Energy Economics 38 (2013) 51–63

Contents lists available at SciVerse ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneco

Saving money vs investing money: Do energy ratings influence consumer demand for energy efficient goods?

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ARTICLE INFO

Article history:
Received 23 August 2012
Received in revised form 4 March 2013
Accepted 10 March 2013
Available online 16 March 2013

JEL classification:
C10
D12
Q41
Q48
Q55

Keywords:
Energy-efficiency gap
Energy-using products
Electricity
Consumer behaviour
AIDS model

ABSTRACT

The article analyses economic barriers leading to the energy efficiency gap in the market for energy-using products by observing several million transactions in the UK over two years. The empirical exercise estimates AIDS models for refrigerators, washing machines, TVs, and light bulbs. Results indicate that market barriers are crucial in the demand for energy efficient options, and consumer response to changes in appliance prices, total expenditures, and energy prices depends on the possibility of behavioural adjustments in consumption. In contrast with the induced innovation hypothesis, current electricity prices can fail to induce innovation because of their short-term impact on disposable income, while consumers invest in energy efficiency when expecting electricity prices to rise in the future.

1. Introduction

Energy conservation originates from the need to preserve the existing stock of non-renewable natural energy resources (e.g. Sutherland, 1996), as well as reducing the economic and political dependence on these energy goods (Hamilton, 2003; Kilian, 2008). Current policies have focused on two main aspects: investment in the production of renewable or less carbon-intensive energy sources (Fischer, 2008); and the reduction of energy waste (Linares and Labandeira, 2010). This second item promotes investments in energy-efficiency by reducing the amount of energy required to obtain a unit of consumption (e.g. the same amount of light using less electricity; or travel the same distance with less fuel).

Energy efficiency policy has focused primarily on the supply side, targeting firm investments in efficient technology and imposing production standards (e.g. emission standards for cars) (Gillingham et al., 2009). Efforts to improve household energy consumption have gained popularity in the last decades, with a focus on environmental labelling and more recently on targeted behavioural campaigns (e.g. smart meters, carbon calculators) (see e.g. Allcott and Mullainathan, 2010). The shift in focus to household consumption is due to its crucial role in achieving carbon reduction and energy conservation targets in developed economies (Dietz et al., 2009; Vandenbergh and Steinemann, 2007): in the UK, households emit around 32% of total CO_2 (2008 estimates) and consume around 29% of total energy and 38% of electricity (2009 estimates).[1] By investing in existing energy-efficient technology, this sector has the potential for rapid and large reductions in carbon emissions (Dietz et al., 2009), counting on a double incentive to spend: environmental improvements (a social benefit); and monetary savings from reduced waste and cheaper energy consumption (a private benefit) (Gillingham et al., 2009).

Despite the theoretical advantage of purchasing energy efficient appliances, the difference between observed and optimal levels of energy use remains significant (Allcott and Greenstone, 2012; Brennan, 2011), a phenomenon known as "energy-efficiency gap" (Gillingham et al., 2009; Jaffe and Stavins, 1994; Jaffe et al., 2004). According to models of rational consumer behaviour, a household is always

Abbreviations: 2SLS, Two-stage least squares; 3SLS, Three-stage least squares; AIDS, Almost Ideal Demand System; BC, Bayonet Cap (light bulb fitting); CFL, Compact Fluorescent Light bulbs; DECC, Department of Energy and Climate Change; EEI, Energy efficiency index; ES, Edison Screw (light bulb fitting); EST, Energy Saving Trust; EUP, Energy Using Product; GLS, General lighting service; RPI, Retail Price Index; SES, Small Edison Screw (light bulb fitting); SUR, Seemingly unrelated regression.

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[1] Eurostat statistics, available at http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database, section "Environment and energy".

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http://dx.doi.org/10.1016/j.eneco.2013.03.002

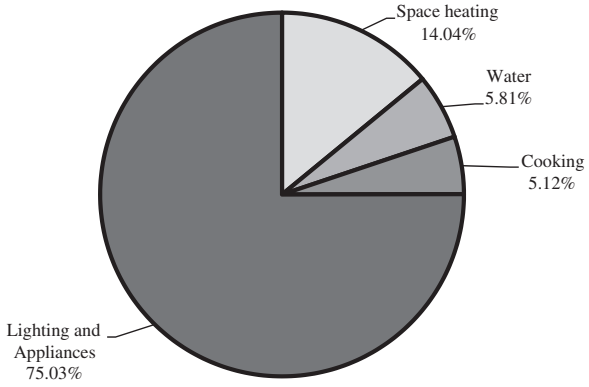

Fig. 1. Household electricity consumption by area of consumption (2009).
Source: DECC (2011).

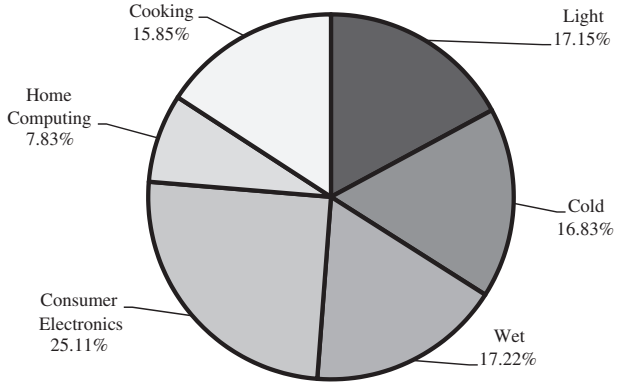

Fig. 2. Household electricity consumption ('000 tonnes of oil equivalent) by category of appliance (2010).
Source: DECC (2011).

expected to invest (i.e. spend) money[2] on a new technology whenever it provides positive long-term benefits. A violation of this principle is considered a counterintuitive violation of the law of demand: consumers who would benefit from investments in energy efficiency do not invest, causing both a private loss (missed savings, an internality[3]) and a public loss (overconsumption of energy, an externality). The energy-efficiency gap could still be a rational behaviour causing no private or public loss (Jaffe et al., 2004): costs and benefits of the investment might go to different agents (the owner-renter problem, see Davis, 2011); and lack of capital might discourage a motivated investor. The gap could also arise when an agent invests excessively in efficiency, due to the desire to contribute to a public good even at an economic loss.[4]

This article advances existing empirical research on the energy efficiency gap by exploring the market for Energy Using Products (EUPs) in the UK. The focus on the discussion is on four goods: *light bulbs*, a commodity with limited impact on the budget constraint; *refrigerators*, a white good with limited substitution in the household production function; *TV*,[5] an appliance used for leisure; and (clothes) *washing machines*,[6] a white good with direct substitutes in the household production function (e.g. laundrettes and laundry shops). The relevance of these items is depicted in Figs. 1–3: appliances and lighting account for three quarters of energy consumed within UK households (Fig. 1). Here, consumer electronics, wet appliances, lighting, and cold storage facilities are the four areas with the highest patterns of consumption (Fig. 2), and within each subcategory the articles focus on the item consuming the most electricity[7] (Fig. 3).

From a behavioural perspective, these four products differ substantially. Refrigerators represent a significant part of the energy bill, and are the category with the lowest possibility of behavioural adjustment because they require continuous electricity consumption. Here, changes in consumer behaviour are limited to substitution to other storage type (e.g. canned food); however, because running costs are given once the refrigerator is connected, unit costs of storage decline only with the amount of food stored (i.e. usage is cheapest when the refrigerator is full). The purchase of energy efficient light bulbs is instead partially unrelated to their consumption, because items are often stored for perspective use. Light bulbs usage is also discontinuous and influenced by seasonal factors (e.g. seasonal light). Finally, TVs and washing machines only require discontinuous, albeit periodic, usage and their purchase often accommodates personal needs (e.g. limited space for washers; or an ornamental TV set). Conversely, investments in energy efficient EUPs provide long-term reductions in energy consumption with no need for behavioural change.

The provision of energy-efficiency ratings on the labels of EUPs (e.g. class A refrigerator) aims at achieving a change in consumer shopping behaviour by making the environmental outcome of choices salient and reducing asymmetric information (e.g. Mills and Schleich, 2010). Previous research established that the resistance of the gap in the presence of energy ratings can be attributed to market barriers, the focus of this article, as well as psychological barriers such as performance uncertainty and loss aversion (Greene, 2011; Jaffe et al., 2004). Among market barriers, energy and technology prices play a central role in household investments in efficient EUPs together with perceived discount rates, which however are not discussed in this work.[8] While these factors do not constitute market failures, their role is mediated by an energy label: the moral duty of environmental preservation justifies the investment in an efficient EUP on social grounds despite a short-run reduction in disposable income.

The price of EUPs is an important barrier to energy efficiency because it represents the fixed costs of an investment. The purchase of a new appliance requires a substantial sum of money per se, and energy-efficient options demand a further price premium (Dale and Fujita, 2008; Galarraga et al., 2011a). The same argument applies to light bulbs, despite representing a relatively small expense (see Section 3). Moreover, EUPs are characterised by a fast technological development, which induces consumers to expect a fast depreciation of the money they spend (Dubin and McFadden, 1984; Hausman, 1979) and imperfections in the functioning of new technologies (Mick and Fournier, 1998). As a result, consumers tend to delay the replacement of EUPs until unavoidable (Galarraga et al., 2011b; Young, 2008). The overall response to a price change would then depend on consumer perception of energy efficiency: efficient EUPs would be expected to be price-sensitive because efficiency is not a necessity feature; however, efficient EUPs tend to have less luxury features (e.g. refrigerators with no ice dispensers; or washing machines with no drier), making these products less responsive to price changes.

[2] The Merriam-Webster dictionary defines investment as the "Process of exchanging income for an asset that is expected to produce earnings at a later time" (http://www.merriam-webster.com/dictionary/investment). The present purchase of an energy efficient appliance corresponds to the payment of an extra amount of income equal to the price premium that will produce future savings, hence the use of the term "investment", as also consistent with the literature (e.g. Jaffe and Stavins, 1994; Sutherland, 1996). The use of this term differs from the usual macroeconomic discussion of investment, which refers to assets that can appreciate in the future and generate benefits upon resale.

[3] An internality is defined as a behaviour that imposes extra costs on the agent who is responsible for it (Herrnstein et al., 1993). In the case of the energy-efficiency gap, the forgone investment imposes extra long-term monetary costs to households because the decision-making process does not fully account for future costs and benefits (Jaffe et al., 2004).

[4] I am thankful to an anonymous referee for suggesting this point.

[5] According to the 2009 Family Spending survey of the ONS, in the UK 97% of households own a TV.

[6] According to the 2009 Family Spending survey of the ONS, in the UK 96% of households own a washing machine.

[7] Washing machines have been preferred to tumble driers because they are segmented by efficiency class.

[8] The implications of the absence of this factor on the results are presented at the end of the discussion section.