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Why don't households see the light? Explaining the diffusion of compact fluorescent lamps

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ABSTRACT

Starting in 2009 the EU ban on the sale of incandescent bulbs will force households to purchase energy-saving compact fluorescent lamps (CFLs). The impact of the ban on consumers will depend on the nature of current barriers to the use of CFLs. This paper employs a Double-Hurdle model to identify distinct barriers to household consideration of CFLs and to the subsequent intensity of adoption using a large survey of German households. Barriers to CFL consideration are found to be low for all households, except those with very low incomes. Barriers to CFL consideration are, however, strongly linked to the residential characteristics of low-income households like small size and to the lack of household knowledge of energy consumption. CFLs use will increase after the ban mainly through a rise in the intensity of adoption. But the ban will be costly to consumers because the range of applications where households chose to employ CFLs is limited, particularly for high income households.

1. Introduction

Improving energy efficiency is a core strategy for a sustainable energy system. In the residential sector, energy-saving technologies can spur cost savings for private households, while reducing greenhouse gas emissions and other pollutants and increasing the security of energy supplies. Two policy pathways exist to accelerate residential energy-efficiency gains. First, research investments and other policy interventions can be designed to accelerate the generation of new energy-saving

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innovations. Second, policies can be designed to promote the diffusion of existing residential energy-saving innovations. For example, residential energy efficiency in the European Union expanded group of 25 member states (EU 25) is estimated to have improved 10% since 1990 (ENERDATA, 2007). The 2007 European Council Action Plan for Energy Efficiency (European Commission, 2006) states that the residential buildings sector exhibits the potential for further cost-effective energy-savings of 27% by 2020 using existing technologies. Thus, enhanced diffusion of 'off-the-shelf' technologies are expected to play a substantial role in medium-term residential energy savings and attendant greenhouse gas reductions.

Energy-efficient compact fluorescent lamps (CFLs) are an off-the-shelf technology with a particularly high potential to generate residential energy-savings. There are an estimated 33 billion light bulbs worldwide that consume 2600 TWh per year or 19% of global electricity use, with 30% of this consumption by the residential sector (Zissis et al., 2007). However, energy-efficient CFLs represent only 4% of the global market and 6% of the European market. Fluorescent lamp adoption is also considerably lower in the residential sector than in the service sector, despite significant publicly supported efforts to increase diffusion (Menanteau and Lefebvre, 2000). Atanasiu et al. (2007) estimate that cost-effective savings of at least 11.7 TWh per year (1.5%) in residential electricity consumption still exist in the EU 25 from increased adoption of CFLs, with potential savings of up to 21.9 TWh per year with aggressive policies to increase diffusion.

A considerable body of research exists on the technical merits of CFLs. However, as with residential energy-saving technologies in general, empirical analysis of the relationship between socio-economic factors and diffusion has been limited.[1] An early study of CFL adoption by Scott (1997) for Ireland finds very low levels of household use and few relationships with household socio-demography characteristics. Kumar et al. (2003) also find limited adoption in India, but increased probability of household adoption with higher education and income levels. We know of no recent studies that empirically examine the factors driving CFL diffusion, particularly for Northern European countries which have some of the highest rates of household adoption in the world (Menanteau and Lefebvre, 2000). However, understanding the relationship between socio-demographic characteristics and adoption is particularly timely in EU countries, as a ban on the sale of incandescent bulbs is set to go into affect in 2009.[2] Accordingly, inefficient incandescent bulbs will have to be replaced by more efficient alternatives like CFLs between 2009 and 2012 (European Commission, 2009).[3] The impending ban stands to differentially impact households based on current barriers to adoption. However, the distributional impacts of policies to aggressively promote residential use of CFLs are unclear without a solid understanding of the relationship between socio-demographic factors and household use of CFLs.

This paper empirically identifies the socio-demographic and other factors associated with the residential diffusion of energy-saving CFLs in Germany using a large household survey. As CFLs are a highly divisible innovation, a Double-Hurdle model is employed that specifies observed adoption as the outcome of a two-part decision. In part one, the household decides whether to actively explore purchasing CFLs (enter the market). Then, in part two, the household determines the intensity of adoption. The statistical model and its empirical specification are presented in the next section. Data and descriptive statistics on residential CFL usage in Germany and on the variables employed to explain differential household market entry and adoption intensity are presented in Section 3. Model estimation results are presented in Section 4. The paper then concludes with an examination of the potential impact of the impending EU ban on incandescent bulbs and other policies to increase CFL diffusion.

2. Conceptual framework, statistical model, and empirical specification

CFL adoption is viewed as a utility maximizing decision by the household within the constraints of uncertain and costly information. The observed use of CFLs is assumed to stem from the following

[1] studies of factors associated with other residential energy-saving innovations include attic and wall insulation and window glazing in the U.K. (Brechling and Smith, 1994) attic insulation and water heater insulation in Ireland (Scott, 1997), and energy efficient appliances and heating systems in Germany (Schlomann et al., 2004, 2005).

[2] and the United States, among others, have also passed similar legislation.

[3] bulbs may also be replaced by improved bulbs with halogen technology.