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Utility rebates for ENERGY STAR appliances: Are they effective?

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ABSTRACT

We estimate the impact of utility cash rebates on the market share of ENERGY STAR appliances by exploiting the variation in timing and size of rebates across US states. We find that a dollar increase in the population-weighted utility rebate raises the share of ENERGY STAR qualified clothes washers by 0.4%, but does not affect dishwasher and refrigerator shares. Using information on energy saved by an ENERGY STAR appliance and assuming a redemption rate of 40%, the cost per tonne of carbon saved is about $140 for the clothes washers rebate program. The corresponding cost of a megawatt hour saved, about $28, is lower than the estimated cost of building and operating an additional power plant and the average on-peak spot price. We conclude that the ENERGY STAR clothes washers rebate program is, on average, a cost-effective way for utilities to reduce electricity demand.

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"Efficiency is the steak. Renewables are the sizzle." – Carl Pope, former executive director of the Sierra Club[2]

Introduction

It is now widely accepted that anthropogenic greenhouse gas (GHG) emissions are the main cause of climate change. The energy sector accounts for approximately 65% of our output of GHGs (International Energy Agency, 2009a) and, therefore, reducing emissions in this sector is a crucial element of GHG reduction. To reduce GHGs, increasing energy efficiency is considered a "low-hanging fruit" because of its low marginal cost. The World Energy Outlook 2009, published by the International Energy Agency (IEA), 2009b highlights the huge potential of CO_2 reductions from increased energy efficiency. In this paper we analyze a policy in the US that uses financial incentives to encourage the adoption of energy efficient household appliances.

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Federal and local governments and utility companies across the US and Canada promote the adoption of energy efficient appliances identified by a voluntary eco-labelling program, the ENERGY STAR label, by offering financial incentives. These incentives are usually in the form of cash rebates.[3] The ENERGY STAR label is designed to promote the use of energy-efficient products and reduce the emissions of greenhouse gases by reducing energy consumption. The adoption of energy efficient appliances has public (reduced GHG emissions, other criteria air pollutants) and private (savings in utility bills) benefits.[4] In this paper we ask two questions. First, what is the sales impact of these rebates? Second, is it cost effective for a utility company to offer rebates to its consumers for buying ENERGY STAR appliances?

To study the impact of rebates on the sales of energy efficient ENERGY STAR appliances we use quarterly sales data on the percentage of ENERGY STAR labelled appliances (clothes washers, dishwashers, and refrigerators) for all 50 US states. We combine this with a detailed utility-level and state-level dataset on rebate programs between 2001 and 2006. Our aim is to identify the impact of rebates on sales of ENERGY STAR appliances by correlating differences in the market share of ENERGY STAR appliance sales with variation in rebate values across and within appliances and across and within US states over time. The panel nature of our dataset allows us to ensure that we do not attribute state-level differences, or national-level common time effects to the rebate variable. Our results indicate that, on average, an increase of the (population) weighted utility rebate by $1 increases the market share of ENERGY STAR clothes washers by 0.4%. We also find that the utility rebates have no statistically significant impact on the sales of ENERGY STAR-qualified dishwashers and refrigerators.

We then use the above estimates to evaluate the cost of a tonne of carbon emissions saved as well as the cost of a megawatt hour saved. The former cost calculation will enable us to compare the cost with that of the social opportunity cost of carbon while the latter cost will be informative in comparing with the cost of constructing and operating a power plant or the average price of additional electricity bought in the spot market. Both costs depend on the assumption for redemption rates of mail-in rebates, which are the main avenue for these rebates. The cost, per tonne of carbon saved, ranges from $140 to $352 depending on a redemption rate of 40% and 100% respectively. We also calculate the cost of a megawatt hour saved from having the rebate programs in place by comparing it with the estimated cost of building and operating a power plant as well as the cost of on-peak spot prices. The cost of a megawatt hour saved ranges from around $28 to $71 when we use redemption rates of 40% and 100% respectively. The lower estimate of $28 per MWh saved is much lower than the cost of constructing and operating the cheapest power plant.[5] Average on-peak prices of $60 are also higher than the cost of rebate programs which means that buying electricity when demand exceeds supply is more expensive than reducing electricity demand through increased efficiency.

There has been, to the best of our knowledge, no previous research on evaluating the impact of utility rebates to promote the sale of ENERGY STAR appliances. Earlier work in marketing focuses more on the effects of sales promotions in the nondurable goods sector rather than the durable goods sector. Thompson and Noordewier (1992) investigate the effects of sales promotions on automobile sales of the Big Three automobile manufacturers in the US (General Motors, Ford and Chrysler) and find that major year-end promotions using low-rate financing and cash rebates to stimulate sales were effective in 1985 and 1986 but not in 1987. There has also been recent work on the impact of financial incentives on the sales of electric hybrid vehicles (see, for example, Gallagher and Muehlegger, 2011; Sallee, 2011; Chandra et al., 2010). All the authors find that incentives uniformly increase the market share of hybrid vehicles. Bennear et al. (2011) look at the impact of high efficiency toilet (HET) programs and find that incentives increase their uptake.

The utility rebate programs we study in this paper are a part of demand-side management (DSM) initiatives undertaken by utility companies. DSM refers to the "planning, implementation, and monitoring of utility activities designed to encourage consumers to modify patterns of electricity usage, including the timing and level of electricity demand" (Energy Information Administration, 2009). They were initiated in the late 1970s primarily due to rising gas and oil prices.[6] The Energy Information Administration (2009) reports that the total actual peak load reduction achieved in 2007 through DSM was 30,276 MW with 58% being attributed to energy efficiency while the total DSM cost was $2.5 billion. There is a sizeable literature on the impact of DSM programs. Gillingham et al. (2006) provide a review of, among other energy efficiency policies, DSM activities and also report the range of negawatt costs calculated in the existing literature to be between $8 and $229 per MWh saved.[7,8] A recent paper by Arimura et al. (2012) finds that DSM expenditures over the last couple of decades have cost utilities around $50 per MWh saved.

Our focus in this paper is on a specific component of DSM, namely, the utility rebate programs promoting the purchase of energy efficient household appliances. Very few studies have looked at the cost-effectiveness of such rebate programs in the residential sector. Revelt and Train (1998) estimate the impact of rebates and loans on the choice of efficiency of refrigerators by residential customers of Southern California Edison (SCE) using stated preference data. They predict that the rebate program leads 8.5% customers to switch from a standard-efficiency refrigerator to a high-efficiency one. They also

[3] Some US states have also offered sales tax holidays on energy efficient appliances. For example, Connecticut, Delaware, Florida, Georgia, Missouri, North Carolina, South Carolina, Texas, Vermont, Virginia and West Virginia. However, in the majority of the cases these sales tax holidays are offered only over an extremely short period of time, e.g. a weekend.

[4] According to calculations made by D&R International Ltd. the lifetime cost for clothes washers, using the product database from 2007, was $1883 for a standard model and $1726 for an ENERGY STAR model. While the median purchase price for a standard model ($573) was much lower than an ENERGY STAR model ($966) the average energy costs for the former were much higher at $1310 than the latter ($760).

[5] The levelized cost of electricity for a coal-fired power plant, according to Du and Parsons (2009), is the lowest at $62 per MWh.

[6] See Eto (1996), Nadel and Geller (1996) and Nadel (2000) for a history of utility DSM programs in the US.

[7] "Negawatt" is a term coined by Amory Lovins of the Rocky Mountain Institute to refer to a watt of electricity that does not have to be produced due to an energy saving process in place.

[8] We, hereon, convert all figures originally reported in kilowatt hours to megawatt hours for consistency. 1 megawatt hour (MWh) = 1000 kilowatt hours (kWh).

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