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Valuing improvements in comfort from domestic energy-efficiency retrofits using a trade-off simulation model

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Abstract

There are a number of stimuli behind energy efficiency, not least the Kyoto Protocol. The domestic sector has been highlighted as a key potential area. Improving energy efficiency in this sector also assists alleviating fuel poverty, for research is now demonstrating the strong relationship between poor domestic thermal efficiency, high fuel poverty and poor health and comfort status. Previous research has modelled the energy consumption and technical potential for energy saving resulting from energy-efficiency upgrades in this sector. However, there is virtually no work evaluating the economic benefit of improving households' thermal comfort post-retrofit. This paper does this for Ireland using a computer-simulation program. A dynamic modelling process is employed which projects into the future predicting the extent to which energy savings are forgone for improvements in comfort.

JEL classifications: C88; Q41

Keywords: Domestic energy efficiency; Thermal comfort; Computer-simulation modelling

1. Introduction

The impetus to conserve energy comes from a variety of sources. In recent times, the Kyoto Protocol has been the most prominent in bringing energy efficiency to the fore. In some countries, the domestic sector has been highlighted as an area which has a significant potential for improvement. A key issue strongly linked with

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energy (in)efficiency in this sector, particularly in western Europe, is that of fuel poverty.[1] Research is beginning to show the tangible relationship between low levels of domestic thermal efficiency, high rates of fuel poverty and reduced health and comfort status (Clinch and Healy, 1999), the end result of which can be premature mortality (Clinch and Healy, 2000a; Rudge and Nicol, 2000).

Evidence from studies around the world continues to support the hypothesis that energy-efficiency measures and programmes result in highly cost-effective investments, using even the narrowest criteria. The early work of Pezzey (1984) and later research by Henderson and Shorrock (1989) and van Harmelen and Uyterlinder (1999), show the clear net benefits of individual retrofitting technologies. At the macro level, Arny et al. (1998), Brechling and Smith (1994), Clinch and Healy (2001) and Goldman et al. (1988) demonstrate the benefits of comprehensive retrofitting programmes. However, the energy-assessment models upon which energy-efficiency studies are based vary in quality and reliability. In addition, the scope of the economic analysis is almost always narrow—typically just evaluating the costs and benefits in terms of reductions in energy consumption and attendant environmental emissions.

There are a number of papers in the literature of energy economics that attempt to model both the energy consumption and technical potential for energy saving in the domestic sector resulting from energy-efficiency improvements; in northern Europe, such energy benefits arise from reduced energy use in heating the home.[2] Such research has been carried out in Australia by Michalik et al. (1997), in Belgium by Hens et al. (1998), in Denmark by Jacobsen (1998), in Spain by Cuchi (1998), in Taiwan by Yang and Su (1997), in the UK by the Building Research Establishment (1998) and Jaggs and Palmer (2000), and in the USA by Hoffman and Jorgenson (1977) and Holz et al. (1997). However, there is virtually no research which places an economic value on the improvement in comfort that results from such retrofitting exercises. This paper does this for Ireland using a computer-simulation model, the precise details of which are given in Clinch et al. (2001).

A feature of many domestic energy-assessment models is that they assume that private benefits from energy-efficiency programmes will take the form of reduced energy bills, while external benefits may include reductions in environmental emissions. If it is assumed that all dwellings are heated to a safe and comfortable temperature, this assumption is reasonable. However, if a portion of the housing stock has sub-optimal levels of warmth, a domestic energy-efficiency programme is likely to result in some of the energy savings (predicted on the basis of fixed internal temperatures) being forgone in exchange for increased internal temperatures. A key feature of this research is that a dynamic modelling process was used to project into the future to predict the extent to which energy/emissions' savings might be forgone in exchange for improvements in comfort/health.

[1] The inability to heat the home to an adequate (safe and comfortable) temperature owing to low household income and poor (energy inefficient) housing conditions.

[2] Of course, such benefits will not accrue to those countries that experience warmer climes whose requirements will be for cooling as opposed to heating.