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The dynamics of behavior change: Evidence from energy conservation

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ABSTRACT

Little is known about the effect of message framing on conservation behavior over time. In a randomized controlled trial with residential households, we use advanced metering and information technologies to test how different messages about household energy use impact the dynamics of conservation behavior down to the appliance level. Our results, based on 374 million panel observations of kilowatt-hour (kWh) electricity consumption for 118 households over 9 months, show that differences in behavioral responses due to message framing become more significant over time. We find that a health-based frame, in which households consider the human health effects of their marginal electricity use, induced persistent energy savings behavior of 8–10% over 100 days; whereas a more traditional cost savings frame, drove sharp attenuation of treatment effects after 2 weeks with no significant savings versus control after 7 weeks. We discuss implications for the design of effective information campaigns to engage households in conservation behavior.

1. Introduction

Information programs solve problems of imperfect information in markets – often helping individuals and institutions make better consumption or investment decisions, and overcome cognitive or behavioral biases (Thaler and Sunstein, 2008; Ratner et al., 2008). Information framing has been used in a wide range of decision-making domains, including saving money for retirement (Benartzi and Thaler, 2007); paying for charity and performance (Gneezy and Rustichini, 2000); reducing poverty and improving access to financial institutions (Bertrand et al., 2006); designing health behavior programs (Rothman and Salovey, 1997; Keller and Lehmann, 2008); and encouraging resource conservation (Schultz et al., 2007). In this paper, we use information-based strategy to motivate household energy conservation. We provide experimental evidence from a randomized trial that non-price based framing interventions can be effective for conservation behavior over time.

Typical framing interventions provide study subjects with alternative representations of a decision problem, e.g. framing a quantity as a gain or loss, shifting reference points, or manipulating a choice set (Tversky and Kahneman, 1981; Kahneman and Tversky, 1979; Levin et al., 1998; Keren, 2011). Information framing effects are defined when the manner in which stimuli are represented or "framed" to decision-makers affects its evaluation. Historically, framing research has been conducted in

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small-scale studies with short trials and one-shot decisions. While more recently, this research has moved from the laboratory to field experiments in market settings (Levitt and List, 2009; List and Price, 2013), we still have limited understanding of the effectiveness of information framing on behavior over long time periods (Bernedo et al., 2014). Studying the dynamics of framing interventions is important because there is a fundamental question about how long framing effects can last after initial exposure, and what happens when decision frames are repeated.

In this paper, we conduct a field experiment to analyze how framing interventions can affect residential energy consumption behavior over time. Understanding the potential mechanisms to reduce energy consumption is an essential part of addressing climate change (Davis and Gertler, 2015), since electricity generation accounts for over 40% of carbon emissions in the United States. Residential and commercial buildings collectively account for over two-thirds of total U.S. energy consumption (EIA, 2014; EPA, 2013). Energy conservation can be achieved not only with technological changes in buildings and appliances, but also with behavioral changes in consumption (Asensio and Delmas, 2015; Allcott and Mullainathan, 2010; Gillingham and Palmer, 2014; Harding and Hsiaw, 2014).

In a fast growing experimental literature, scholars have demonstrated that tailored information programs have a tremendous potential for reducing household electricity use (Allcott, 2011; Ayres et al., 2013; Costa and Kahn, 2013; Davis and Metcalf, 2014; Delmas and Lessem, 2014; Jacobsen et al., 2012). These studies report significant conservation effects using social comparisons and other normative appeals to conserve energy, which build on seminal work in psychology (Cialdini et al., 1990; Cialdini, 2003; Schultz et al., 2007; Nolan et al., 2008). Despite the popularity of this growing body of research, very little is currently known about the dynamics of household responses to norm-based behavioral interventions, and even less so at the appliance level. Conservation is not a one-time occurrence but requires repeated consumer effort and attention. Some responses may be immediate, others not; and currently, researchers have not been able to differentiate well between short- and long-run behavior change mechanisms in a framing intervention. A dynamic analysis of conservation behavior with real-time information strategies is lacking.

There are many reasons to expect that information framing could have differential impacts on energy consumption over time. First, household conservation behavior such as turning off unused lights, unplugging charging devices or reducing standby power, are habitual or event-based actions that might require timely information feedback to consumers about monetary or social costs. Consumers, however, receive infrequent information about the monetary costs of electricity (Gilbert and Graff-Zivin, 2014; Jessoe and Rapson, 2012; Ito, 2014). Second, consumers are generally unaware, or unable to observe the negative externalities of their electricity consumption such as outside air pollution and related environmental health damages (Brunekreef and Holgate, 2002). These social costs of individual electricity use are also usually not reflected in prices for electricity services (National Research Council, 2010). From the above, we could expect that more salient information regarding these unobserved costs might influence judgments and decisions over time. In the present study, we offer new field evidence that framing effects – e.g. alternative representations of the external effects of household consumption decisions, either in terms of monetary or social costs – can dramatically alter energy savings behavior over time.

We conduct a field experiment using advanced energy metering technologies with real-time energy use information provided to households at the appliance level. We give households information about unobserved monetary and social costs related to their electricity consumption. The use of advanced metering and information technologies offers new benefits for behavioral research (Chen et al., 2014). First, information diffusion and feedback is relatively fast and can improve the salience of prices and quantities (Gilbert and Graff-Zivin, 2014). Second, analytics data can be deployed to verify when and how households interact with information treatments or alerts. This is important because engagement analytics allow us to assess the effect of the actual treatment, that is to say when people access their energy feedback information, rather than just measuring the effect of the intent to treat, that is to say sending the email or making the information available on the dashboard.

Our results are based on 374 million high-frequency panel observations of kilowatt-hour (kWh) electricity consumption for 118 households observed over 9 months. While households respond immediately to tailored messages about their electricity use, the effectiveness of repeated messages on consumption behavior varies by decision frame. We find that a health-based frame, in which consumers consider the environmental and human health effects of their marginal electricity use, induced more persistent energy savings behavior over a 100-day treatment period; as compared to a more conventional savings frame over the same period. In other words, conservation was short-lived with cost savings framing, but was more persistent with environmental and health framing. These results indicate that framing can be used as a strategy to overcome behavioral barriers, especially in settings where price-based policies may not be politically feasible or effective (Gneezy et al., 2011).

The rest of the paper proceeds as follows. Section 2 presents some background on possible mechanisms for behavioral changes in responses to high frequency messaging over time. Section 3 discusses the setting of the field experiment and Section 4 describes the experimental design. Section 5 presents the econometric approach. Section 6 discusses the results by framing intervention including appliance dynamics and a concluding discussion follows.

2. Background

2.1. Novelty and repetition

Most households in the United States receive no information about their electricity usage apart from their monthly bills, which generally do not disaggregate across time periods or sources of usage. Because of this, most households know little