Consumer Rationality and Energy Efficiency

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Whether consumers behave rationally or optimally when making decisions concerning energy use and energy efficiency is sharply contested in both policy and academic circles. Two polar positions on this issue and its policy implications are readily identified in the literature. Economists typically view rationality as a fundamental axiom of human behavior; accordingly, energy-related decisions must be rational if analyzed correctly, and policy interventions such as equipment performance standards and demand-side management programs are likely to impair economic efficiency by depriving consumers of desired options. Behavioral researchers and technology analysts, in contrast, argue that consumers' real-world decisions deviate from the ideals of preference maximization, providing a possible justification for government intervention.

Extensive research over the past two decades on the characterization of energy-related decisions has failed to resolve the key questions surrounding this issue. We argue that a resolution and synthesis is unlikely to arise without due attention to underlying methodological issues. This paper examines the methodological disparities between rational choice theory and alternative approaches using examples drawn from the literature on energy-related decisions. Particular attention is given to the meaning of "bounded rationality" and the extent to which this concept can serve as an organizing principle in the study of consumer behavior in markets for energy and energy-using equipment. We critically examine the policy positions described above and elucidate the weaknesses in both. We present recommendations for partially bridging the methodological gap between the two positions in research and policy.

Introduction

Do consumers behave rationally in making decisions regarding energy use and energy efficiency? Do observed choices reflect an optimal balance between the costs and benefits of energy-efficient technologies? Do people use economic criteria when purchasing appliances or automobiles, or when considering building shell retrofits that would reduce household fuel consumption? Do households minimize the present-value costs of obtaining energy services?

Debates over these key questions have continued unabated for two decades, becoming more intense in recent years due to growing concerns over the environmental impacts of energy use. An apparent answer is provided by studies documenting the costs and benefits of energy-efficient technologies. The National Academy of Sciences (1991), for example, found that energy-related emissions of carbon dioxide could be reduced by up to 37% using technologies that are cost-effective given today's prices and market conditions. Based on such results, technology analysts argue that departures from rational behavior create "market barriers" to energy efficiency that drive a wedge between realized outcomes and the economic optimum. A standard argument is that consumers use excessive discount rates (perhaps as high as 800%/yr) when making energy-related decisions (Ruderman et al. 1987).

Some analysts argue that the interaction of producers and consumers in competitive markets should lead to the implementation of all energy-efficient technologies that are truly cost-effective; accordingly, the perceived "efficiency gap" must be based on the mismeasurement of costs and benefits (Sutherland, 199 1). Closer scrutiny, however, shows that many of the "market barriers" identified by technology analysts may be understood as market failures generated by problems of imperfect information and transaction costs. Thus the existence of the efficiency gap may be reconciled with the hypothesis that consumers make energy-related decisions in a fully rational manner (Sanstad and Howarth 1994, Jaffe and Stavins 1994). This line of reasoning, however, assumes that consumer decision-making conforms to the standard dictates of economic theory. As such, it avoids a direct examination of the rationality hypothesis and its consequences for energy analysis and policy.

For all the attention devoted to the topic, no widely-accepted answers to the basic questions about consumer rationality and its role in energy-related decisions have emerged in the literature. Moreover, there are few signs that any are soon forthcoming. This is not to say that strongly-held views on the subject cannot be identified. Among energy specialists, one can identify two polar positions to the question of whether consumers behave rationally when making decisions regarding energy use and energy technologies: Economists say "generally yes" while technologists and behavioral researchers say "definitely not." The middle ground is held by researchers from a variety of disciplines who argue that "more research is needed."

This last opinion is the point of departure for our paper. *We emphatically agree that more research is needed on the nature of consumers' decision-making related to energy.* We believe, however, that such research is unlikely to resolve this ongoing controversy in the absence of careful consideration of underlying disagreements over methodology and first principles. This argument is based in part on a simple observation: Research over the past twenty years has produced hundreds of papers on consumer energy decision-making (Lutzenhiser 1992), yet debates over consumer rationality and energy use continue to rage today. Almost every aspect of the problem has been studied: different end-uses; technologies; types of decisions; psychological, economic and social factors; and so forth. Energy analysts who call for more research typically fail to address this fact and to answer these fundamental questions: What is further research likely to uncover that has heretofore passed unrecognized in the literature? Why has all the work done to date failed to clarify debates over consumer rationality and its ties to energy efficiency?

One easy answer is disciplinary fragmentation: Researchers in one field ignore contributions from other disciplines and thus do not appreciate that "true" answers have already been considered and possibly found. Although there is some truth to this argument, our perspective is rather different. We see the controversy as stemming from a *scientific illusion* regarding the study of rationality and energy demand. That is, energy analysts on all sides of the debate consider the question of consumer rationality amenable to the scientific method: If one wants to know what consumers are doing, one has only to go out and look—collect some data, perhaps formulate a model—and the answers will emerge.

In our view, this line of attack overlooks a key aspect of the problem: The quandary over consumer rationality and energy use is not empirical, nor even theoretical, but *methodological.* That is, we must begin by addressing fundamental definitional and epistemological questions: What does it mean to say that consumers are or are not "rational" or that they do or do not "optimize"? What counts in principle as a description or explanation of people's behavior? What counts as evidence one way or another? And how do the answers translate, in principle, into guidance for policy makers?

We believe that differences over these "meta-questions" lie at the heart of the debate over consumer rationality and energy use. Without much-improved understanding of these underlying issues, empirical findings are unlikely to substantively alter the debate. The aim of this paper is to clarify these issues in the hope that truly interdisciplinary approaches to studying consumer rationality and energy may emerge.

While our focus is on first principles as opposed to the immediate needs of policy analysis, the problems under consideration are highly relevant to the design of effective energy policies. Particularly in the context of global climate change, policies to restrain energy use and/or promote the adoption of energy-efficient technologies are a matter of increasing urgency. The analysis of such policies depends critically on the role of rationality in consumer decisions relating to energy-efficient technologies. Policy makers continue to be hampered by the research community's failure to reach consensus on this issue.

Two Polar Views

It is useful to describe two polar perspectives on the ties between consumer rationality and energy demand behavior. Although the views of most analysts would fall somewhere in between these extremes, the distribution of beliefs is strongly bimodal. Proponents of the extremes are readily identified in the literature, so that these characterizations are not easily dismissed as mere caricatures.

The first point of view is closely associated with neoclassical economists. According to this view, producers and consumers have stable preferences that they seek to satisfy through market transactions. Consumer choices thus reveal information about underlying preferences, and the acceptance or rejection of energy-efficient technologies reflects a rational evaluation of the relevant costs and benefits. Market imperfections involving imperfect information or transaction costs might impede the adoption of cost-effective energy-efficient technologies. But deviations from rational behavior are ruled out by assumption and cannot, therefore, constitute an appropriate basis for policy intervention.

The second perspective is generally attributed to energy technologists and behavioral scientists. Proponents of this view assert that people do not appear to be minimizing the costs of obtaining energy services. Anomalies are observed both in engineering and in clinical studies. Consumers are not merely ill-informed about energy technologies but also have trouble determining how to make "correct" choices when provided with full and complete information. Thus policies of various kinds are justified to ensure that consumers reap the benefits of energy-efficient technologies as identified by technical experts.

Before examining each of these views in more detail, it is important to emphasize that there is little dispute among energy analysts of all disciplines that people are purposive, have goals that they generally try to pursue, try to make good decisions, like to save money when they can, and so forth. That is, nobody disagrees that people are "rational" in a colloquial sense. But we must distinguish this informal view from the *theoretical description* of rationality, and in this case the cognitive processes consumers utilize when making choices related to energy use and energy efficiency.

Economic Rationality and Its Discontents

The basic notion of economic rationality is often presented in informal terms: individuals have preferences that they seek to satisfy as fully as possible through purchases of goods and services given the constraints imposed by their incomes and market conditions. Underlying this description is a precise mathematical definition that provides the basis for economic models of consumer behavior. This distinction is critical to understanding economists' perspective on the question of rationality. Economists frequently justify their views on the performance of the market system in terms of informal arguments based on intuitive notions of rationality and preference. Yet the theory itself rests on stronger formal principles that are generally not subjected to empirical testing or epistemological scrutiny.

If rational choice theory were a literal description of consumer behavior, then energy consumers would need to solve extremely complex optimization problems: not just life-cycle cost minimization, but optimal control problems, stochastic dynamic programs, and the like (Cowing and McFadden 1984). In one recent paper, consumers were modelled as forecasting energy prices using a stochastic model of Brownian motion (Hassett and Metcalf 1993). Such are the forms that the hypothesis of utility maximization takes when applied to problems in energy economics.

Non-economists typically find it perplexing that economists ascribe such high levels of expertise to consumers. Indeed, this appears to be one of the major sources of tension between economists and other energy specialists. To the latter, the assumption that consumers solve complex (or even not-so-complex) optimization problems appears false on its face: the relevant technical skills are held only by specialists in mathematics, economics, and related disciplines; solving even simple problems often requires the use of high-speed computers and sophisticated software. Therefore, the usual economic models of decision-making are either clearly false or simply do not make sense. Moreover, critics point out that even the most sophisticated economic models invoke simplifying assumptions that abstract from the complexities of real-world choices. Such assumptions are required to ensure the tractability of rational choice models, yet they suggest that even technical experts have trouble solving the optimization problems ostensibly faced by consumers.

When pressed on this point, economists sometimes invoke a methodological response formulated by Milton Friedman (1953). According to Friedman, people may not actually solve complicated problems of utility maximization. They just behave "as if" they do so that the models provide a good description of observed behavior. Goett (1988) uses a form of this argument to explain the use of life-cycle cost calculations in modeling consumer decisions regarding energy-efficiency. According to Goett, implicit discount rates

> "do not simply reflect a conscious, mental calculation of the cost tradeoffs among alternative technologies. Rather, they summarize an amalgam of market forces that determine consumers' actual choices."

A central problem with Friedman's defense of rational choice models is that it does not allow for falsification of the rationality hypothesis when empirical results run counter to theoretical predictions, as is the case with the pattern of high implicit discount rates observed in markets for energy-using equipment. Instead, Friedman invites analysts to modify their models by adding transaction costs, information asymmetries, and other special features until a fit to the data is obtained.

The claim that consumers behave "as if " they solve complex optimization problems is not universally accepted by economists. Simon (1959, 1986), perhaps the best-known critic of the rational choice school, begins with the premise that behavioral models should be taken at face value in terms of their descriptive content. He rejects the "as if" approach in favor of an alternative grounded in psychological studies of human behavior, drawing a distinction between "substantive" and "procedural" rationality. Substantive rationality implies that individuals make decisions in the manner prescribed by formal optimization models, or that their choices are fully consistent with the predictions of such models. Procedural rationality, in contrast, implies that people make decisions subject to constraints on their attention, resources, and ability to process information; the results may differ systematically from the choices people would make in the absence of such constraints. Simon's core argument is that real-world decisions are best characterized by the concept of "bounded rationality:" Since psychological limitations imply that individuals cannot render substantively rational decisions, the best they can do is muddle through with generally imperfect results.

Empirical studies of consumer decisions regarding energy use generally support the bounded rationality hypothesis. Stern (1986), for example, finds that the information held by consumers regarding residential energy use "is not only incomplete, but systematically incorrect. Generally speaking, people tend to overestimate the amounts of energy used by and that may be saved in technologies that are visible and that must be activated each time they are used." Similarly, studies of equipment performance labeling have found that the provision of technically accurate information on the costs and benefits of energy efficiency does not necessarily improve the quality of decision-making (McNeill and Wilkie 1979, Robinson 1991). Such findings suggest that consumers lack expertise in balancing the costs and benefits of energy-related decisions even when they are motivated to do so and are trying to make good choices.

One response to such empirical findings is to argue that, while consumers may indeed "optimize imperfectly" in making energy-related decisions, they do so randomly (Sweeney 1994). This would imply that some people overconsume while others underconsume energy due to the phenomenon of bounded rationality. According to this view, while policies designed to improve consumer decision-making might very well benefit individual consumers, they would not necessarily result in aggregate energy savings, the *sine qua non* of most such policies.

The first problem with this argument is that it does not appear to be supported by the evidence. The behavioral literature, for example, has identified the following empirical regularities, each of which is thought to promote the overutilization of energy:

- Use of high implicit discount rates in evaluating energy-efficiency investments (Hausman 1979, Meier and Whittier 1983);

- Use of incorrect units in calculating energy consumption and related costs, resulting in overconsumption relative to what would result from technically correct computations (Kempton and Montgomery 1982);

- Salience effects, whereby consumers attach excessive weight to factors that are psychologically vivid or easily observed-for example, turning down the lights in an effort to reduce energy bills when such action will generate negligible cost savings (Yates and Aronson 1983);

- Incorrect use of technology—for example, failure to understand the concept of thermostatic control so that users set air conditioners too "high" relative to the levels required to assure sustained comfort (Kempton et al. 1992).

In each of these examples, departures from substantive rationality favor the *systematic* overconsumption of energy relative to the level that would prevail given the cost-effective provision of energy services.

The idea of "random misoptimization" is also cast into doubt by recent findings on the numeracy of Americans. Making rational decisions about energy use and energy efficiency would seem to require consumers to carry out numerical calculations on the costs and benefits of their actions. A recent study by the U.S. government (Kirsch 1993), however, found that some 90 million American adults are functionally illiterate and innumerate: they cannot, for example, reliably read a bus schedule or understand a grocery receipt. It seems to us unreasonable to expect that people who do not understand elementary arithmetic should arrive at energy-related decisions that are "right on average."

In addition to these empirical arguments, recent work in economic theory suggests that departures from perfect optimization may have important implications for the efficiency of competitive markets (Akerlof and Yellen 1985, Haltiwanger and Waldman 1985, Conlisk 1988). The emerging literature extends standard rational choice models to allow for transaction costs and limitations on consumers' ability to assimilate and analyze information. As such, it provides a bridge between the notions of substantive and bounded rationality, pointing to the enormous flexibility of optimization as an approach to behavioral modeling. Two studies that deal specifically with energy issues were carried out by Howarth and Andersson (1993) and Friedman and Hausker (1988). These studies establish that limitations on consumers' ability to form unbiased and/or efficient estimates of the energy savings achievable through state-of-the-art technologies may impede the adoption of technologies yielding clear economic benefits.

A final defense against critiques of rational choice models is to argue that departures from substantive rationality are irrelevant to questions of public policy: individuals should be free to make their own decisions, and the government has no business interfering. One version of this argument, however, reduces to a simple tautology: whatever consumers are doing must be rational or they wouldn't have done it. Under this interpretation, utility maximization is more of a metaphysical commitment that a scientific hypothesis amenable to empirical test.

On the other hand, the argument can be framed with a somewhat different emphasis: consumer behavior may deviate from the dictates of perfect optimization; indeed, people may be flipping coins or consulting their astrologers when making energy-related decisions. But that's their prerogative, and the government should refrain from intervention on the ground that freedom of choice is fundamentally more important than economic efficiency. This point of view is expressed by Kahn (1991) in his critique of least-cost planning by public utilities.

Although we do not agree with its conclusions, we are generally sympathetic with this line of reasoning. For one thing, the approach is intellectually honest, staking its claims on well-defined principles that may be subjected to scrutiny and debate. It is important to note, however, that this way of thinking is explicitly political, and is distinct in principle from both formal theories of rationality and economic approaches to policy analysis.

Energy Analysis, Market Barriers, and Energy Policy

Does our discussion thus far constitute an endorsement of the view that anomalies in consumer decision-making provide justification for policies that promote the adoption of energy-efficient technologies? Not exactly. To explain why, we examine what is perhaps the most basic question of all: Why should consumers invest in energy efficiency?

When the field of energy analysis was founded following the 1973 Arab oil embargo, "energy conservation" and "energy efficiency" were viewed as virtually synonymous by advocates of interventionist energy policies. Given concerns over energy resource scarcity, the geopolitical risks of imported oil, and the environmental impacts of energy utilization, using less energy was seen as a policy imperative, whether through behavior changes or alternative technology. According to this view, actions such as turning down thermostats and improving appliance energy-efficiency were seen as providing commensurate benefits.

This stance was fundamentally revised in the 1980s as oil prices eased and political trends favored more market-oriented policies. Today energy analysts focus on the costs and benefits of energy-efficient technologies, searching for opportunities to reduce the private and social costs of providing energy services. If the adoption of cost-effective energy-efficient technologies is impeded in the market, then energy analysts argue that policies to promote energy efficiency are warranted. Although this argument is commonly viewed as an "engineering" point of view, it is in fact fundamentally based on economic reasoning. Cost-minimization is a necessary condition for economic efficiency, and the life-cycle cost criteria of engineering economics are nothing more than applied project analysis. Thus evidence that least-cost technologies are routinely passed-up by markets points to the existence of market failures (Sanstad and Howarth 1994).

This point is fundamental in evaluating arguments that intervention in energy markets is justified by anomalies in consumer decision-making, a view expressed by Stern and Aronson (1984) and more recently by Robinson (1991). The basic structure of these arguments is as follows: individuals frequently do not purchase energy efficiency measures that would benefit them by reducing the cost of obtaining energy services. Research reveals, for example (as we described above), that consumers use heuristics that result in systematically incorrect energy-related decisions; do not process information in an effective ("objective") manner; or otherwise do not or cannot arrive at "correct" conclusions regarding the potential benefits of efficiency investments. Three conclusions are drawn from this reasoning: (1) consumers do not behave according to the standard model of rational choice; (2) policies to promote energy efficiency are therefore warranted; and (3) these policies should be designed using results from behavioral research on energy decision-making so as to ensure their effectiveness.

We would paraphrase this line of reasoning as follows: consumers generally do not behave according to the logic of economic rationality *but they should.* They need policies to help them do it. The point we wish to emphasize is this: despite frequent claims that concepts of rational choice do not apply to, or are insufficient for, analyzing the particulars of energy-related decisions, the use of bounded rationality arguments to justify policy intervention is based on an economic benchmark grounded in principles of substantive rationality.

Confusion about this point abounds. One result is that noneconomists often fail to recognize that their arguments are in principle not only consistent with economic reasoning but might in fact find their best expression through economic models. The technique of "qualitative choice analysis" (Train 1986) for example, provides a very general approach to modeling consumer choice among discrete possibilities such as alternative appliances. It can, in particular, readily incorporate a number of "non-economic" factors that behavioral studies suggest play a role in energy-related decisions.

A more subtle problem is that technologists and behavioral scientists studying energy demand seem not to understand the weakness of the simple but common argument that "people don't really maximize utility." As we have discussed, economists are generally aware of the limitations of the rationality hypothesis, and have constructed methodological defenses to counter this line of criticism. Economists themselves have proceeded furthest in the development of models that relax the rationality assumption while preserving its essential insights into human behavior and decision-making. The resulting literature on bounded rationality suggests that the question is not *whether* but rather *in what sense* people are rational.

What does all this have to do with energy policy and program evaluation? One implication is not widely appreciated if it has been recognized at all: even if we agree that consumers are boundedly rational when it comes to making energy-related decisions, this fact does not necessarily provide a blanket justification for policies aimed at promoting energy efficiency. If consumers are inexpert at dealing with energy choices, this constitutes a potential barrier not only to effective market decisions but also to programs designed to improve on market outcomes. If, for example, consumers have trouble understanding how energy "works" when left to their own devices, how can they appreciate the benefits that demand-side management programs offer them? The consistent finding that information programs directed at energy use often have very limited effects (McMahon 1991) is relevant to this point. Changing people's behavior is of course feasible, but it can be very difficult and costly to accomplish. This is one true "hidden cost" that must be confronted by policy makers: limitations on consumer rationality do not simply disappear in the face of policy; indeed, they may undermine efforts to fix observed imperfections in markets for energy and energy-using technologies.

This line of reasoning indicates an important distinction between policies aimed directly at technology, such as equipment performance standards, and those relying on marketing, such as demand-side management. If consumers cannot, on average, make correct calculations regarding energy efficiency, as may be implied by the findings of high implicit discount rates, then efficiency standards may serve to replicate the correct calculations on a centralized, cost-efficient basis. Thus direct regulation may in some cases bypass the problem of bounded rationality altogether by focusing on technologies rather than behavior. By contrast, demand-side management programs aimed at residential users must confront the problem head-on, a difficulty that might account for the rather modest results achieved by many residential demand-side management programs (Nadel 1990).

Although applying behavioral research to program design might help to overcome such problems, complications arise on several fronts. First, the behavioral literature provides heuristics but not routine techniques that can be readily applied by non-specialists. Moreover, behavioral research on energy-related decision-making is rarely connected to standard cost-benefit analysis, a step that is essential if this research is to be fruitfully applied in practice. It is interesting to note, for example, that what may be the most comprehensive review of energy efficiency programs from a social and behavioral perspective (Katzev and Johnson 1987) contains almost no quantitative discussion concerning costs and benefits.

Summary and Conclusions

If substantive rationality provided a fully adequate account of human behavior, then neoclassical economics would emerge as a unified approach to energy policy analysis. Under this circumstance, economic models would provide a precise *description* of energy demand behavior and *prescriptive tools* for measuring the costs and benefits of energy policies. This would presume the philosophical claim that what people want/choose is really good for them—i.e., that rationality is more than an "as if" assumption.

Substantive rationality is a good heuristic for motivating the theory of consumer demand. As a methodological device, the rationality assumption yields key insights regarding consumers' response to changes in prices and economic conditions. Clearly people are rational in the sense that they prefer better to worse outcomes and are motivated to do the right thing.

However, empirical studies cast doubt on substantive rationality as a literal description of consumer decision-making. This model is therefore incomplete. Furthermore, the claim that observed behavior reveals information regarding consumer *welfare* rests on a philosophical premise claim that, although generally plausible, is not amenable to scientific evaluation. It is thus not plausible to denounce programs and policies as "inefficient" based on purely theoretical arguments grounded in substantive rationality. Opponents of policies to promote energy efficiency are at pains to (a) explain how alleged market barriers are in fact consistent with the notion of efficiently working markets; (b) document empirically the supposed "hidden costs" that tip the scale against intervention; or (c) carefully explain that their concerns are essentially libertarian in character.

Departures from substantive rationality imply potential inefficiencies in energy markets—in principle, opportunities could be found to improve consumer welfare while leaving no one worse off. This fact is signalled by life-cycle-cost calculations on the net benefits of energy efficiency, which are rooted in the standard principles of project analysis.

But the question of whether energy efficiency programs promote economic efficiency *in practice* cannot be answered on the basis of engineering calculations or behavioral studies per se. The existence of behavioral anomalies or market failures does not in itself imply that the benefits of government intervention exceed the costs. The same factors that induce "market barriers" may also impede the effectiveness of policies and programs aimed at altering consumer behavior.

With this in mind, efficiency advocates are at pains to demonstrate the effectiveness/efficiency of their policies and programs. This is in general no easy task, since the theory of project analysis is built on the construct of substantive rationality. On the other hand, the approach of reducing life-cycle costs while holding energy services constant is operational, even though arguments break out over the details. A stable strategy is to count tangibles carefully, including administrative/program costs; to the fullest extent possible, analysts should identify intangible changes in energy services and evaluate their potential implications for efficient policy design.

The rational choice model is embraced by economists because of its analytical simplicity and tractability in addressing empirical problems. In macroeconomics, it is generally acknowledged that business cycles and employment fluctuations cannot be explained using models of perfectly functioning markets. This point was first raised by Keynes, and is the starting point for contemporary theorists. But steps towards greater realism produce models that are analytical intractable; moreover, many different models may be used to explain the same data. Epistemologically, this implies that the underlying behavior of the system is truly unknowable, though theory and empirical work may succeed in describing key aspects of the phenomena.

In markets for energy and energy-using equipment, this means that disagreements over facts and models are an inescapable part of the field. With this in mind, methodological pluralism is both necessary and desirable: Where no one model can describe the system in detail, competing theories provide a broader perspective that is greater than the sum of the parts.

In practical terms, the implication is that the costs and benefits of energy efficiency cannot be measured with precision. This is because measurement requires an underlying theoretical framework that withstands empirical scrutiny, yet in this case alternative theories may be used to explain the same data.

Thus, decision makers are poorly served by existing studies that claim to establish well-defined results. In our judgment, good policy requires a mix of sound analysis and pragmatism. Empirical analysts can't do their jobs unless they (a) ground their work in relevant theoretical principles that are clearly stated and subject to scrutiny; (b) acknowledge factors that escape quantification with at least some attention to their qualitative importance.

For economists, the problem is to acknowledge the relevance of behavioral studies and the technology literature, along with a recognition that these phenomena are closely tied to recent developments in economic theory. Simplistic models cannot be applied to generate precise, well-grounded measures of the costs and benefits of programs and policies.

For efficiency analysts, the task is to address hidden costs, program costs, and potential losses in consumer welfare due to reductions in energy services. Heuristic models and "constant energy services" assumptions should be phased out (or augmented) in favor of more realistic behavioral assumptions. Criticisms of the rationality hypothesis invite modifications and elaborations of existing models and methods, not a rejection of economic reasoning per se. Here the literature on energy-related behavior and technology choice would seem to hold considerable promise. Bounded rationality models provide one means of expressing the findings of behavioral studies regarding the complexities of consumer decision-making. As we noted above, discrete choice analysis is also useful in evaluating the real-world aspects of energy-related behavior. Each of these approaches provides bridges between economic analysis and the insights of other disciplines.

It would be unreasonable to expect, however, that the existing strands of the literature could be systematically integrated to provide a unified approach to understanding consumer choices concerning energy use and energy efficiency. Indeed, we would argue that competing claims cannot even be directly compared as "alternative scientific hypotheses." In our view, methodological pluralism will therefore prove indispensable in redefining the debate.

In the final analysis, the problem is to cut across disciplinary boundaries to establish a field of energy analysis that draws on key points from the economics, behavioral, and technology literatures, while retaining the necessary diversity and flexibility required to provide pragmatic answers to complex policy questions.

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