Energy Policy 111 (2017) 157–165

Contents lists available at ScienceDirect

Energy Policy

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

Making the case for supporting broad energy efficiency programmes: Impacts on household incomes and other economic benefits

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ARTICLE INFO

Keywords:
Energy efficiency
Energy demand
Fuel poverty
Multiple benefits
General equilibrium

ABSTRACT

In recent years, an overly narrow focus on rebound effects has limited the extent of researcher and policy attention afforded to the wider multiple benefits of increased energy efficiency. Our objective is to focus policy attention on the sustained added value to the economy that is created by improving energy efficiency in the residential sector. Governments around the world are committed to increasing energy efficiency more generally, but often focus public support in low income households where energy poverty is a particular concern. However, governments operate in a context of multiple objectives where energy efficiency is expected to deliver significant reductions in carbon emissions alongside sustainable economic development. We use a UK CGE model to consider the general effects of supporting increases in energy efficiency in residential energy use. Our results demonstrate that the increase in GDP, and economic activity more generally, triggered by increased energy efficiency delivers more in terms of increased household incomes than the efficiency improvement itself. We find that the more wide ranging the boost to energy efficiency, the greater the economic expansion and associated returns are likely to be, and the less the means of financing through public budgets will erode the benefits over time.

1. Introduction

In recent years the literature on the wider economic impacts of energy efficiency improvements has tended to focus on the issue of rebound effects. In particular, rebound studies have mainly focussed on measuring direct and indirect ('re-spending') rebound effects using microeconomic or limited input-output economy-wide models (see for example Chitnis and Sorrell, 2015; Druckman et al., 2011; Freire-Gonzáles, 2011). Where different household income groups are identified, emphasis has tended to be placed on how rebound effects that are driven by changes in real income following an energy efficiency improvement will be bigger the larger the share of total income that is spent on energy consumption (Chitnis et al., 2014; Murray, 2013; Thomas and Azevedo, 2013).

However, certainly in colder climates like that of the UK, where lower income households tend to spend a larger share of their income on energy (Office for National Statistics, 2011, 2012, 2013), there are concerns over energy or fuel poverty (UK DECC, 2015).[1] This both raises a challenge for the rebound-focussed literature, in that direct rebound effects triggered by lower energy costs may in fact be a true representation of required demand (to adequately heat properties), and focuses attention on the nature of socio-economic returns from increased energy efficiency.

The latter point reflects the 'multiple benefits of energy efficiency' argument proposed by the International Energy Agency (IEA, 2014; Ryan and Campbell, 2012). In particular the current paper focuses attention on the sustained added value to the economy that is created as result of increasing energy efficiency. We consider this in the context of a general equilibrium argument. That is, we propose that the increase in GDP and economic activity more generally that is triggered by increased energy efficiency (here in the household sector) delivers more in terms of energy poverty reduction than the efficiency improvement itself.[2] This is through the additional return to household incomes as the economy expands. The larger and more wide-ranging the boost to

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[1] In warmer climates, cooling may be a greater concern than heating. However, the expense of running air conditioning systems may deter low income households from investing in systems, so that expenditure on cooling does not manifest in economic statistics in the same way as energy poverty linked to heating.

[2] Note that in this paper we do not attempt to investigate impacts on precise measures of energy or fuel poverty currently adopted in the UK. At this stage, in our general analysis, we focus simply on whether the share of disposable income spent on energy goes up or down, given that a commonly adopted fuel poverty indicator compares the share of income spent on energy to a given threshold.

http://dx.doi.org/10.1016/j.enpol.2017.09.028
Received 12 November 2016; Received in revised form 11 July 2017; Accepted 12 September 2017

household energy efficiency, the greater the economic expansion and associated returns are likely to be.

We also consider a government funding argument, that public support should be directed at helping those less able to pay for energy efficiency improvements themselves. Specifically, we consider whether economic expansion triggered by more wide ranging support of energy efficiency programmes is likely to provide sufficient stimulus to the economy to justify greater levels of public support. This may also provide the basis for setting energy efficiency programmes in the context of a national infrastructure argument linked to improving the quality of a country's domestic building stock.

The remainder of the paper is structured as follows. Section 2 reviews the recent indirect and economy-wide rebound literature that has been the recent setting for considering the impacts of increased efficiency in household energy use. We focus on the extent to which wider economic expansionary and socio-economic arguments have been made. Section 3 then focuses attention on the policy context for identifying the issues outlined above, expanding on the multiple benefits, general equilibrium and public funding/national infrastructure arguments. Section 4 describes the UK CGE model that we use to consider the general effects that may be anticipated if energy efficiency increases in one or more household income groups in an economy. Section 5 details the simulation scenarios that are then implemented in Section 6, where we discuss our results. Finally, Section 7 draws conclusions and considers policy implications.

2. Existing literature on the wider impacts of energy efficiency

In recent years a number of studies have analysed the impact of improved household energy efficiency using microeconomic demand systems, and input-output (IO) techniques. Their main focus has been the estimation of direct and indirect rebound effects (see for example Brännlund et al., 2007; Chitnis and Sorrell, 2015; Druckman et al., 2011; Freire-Gonzáles, 2011; Lenzen and Dey, 2002; Mizobuchi, 2008).

More broadly, the main objective of this literature is to assess the effectiveness of energy efficiency, specifically in reducing energy use and CO_2 emissions throughout the economy triggered by a reduction in final energy demand. For this reason, they estimate the rebound effect as a measure of the extent to which technically possible energy savings are eroded by economic responses.

Some of these studies have estimated energy rebound effects by considering the impacts of energy efficiency and energy saving behavioural changes across different household income groups (Chitnis et al., 2014; Murray, 2013; Thomas and Azevedo, 2013). In this context, a common finding is that the lowest income groups tend to be associated with higher rebound effects. This is for two reasons. First, lower income groups tend to spend a larger share of their income on energy. Second, the price elasticity of demand for energy goods is generally higher when income is lower, indicating that lower income households are more responsive to changes in energy price (Chitnis et al., 2014). When the price of energy in efficiency units decreases, price elastic groups respond by consuming more energy.

However, a key limitation of the approaches adopted in the aforementioned studies is to rely on models that implicitly or explicitly adopt the assumption of fixed market prices and nominal incomes. Such models are not able to capture the full set of economic responses triggered by an energy efficiency improvement that will occur as the economy adjusts to a new steady state with different spending and production decisions. Thus, they are limited in their capability to identify other potential benefits of energy efficiency (Brännlund et al., 2007; Chitnis and Sorrell, 2015; Lecca et al., 2014).

Duarte et al. (2015), and Lecca et al. (2014) have estimated the impact of improving energy efficiency in household energy use using more flexible computable general equilibrium (CGE) models that incorporate IO data but permit the relaxation of the assumptions inherent in partial equilibrium and IO studies. Specifically, Lecca et al. (2014) take the case of the UK and explore the value added of moving from a partial to a general equilibrium modelling framework (via an intermediate stage involving IO analysis) in the analysis of energy efficiency improvement. This is done by considering the impact of a 5% increase in household energy efficiency using models with different degrees of complexity calibrated on a common database.

Lecca et al. (2014) initially estimate the direct rebound effect by estimating the elasticity of demand for energy goods and then derive the indirect (re-spending) rebound effects using IO techniques. They find that the indirect component of rebound is typically negative[3] when the direct rebound is less than 100% and the economy is characterised by energy sectors that are relatively energy intensive. In their UK case study, households decrease their demand for energy and reallocate spending towards less energy intensive non-energy goods, thereby reducing both direct energy use and energy embodied in supply chains supporting consumption demand. These net negative indirect effects persist when Lecca et al. (2014) derive the full economy-wide rebound using a CGE model. However, here the fuller economy-wide responses to the energy efficiency improvement are influenced by endogenous market price determination, nominal income and supply responses. This implies, for example, that the initial drop in demand for energy decreases the market price of energy in the short-run, exacerbating the rebound effect by amplifying the decrease in the price of energy services (for any given market price), which may be considered as the effective price of energy. However, it also negatively influences the revenue and capacity decisions of energy producing firms and, over time, their output prices (i.e. countering decreases in both the effective and market price of energy). Moreover, the increase in demand for non-energy goods puts upward pressure on domestic consumption prices, negatively influencing competitiveness of UK industries. Nonetheless, overall the Lecca et al. (2014) results show a net expansion in the UK economy, with an increase in investment, employment and household spending. However, with a fixed national labour supply, depending on how households respond to the change in cost of living given by increased energy efficiency, a sustained increase in wages may give rise to a higher price level and reduced export demand.

The Lecca et al. (2014) contribution helps to clarify the importance of analysing the full general equilibrium impacts of increased household energy efficiency. However, it is limited in only considering one single representative household, thereby not permitting any differentiation among household income groups. However, differences in the composition of both incomes and expenditures are likely to be crucial in influencing the distribution of the effects of economic adjustment across household income groups. Here, heterogeneity of households proves to be very important from a policy perspective.

Duarte et al. (2015) also use a CGE model, this time for Spain to assess a range of energy-saving policies including increasing energy efficiency, but identifying four household income groups. They actually find that lower income household are less responsive to an energy efficiency improvement, and indeed are associated with lower rebound effects.[4] However, the main point is that (although the focus of the work is on potential reduction of CO_2 emissions) Duarte et al.'s (2015) results also show that an energy efficiency improvement delivers an economic stimulus with a broader set of outcomes than reducing energy use.

In general, though, much of the rebound literature neglects the wider range of potential economic benefits associated with increased energy efficiency that have been the focus of policy community contributions such as the IEA (2014) report. In response, this paper aims to add to the energy efficiency and CGE literature in filling this gap by

[3] This means that actual energy savings from an energy efficiency improvement are greater than expected energy savings.

[4] This may relate to the issue of cooling vs. heating and that in warmer climates, such as Spain, low income households cannot afford more electricity-intensive systems such as air conditioning.