

Measuring Energy Efficiency: Accounting for the Hidden Costs of Product Failure

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1. Motivation underlying research

DOE sets energy efficiency standards for a wide variety of consumer appliances to achieve a “significant conservation of energy.” Advocates for these standards claim that households have realized substantial cost savings with the existing standards. There is a substantial literature—although no consensus—on the effects of energy efficiency regulation, however.

While an increasing emphasis has been placed on the potential reduction in greenhouse gas emissions, the relative benefits of these emissions reductions are generally small. Instead, the basis for energy efficiency regulation rests on the claim of an “energy paradox”—that the private benefits of energy efficiency measures substantially exceed the marginal costs, and that households and firms fail to adopt them because of market or behavioral imperfections.

As further support for an energy paradox effect, ex ante engineering analyses by regulatory agencies typically estimate substantial net private benefits for energy efficiency rules. In the case of the 2001 energy efficiency standards for clothes washers and the 1997 standards for refrigerators, DOE estimated between \$16.97 billion and \$26.5 billion in cumulative net benefits through 2030. However, both rules resulted in unanticipated burdens for consumers in the form of diminished product reliability, increased repair costs, and decreased product lifetime. To date, existing retrospective analyses have considered consumers’ energy savings without considering these substantial added burdens, which captures only half of the picture.

2. A short account of the research performed

In 1997 and 2001, DOE established statutorily-mandated minimum efficiency standards for refrigerators and clothes washers, respectively. These two standards—especially the clothes washer standard—have received special attention in other recent studies of the DOE standards. While these studies have considered the effect of the two standards on price and some aspects of product quality, these studies largely neglect some important factors related to in-use performance that affect consumer welfare.

This paper examines the experience with these two energy efficiency standards over the 2001 to 2011 period and finds that design changes occasioned by energy efficiency standards resulted in problems with product quality. Specifically, three issues plagued these appliances and yielded lower cost savings than projected in DOE’s ex ante analyses: (1) product life and reliability; (2) greater energy usage than anticipated; and (3) additional operation and maintenance (O&M) costs. As a result, households would have benefited from these standards far less than ex ante estimates predicted, and in some cases, they would have had net costs.

We use information from class action lawsuits in our case studies to develop a link between DOE energy efficiency standards and product defects. The product defects that attract class action lawsuits tend to be attention-getting issues such as moldy washers and defects requiring immediate repair, while longer-term repair or replacement issues that affect product life generate less attention. As a result, we have also obtained information on product life expectancy for our case studies from Consumer Reports articles on reliability and product repair or replacement decisions, product life data from the housing industry, and internet postings.

We used this information to develop a revised analysis illustrating the sensitivity of DOE’s life-cycle analysis to different energy usage and product life assumptions. As a result, we estimate that only 24% -

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49% of consumers actually benefitted from DOE's standards for clothes washers (in comparison to the 81% estimated by DOE). With higher energy usage than projected and reduced product lifetime, our analysis suggests that many consumers did not save money as a result of DOE's standards for refrigerators.

3. Main conclusions and policy implications of the work

For both clothes washers and refrigerators, consumers bore significantly more costs than accounted for in DOE's ex ante analyses and other retrospective analyses. In the case of clothes washers only a minority of households would realize net energy savings based on ex post estimates of usage and product life; in the case of refrigerators, breakeven analysis suggests that, accounting for reduced product life, a modest increase in energy usage relative to DOE projections would offset the expected savings for many consumers.

In the cases of clothes washers and refrigerators, actual product lifetime and product usage differed significantly from DOE's ex ante estimates, which negatively affected consumer net benefits. DOE could have improved its analyses by developing distributions for these key analytical components. To the extent that it is not possible to do so, sensitivity analysis could help identify the effect of alternative values for the key variables that affect life-cycle analysis.

Our research points to a potential information problem in these durable goods–appliance markets. These markets are characterized by a rapid turnover in a large number of models. As a result, there is only limited information available to consumers on repair and replacement rates at the time of purchase. Our analysis suggests that many consumers experienced a much shorter product life over 2000–2011 than DOE projected in its ex ante analyses for these two rules, which dramatically reduces the benefits to consumers.

In addition, current standards only require the certification of appliances prior to distribution and fail to consider potential reductions in product reliability and product life. While manufacturers claim a 10-year or longer product life, current standard manufacturer warranties typically only provide 1 year of protection—a significant decrease from the 1990s. This suggests that energy efficiency standards should consider potential effects on product reliability, and that the appliance market could be enhanced with information disclosure on product life and reliability, and full warranty for repair over an extended period.