The Interlinkages between Improvements in Energy Efficiency and Macroeconomic Impacts

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Overview

Improving energy efficiency is widely accepted as one of the most cost-effective means to reduce CO_2 emissions through reduction in fossil fuel energy consumption. However, the benefits are not limited to energy and greenhouse gas emission savings. There are other considerable benefits from improving energy efficiency that are now being coined the multiple benefits of energy efficiency (IEA, 2014). These benefits extend from individual level to national and regional level and across economic, social and environmental benefits. Nonetheless, energy efficiency measures are generally evaluated in terms of their payback in energy savings alone.

Rebound effects occur when the realised reduction in energy demand from improvements in energy efficiency is less than the engineering estimates would predict. This can occur at a macroeconomic level when energy efficiency improvements drive increased economic activity and productivity. Recent work by the IEA and others illustrates the extent of the macroeconomic and public budget benefits from improvements in energy efficiency when quantified (IEA, 2014). This paper examines the relationship between rebound effects and the macroeconomic benefits from energy efficiency measures. Some results are presented for the distribution of welfare across household income groups from energy efficiency improvements and the link to the rebound effects. It proposes that welfare gains from energy efficiency measures arenot only derived from the rebound effect but that the rebound effect may be necessary to realise the full benefits of energy efficiency measures. The paper proposes insights for policymakers on the approach to take in designing energy efficiency policy that maximises societal benefit.

Methods

The objective of this paper is to examine the link between rebound effects and welfare gains from energy efficiency improvements at the macroeconomic level. This is an important subject in the context of the highly contentious recent media debate around the potential rebound effects associated with energy efficiency measures (Revkin, 2014). This paper contends that while there is likely to be a tradeoff between any macroeconomic benefits associated with energy efficiency and a rebound effect, the net value of the tradeoff is likely to be positive. There is strong interest from politicians and the general public in measures that support economic development, especially in the current economic climate of recession and relatively high energy prices in many countries. It is also important to examine where the welfare gains arisein order to better understand who benefits most from energy efficiency improvements.

Policy makers are under pressure to estimate the potential impact of energy efficiency improvements on the wider economy by carrying out ex-ante assessment or appraisal of competing energy efficiency policies. In order to be able to present credible and transparent results, it is important that any macroeconomic assessment is carried out as rigorously and transparently as possible, and supported by sound analysis of the microeconomic public and private costs and benefits. It is a complex subject and caution is needed when estimating the impacts of energy efficiency to avoid pitfalls such as crowding out other investment, rebound effects or energy price impacts in the calculation (IEA, 2014).

The methodology of this paper consists firstly of a review of the academic and policy literature on the macroeconomic assessment of energy efficiency policy measures. This involves carrying out interviews with a range of policymakers, experts, consultants and academics who are involved in the research and applied evaluation of energy efficiency policies, in particular with macroeconomic modellers. The assessment involves comparison of the results of the literature on the macroeconomic benefits and looks at the modelling techniques to ascertain whether there is an influence of the modelling technique on the results. A second piece of analysis examines the welfare gains across household income groups in the UK. This work builds on recent modelling results by Lecca et al. (2014) which examined the macroeconomic effects of a 5% energy efficiency improvement in the UK household sector. In this paper we model the gas and electricity rebound effects across five income groups and examine the differences between groups.

Results

The main techniques used to assess the macroeconomic impacts in the literature are I/O, relatively basic assessments using multipliers, macroeconometric models and computable general equilibrium models. A sample of the results from the literature are presented in Table 1.

Table1. Sample results of estimated value of multiple benefits of energy efficiency measures

Indicator	Metric	Value	Reference
GDP	GDP change per unit investment	0.9-3.73 (EUR/EUR)	Copenhagen Economics (2012), EC (2011); Lehr et al. (2012)
Public budgets	Ratio of public revenue to public investment	7:1, housing sector 2009-2011	Kuckshinrichs et al. (2013)
Employment	Net jobs created per year per unit investment	0.0 – 19 (Million jobs/EUR)	ACEEE (2014), Janssen and Staniaszek (2012) ; Copenhagen Economics (2012); EC (2011); Lehr et al. (2012); Cambridge Econometrics (2014); Diefenbach (2014)
Industrial productivity	Change in output	0.2 – 0.4%	Cambridge Econometrics (2014)

Conclusions

The economy-wide impacts of energy efficiency measures can be derived from two separate sets of effects: (i) the investment effects and (ii) energy cost reduction effects. The macroeconomic indicators most likely to be affected by energy efficiency programmes (and estimated by researchers) are GDP, outputs (value-added + intermediate consumptions), household consumption, job creation, and trade. The macroeconomic rebound effects appear to be generally welfare-enhancing, with for example, Lecca et al. (2014) showing that a 5% average increase in household energy efficiency in the UK can increase GDP by 0.1% with a rebound effect of approximately 60%. So while the rebound effects are significant, the welfare gains are likely to compensate the energy loss. The results of this paper also showed that all income groups benefit from energy efficiency improvements and the savings made. The difference in rebound effects between income groups is small but is higher for the lowest and highest income groups. Nonetheless, if the primary objective of energy efficiency policy is to mitigate CO2 emissions, then these results would suggest that emissions forecasts should be adjusted to account for the rebound effects and the reduced CO2 emissions savings that will be achieved through energy efficiency measures. Also, when carrying out a regulatory impact assessment of potential energy efficiency policies, a full welfare analysis should be included and a policy decision made on the wider benefits of energy efficiency measures than energy and CO2 emissions savings alone.

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