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How present bias forestalls energy efficiency upgrades: A study of household appliance purchases in India

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A B S T R A C T

This paper investigates household decision-making behaviour in the market for energy-efficient lighting and appliances in Delhi, India to study the energy efficiency gap using the inter-disciplinary framework of behavioural economics. A primary dataset of survey responses and choice experiments is analysed to test whether under-investment in energy-efficient technologies is explained by present-biased preferences. A 'Multiple Price List' set is employed to compute the standard discount factor, and the present bias and long-run component of a quasi-hyperbolic specification. Individuals who are more patient and less present-biased are found to be more likely to invest in certain energy-efficient appliances. As expected, time preferences are relevant for larger purchases such as refrigerators but lose some or all of their explanatory power for inexpensive purchases such as light bulbs. Our quantitative study contributes to the existing literature, which is limited to qualitatively identifying the (market failure) barriers for energy efficiency; *inter alia*, it tests for behavioural failures in individuals' decision-making towards the environment.

1. Introduction

Energy efficiency has been dubbed the world's 'first fuel' (IEA, 2014) because of its favourable cost characteristics compared to meeting the increasing demand for energy with the construction of new power plants. Despite these favourable investment attributes, observed levels of energy efficiency take-up and retrofitting lag are far lower than predicted from a purely economic and financial point of view, a phenomenon which is known as the 'energy efficiency gap' (Jaffe et al., 2004). One of the most egregious examples of this gap is the slow take-up of energy-efficient lighting and appliances. For example, although the cost of residential LED bulbs has sharply decreased over time (EIA, 2014) and LEDs are known to pay back the investment many times over a typical lifespan, their market share is still negligible (PWC, 2011). Hence, household lighting and appliances appear to be an excellent case in point for understanding the workings behind the energy efficiency gap.

Energy efficiency enhancements and behavioural changes have the potential to substantially lower emissions and offset the growth in electricity demand (IPCC, 2014). Given decisions towards the environment characteristically involve an inter-temporal dimension, our study tests whether individuals' reluctance to purchase energy-efficient appliances can be explained by time-inconsistent preferences (using a behavioural economics framework). We seek to answer the question: are present-biased individuals less likely to invest in residential energy-efficient technologies? Importantly, our case study of India is motivated by the scarcity of experimental literature examining the prevalence of the energy efficiency gap in the context of developing countries (Gillingham and Palmer, 2013). Our study of the behavioural barriers to the adoption of otherwise profitable investments in energy efficiency is a first-step towards designing efficiency-improving policy that is not exclusively motivated by conventional market failure analysis.

2. Energy efficiency gap

Understanding how individuals make decisions is crucial if policy-makers are to design interventions that counter the impact of unconstrained human behaviour on the environment. Energy efficiency – and the evidence suggesting that individuals forego investment in cost-effective energy-efficient technologies – provides an exemplar case for analysis. In the discipline of economics,

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utility theory and rational choice provide the foundation for conventional models of decision-making. Accordingly, individuals invest in energy-efficient technologies if and only if the willingness to pay (WTP) (accounting for the implicit weight on energy cost savings) outweighs incremental capital costs (Allcott and Greenstone, 2012).

The energy efficiency literature is defined by the long-standing debate on the existence of an energy efficiency gap, which, in theory, describes a significant difference between observed levels of energy efficiency and some notion of optimal energy-use (Jaffe et al., 2004). In principle, the gap represents the 'paradox of the inadequate diffusion of cost-effective energy-efficient technologies' given that: (i) energy-use can be reduced through adoption of existing technologies (Norberg-Bohm, 1990), and (ii) the diffusion of such technologies follows a gradual S- shaped curve (Jaffe and Stavins, 1994). Within an investment framework, the energy efficiency gap characterises under-investment in energy efficiency relative to the socially optimum level of energy efficiency (Gillingham et al., 2009).

Taking into account the disproportionate impact that climate change will have on the global South, India presents an interesting case for analysis. Given that a unit of energy saved through conservation or efficiency measures ('negawatt') is cheaper than a unit of energy produced ('megawatt') (Lovins, 1990), the Government of India's (GoI) National Mission for Enhanced Energy Efficiency (NMEEE) aims to lower the energy intensity of GDP growth through energy efficiency and demand side management (DSM). In particular, residential consumption comprises around 20 percent of total electricity consumption in India (as of 2011) (Singh et al., 2012), with up to 80 percent of household electricity consumption attributable to just four end-uses: lighting, ceiling fans, refrigerators, and televisions (Boegle et al., 2010). The potential for energy efficiency measures to achieve an electricity reduction of around 20 percent of total generation by 2020 (over 2005 levels) (Planning Commission, 2014) is contingent on harnessing savings in present consumption (via retrofit measures) and incremental consumption (via new installations).[1]

Lighting is a major component of residential peak load, and LED penetration has the potential to cut CO_2 emissions by 50–70 percent (TCG, 2014). For energy-efficient appliances, the Bureau of Energy Efficiency's (BEE) initiatives are founded on a strategy of market transformation. Current adoption has been sluggish owing to Indian consumers' sensitivity to high capital costs, lack of awareness about energy-efficient variants, and the shortcomings of DSM programmes. Nevertheless, because of the high cost of energy relative to incomes, economic incentives have significant potential to alter behaviour; when electricity is priced at Rs. 6/kWh, star rated appliances are economically notionally attractive, even at a discount rate of 20 percent (Planning Commission, 2014). In this context, the BEE's 'Standards and Labelling (S&L)' initiative (star rating scheme[2]) specifies minimum energy performance standards and mandates disclosure of appliances' power consumption. In addition, the BEE's 'Super Efficient Equipment Programme (SEEP)' promotes super-efficient variants of appliances, which has the potential for total annual savings of 61 TWh over a moderate S&L scenario, avoiding around 48 million tonnes of CO_2 equivalent (Chunekar et al., 2011). This amounts to a reduction (in 2020) of roughly 15 percent of residential electricity consumption from just four appliances (Singh and Sant, 2011).

3. Literature review

There exists a wealth of experimental evidence in favour of the view that individuals do not make consistently rational decisions, including in the domain of energy-use and the environment (Camerer and Loewenstein, 2004). Unlike neoclassical economics, behavioural economics questions the assumptions of full information and agents' optimising behaviour. In contrast to stylised predictions, both sophisticated and naïve respondents consistently violate the axioms of rational choice under certain situations (Tversky and Kahneman, 1974). The 'crucial question is whether these deviations from perfect rationality lead to significant systematic biases in energy efficiency decision-making' (Gillingham et al., 2009). Simon (1955) concept of bounded rationality notes that individuals face cognitive constraints in gathering and processing information. Kahneman (2011) further develops this notion to suggest that day-to-day decision-making involves the use of shortcuts (i.e., heuristics). Although the use of heuristics as decision-making tools is reasonable under conditions of uncertainty, biases (i.e., deviations in judgement) can emerge from agents' misapplication of heuristics.

In the environmental domain, investments in energy-efficient technologies characteristically involve a trade-off between short-run costs and long-run benefits. In the context of inter-temporal decision-making, rational choice theory posits that individuals are consistent in their ability to plan decisions over time, that is, discount rates are constant (and preferences are stable) (Samuelson, 1937). Under exponential discounting, the discount rate is a positive number measuring impatience (and declines at a constant rate over time). By extension, individuals who are patient have lower discount rates (i.e., higher discount factors), and so value future rewards by a larger amount. The assumption of rationality implies that individuals' preferences are independent of the decision date; time-consistency is ensured by trading-off present for future consumption at a constant discount rate (Gintis, 2000), which is also consistent across different contexts (for example, for different household appliances). Empirical studies however find that investment decisions are influenced by factors other than standard cost-benefit analysis. For instance, discount rates for energy-efficient household appliances are found to range from 25 to 300 percent (Sanstad, 2006).

In particular, the empirical literature documents the discounted utility anomaly known as 'hyperbolic discounting', which implies that individuals have a declining rate of time preference (Frederick et al., 2002). In reality, individuals exhibit time-inconsistent decision-making, that is, people discount future costs or benefits much more sharply and at a non-constant rate, such that delaying an immediate benefit is viewed much more negatively than if a similar delay occurs at a later point in time (Gillingham et al., 2009). The most prominent approaches to modelling this anomaly include work by Laibson (1997), and O'Donoghue and Rabin (1999), who make the more accurate assumption that individuals maximise a discounted utility stream that places disproportionately higher weight on present payoffs relative to all future ones. In effect, individuals exhibit a present bias. Laibson (1997) adopts a 'quasi-hyperbolic' discounting function, which incorporates a present bias parameter to model present discounted utility as:

$$U(x_0, \ldots, x_T) = \beta \sum_{t=0}^{T} \delta(t) u(x_t)$$

[1] Savings estimates do not account for 'rebound effects', which occur when cost savings (from the efficiency improvement) induce a higher rate of appliance usage such that the net energy saving is not as large as expected (Greening et al., 2000). Rebound effects for appliances other than room air-conditioners are usually small (Sorrell, 2007).

[2] Star rating for electrical appliances ranges from 1 to 5 in ascending order of energy efficiency potential, i.e., a 5* appliance is the most energy efficient in its category.