J Regul Econ (2013) 43:248–264
DOI 10.1007/s11149-013-9210-2

ORIGINAL ARTICLE

Overriding consumer preferences with energy regulations

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Published online: 12 February 2013

Abstract The recent wave of enacted and proposed U.S. energy regulations imposes energy efficiency standards on light bulbs, appliances, and motor vehicles based on the unsupported assumption that consumers and firms are irrational and that energy efficiency should be the paramount concern. The regulatory analyses do not document these purported failures in consumer choices or firms' energy utilization decisions with any empirical evidence. The preponderance of the benefits that agencies claim for the regulations is derived from private benefits to consumers and firms attributable to lower energy costs. Without these benefits, the regulatory costs would greatly exceed the benefits. The regulatory analyses consider only mandates as a means of achieving energy-efficiency improvements and ignore other policy options.

Keywords Energy regulations · Cost–benefit analysis · Consumer choice · Climate policy · Energy efficiency standards

JEL Classification Q48 · K23 · K32 · L68 · L62

1 Introduction

This article examines a major class of recent government initiatives by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the

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U.S. Department of Transportation (DOT) pertaining to energy efficiency (as distinct from economic efficiency). We examine the justification for these energy regulations and show that demonstrable market failures are largely incidental to agencies' assessment of the merits of these regulations. Rather, the preponderance of the assessed benefits is derived from agencies' assumption that consumers and firms act irrationally and that government choices therefore better reflect the preferences of consumers and firms than the choices consumers and firms would make themselves. In the absence of these claimed private benefits of the regulation, the costs to society dwarf the estimated benefits.

The agencies' presumption of consumer and firm irrationality is motivated by an unsupported claim that there is an energy-efficiency gap, whereby consumers' choices for energy-efficiency purchases imply a discount rate much higher than market discount rates. Consequently, consumers underweight the future cost savings stemming from an energy-efficient product compared to the weight they put on the future in other market settings (see, for example, Hausman 1979). As we review in Gayer and Viscusi (2012), the evidence in the economics literature on the existence and magnitude of such an energy efficiency gap is mixed and does not provide a compelling justification for overriding consumer decisions in the absence of supporting evidence. Moreover, as we demonstrate below, the agencies' regulatory analyses offer little to no evidence of the existence of such a failure for any of the products targeted by the regulations.

There are a number of alternative reasons that can explain a purported energy-efficiency gap, many of which are consistent with individual rationality. The observed high discount rates could be rational in the presence of high sunk costs and uncertainty over future conservation savings (Hassett and Metcalf 1993). Also, many of the studies purporting to show that consumers forgo profitable energy decisions are based on engineering studies that calculate the net present value of a set of possible energy-efficiency consumption choices, which requires assumptions for such things as capital costs, current and future energy prices, duration and frequency of appliance use, and discount rates (McKinsey & Company 2009). These studies omit other relevant costs or benefits of the product to consumers that can drive the purchase decision (see, for example, Anderson and Newell 2004). By ignoring these relevant characteristics of the product, and the specifics of the customer's economic circumstances, the engineering studies can arrive at incorrect findings of personal savings from the products that have higher up-front costs but yield lower operating costs. Since the engineering studies focus only on capital costs and operating costs, they do not allow for any heterogeneity of preferences and use of products across consumers. Engineering estimates of potential energy savings also may misrepresent energy savings because they are based on highly controlled studies that do not directly apply to actual realized savings in a representative house (see, for example, Nadel and Keating 1991; Metcalf and Hassett 1999).

A common but potentially misleading approach to measuring the energy-efficiency gap is to use empirical studies of energy-use data to estimate the average returns for the set of consumers that adopt an energy-efficient technology, for example, by comparing natural-gas billing data in the first year after weatherization work is done to the previous year. In addition to the problems associated with the short time horizon of such studies, the findings of such studies may be spurious as they suffer from omitted variable bias in which other key factors affecting the decision are ignored (Allcott and Greenstone 2012). Taken as a whole, the engineering, empirical, and behavioral literature on the energy-efficiency gap does not provide strong, credible evidence of persistent consumer irrationality.

In the discussion below we present case studies of recent analyses used to support energy-efficiency regulations promulgated by DOE, EPA, and DOT for which we will show that the undocumented assumption of a fundamental market failure provides the pivotal justification for the claimed regulatory benefits. Section 2 examines the corporate average fuel economy (CAFE) standards for passenger cars and light trucks, and Sect. 3 considers the analogous corporate average fuel economy standards for heavy-duty trucks. Section 4 assesses energy efficiency standards for clothes dryers, room air conditioners, and other appliances. Section 5 examines energy efficiency standards for standard incandescent or halogen-type light bulbs. Section 6 concludes.

2 CAFE standards for passenger cars and light trucks

The National Highway Transportation Safety Administration (NHTSA) within the DOT regulates corporate average fuel economy standards pursuant to the Energy Policy and Conservation Act of 1975 (EPCA), as revised by the Energy Independence and Security Act of 2007 (EISA).[1] The 2007 Supreme Court decision in *Massachusetts v. EPA* found that the EPA had authority to regulate greenhouse gases under the Clean Air Act, which meant the EPA could regulate vehicle fuel-economy standards as a means of reducing greenhouse gases (*Massachusetts v. EPA* 2007). Thus, the CAFE rulemaking is performed jointly by EPA and NHTSA (on behalf of DOT), subject to DOE review.[2]

On December 1, 2011, NHTSA and EPA jointly proposed similar new fuel-economy standards for passenger cars and light trucks for model years 2017 through 2025 (EPA and DOT 2011a). NHTSA proposed standards that would require an average industry fleet-wide standard of 40.9 miles per gallon (mpg) by 2021 and 49.6 mpg by 2025 (EPA and DOT 2011a; NHTSA 2011). EPA's requirements are framed not in terms of fuel economy but as greenhouse-gas emissions standards. This may be effective political salesmanship, but we believe it is a bit of a misnomer given the very minor role greenhouse-gas benefits play in justifying the economic desirability of the regulation. Unlike the NHTSA approach, EPA's greenhouse-gas emission standards impose requirements pertaining to carbon dioxide emissions rather than fuel mileage. The EPA standard of 163 g of carbon dioxide per mile translates into a 54.5 mpg standard if manufacturers rely solely on fuel efficiency to reduce the emissions. However, there are other mechanisms by which greenhouse-gas emissions can be reduced, such as improved air-conditioning systems, so fuel-economy standards for the two agencies' proposed regulations are not necessarily incompatible.

1 The EISA amended EPCA to require, among other things, the creation of CAFE standards for medium- and heavy-duty vehicles for the first time.

2 NHTSA consults with DOE on CAFE standards pursuant to EPCA, as revised by EISA.

The use of engineering models to compute the net present value (that is, the value today of a stream of future benefits, less costs) of a more versus less fuel-efficient product includes a number of input values that demonstrate the computational complexity that exists for the regulator's analysis. For the analysis of CAFE standards for passenger cars and light trucks (for 2017 and later model years), the EPA and NHTSA needed to derive input values for such things as vehicle miles driven per year, the responsiveness of annual vehicle miles driven to changes in fuel cost, the magnitude of the rebound effect (which is the increase in driving that would occur with more fuel-efficient vehicles), projections of future fuel costs, the number of years the vehicle would be in service, the relationship between the measured fuel efficiency and the actual on-road efficiency, and the discount rate (EPA and DOT 2011a; EPA and NHTSA 2011). The analysis presumes the regulator is better than the consumer at computing the various inputs to the net present value computation, and the consideration of different vehicle classes controls for other features of the vehicles that might appeal to the consumer. This assumption effectively rules out consideration of motor-vehicle attributes other than fuel efficiency that will be affected by the regulation. The dimensions of consequence in the EPA and NHTSA analyses neglect motor-vehicle attributes other than fuel efficiency and cost.

The analyses by EPA and NHTSA ignore the loss in consumer welfare that would result if achieving higher fuel-economy standards means manufacturers have to sacrifice vehicle characteristics other than fuel efficiency. The EPA and NHTSA analyses abstract from all these concerns and focus on several cost-related aspects. In addition to the calculation of lifetime fuel savings to the consumer, the regulators also compute the private consumer surplus from additional driving (that is, the private benefit to consumers net of driving costs that occurs because the amount of driving increases as fuel efficiency increases) and the private benefit of reduced fueling time (because consumers would have to refuel less often).[3] The sum of these private net benefits to the consumer represents the bulk of the benefits of the fuel-efficiency mandate for both the NHTSA and EPA analyses. As shown in Table 1, NHTSA estimates a total cost of $177 billion and a total benefit of $521 billion.[4] Of the $521 billion in the NHTSA estimate of total benefits (assuming a discount rate of 3 % and constant 2009 dollars) resulting from the proposed CAFE standards for passenger cars and light trucks, fully $440 billion (or 85 %) stem from private savings to consumers. This $440 billion consists of $416 billion in lifetime fuel savings, $9 billion in consumer surplus from additional driving, and $15 billion in refueling time value.

The EPA analysis for a slightly different standard is similar. As shown in Table 2, EPA estimates $192 billion in total costs and $613 billion in total benefits (EPA and DOT 2011a). Most of these benefits (87 %) are private benefits to consumers: $444 billion in lifetime fuel savings, $71 billion in consumer surplus from additional driving, and $20 billion in refueling time value.

The environmental benefits play a largely incidental role in both analyses. In the NHTSA analysis, the estimated benefits from reducing the greenhouse-gas

[3] See EPA and NHTSA (2011, 4-27 and 4-54).

[4] See EPA and DOT (2011a) and also Table 13 in NHTSA (2011). Costs include technology, congestion, accident, and noise costs; benefits are everything else.

Table 1 NHTSA's estimated costs, benefits, and net benefits of the CAFE rule

Input	Value (2009$, billions)
Costs	
Technology costs	132.137
Congestion costs	30.040
Accident costs	14.250
Noise costs	0.568
Total costs	176.995
Benefits	
Lifetime fuel savings	416.456
Consumer surplus from additional driving	9.105
Refueling time value	15.292
Petroleum market externalities	21.547
Fatality costs	0.010
CO_2	45.614
CO	0.000
VOC	0.601
NO_x	0.594
Particulate matter	6.705
So_x	5.401
Total benefits	521.325
Net total benefits	344.330

Source NHTSA (2011, Table 13) Estimates are for combined passenger cars and light trucks, 3 % discount rate, billions of 2009$

carbon dioxide accounts for only $46 billion, or 9 % of total benefits (NHTSA 2011). The greenhouse-gas carbon dioxide benefits in the EPA analysis are also $46 billion, or 8 % of the benefits EPA estimates (EPA and DOT 2011a).

Even these comparatively modest benefits overstate the benefits to the U.S. citizenry, since they also include the climate-change related benefits to other countries of reduced emissions within the United States. If one counted only the domestic benefits, the social cost of carbon dioxide benefits would be just 7–23 % of the estimated carbon dioxide benefits. Counting only domestic benefits would reduce the CAFE rule's greenhouse benefits from $46.4 billion to a range of $3.2–10.7 billion. The domestic benefits of reducing greenhouse-gas emissions therefore only account for 0.5–1.7 % of total estimated benefits. The estimated costs of the regulation are 18–60 times greater than the domestic greenhouse-gas benefits. If the purpose of the standards is to reduce greenhouse-gas emissions, these regulations are very inefficient.

The role of CAFE standards in reducing other pollutants is not a driver in terms of generating substantial policy benefits. The benefits from reducing other pollutants account for $13 billion in the NHTSA analysis and $8 billion in the EPA analysis (EPA and DOT 2011a; NHTSA 2011). The reduction in petroleum-market externalities associated with energy security accounts for another $22 billion in the NHTSA analysis and $24 billion in the EPA analysis. With estimated costs of the regulation at $177

Table 2 EPA's costs, benefits, and net benefits of the CAFE rule

Input	Value (2009$, billions)
Costs	
Technology costs	140.0
Accidents, congestion, and noise costs[a]	52.0
Total costs	192.0
Benefits	
Lifetime fuel savings	444.0
Consumer surplus from additional driving	70.9
Refueling time value	19.5
Energy security benefits	24.2
CO_2	46.4
Non-CO_2 greenhouse-gas impacts	n/a
$PM_{2.5}$-related impacts	8.0
Total benefits	613.0
Net total benefits	421.0

Source EPA and DOT (2011a, Table III-82) and EPA (2011a, Table 1)
[a] These were included as negative benefits in EPA's tables. Estimates are for combined passenger cars and light trucks, 3 % discount rate, billions of 2009$

billion by NHTSA and $192 billion by EPA, this regulation clearly fails a benefit-cost analysis (BCA) without the presumption of consumer irrationality and the resulting substantial private benefits associated with mandating more-fuel-efficient vehicles.

Figure 1 illustrates the relative role of the different benefit components. Domestic greenhouse-gas benefits constitute only 1 % of total benefits. Other domestic environmental benefits contribute an additional 1 %. Greenhouse-gas benefits to other countries contribute an additional 6 % of benefits, but in our view such benefits should be excluded from any assessment of the benefits and costs to U.S. citizens. An astounding 87 % of the claimed benefits are derived from the assumption that consumers' fuel economy choices are fundamentally flawed.

NHTSA does attempt to address "the question of why current vehicle purchasing patterns do not result in average fuel economy levels approaching those that this rule would require … [and] why manufacturers do not elect to provide higher fuel economy even in the absence of increases in CAFE standards" (NHTSA 2011). The main explanations NHTSA offers, without any empirical support, are that consumers might have inadequate information about the value of higher fuel economy, they may not give enough attention to long-term horizons, they may be driven by loss aversion in which they place more weight on short-term losses versus long-term gains, and there may be a lack of salience of fuel savings. NHTSA also postulates that the irrationality might lie with the manufacturers, who may be forgoing profitable activities because of mistaken assumptions about the premiums prospective buyers would pay for increased fuel economy.

NHTSA does acknowledge that perhaps "the agency's underlying assumptions about some of the factors that affect the value of fuel savings differ from those

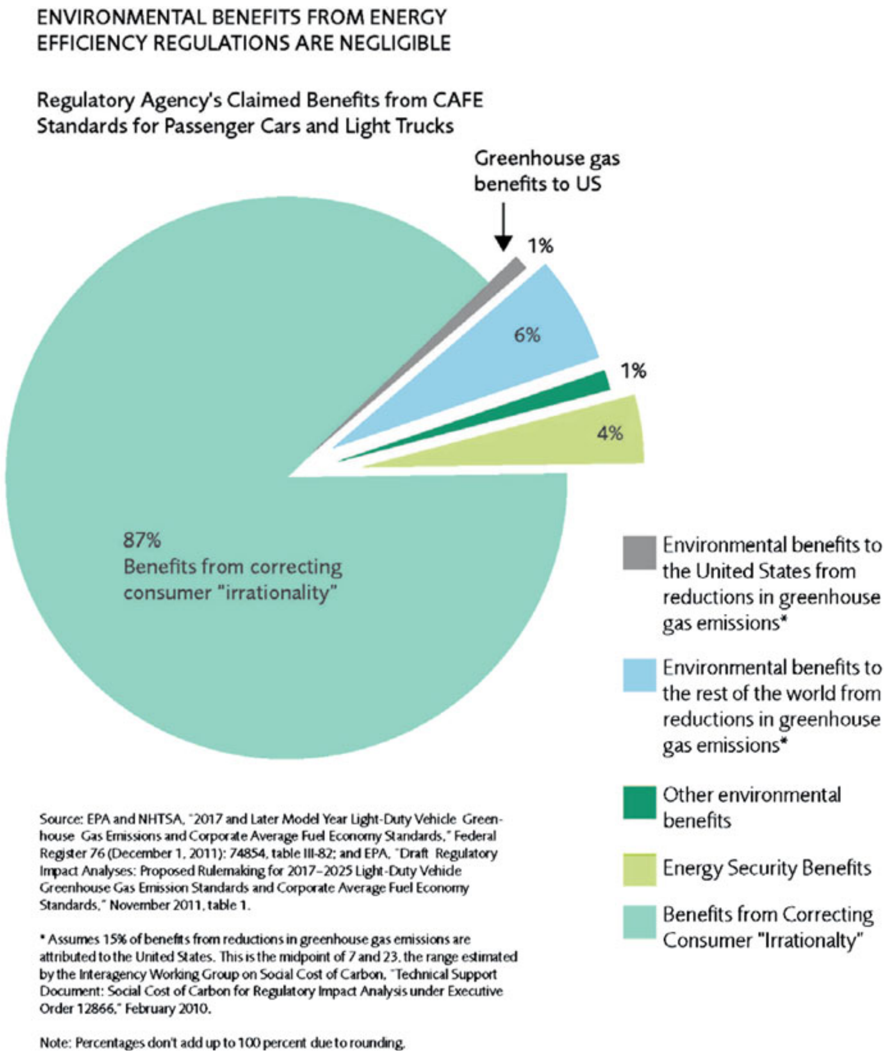

Fig. 1 Relative roles of the different environmental benefit components for CAFE standards

made by potential buyers, because NHTSA has used different estimates for some components of the benefits from saving fuel from those of buyers, or simply because the agency has failed to account for some potential costs of achieving higher fuel economy" (NHTSA 2011). Similarly, NHTSA acknowledges the existence of heterogeneous preferences across a range of characteristics by mentioning the possibility "that achieving the fuel economy improvements required by stricter fuel economy standards might lead manufacturers to forego [*sic*] planned future improvements in performance, carrying capacity, safety, or other features of their vehicle models that represent important sources of utility to vehicle owners" (NHTSA 2011). This would suggest that "compromises in these or other highly-valued attributes would be viewed by potential buyers as an additional cost of improving fuel economy that the agency has failed to acknowledge or include in its estimates of the costs of complying with stricter CAFE standards" (NHTSA 2011). Ultimately, NHTSA reports that it "has been unable to reach a conclusive answer to the question of why the apparently large differences between its estimates of benefits from requiring higher fuel economy and the costs of supplying it do not result in higher average fuel economy for new cars and light trucks" (NHTSA 2011). Despite NHTSA's admission that it is uncertain whether the lack of market demand for higher fuel economy is due to consumer irrationality or consumer preferences, it proceeds to promulgate a regulation that assumes the former.

EPA also acknowledges that "it is a conundrum from an economic perspective that these large fuel savings have not been provided by automakers and purchased by consumers" (EPA 2011a). Rather than explore possible determinants of consumer choice other than fuel economy, EPA then proceeds to conjecture possible justifications. The first justification offered amounts to an assertion of consumer irrationality, in that "consumers put little weight on benefits from fuel economy in the future and show high discount rates" (EPA 2011a). Another justification hints at a systematic behavioral bias without offering specifics: "Fuel savings in the future are uncertain, while at the time of purchase the increased costs of fuel-saving technologies are certain and immediate" (EPA 2011a). Another justification seems grounded in neither neoclassical economics nor behavioral economics: "Consumers may not be able to find the vehicles they want with improved fuel economy" (EPA 2011a). The other justifications largely amount to problems of inadequate information, such as the reasoning that fuel-economy benefits are not salient enough to consumers, that consumers have difficulty calculating expected fuel savings, or that consumers might associate higher fuel economy with inexpensive, less well-designed vehicles. Among the justifications for the "paradox" are acknowledgements that it could be a consequence of EPA's miscalculation or omitted variables, in that "factors such as transaction costs and differences in quality may not be adequately measured" and "there is likely to be variation among consumers in the benefits they get from improved fuel economy" (EPA 2011a). The behavioral justifications offered by NHTSA and EPA offer very little evidence that consumers are causing themselves harm in their vehicle-purchasing decisions and would thus accrue private benefits by having their options restricted.

This review also raises the question of why a rigid mandate is warranted rather than an informational regulation that would provide consumers with the guidance to make sounder choices. Indeed, in 2011 EPA did just that by issuing its Motor Vehicle Fuel Economy Label Final Rule (EPA 2011b). The mandated label for all new cars is quite extensive, including an overall mpg rating, a city mpg rating, a highway mpg rating, gallons/100 miles, driving range on a tank of gas, fuel costs in five years versus the average new vehicle, annual fuel costs, fuel economy and greenhouse-gas rating, and smog rating. These components of the label address the purported behavioral failures in that they (i) indicate the longer-term fuel costs, thus diminishing the effect of high discount rates, (ii) make the benefits of fuel economy salient and a less "shrouded" attribute, (iii) provide easy calculations of fuel economy, (iv) enable consumers to know the actual fuel-economy benefits rather than relying on rough rules of thumb, (v) make it clear that fuel economy is a valued vehicle attribute, not a proxy for a less-expensive vehicle, (vi) make it easier for consumers to identify which vehicles provide fuel economy, (vii) provide diverse measures of fuel economy that consumers can relate to their driving style, and (viii) make the fuel costs more apparent as an upfront cost similar to that of the sticker price. Indeed, the EPA label rule is directed at remedying all but a couple of the types of consumer choice failures that EPA claims account for the private benefits of fuel-economy standards.

What is striking about the EPA analysis of the CAFE standard is that the EPA regulatory impact analysis does not even mention the existence of the agency's own new label rule. This oversight goes to the heart of the CAFE standard analysis, as most of the benefits needed to justify the regulation relate to consumer choice failures targeted by the new label rule.[5] If the label rule does not have zero economic benefits, then the EPA analysis of the fuel-economy standard necessarily overstates the benefits associated with the proposed CAFE standards. If the label rule is completely worthless and generates no benefits for consumer choice, was EPA remiss in promulgating a rule that subsequent EPA assessments implicitly treat as worthless?

We take an intermediate view with respect to the labeling regulation. Informational strategies have a productive role to play and should be the primary policy instrument used if the alleged market failure stems from a lack of information. Before EPA should consider other, more intrusive forms of intervention, it should demonstrate that private decisions are flawed and that informational remedies will not suffice. In general, agencies should examine less-restrictive regulatory alternatives before adopting highly intrusive technology-forcing standards. The proposed EPA fuel-economy label rule is not ideal, but it is far superior to restricting the choices available to consumers (Cohen and Viscusi 2012). That a particular labeling approach may fall short should serve as an impetus for developing more effective informational policies rather than abandoning all labeling regulations because the particular policies implemented were not designed as well as they could have been. Informational regulations remain highly attractive, as they use a form of intervention that does not attempt to homogenize consumer choice or override the preferences of those who value a more diverse set of automobile attributes than mpg and cost.

Even if EPA and NHTSA could demonstrate some form of consumer choice failure, these choices would need to be completely flawed to warrant counting the entirety of the private savings as net economic benefits. In the absence of the regulation, EPA and NHTSA are assuming there could be no rational basis for choosing a vehicle that does not meet the proposed standards even though the majority of the vehicles people currently drive do not meet the fuel-efficiency target. Choosing a car other than a Toyota Prius or a Nissan Leaf is not an inexplicable quirk of individual behavior but generally stems from valuation of car attributes these models do not offer. Indeed, applying the behavioral economists' critique of conspicuous consumption and status goods to cars may suggest that the purchase of highly fuel-efficient cars may be driven by forces behavioral economists view as irrational. The issue of rationality based on behavioral economists' scorecards may cut in the opposite direction to the extent that people purchase visibly fuel-efficient vehicles such as the Prius not for their own benefit but

5 The labeling policy even seeks to call consumers' attention to greenhouse-gas emissions and environmental externalities generally. However, it is unlikely voluntary restraints will be sufficient to generate efficient control of the external damages from energy use.

as a badge of political correctness to signal their environmental credentials to their neighbors. Such conspicuous consumption poses no problems if private choices are respected, irrespective of the source of the preferences.

3 CAFE standards for heavy-duty vehicles

On September 15, 2011, NHTSA and EPA jointly proposed fuel-economy standards for on-road heavy-duty vehicles, categorized as combination tractors, heavy-duty pickup trucks and vans, and vocational vehicles. The agencies relied on the same analytical framework they used for the CAFE standards for passenger cars and light trucks, meaning computing private fuel savings through an engineering analysis of the net present value of higher fuel economy and reduced fueling time, as well as computing effects on emissions of carbon dioxide and other pollutants, congestion, traffic fatalities, noise, and energy security.

As with the CAFE standards for passenger cars and light trucks, the bulk of the benefits of the heavy-duty vehicles standards are private benefits to the purchasers rather than benefits from reducing externalities. As shown in Table 3, using a 3 % discount rate and 2009 dollars, the agencies estimate a total cost of $9.6 billion and a total benefit of $58.9 billion for model-year trucks 2014 through 2018 (EPA and DOT 2011b). Of the $58.9 billion in estimated total benefits, fully $50.5 billion (86 %) stem from private savings to consumers. This $50.5 billion consists of $50.1 billion in fuel savings and $400 million in the value of reduced fueling time.

The estimated benefits from reducing greenhouse-gas carbon dioxide account only for $5.7 billion, or less than 10 % of total benefits. This number overstates the benefits to U.S. citizens, as it includes the climate-change related benefits to other countries of reduced emissions within the United States. In the final rule, EPA and NHTSA acknowledge that "the reductions in external costs are less than the costs of new fuel saving technologies needed to meet the standards" (EPA and DOT 2011b). Rather than seeing this discrepancy as violating the market-failure rationale for the regulation, the agencies justify their rule by stating that the private "savings in fuel costs are

Table 3 NHTSA's estimated costs, benefits, and net benefits of the heavy-duty vehicle CAFE rule

Input	Value (2009$, billions)
Costs	
Technology costs	8.100
Accident, congestion, noise costs	1.500
Total costs	9.600
Benefits	
Lifetime fuel savings	50.100
Refueling time value	0.400
Energy security impacts	2.700
CO_2	5.700
Total benefits	58.900
Net total benefits	49.300

Source EPA and NHTSA (2011, Table VIII-33)
Estimates are for combined heavy-duty vehicles, 3 % discount rate, billions of 2009$

by themselves sufficient to pay for the technologies" and thus the "*entire* value of the reductions in external costs represents additional net benefits of the program, beyond those resulting from the fact that the value of fuel savings exceeds the costs of technologies necessary to achieve them" (EPA and DOT 2011b).

The agencies' attempts to explain the seeming irrationality of buyers of heavy-duty trucks is more strained than in the case of passenger cars, because in this case the vast majority of the vehicles are purchased and operated by businesses, which the agencies acknowledge have "narrow profit margins, and for which fuel costs represent a substantial operating expense" (EPA and DOT 2011b). The agencies are arguing that these firms, operating in a highly competitive environment, are forgoing substantial cost-minimizing purchases and thus incurring losses to owners and shareholders. A myriad of firms are making decentralized profit-maximizing decisions specific to their particular economic situation, whereas agencies are second guessing these choices utilizing a one size fits all framework in which the market heterogeneity is ignored.

The agencies' first hypothesis for why the trucking industry fails to adopt cost savings technologies is that "there is inadequate or unreliable information available about the effectiveness of many fuel-saving technologies for new vehicles" (EPA and DOT 2011b). The agencies reason that the lack of information might be because "information on technologies is costly" and "information has aspects of a public good." There is no evidence given to support these claims with respect to heavy trucks. Fuel-efficiency information can be conveyed and obtained at low cost, and with billions of dollars at stake there are ample private-market incentives to ensure the necessary information flows. And if the problem is purely informational, labeling policies will suffice. The agencies' second hypothesis is that the resale market "may not adequately reward the addition of fuel-saving technology to vehicles" (EPA and DOT 2011b). Again, given the low cost of conveying information and the substantial amount of savings at stake, this hypothesis lacks credibility.

The agencies' third hypothesis is that there are split incentives between owners and operators of heavy-duty trucks. Since the operators, not the owners, must purchase the fuel, "capital investments by truck owners may be channeled into equipment that improves" other features of the trucks rather than into fuel-saving technology (EPA and DOT 2011b). The agencies acknowledge that "if operators can choose freely among the trucks they drive, competition among truck owners to employ operators would encourage owners to invest in fuel-saving technology" (EPA and DOT 2011b). They offer no evidence of a lack of competition in the industry that would support the split-incentives hypothesis.

The agencies also offer the hypothesis that "transaction costs of changing to new technologies … may slow or prevent their adoption" (EPA and DOT 2011b). As noted earlier, given high sunk costs and uncertainty over future savings, a high discount rate is entirely rational. A regulatory mandate that prevents firms from transitioning to a new technology at their desired rate would thus harm, not help, expected firm profits. The agencies acknowledge the possibility that uncertainty about future cost savings may be the reason firms are not purchasing the more fuel-efficient vehicles. Yet they later justify the mandate in part due to this rational response to uncertainty. They acknowledge that "the engineering estimates of fuel savings and costs … might overstate their benefits or understate their costs in real-world applications" (EPA and

DOT 2011b). The agencies present little or no evidence to support their hypotheses of why firms are foregoing cost-reducing truck technologies, yet the agencies are undeterred in promulgating an expensive rule that relies on these hypotheses to justify approximately 85 % of the rule's estimated benefits.

4 Clothes dryers, room air conditioners, and other appliances

The Energy Policy Conservation Act of 1975 (EPCA) prescribes energy-conservation standards for various consumer products, including residential clothes dryers and room air conditioners. EPCA requires that DOE determine whether amended standards are technologically feasible and economically justified and would save a significant amount of energy. At the end of 2011, DOE adopted new energy-efficiency standards for clothes dryers and room air conditioners (DOE 2011).

DOE relied on a net present value analysis to demonstrate the economic justification for the new standards. This analysis computed the total consumer expense over the life of the appliance, including the purchase expense and operation costs (including energy expenditures), with the future operating costs discounted to the time of purchase and then summed over the lifetime of the product. Similar to the analysis of the CAFE standards, the computational complexity of this assessment required DOE to assign values for each of six product classes on such things as the purchase price (stemming from manufacturer cost, manufacturer markup, and retailer markup), installation cost, repair and maintenance cost, annual energy consumption per unit, projected energy prices, the lifetime of the appliance, and the discount rate.

Of the four product classes of clothes dryers that saw a tightening of the standard, assuming a 3 % discount rate, DOE estimated $2.779 billion in consumer savings stemming from the vented electrical standard dryer regulation, $5 million in consumer savings stemming from the vented electric compact 120-V dryer regulation, $14 million in consumer savings stemming from the vented electric compact 240-V dryer regulation, and $215 million in consumer savings stemming from the vented gas dryer regulation. Of the four product classes of clothes dryers that saw a tightening of the standard, assuming a 7 % discount rate, DOE estimated $1.017 billion in consumer savings stemming from the vented electrical standard dryer regulation, $2 million in consumer savings stemming from the vented electric compact 120-V dryer regulation, $6 million in consumer savings stemming from the vented electric compact 240-V dryer regulation, and $51 million in consumer savings stemming from the vented gas dryer regulation.

As shown in Table 4, the estimated increase in consumer savings measured by net present value (NPV) stemming from a regulatory increase in the energy-efficiency standards for clothes dryers is $3.01 billion (3 % discount rate) or $1.08 billion (7 % discount rate). These values make up a significant share of the total estimated benefits of the regulations. For the external benefits, DOE estimates benefits of $93 million to $1.49 billion from reducing carbon dioxide emissions as a result of the regulation. As in the case of the analysis of fuel-economy standards for motor vehicles, this benefit estimate for greenhouse-gas emissions includes all global benefits from reducing domestic emissions. DOE estimates the benefits as between $4.77 million

Table 4 Impacts of clothes dryer rule (2009$, billion)

	3 % Discount	7 % Discount
NPV of consumer benefit	$3.01	$1.08
Value of CO_2 reduction	$0.093–1.49	$0.093–1.49
Value of NO_x reduction	$0.005–0.049	$0.002–0.021
Change in Industry NPV	– $0.081–0.065	– $0.081–0.065

Source DOE (2011, 22550–22551, Tables V-47 and V-51)
NPV net present value

and $49 million (3 % discount rate) and between $2.06 million and $21.2 million (7 % discount rate) from reducing other pollutants. The clothes dryer regulation may or may not pass a BCA if it focused on environmental benefits, depending on whether one focuses on the upper or lower estimates in the ranges provided by DOE.

An earlier proposed regulation of clothes washers was purported to have great energy savings for consumers, but a Rasmussen Research poll found tremendous consumer opposition to the standard (Dudley 2000). By a margin of 6 to 1 the public opposed regulations that would effectively eliminate top-loading washing machines. Even after being informed of the lower operating costs and greater energy efficiency of the new models, consumers opposed the regulation by a margin of 2.6 to 1. Much of the opposition arose because most consumers wash fewer loads per week than the DOE analysis assumed; for this group the present value of the cost savings is far less than the estimated savings. Engineering studies divorced from consumer usage and preferences can produce policies that produce far fewer benefits than predicted.

DOE's net present value analysis of the energy-efficiency standards of room air conditioners computed the total consumer expense over the life of the appliance, including the purchase expense and operation costs (including energy expenditures), with the future operating costs discounted to the time of purchase and summed over the lifetime of the product. DOE assigned input values for each of the six product classes on such things as the purchase price (stemming from manufacturer cost, manufacturer markup, and retailer markup), installation cost, repair and maintenance cost, annual energy consumption per unit, projected energy prices, the lifetime of the appliance, and the discount rate.

Of the six product classes of room air conditioners that saw a tightening of the standard, assuming a 3 % discount rate, DOE estimated $245 million in consumer savings stemming from the regulation of air conditioners with less than 6,000 Btu/h with Louvers, $1.162 billion in consumer savings stemming from the regulation of air conditioners with 8,000–13,999 Btu/h with Louvers, $3 million *loss* in consumer savings stemming from the regulation of air conditioners with 20,000–24,999 Btu/h with Louvers, $2 million *loss* in consumer savings stemming from the regulation of air conditioners with greater than 25,000 Btu/h with Louvers, $49 million in consumer savings stemming from the regulation of air conditioners with 8,000–10,999 Btu/h without Louvers, and $24 million in consumer savings stemming from the regulation of air conditioners with greater than 11,000 Btu/h without Louvers.

Table 5 Impacts of room air conditioning rule (2009$, billion)

	3 % Discount	7 % Discount
NPV of consumer benefit	$1.47	$0.57
Value of CO_2 reduction	$0.077–1.16	$0.077–1.16
Value of NO_x reduction	$0.004–0.043	$0.002–0.023
Change in Industry NPV	– $0.18–0.11	– $0.18–0.11

Source DOE (2011, 22553–22554, Tables V-51 and V-52)
NPV net present value

Of the six product classes of room air conditioners that saw a tightening of the standard, assuming a 7 % discount rate, DOE estimated $20 million *loss* in consumer savings stemming from the regulation of air conditioners with less than 6,000 Btu/h with Louvers, $558 million in consumer savings stemming from the regulation of air conditioners with 8,000–13,999 Btu/h with Louvers, $3 million *loss* in consumer savings stemming from the regulation of air conditioners with 20,000–24,999 Btu/h with Louvers, $2 million *loss* in consumer savings stemming from the regulation of air conditioners with greater than 25,000 Btu/h with Louvers, $25 million in consumer savings stemming from the regulation of air conditioners with 8,000–10,999 Btu/h without Louvers, and $12 million in consumer savings stemming from the regulation of air conditioners with greater than 11,000 Btu/h without Louvers.

As shown in Table 5, the estimated increase to consumer savings stemming from a regulatory increase in the energy-efficiency standards for room air conditioners is $1.47 billion (3 % discount rate) or $570 million (7 % discount rate). These values make up a significant share of the total estimated benefits of the regulations. For the external benefits, DOE estimates benefits of $77 million to $1.164 billion from reducing carbon dioxide emissions as a result of the regulations. This estimate includes all global benefits from reducing domestic emissions. DOE estimates between $4.16 and $42.7 million (3 % discount rate) and between $2.2 and $22.6 million (7 % discount rate) from reducing other pollutants. The room air conditioning regulation may or may not pass a BCA if it focused on environmental benefits, depending on whether one focuses on the upper or lower estimates in the ranges provided by DOE.

Acting under authority from the EPCA, DOE has proposed energy-efficiency regulations for other appliances as well. For example, DOE proposed standards for residential refrigerators in 2011 and is considering standards for industrial products, such as high-intensity light fixtures (known as metal halide lamp fixtures) and walk-in coolers and freezers. As in the case of the fuel-economy standards, for each of these appliance standards, the preponderance of the estimated benefits consists of private benefits to the purchasers of the products. These are only benefits if consumers are not currently making the utility-maximizing choice, or in the case of the metal halide lamp fixtures and walk-in coolers and freezers, if profit-maximizing firms operating in a competitive environment are all failing to minimize their business costs. Put somewhat differently, there must be some form of individual irrationality or behavioral shortcoming of individual choices to give rise to these benefits. DOE provides little, if any, analysis and documentation of this assumed irrationality in its rules. In the clothes dryers and room air conditioners rule, it consists of a single paragraph devoid of any empirical evidence and specific citations to the literature:

> DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution). There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases (for example, an inefficient ventilation fan in a new building or the delayed replacement of a water pump); (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (that is, renter versus owner; builder vs. purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings (DOE 2011).

5 General service incandescent lamps

The Energy Independence and Security Act (EISA) established specific energy-efficiency standards for general service incandescent lamps (GSILs), which are standard incandescent or halogen-type light bulbs. The standards were set to be phased in over a 2-year period from 2012 to 2014. The light bulb regulation has served as the focal point for much recent controversy over the role of government policies in dictating consumer choices.

Executive Order 12866 requires agencies to assess both the costs and the benefits of intended regulations, even cases (such as the GSIL standards) in which the regulatory standard is specifically prescribed by statute and leaves the agency with no discretion. DOE did not conduct a dedicated BCA for the GSIL standard; instead it included it within a technical-support document that assessed the overall national impacts of EISA (DOE 2009).

DOE presents relatively little documentation on how it calculated the costs and benefits of the standard. The DOE analysis calculated cumulative national energy savings as the sum of annual national energy savings, which in turn was estimated as the difference in annual national energy consumption between the base case and the case with the new GSIL standards. DOE estimates 14.14 quads in cumulative national energy savings.

The net present value to consumers is computed as the present value of operating-cost savings minus the present value of increased total installed costs. (Present values were computed for both 3 and 7 % discount rates.) DOE computed the operating-cost savings for a given year by multiplying the surviving stock of GSILs of a given vintage in that year by the per-unit operating-cost savings for that vintage (obtained by multiplying the vintage's expected energy savings by forecasted energy prices), then summing over vintages. DOE computed increased total installed costs for a given year by researching product catalogs, online distributors, and manufacturing interviews to estimate "the increase in unit prices for products that comply with EISA 2007" (DOE 2009). It then multiplied the surviving stock of GSILs of a given vintage in that year by this annual per-unit total-installed cost increase, then summed over vintages. No consideration was made for consumer preferences for different types of light bulbs or for such things as the rebound effect. Thus, the quality of light, whether the bulb is dimmable, and other aspects of light bulbs are irrelevant to the DOE assessment.

DOE's net present value estimate is for \$27.5 billion (7 % discount rate) or \$64.2 billion (3 % discount rate) in cumulative savings to consumers from 2008 through 2038 stemming from the efficiency standards for light bulbs. These estimates of private benefits far outweigh DOE's estimate of between zero and \$16.34 billion in benefits from reducing carbon dioxide emissions. Once again, private benefits to consumers drive the economic justification for the analysis.

6 Conclusion

The economic puzzle raised by all these energy regulations is why consumers are this remiss. How can it be that consumers are leaving billions of potential economic gains on the table by not buying the most energy-efficient cars, clothes dryers, air conditioners, and light bulbs? Moreover, how can it also be the case that firms seeking to earn profits are likewise ignoring highly attractive opportunities to save money? If the savings are this great, why is it that a very basic informational approach cannot remedy this seemingly stunning example of completely irrational behavior? It should be quite simple to rectify decisions that are this flawed.

Rather than accept the implications that consumers and firms are acting so starkly against their economic interest, a more plausible explanation is that there is something incorrect in the assumptions being made in the regulatory impact analyses. Indeed, upon closer inspection it is apparent that there is no empirical evidence provided for the types of consumer failures alleged. Even if some consumers do sometimes fall short on certain dimensions of choice, the magnitude and prevalence of such a shortfall is important and is never addressed in the regulatory assessments. Nor is there adequate consideration of the actual and potential role of informational remedies that have already been adopted.

Perhaps the main failure of rationality is that of the regulators themselves. Agency officials who have been given a specific substantive mission have a tendency to focus on these concerns to the exclusion of all others. Thus, fuel efficiency and energy efficiency matter, but nothing else does. If other attributes matter, it is assumed they either are irrelevant or will be included at no additional cost in the post-regulation products. In effect, government officials act as if they are guided by a single mission myopia that leads to the exclusion of all concerns other than their agency's mandate.

Acknowledgments The authors would like to thank Caroline Cecot, Kasey Higgins, Jinghui Lim, and Sam Miller for assistance in developing the case studies for this paper, the Mercatus Center for partial financial support, and two referees for valuable expositional suggestions.

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