact variables differ by data source, Environmentalist is a variable ranging from 0-1 measuring individuals' self-reported level of environmentalism.

Columns 1-3 use three different datasets to test whether environmentalists have different factual beliefs about the financial savings from energy efficient goods. Column 1 uses data from the Time-Sharing Experiments for the Social Sciences (TESS) survey panel implemented by AT (2013), showing that environmentalists are an average of 7.8 percentiles higher in the distribution of perceived cost savings from Compact Fluorescent Lightbulbs. Column 2 shows that environmentalists in a phone survey by Allcott and Sweeney (2014) are an average of 21 percentiles higher in the distribution of perceived cost savings from Energy Star water heaters. (Separate regressions quantify that environmentalists believe that Energy Star water heaters save $78 more per year.) Column 3 shows that environmentalists in the Vehicle Ownership and Alternatives Survey (VOAS), a separate TESS survey implemented by Allcott (2013), do not differ statistically in their percentile of the distribution of beliefs about fuel cost savings from a higher-MPG vehicle. Columns 1 and 2 suggest that environmentalists have lower d due to different belief biases. Separately, these divergences are also remarkable because the survey questions elicited factual beliefs about financial savings, not opinions about the social value.

Table 1: **Covariance of Environmentalism with Beliefs and Attention**

	(1)	(2)	(3)	(4)
Dependent Variable:	CFL Savings Belief	Energy Star Savings Belief	MPG Savings Belief	Fuel Cost Calculation Effort
Environmentalist	7.81	21.04	-2.70	0.193
	(3.08)**	(4.80)***	(3.24)	(0.112)*
N	1,475	799	1,392	1,483
Dataset	Lightbulbs	Water Heaters	VOAS	VOAS

Notes: Dependent variables for columns 1-3 are in percentiles, from 0-100. Dependent variable for for column 4 is normalized to mean 0, standard deviation 1. OLS regressions with robust standard errors in parenthesis. *, **, ***: Statistically different from zero with 90, 95, and 99 percent confidence, respectively.

The VOAS also asks consumers how precisely they calculated fuel costs when they were deciding what vehicle to purchase, and we transform this to the Fuel Cost Calculation Effort variable by normalizing to mean zero, standard deviation one. Column 4 shows that environmentalists devote 0.19 standard deviations more effort to this calculation, which suggests that environmentalists have lower d from inattention to energy costs.

II.B Characteristics of Energy Efficiency Subsidy Adopters

Table 2 presents characteristics correlated with takeup of energy efficiency subsidies.

Column 1 analyzes energy efficiency program participation at a large utility in the United States. The dependent variable is an indicator for whether the household claimed a utility-provided subsidy for energy efficient appliances, insulation, heating, ventilation, and air conditioning, or similar investments between January 2007 and April 2009. About ten percent of households receive the subsidy. Subsidy recipients are wealthier, which suggests that subsidies are poorly targeted to address credit constraints. Takeup is a dramatic 6.8 percentage points lower at rental homes, which suggests that the subsidies are also poorly targeted toward "landlord-tenant" information asymmetries. Subsidy recipients are also more likely to have solar energy systems or voluntarily pay extra for renewable energy as part of the utility's green pricing program, suggesting that they are environmentalists who are already relatively knowledgeable about energy-related matters. We note that this utility provides electricity from relatively low-pollution sources, and any uninternalized energy use externalities would best be addressed by ensuring that electricity prices equal social marginal cost.

Column 2 considers the federal Residential Energy Credits, which provide income tax credits for home energy efficiency investments.[2] TESS asks all survey participants if they qualified for this credit in the past two years, and the sample combines all TESS data from AT (2013) and Allcott (2013). About ten percent of households report taking up the credit, which is likely an overestimate. As with the utility subsidy in column 1, results show that subsidy recipients are wealthier environmentalists. Furthermore, the VOAS Fuel Cost Calculation Effort variable is also conditionally positively correlated with takeup, suggesting that lower-d consumers are more likely to take up, even conditional on environmentalist preferences.[3]

Column 3 considers hybrid vehicle ownership, which has been heavily subsidized by federal, state, and local governments. In the VOAS data, hybrid vehicle owners are again wealthy environmentalists who are more attentive to fuel costs.

[2]Some households also qualify by purchasing household-scale solar, geothermal, and wind energy systems. See http://www.irs.gov/pub/irs-pdf/f5695.pdf for the official IRS form.

[3]Fuel Cost Calculation Effort is coded as zero for consumers in the AT lightbulbs data, and the regressions include a separate intercept for VOAS consumers.

Table 2: **Correlates of Energy Efficiency Subsidy Takeup**

	(1)	(2)	(3)	(4)
Dependent Variable:	1(Take up Utility Subsidy)	1(Take up Tax Credit)	1(Own Hybrid)	Subsidy Awareness
1(Green Pricing Participant)	0.015			
	(0.004)***			
1(Installed Solar System)	0.892			
	(0.002)***			
Income ($ millions)	0.543	0.505	0.278	1.022
	(0.066)***	(0.152)***	(0.136)**	(0.720)
1(Rent)	-0.068			-0.084
	(0.007)***			(0.081)
Environmentalist		0.121	0.020	0.248
		(0.024)***	(0.008)**	(0.116)**
Fuel Cost Calculation Effort		0.027	0.017	
		(0.011)**	(0.007)**	
N	75,591	2,982	1,483	1,516
Dataset	Utility	All TESS	VOAS	Lightbulbs
Dependent Variable Mean	.109	.102	.013	0

Notes: OLS regressions with robust standard errors in parentheses. *, **, ***: Statistically different from zero with 90, 95, and 99 percent confidence, respectively.

Two mechanisms could generate these results. First, many consumers are unaware that energy efficiency subsidies are available. Environmentalists might tend to both be aware of energy efficiency subsidies (making them marginal) and be more attentive to energy costs (giving them lower b). Column 4 corroborates this using a question from the AT (2014) TESS experiment, which asked consumers whether energy efficiency rebates or loans are available in their area.[4] There were five possible responses: "Yes," "I think so, but I'm not sure," "I'm not sure at all," "I think not, but I'm not sure," and "No." Rebates or loans exist in most parts of the United States, although many consumers are unaware of this: 38

[4]Specifically, the question was: "Some states and local areas have rebates, low-interest loans, or other incentives available for energy efficiency. These might include rebates for Energy Star appliances or energy efficient light bulbs, low-interest loans for energy-saving home improvements, government-funded weatherization, and other programs. Are any such programs available in your area?"

percent of consumers gave one of the latter three responses. We code responses from 1-5, with 5 being "Yes" and 1 being "No," and normalize the variable to mean zero, standard deviation one. Regression results show that environmentalists are 0.248 standard deviations more likely to be aware of subsidies, which mechanically will make them more responsive to subsidies.[5]

The second mechanism is that some energy efficiency investments are "niche" goods with small market shares, such as hybrid cars and weatherization, so only consumers with high perceived valuation $\hat{v}$ will be marginal to a moderate subsidy. Consumers with high perceived valuations are mechanically unlikely to have large positive d, because $\hat{v} = v - d$. Furthermore, environmentalist consumers could tend to feel more "warm glow" utility from conserving energy (giving them higher v and thus making them marginal) and as above might be more attentive to energy costs. The bottom row of Table 2 shows that the subsidies studied in columns 1-3 are indeed taken up only by a "niche" group of consumers.

There is one important caveat to these results. Columns 1-3 study the average adopters, not the marginal consumers. The two groups are equivalent if no consumer would purchase the energy efficient good without the subsidy, i.e. if $D(c) = 0$. This assumption is tenuous, and direct identification of the marginal consumer would be crucial for developing this into a fully persuasive argument. Notwithstanding, the results do unambiguously show that these subsidies are regressive, as they preferentially accrue to wealthier consumers.

III Conclusion

There are two policy implications. First, energy efficiency subsidies cannot be justified simply by the generic argument that "market distortions reduce energy efficiency investments" - we need to show that consumers affected by distortions are also affected by the subsidies. Even if these subsidies cause energy conservation, from a welfare perspective it matters *who* is

[5]We include state fixed effects to control for any potential correlation between environmentalism and subsidy availability. When we exclude these controls, the income and environmentalism point estimates are slightly more positive.

conserving.

Second, tagging could increase the welfare gains from energy efficiency subsidies. Indeed, Proposition 1 shows that tagging becomes more promising when existing subsidies are more poorly-targeted. This could involve limiting subsidy eligibility to low-income households, rental properties, or consumers who have not yet participated in other utility programs (because program participation suggests being well-informed about energy). If restricting eligibility is not institutionally feasible, targeted marketing at these groups would also generate gains. Interestingly, utilities currently often do the opposite - they target marketing at individuals most likely to be interested in energy efficiency programs: high-income, environmentalist homeowners. While this is the most cost-effective way to comply with existing energy efficiency regulation, our analysis shows that this outcome may be economically inefficient.

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