



# Information provision and consumer behavior: A natural experiment in billing frequency



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## ABSTRACT

In this study, I estimate a causal effect of increased billing frequency on consumer behavior. I exploit a natural experiment in which residential water customers switched exogenously from bimonthly to monthly billing. Customers increase consumption by 3.5–5% in response to more frequent information. This result is reconciled in models of price and quantity uncertainty, where increases in billing frequency reduce the distortion in consumer perceptions. Using treatment effects as sufficient statistics, I calculate consumer welfare gains equivalent to 0.5–1% of annual water expenditures. Heterogeneous treatment effects suggest increases in outdoor water use.

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## 1. Introduction

Conventional economic wisdom implies that more information is typically better. For many consumer goods and services, however,

the decision to consume an economic good is disconnected from its purchase price. In these contexts, providing consumers with more information may affect their behavior. For consumption of water or electricity, for example, information on consumption costs is limited because billing is infrequent. If this source of limited information distorts the signal that consumers use to make decisions, then improving the clarity of this signal has implications for consumer welfare and management of scarce resources.

Whether and how imperfect perception of prices and quantities affects consumer behavior is an empirical question of growing interest. A recent vein of literature suggests that consumers tend to underestimate prices, taxes, and quantities consumed that are transmitted opaquely or allow for customer inattention (Chetty et al., 2009; Grubb and Osborne, 2015). Empirical examples range from behavioral responses to tax-inclusive prices for retail goods to improving the salience of consumption information through text-message reminders for cell-phone use. A parallel literature on consumer behavior in environmental policy considers the impact of social norms (Allcott, 2011; Ferraro and Price, 2013) and information provision (Jessee and Rapson, 2014) and shows that informative

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interventions can reduce consumption and thus serve as an instrument of conservation.

With few exceptions, previous research suggests that various information treatments can be utilized to reduce consumption of economic goods that impose external costs on society. Despite lacking firm theoretical grounding, empirical evidence, so far, is aligned with the stylized notion that inattentive consumers tend to under-perceive price signals. Thus, policies designed to improve the salience of these signals can be cost-effective conservation strategies, particularly in regulated markets for electricity and water where prices may be politically difficult to change.

In this paper, I uncover causal estimates of consumer behavior that is at odds with improved salience being beneficial for resource conservation. I take advantage of a natural experiment in which residential water customers are exposed to exogenous increases in billing frequency within a single water provider's service area in the southeastern United States. I find strong empirical evidence that the provision of more frequent information increases water consumption in the short run. This result stands in stark contrast to findings of previous work and has significant implications for efficient management of scarce environmental resources.

Beginning in 2011, the City of Durham's Department of Water Management in North Carolina transitioned residential customers in geographically differentiated billing districts from bimonthly to monthly billing over the course of two-and-a-half years.<sup>1</sup> By exploiting the assignment of monthly billing, I estimate an average treatment effect on water consumption due to increased billing frequency at the household level. The primary result is that households billed monthly consume 3.5–5% more water than households billed bimonthly. I show that this effect is robust to unobserved neighborhood effects by examining household consumption before and after the change in frequency within 500 ft of common billing group boundaries. I find that inattentive consumers do not respond to the change in billing frequency, casting doubt on the notion that the increase in consumption is due to changes in metering technology. I also find important heterogeneity among baseline water use, lot size, and assessed home value.

My empirical results necessitate a closer examination of the mechanism driving consumer behavior in response to more frequent information. To that effect, I develop conceptual models of imperfect price and quantity perception that reconcile my empirical findings with the current literature on salience and inattention. Based on the notion that consumers are receiving more frequent information about the price and consumption of water with the receipt of monthly (versus bimonthly) bills, the information “treatment” allows consumers to update their perception of price or quantity consumed. This framework is general enough to accommodate the findings of previous research because more frequent information nudges consumers closer to the neoclassical ideal of decision-making under perfect information. As a motivating example, a consumer who initially under-perceives the price of electricity can be modeled similarly to a consumer who over-perceives the price of water, since more frequent billing will reduce the wedge between her perceived price and the actual price.

Further, I develop a transparent welfare framework using treatment effects as sufficient statistics for consumer demand. Because a consumer who misperceives price (quantity), and thus consumes suboptimally from her perfectly informed self, will be better off upon the receipt of new information, there are welfare gains from the provision of more frequent information. Consumer surplus measures suggest a welfare gain of approximately 0.5 to 1% of annual household expenditures on water that are attributable to the change

in billing frequency. Other plausible mechanisms and their policy implications are discussed.

From a policy perspective, informative signals are being used increasingly as a regulatory instrument in the context of electricity and water conservation. The findings of this paper suggest that increases in billing frequency can have the perverse effect of increasing consumption. This result is particularly poignant because the efficient price for residential water is its long-run marginal cost of provision (Timmins, 2002; Olmstead and Stavins, 2009). However, because the market price is likely set below its efficient level (Mansur and Olmstead, 2012), the demand response to more frequent information may exacerbate the wedge between privately and socially optimal consumption levels.

### 1.1. Conceptual background

Consider the choice setting in which a consumer is deciding how much water to use in a given billing period.<sup>2</sup> Gilbert and Graff Zivin (2014), Harding and Hsiaw (2014), and Wichman (2014), for example, posit models of behavior based on prices, quantities consumed, and behavior in previous periods as heuristics for making consumptive decisions for electricity and water. Because utility bills are received periodically, the arrival of billing information offers consumers an opportunity to update their consumption in response to external feedback regarding their behavior. A change in the frequency of billing information is particularly relevant in the intermittent choice setting for water use because consumers generally do not know how much water they are using at any point in time, nor how much water an appliance uses and its associated variable costs (Attari, 2014). Thus, more frequent billing allows a consumer to better align market signals directly with the usage of appliances or water-intensive behavior.

With a fuzzy link between water consumption and the receipt of a water bill, however, the consumer may not have perfect information about prices and consumption that neoclassical models of consumer demand require. Several papers have documented this behavior theoretically and empirically in different markets. Studies show that (1) obtaining the relevant information to make perfectly informed decisions is costly (Shin, 1985; Sallee, 2014; Caplin and Dean, 2015); (2) consumers may be inattentive to or unaware of (changes in) prices or taxes (Sexton, 2015; Chetty et al., 2009; Finkelstein, 2009; Li et al., 2014; Houde, 2014); (3) inattention could be a function of attributes that are “shrouded” from consumers (Gabaix and Laibson, 2006); (4) consumers may use heuristics for decision-making when price and quantity information is opaque or uncertain (Ito, 2014; Wichman, 2014); or (5) consumers may have biased perceptions of prices, expenditures, and consumption (Allcott et al., 2014; Allcott, 2013; Grubb and Osborne, 2015; Bollinger et al., 2011; Byrne et al., 2014). Thus, relaxing the notion that consumers respond with perfect information for water use should not be met with much criticism. But the question remains: how are consumers using price and quantity information to make decisions in intermittent choice settings?

Many researchers examine this question in framed field experiments in the context of water and electricity demand to examine quantity reminders, social norms, and other forms of informative interventions (Allcott, 2011; Ferraro and Price, 2013; Kahn and Wolak, 2013; Jessoe and Rapson, 2014; Brent et al., 2015; Byrne et al., 2014). But, no studies have focused on an information treatment as simple as more frequent billing, which is arguably the easiest form of an intervention to implement as policy. In this paper, the consumer

<sup>1</sup> Bimonthly bills are those received every two months.

<sup>2</sup> While the model presented in this paper is generalizable to many choice settings in which consumption of the economic good and payment for consumption are separated temporally (e.g., cell phone usage, credit card purchases, and electricity demand), the discussion henceforth will consider water consumption to coincide with the empirical setting.

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