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## Consumers' Response to State Energy Efficient Appliance Rebate Programs

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Over the past 40 years, policymakers have implemented an array of instruments—regulatory mandates, information campaigns, and technology subsidies—to promote energy efficiency. For energy-consuming durables, it is quite common that an individual consumer purchases a product designed under an energy efficiency standard, marketed subject to government-required information disclosure, and eligible for a subsidy. For example, an individual who bought a Chevrolet Volt in 2017 contributed to General Motors' compliance with Department of Transportation Corporate Average Fuel Economy standards, likely learned of the fuel savings of the plug-in hybrid from the vehicle's Environmental Protection Agency fuel economy label, and benefitted from a federal tax credit administered by the Internal Revenue Service. Likewise, large appliances are subject to federal minimum energy efficiency standards, information disclosure on typical annual energy usage, and occasionally various kinds of local, state, and federal rebates and tax credits. Given scarce resources and the existing overlay of policy instruments, what is the incremental effect of energy efficiency subsidies on energy outcomes?

To address this question, we evaluate the State Energy Efficient Appliance Rebate Program (SEEARP), commonly referred to as "Cash for Appliances" (C4A). As a part of a suite of programs funded through the 2009 Recovery Act aimed at promoting investment in energy-efficient durables and equipment, state governments received \$300 million to subsidize the purchase of energy-efficient residential appliances. A consumer could claim a rebate under a state's C4A program if he or she purchased an appliance with an ENERGYSTAR (ES) rating—one of the federal government's information programs for appliances that assigns a label to appliances that meet specific energy efficiency requirements. The states had considerable discretion in the design and implementation of their C4A programs, a policy that resulted in significant heterogeneity across the country in the timing, subsidy amount, and appliance category eligibility.

Using transaction-level data from a large national retailer, we estimate the effect of C4A rebates on the sales of refrigerators, clothes washers, and dishwashers. We find that state C4A programs increased appliance sales 7 to 10 percent during the rebate period for these three appliance categories.

The market share of ES-rated appliances—those eligible for the rebates—increased 1 to 2 percent during the rebate period. A 2 percent increase in the ES share of the refrigerator market during the rebate period, however, resulted in a statistically significant but economically minuscule effect on refrigerator energy efficiency. Consumers claiming rebates for refrigerator purchases through the state C4A programs could expect to consume about 2 kilowatt-hours less per year, depending on appliance energy efficiency ratings.

We quantify the behavioral response to rebates along three dimensions: (1) substitution from ineligible products toward eligible products, (2) intertemporal substitution, and (3) upgrading toward higher-quality products. We find that about 70 percent of consumers who claimed a rebate would have bought an ES-rated appliance during the period of the C4A program in the absence of the rebates. An additional 15 percent to 20 percent of consumers changed the timing of their purchase of an ES-rated appliance by a few weeks. Expanding our analysis from the rebate period to also include each of the three months before and after the rebate period results in zero impacts for sales, ENERGYSTAR market share, and appliance energy efficiency. Altogether, about 90 percent of consumers who claimed a rebate do not contribute to an improvement in the energy efficiency of purchased appliances. Our finding on the importance of intertemporal substitution for energy-consuming durables is consistent with the research on the Cash for Clunkers program. Other research has found significant intertemporal shifting under Cash for Clunkers: a large share of program participants moved forward their car purchase decision by a few months. Likewise, research has shown that consumers shifted the timing of the purchase of the Toyota Prius to maximize their tax benefits.

We also find that rebates led consumers to upgrade toward higher-quality, but less energy-efficient models. Upgrading reflects the focus of the rebate programs on ES certification. Specifically, the ES certification requirement is a function of minimum efficiency standards for appliances, which are less stringent for larger appliances (and can be less stringent depending on other valued appliance attributes). For example, a large refrigerator with a given level of energy efficiency could qualify for the ES label, but a smaller refrigerator with the same level of energy efficiency might not.

We show that holding utilization constant, the interaction between subsidies and minimum energy efficiency standards results in a particular case of attribute-based regulation that induces perverse upgrading. Finally, we also find some evidence that the generous rebates may have induced an income effect that led consumers to upgrade toward higher-quality, but larger-size models.

The design and implementation of the C4A program facilitate our empirical analysis. First, the federal government allocated funds to the states on a per capita basis; thus the “size” of this stimulus program, at the state level, is exogenous of the state’s economic condition in 2009 and 2010. Second, the state discretion in program design resulted in significant heterogeneity in terms of start dates, eligible appliance categories, rebate amounts, and other characteristics.

As a part of the 2009 Recovery Act, C4A had dual purposes: stimulating economic activity and improving the energy efficiency of purchased appliances. The C4A program was a relatively small fraction of Recovery Act spending (less than 1/20 of 1 percent), which precludes direct statistical analysis of its effect on economic activity. While transferring approximately \$300 million to households contributed to the overall economic stimulus effort, the disbursement was not necessarily quick by Recovery Act standards: only one state distributed rebates in 2009. Moreover, the high freeriding rate suggests little opportunity for leveraging private investment, an important effect of other Recovery Act energy programs.

Our findings offer a cautionary tale to federal, state, and local program managers designing energy efficiency programs to promote cost-effectiveness and maximize their net social benefit. We show that for C4A, the cost per kilowatt-hour saved is on the order of about \$0.21 to \$1.10, depending on assumptions and appliance category. The low end of this range is four times the average cost per unit of energy saved by utility-sponsored energy efficiency programs.

#### **NOTE:**

This research brief is based on Sébastien Houde and Joseph E. Aldy, “Consumers’ Response to State Energy Efficient Appliance Rebate Programs,” *American Economic Journal—Economic Journal* 9, no. 4 (November 2017): 227–55.