Fiscal impacts of energy efficiency programmes - the example of solid wall insulation investment in the UK

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Abstract

Programmes supporting the installation of energy efficiency measures typically incur a cost in the form of subsidies as well as lost VAT income due to reduced energy consumption. Those costs are to some extent offset by the tax receipts and other revenue streams generated as a result of the activities promoted under the programme. In this paper we analyse the budgetary effects of energy efficiency programmes focusing on the example of solid wall insulation in the UK. Three distinct subsidy options have been defined and modelled for the purpose of this research including two policies with varying degrees of direct subsidy and a low interest loan scheme. Our analysis shows that a significant amount of the cost of a scheme funding solid wall insulation would be offset by increased revenues and savings. A loan scheme, due to the high leverage, achieves not only budget neutrality but generates additional revenue for the Exchequer.

Keywords: energy efficiency; subsidies; public budgets

1 Introduction

Public policy often provides financial incentives for certain technologies and/or sectors to achieve environmental goals and/ or support employment. Such programmes can incur significant cost in the form of subsidies paid for via general taxation. However, the costs of subsidies are to some extent offset by additional tax receipts, savings in unemployment benefits payments, and other revenue streams generated as a result of the activities promoted under the programme (Brown et al. 2012). This effect can even lead to subsidies becoming self-financing – examples include wage subsidies targeted at low-income/ability workers (Brown et al. 2011) and subsidies of tuition fees (Trostel 1996).

Subsidies are also an important policy instrument in the energy efficiency arena – all IEA country governments use economic instruments (particularly grants) to encourage the uptake of energy efficiency measures enabling consumers to fund those measures and overcome the barrier of high upfront cost (IEA 2013).

However, there are very few examples of studies analysing the fiscal effect of subsidies in the energy efficiency arena. A recent study from Ireland confirms that a significant proportion of the cost of providing the subsidies is offset by the revenue streams generated (Curtin 2012). An assessment of the budgetary effects of one of the world's most prominent soft loan scheme for energy efficiency, the German KfW CO_2 Building Rehabilitation Programme, shows that the programme cost are exceeded by the various income streams and savings generated making it budget-neutral or even budget-positive (Kuckshinrichs et al. 2010).

This paper makes a contribution to this emerging body of literature by assessing the fiscal implications of providing financial support to the insulation of solid walled homes in the United Kingdom (UK). We have deliberately chosen solid wall insulation as an example as this technology a) is relatively costly compared to other energy efficiency technologies which is why it requires substantial subsidies, and b) because it is a measure that is deployed in many countries and one of the most prominent retrofit measures. Furthermore, with the current development around the EU 2030 energy efficiency targets we expect solid wall insulation to become increasingly important. However, had we chosen a set of other energy efficiency retrofit technologies the results of our analysis would not be significantly different, assuming that the total amount of subsidy would be similar. Even though there are differences in the labour intensity of different technologies we have primarily used sources for our analysis based on the energy efficiency sector more generally rather than one particular technology as this data is not (yet) readily available. Our decision to focus our analysis on one of the various technologies available is also a pragmatic choice allowing us to use a limited set of assumptions keeping the model fairly simple whilst being able to scrutinise the evidence which our analysis is based upon. In reality a mix of energy efficiency technologies are supported by public subsidies rather than one single measure which is why the results of our analysis should be seen as indicative and illustrative.

The following analysis shows how, if the Exchequer receipts from energy efficiency investments are taken into account, the cost to government of supporting the technology is significantly lower than might otherwise be assumed. A key factor which affects the level of exchequer revenues generated is the amount of subsidy the Government provides towards the cost of an installation. Three distinct subsidy options have been defined and modelled for the purpose of this research:

- **Option 1 - Private householder scheme**: For this scenario we have assumed a 2:1 funding ratio for the funds invested by government and private householders. This is equivalent to the level of subsidy the Government makes available through the UK's Green Deal cashback scheme although it varies according to measure (DECC 2014).
- **Option 2 - Social housing scheme**: For this scenario we have assumed a 1:1 funding ratio for the funds invested by government and social housing providers. This is equivalent to the level of subsidy provided by energy suppliers assumed under previous energy efficiency programmes in the UK (HM Government 2008).
- **Option 3 - Loan scheme**: For this scenario we have assumed that government issues subsidies to a financial intermediary that provides low interest loans similar to the German KfW scheme with a 1:4 funding ratio for the funds invested by government and private householders (calculated based on Federal Ministry of Transport, Building and Urban Development 2011, Kuckshinrichs et al. 2009).

To assess the impacts on the Exchequer of these different subsidy options we have built a bespoke economic model. The model takes account of five distinct types of exchequer revenue:

- value-added tax (VAT) paid when installing solid wall insulation;
- corporate tax income paid by all companies involved in the solid wall insulation supply chain;

- income tax generated by jobs directly and indirectly created (since estimates of induced jobs are inherently uncertain these can be omitted from the assessment);
- avoided costs of unemployment, as job creation lead to reduced social benefit payments; and
- savings for the health budget achieved as the health of occupants of buildings receiving solid wall insulation is improved and they require less health treatment.

The model does not include VAT impacts that occur due to reduced energy consumption. We can expect this to be net positive because it can be assumed that a large proportion of any cost savings will be reinvested by consumers and spent on goods and services with a higher VAT rate (domestic energy consumption is subject to a reduced 5% VAT) (Cambridge Econometrics and Verco 2012).

The model assesses the impact of a scheme to support the uptake of solid wall insulation measures across the UK's domestic housing stock. Using a set of peer-reviewed and accepted assumptions, the model estimates the effects of a subsidy scheme implemented. Several assumptions and simplifications had to be made to assess the overall costs and benefits of the scheme.

For each of the three subsidy options we have modelled exchequer revenues in two ways. The 'low revenue scenario' is conservative and includes all of the subsidy cost but excludes some of the revenue streams identified above, specifically the income tax from induced jobs, the avoided cost of unemployment from induced jobs and the reduced NHS spending due to health improvements. We have done this because there are larger uncertainties associated with these revenue streams. By contrast, the 'high revenue scenario' includes all of the cost and all of the revenue. Crucially, our model shows the Exchequer revenues generated in the same year that subsidy costs are paid out. By doing so, it illustrates the net impact on the public finances in any single fiscal year.

The paper is structured along four distinct sections: First, we provide background information on the different options modelled and the overarching context and aim of the study. Second, the methodology and the data used are presented in detail. Third, we present the results of the analysis for each of the options modelled. Finally, we conclude and raise questions for further research.

2 Methods

The model assesses the impact of a scheme to support the uptake of solid wall insulation measures across the UK's domestic housing stock on the Exchequer. Using a set of peer-reviewed and other validated assumptions where no peer-reviewed evidence exists (see section 2.2 for a detailed discussion of the assumptions made and the sources used), the model estimates the effect of a subsidy scheme implemented according to the following inputs values:

1. Subsidy as % of capital cost (materials + labour + VAT) required to complete the insulation works: depending on scenario
2. Number of properties insulated per year: 100,000

Several assumptions and simplifications had to be made to assess the overall costs and benefits of the scheme. The investment to be financed includes the cost of labour and material plus VAT and it will be covered by:

- private finance: percentage of costs that private households are expected to pay directly (Option 1+2) or through a loan (Option 3); and
- subsidy: percentage of costs covered by the Exchequer in the form of a non-repayable grant (Option 1+2) or through a loan (Option 3).

The three options analysed thus are:

Table 1: Options modelled

Option	**Funding source**	
	Private finance	**Subsidy**
Option 1 – Private householder scheme	33.3%	66.6%
Option 2 – Social housing scheme	50%	50%

Option	Funding source	
	Private finance	**Subsidy**
Option 3 – Loan scheme	80%	20%

This section provides the source of the modelling assumptions and how they have been combined to create a set of three options which simulate three different capital cost funding options. The total benefits that will flow to the Exchequer do not vary with each option as they are not related to how the insulations measures are funded. We have used a fixed number of solid wall insulation installations for all of the options modelled – in reality the market response to different types of incentives would vary.

2.1 Scenarios

For each option we have modelled a lower and a high revenue scenario with the low revenue scenario being very conservative and the high revenue scenario including parameters associated with larger uncertainties. The table below lists the parameters included and excluded in the lower and high revenue scenarios.

Table 2: Revenues considered in lower and high revenue scenarios

Revenue stream	Low revenue scenario	High revenue scenario
Costs		
Subsidy required	Included	Included
Lost VAT income	Excluded	Excluded
Benefits		
VAT paid on labour and materials	Included	Included
Corporate tax (installers and supply chain)	Included	Included
Income tax (installers and supply chain)	Included	Included
Income tax (induced jobs)	Excluded	Included
VAT paid due to increased household spending	Excluded	Excluded
Avoided cost of unemployment (installers and supply chain)	Included	Included
Avoided cost of unemployment (induced jobs)	Excluded	Included
Reduced NHS spending due to health improvements	Excluded	Included

2.2 Sources and assumptions

As any model the quality and reliability of the outputs depend heavily on the appropriateness of the inputs. In order to be fully transparent regarding the modelling inputs we set out all assumptions made and the sources those are based upon. Where possible we used official sources such as government statistics and assessments. In some instances we had to use grey literature such as consultancy reports (for example in order to derive the cost of solid wall insulation). In those cases we have validated those figures by cross-checking with other references in order to increase confidence in the assumption.

The following sources and assumptions have been selected on which model's calculations are based upon:

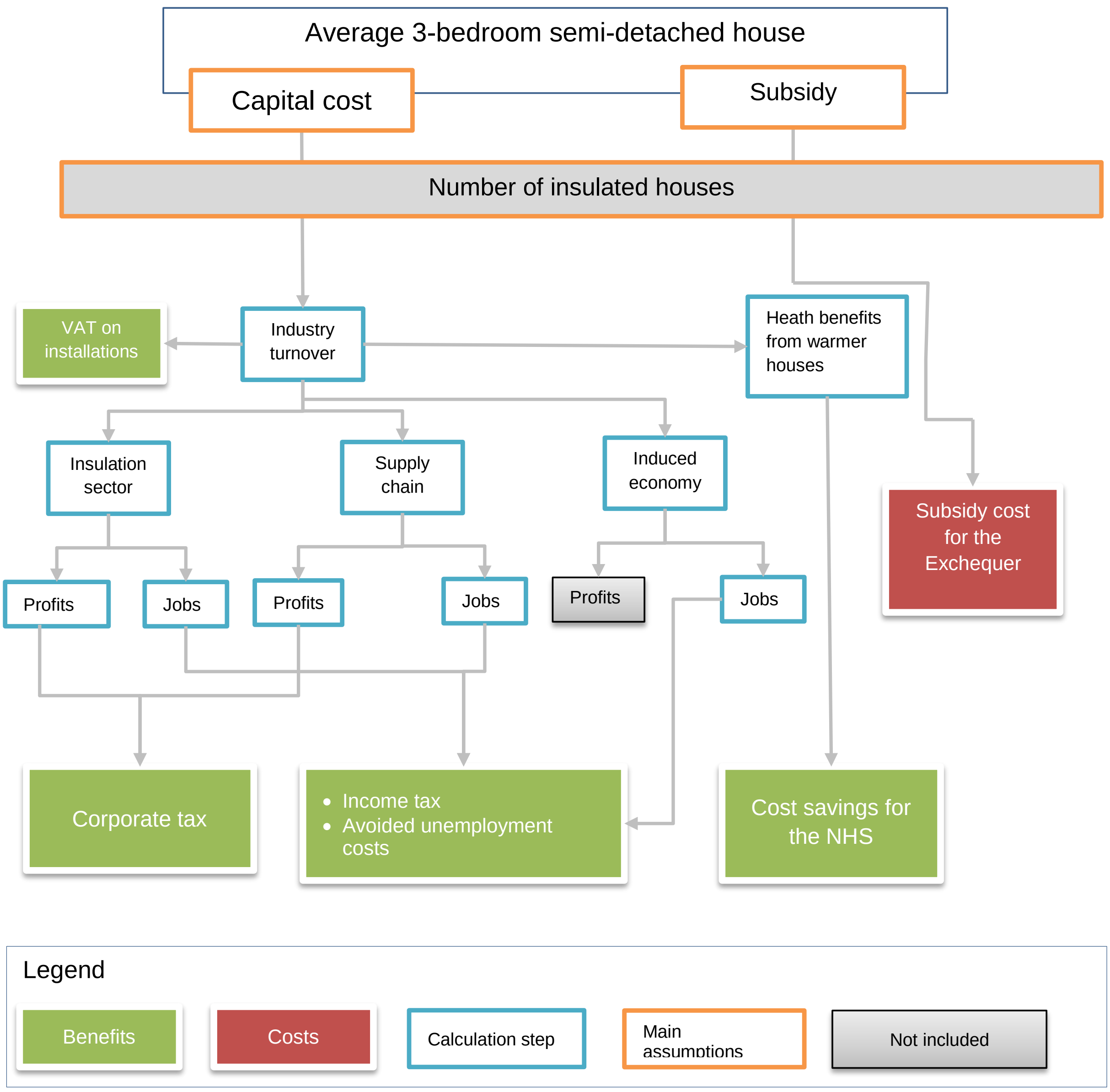
Table 3: Sources and assumptions used in model

	Item	Value	Source
A	Cost of insulating a 3-bed semi-detached property	£9,000	Purple Market Research 2009
			Lawrence 2014
			INCA 2014

	Item	Value	Source
B	VAT on home insulation materials and labour	5%	HMRC 2014a
C	Proportion of labour costs	50%	INCA 2014
D	Energy savings per year following insulation of a 3-bed semi-detached house	6,700 kWh/year	Element Energy and Energy Saving Trust 2013
E	Heating fuel type share	gas: 85% electricity:8% oil:4% solid fuel:1%	DECC 2013a
F	Heating fuel price projections up to 2030 (pence/kWh)	2014 price: gas: 4.8 electricity:15.9 oil:6.1	DECC 2013b
G	Average net profits/turnover construction industry	3.45%	Building 2013
H	Average tax rate	21%	HMRC 2014b
I	Pre-tax profit/turnover ratio	G/(1-H)=4.37%	calculation
J	Direct job impact (Direct job creation per £1M spent)	23 per 1 year	Janssen and Staniaszek 2012
K	Sector jobs impact (Direct + indirect jobs creation per £1M spent)	32.6 per 1 year	DECC 2012a
L	Induced jobs multiplier: supply chain and induced jobs created for each direct job	2.8	Scottish Government 2013
M	Average pay - skilled trades occupations	£465.7/week	ONS 2012
N	Average income tax (annual)	£4,819	calculated based on HMRC 2014c
O	Indirect jobs	K-J = 10/year	calculation
P	Induced jobs	J*L-K =31.5/year	calculation
Q	Cost to Exchequer of 1 unemployed person	£4,307	Browne and Hood 2012
R	Health impact	1-2%	Liddell 2008

The model is based on a set of relatively simple and straightforward calculations combining all of the parameters listed in Table 3. Figure 1 summarises the model framework which should enable others to replicate our work or conduct similar analyses.

Figure 1: Model framework



2.3 House type used

The model assesses energy savings and associated costs of insulating the average 3-bedroom semi-detached house. Following consultations with various stakeholders (Lawrence 2014, INCA 2014) and market research reports (Purple Market Research 2009) the average investment was set at £9,000 (***A***) plus VAT at 5% (***B***). Capital expenses would pay for materials and labour with a 50% split (***C***), therefore half of the initial income would be passed to the supply chain. The investment would deliver 6,700 kWh (***D***) energy savings to each property, which amount to £386 savings on bills in 2014, considering the current heating fuels mix of UK's housing stock (***E***) (DECC 2013a) and the relative fuel price (***F***)[1] (DECC 2013b).

2.4 Employment impact of solid wall insulation investment

Investing in energy efficiency compares very favourably with investing in other energy sectors in terms of local job creation impacts. Analysis by Pollin et al. (2009) evaluating different economic stimulus options, has shown that the employment creation from investing in energy efficiency is 2.5 times to 4 times larger than that for oil and natural gas. A similar study by Wei at al. (2010) has shown that the energy efficiency industry is about twice as labour-intensive compared to the fossil fuel-based energy supply sector per unit of energy saved/produced.

[1] weighted average price in 2014 is 5.76 pence per kWh

Investments in energy efficiency also compare favourably to renewable energy as the investment costs are offset to some extent or even completely by the energy savings.

To analyse the job creation impacts of investing in solid wall insulation, three forms of job creation must be taken into account:

- **Direct impact**: persons employed directly by solid wall insulation companies (including contractor staff) who receive wages and salaries;
- **Indirect impact**: persons employed in businesses which supply the goods and services used in the process of installing solid wall insulation; and
- **Induced impact**: further income and employment generated as incomes created directly and indirectly are spent within the economy.

In order to estimate the number of jobs supported by investing in solid wall insulation we make use of input-output tables that are based on theories first developed by Leontief (1966). Input-output tables show the flows of expenditure which take place between sectors of the economy and allow the impact of a given level of expenditure on income and employment to be calculated.

These 'ripple effects' (Archer 1982) of capital expenditure can be estimated using multipliers. Multipliers are measures of the way in which an increase in activity by one firm will lead to an increase in activity by other related firms. For example, the contractor for a new building buys concrete, the concrete subcontractor buys new tires for its trucks, all the firms' workers spend their wages on food or consumer goods, and so forth. Multipliers are estimated by indirect means, using input-output tables. They are calculated by using the estimates for direct, indirect and induced effects, which are also estimated from I-O tables.

The ratio of the sum of direct, indirect and induced output effects to the direct effect is called the Type II output multiplier (induced effect). A Type I output multiplier excludes the induced effects (i.e. it represents the ratio of sum of direct and indirect effects to direct effects alone). Multipliers can also be derived for employment and income (Miller and Blair 2009).

While this use of the input-output tables is not strictly accurate, the tables were not designed for a different type of analysis, use of type 1 and type 2 multipliers is a commonly used approach as a means of approximating the impact of each pound of additional spent on final consumption. In the UK, the procedure for doing so is set out in the UK Treasury Green Book and in the English Partnerships Additionality Guidance. It represents a useful first approximation of the impact of additional spending as a result of investments or sub contracts. The reason we use multipliers is because of two effects the first is known as a supply linkage multiplier reflecting the fact that purchases from one company result in purchases further down supply chains, so in the case of solid wall insulation related expenditure on suppliers, each of them in turn purchase supplies from others in order to allow them to fulfil the contract, in addition the staff of suppliers receive income for their work in fulfilling the contract which they in turn spend on goods and services for themselves and their families this is known as an income multiplier. These effects are real, and experienced by the communities in which the spending occurs.

2.4.1 Direct jobs

Installing solid wall insulation is labour intensive compared to other types of energy efficiency work due to the relatively high labour cost. A recent review of more than 20 sources concluded that for every £1 million spent on energy efficiency about 23 jobs are directly supported in the energy efficiency industry (Janssen and Staniaszek 2012). Since most of the sources reviewed focused on building retrofits, it can be assumed that at least a similar amount of jobs are supported through investment in solid wall insulation. However, this is a conservative estimate since it does not take into account the high labour intensity of solid wall insulation. The Department of Energy and Climate Change (DECC) stresses in the impact assessment for the ECO and the complementary Green Deal policy that solid wall insulation is 'more labour intensive than easy to treat cavity wall insulation and loft insulation (DECC 2012a).

2.4.2 Indirect jobs

A wide range of estimates exist for the number of jobs created indirectly through investments in solid wall insulation. For example, in the impact assessment for the ECO and the Green Deal (DECC 2012a), the DECC quote evidence from the sector skills council for construction, Construction Skills, to estimate that for every £1 million spent on housing repair and maintenance 32.6 direct and indirect jobs are supported. Industry evidence provided to IPPR broadly corroborates this figure. It shows that in 2012, the last year for which comprehensive data is available, 28,005 direct and indirect jobs existed[2] based on 81,643 installations being carried out in 2012 (Committee on Climate Change 2013).

Based on the evidence for the number of jobs directly supported by investing in solid wall insulation (above), the Construction Skills figure would suggest that 9.6 jobs are supported indirectly for every £1 million spent. If correct, this would mean that 0.4 indirect jobs are created in the supply chain for each direct job. However, as the authors of the report state, in many cases the direct jobs figures may include some indirect jobs making it difficult to compare.

Alternative evidence sources suggest that a much higher ratio of indirect to direct jobs is generated by investing in solid wall insulation. Evidence from Innovas (2009), also quoted by the DECC, assumes that for each direct job created in the solid wall insulation industry, 4.75 indirect jobs are created. Another report looking at the European energy efficiency industry suggests that for each direct job there are 2 indirect jobs (Impetus Consulting 2009). Research on behalf of the Energy Bill Revolution campaign assumed that for each direct job three indirect jobs could be supported (Camco 2012). Overall, a ratio for direct to indirect jobs of 1:3 is an approximate mid-point figure of the different sources reviewed.

Given the large discrepancies in the literature about the relationship between direct and indirect job creation from solid wall insulation investments, in the calculations presented below we have assessed the two elements together rather than separately using the same evidence quoted by DECC provided by Construction Skills.

2.4.3 Induced jobs

Official statistics of the Scottish Government suggest that for every job directly created through investment in solid wall insulation, 1.8 indirect and induced jobs are created (Scottish Government 2013)[3]. However, there are more uncertainties involved in estimates of induced jobs than there are for estimates of direct and indirect jobs. This is because, for example, if the economy is operating at a high level of activity, there is not likely to be a large employment gain beyond what resulted from the initial direct and indirect effects. Even though we would expect induced impacts to be significant at this point in time this could change in the future with increased economic growth. For this reason we identify the impacts of induced jobs separately from direct and indirect jobs in the analysis that follows.

2.5 Costs to the Exchequer

We assume that a subsidy would be awarded to households and reduce the initial investment by a portion as set according to the four scenarios. The following table provides the corresponding amount of subsidy awarded in each scenario modelled:

Table 4: Cost to Exchequer under different scenarios

Option	Subsidy	
	As share of investment	Amount
Option 1 – Private householder scheme	66.6%	£629,370,000
Option 2 – Social housing scheme	50%	£472,500,000
Option 3 – Loan scheme	20%	£189,000,000

The scheme is estimated to encourage 100,000 properties to be insulated each year, representing 1.25% of the 8 million solid wall properties that may be eligible for such intervention.

[2] data submitted by the Insulated Render and Cladding Association (INCA)

[3] The Office for National Statistics [ONS] does not produce employment multipliers for the UK

As noted before, the VAT lost as a result of reduced energy consumption has not been included in the model because we assume that overall this effects is offset by increased spending by consumers on goods and services charged at the higher 20% VAT rate.

2.6 Benefits to the Exchequer

It is possible to identify various streams of income to the Exchequer deriving from the intake of the scheme. Some of these benefits are direct and straightforward, while others are associated with more uncertainties. As a general simplification, it was assumed that solid wall insulation investments would be additional to other building works, i.e. they would not displace other investments, therefore generating only additional income, jobs, and tax revenues. The following sub-paragraph describes benefits associated with the lower and high revenue scenarios developed under these assumptions:

- **Corporate tax:** solid wall insulation installers and supply chain companies would pay corporate tax based on their profits. The main corporate tax rate (***H***) in the UK is 21% (HMRC 2014b). We have used the average profitability of the UK's building sector (Building 2013) and applied the same pre-tax profit/turnover ratio (4.37%) to calculate profits for installers (***I***). Corporate tax from installers would deliver £8.26 Million to the Exchequer. With the addition of supply chain companies (assuming 50% of total investment would be passed to them (***C***)), the total corporate tax would amount to £12.4 million.
- **VAT:** The VAT rate (***B***) levied on capital costs of energy saving materials (labour and materials) is currently set at 5% (HMRC 2014a) (compared to the standard 20%) would generate £45 million (the VAT rate is reduced for investments in energy efficiency retrofits).
- **Income tax from direct and indirect jobs:** DECC estimate that for each £1 million spent 32.5 direct and indirect jobs (***K***) would be supported. These jobs, at the average pay for the "skilled trade employee" (***M***) of £465 per week (ONS 2012), would generate £4,819 per year of additional income tax (***N***) each (based on HMRC 2014c). For a programme supporting 100,000 solid wall insulations per year we estimate that £141 million will be paid to the Exchequer in the form of income tax from direct and indirect jobs.
- **Income tax from induced jobs:** The Scottish Government provides the induced job multiplier by sector (**L**): each job gained in the construction sector (direct jobs) creates 2.8 additional jobs, both in the supply chain (indirect jobs) and in the induced economy (the income spent by installers and supply chain workers would generate new jobs in the local economy). Combining this data with the sectorial job creation estimate provided by DECC (***K***), we expect that every £1 million invested would generate 31.5 induced jobs. The income tax impact of the induced jobs is included only in the high case scenarios. We have not included additional jobs created due to increased consumer spending resulting from bill savings. Research has shown that increased consumer spending following reduced energy bills can create employment of up to 25 per cent of the jobs created by the financial stimulus itself (Cambridge Econometrics and Verco 2012). However, the amount of additional consumer spending depends on the contributions from consumers to the capital cost which varies across the three options analysed.
- **Avoided cost of unemployment:** Keeping people in work as well as creating new jobs generates savings in the budget of DWP due to the avoided cost of paying benefits. In 2011-12, 1,199,000 claimants received a total of £5,164 million (unemployment benefits only), at an average of £4,307/year each (***Q***). In the low revenue scenarios unemployment benefits are considered only for direct and supply chain jobs. The high revenue scenarios also include unemployment benefits related to induced jobs. There are other costs to the Exchequer associated with unemployment such as funding for training schemes which have not been included. We therefore consider the estimate conservative.
- **Health impacts:** according to the paper "Estimating the health impacts of Northern Ireland's Warm Homes Scheme 2000-2008", published by the University of Ulster (***R***), the NHS would save between 1% and 2% per year in treatment costs for each £1 million invested in housing insulation improvements, due to the better living environment provided by well insulated homes. This factor would provide additional benefits around £13.5 million and is included only in the high revenue scenarios.

3 Results

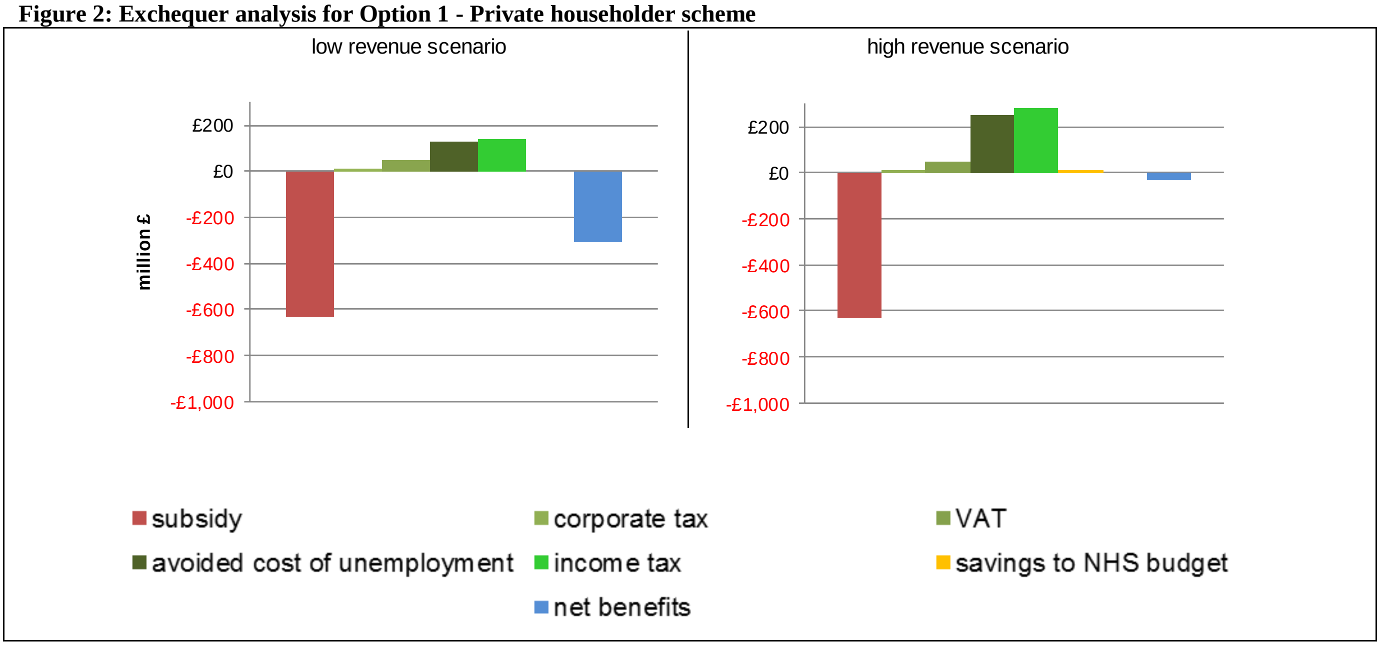
The outcomes of the three subsidy options on Exchequer revenues are presented below, starting with the option with the highest government costs (Option 1 – private householder scheme) and concluding with the option with the lowest costs (Option 3 – the loan scheme).

3.1 Option 1 - Private householder scheme

The option 'Private householder scheme' assumes a 2:1 funding ratio for the funds invested by government and private householders i.e. 2/3 of the total cost would be covered by a non-repayable grant provided by government. Beneficiaries would contribute the remaining 1/3 of the total cost of solid wall insulation, which is a rate at which the benefits realised through energy bill savings comfortably exceed the contribution made by householders. This is broadly in line with the current grants made available through the cashback incentive for Green Deal (note: the cashback scheme will be amended from June 2014 with grants of up to 75% for solid wall insulation) although this is slightly more generous (DECC 2014).

Figure 2 shows the results of the Exchequer analysis for Option 1 - Private householder scheme. The analysis indicates that between 52% (low revenue scenario) and 95% (high revenue scenario) of the total subsidy cost would be offset by revenue streams. The most important revenue streams are income taxes generated through jobs supported and the avoided cost of unemployment in the form of reduced benefits payments to claimants.

Figure 2: Exchequer analysis for Option 1 - Private householder scheme



Source: results based on original analysis and modelling

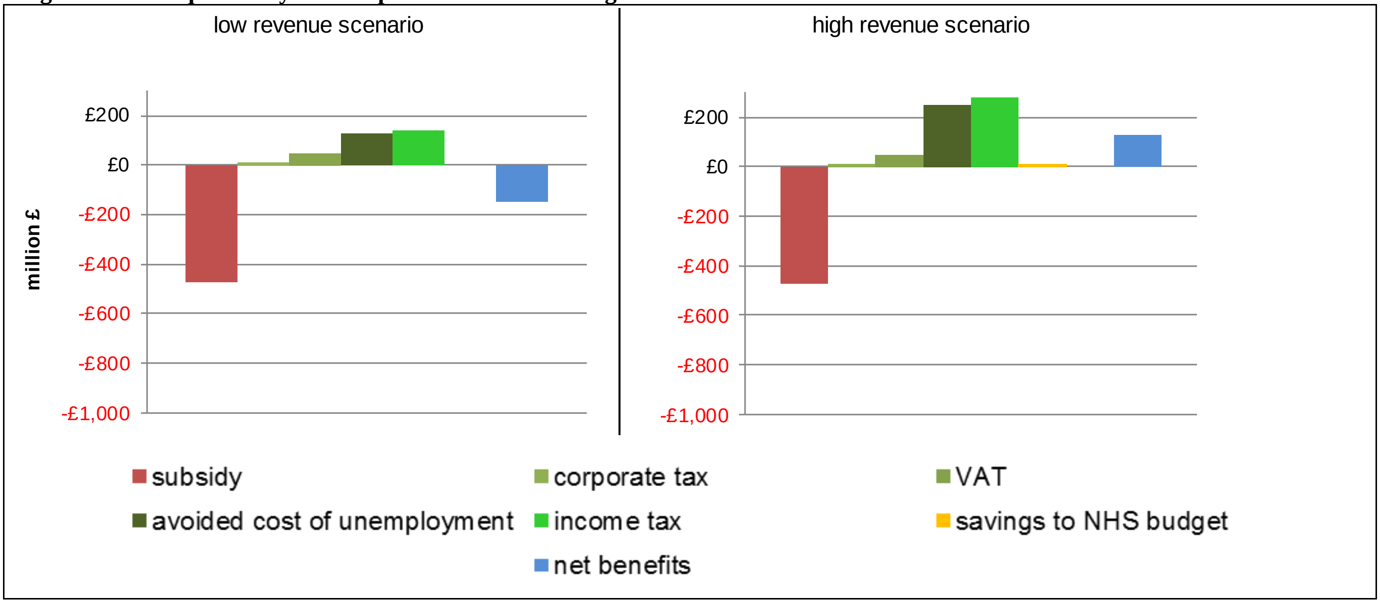
3.2 Option 2 - Social housing scheme

Social housing providers have benefited from past energy efficiency programmes such as the Carbon Emissions Reduction Target (CERT) and installed many of the lower cost efficiency measures, for which the remaining potential is becoming low. However, there are still close to 700,000 uninsulated solid wall properties left in the social housing sector which is more than 80% of all solid wall properties in social housing (DECC 2012b).

For this scenario we have assumed a 1:1 funding ratio for the funds invested by government and social housing providers.

Figure 3 provides the results of the Exchequer analysis for Option 2 - Social housing scheme. It shows that between 69% (low revenue scenario) and 126% (high revenue scenario) would be offset by the revenue streams generated.

Figure 3: Exchequer analysis for Option 2 - Social housing scheme



Source: results based on original analysis and modelling

3.3 Option 3 - Loan scheme

One option to increase the leverage of government subsidies is to set up a loan scheme rather than providing non-repayable grants. Loans would be made accessible to private households and social housing providers. For the purpose of modelling the impacts on the Exchequer of such a loan scheme we have looked at successful loan schemes elsewhere which are subsidised by public funds rather than fully rely on the market such as the Green Deal.

The most prominent loan scheme in Europe for building retrofits targeted at high performance measures is the German CO_2 Building Rehabilitation Programme run by the KfW bank. The scheme focuses mainly on high-performance measures including solid wall insulation worth up to €75,000 per property and therefore is a suitable example in the context of this report.

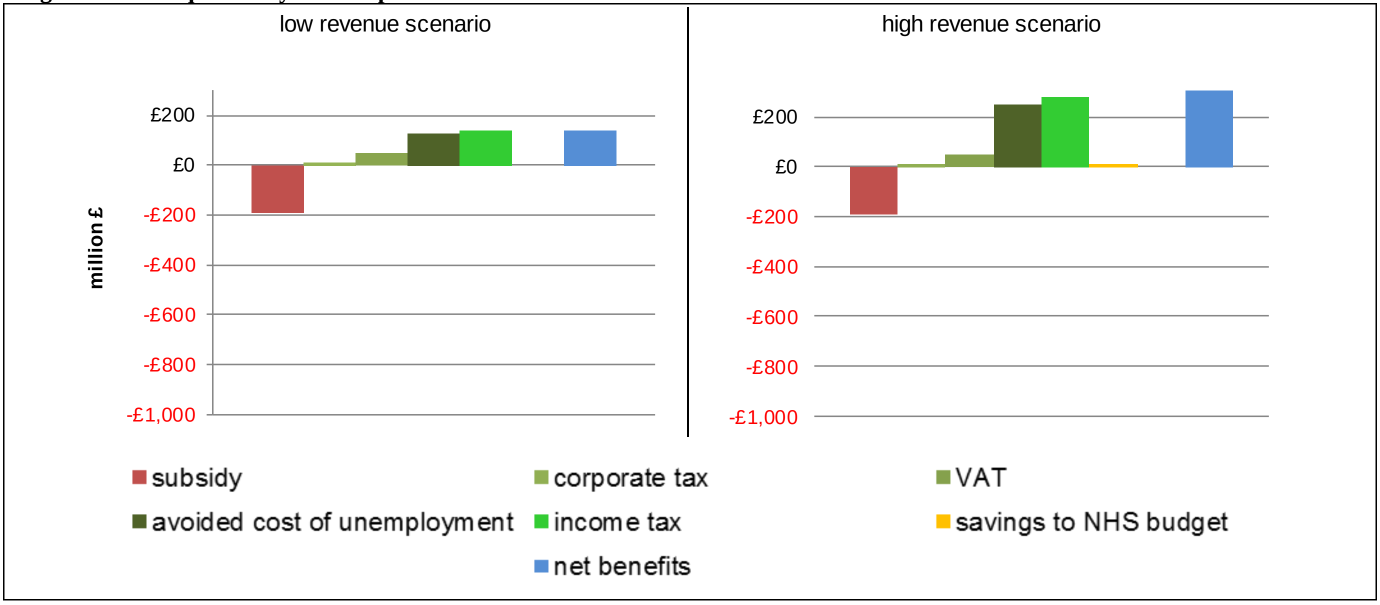
The German Federal Government funds the loan scheme and enables the KfW to issue loans with an interest rate lower than the market rates. The federal funding is used to 'buy down' the interest rate which enables KfW to offer loans significantly below market rates. For example, in 2012, the interest rate for loans supported by the scheme was 1%, which is lower than in previous years where it usually exceeded 2%.This compares to a market rate of around 5-9% in 2008/2009 and 3-8% in 2010-2012 depending on the conditions (Rosenow et al. 2013).

The ratio of federal funding to loan volume is about 1:4 (calculated based on Kuckshinrichs et al. (2009) and Federal Ministry of Transport, Building and Urban Development (2011)). This means that for every £1 of funding provided £4 of private investment covered by low interest loans is triggered. The government funding paid to KfW covers the cost of reducing the interest rate over the whole lifetime of all loans issued in a given year.

We have assumed a ratio similar to the KfW loan scheme in Germany of 1:4 for the purpose of assessing the Exchequer impacts of a loan scheme in the UK. The analysis shows that such a scheme potentially offsets 100% of the total costs with total benefits.

Figure 4 presents the results of the modelling of Option 3 – Loan scheme. The analysis shows that the benefits in the form of increased tax revenue and savings due to reduced unemployment by far increase the cost to the Exchequer (72% in case of the low revenue scenario).

Figure 4: Exchequer analysis for Option 3 - Loan scheme



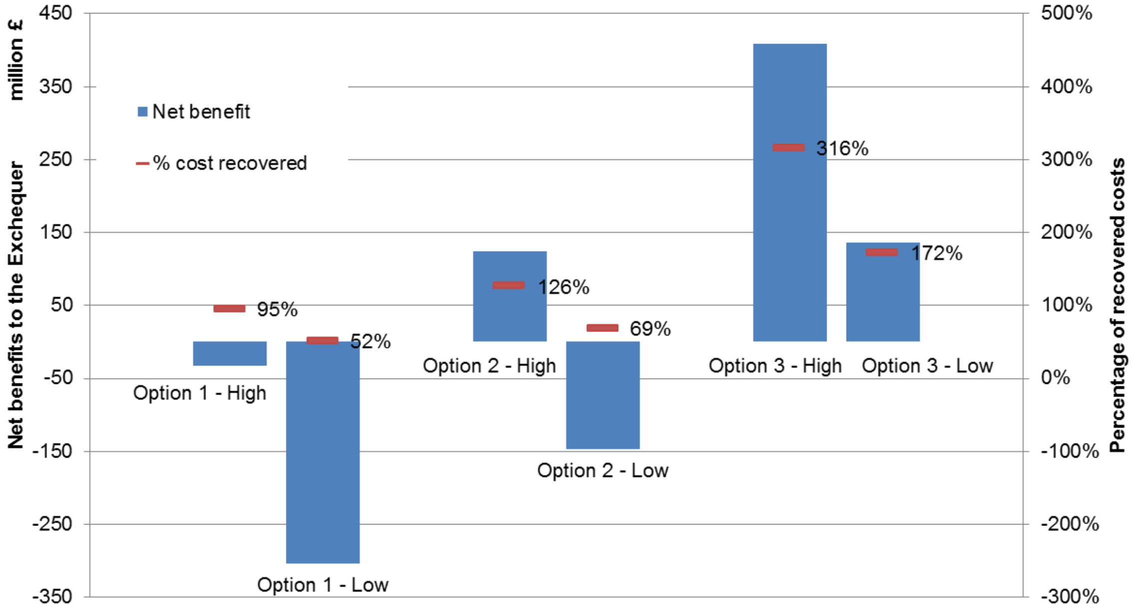
Source: results based on original analysis and modelling

The results are supported by evidence from Germany - analysis of the German KfW loan programmes for building retrofits shows that in the years 2005 to 2007, the investments undertaken with support from the programmes had a positive effect on public budgets, even after deduction of programme cost. Not only were the programme cost completely offset, the programme generated additional revenues and savings for the Exchequer exceeding the cost of the subsidies by 45-92% which is in line with our low revenue scenario (induced jobs are not considered in the evaluation of the German loan scheme) (Kuckshinrichs et al. 2010).

3.4 Summary of exchequer analysis

The analysis above shows that a significant amount of the cost of a scheme funding solid wall insulation would be offset by increased revenues and savings. A loan scheme, due to the high leverage, achieves not only budget neutrality but generates additional revenue for the Exchequer.

Figure 5: Exchequer analysis summary



4 Discussion

Our findings are in line with existing evidence from Germany (Kuckshinrichs et al. 2010) and Ireland (Curtin 2012) in that some or all of the cost of subsidising energy efficiency technologies are offset by several revenue streams stimulated by the subsidies. We find that the extent of this effect depends very much on the design of the finance mechanism and the amount of subsidy required compared to the total investment. Hence loan schemes with high leverage similar to the German KfW scheme are most likely to be cost-neutral or even budget-positive.

There are, however, significant uncertainties around such analyses which we elaborate on below.

4.1 Employment impacts

Estimates of the indirect and induced jobs are a key component in terms of revenue streams generated for the Exchequer (see the figures on fiscal effects of each option above). Any changes to the assumed level of indirect and induced jobs have major impacts on the results of such analyses. Whilst the evidence base around direct jobs is relatively robust there is less clarity on the indirect and induced effects of subsidies. As sections 2.4.2 and 2.4.3 show the literature provides a rather wide range of estimates that are not easy to reconcile. Further research would enable a more precise analysis but at this stage the analysis is associated with uncertainties in this particular area which are important due to the high sensitivity of the fiscal impacts regarding employment effects.

Furthermore, in our analysis we have not considered the time dimension of subsidising energy efficiency technologies. According to Fankhauser et al. (2008) there are at least three types of employment effects associated with climate policy:

- *short-term effect*, when jobs are lost in directly affected sectors and new ones are created in replacement industries. These are direct job impacts.
- *medium-term effects*, when the impact of climate change policy ripples through the economy. Jobs are created and lost along the value chains of affected industries. Fankhauser et al. (2008) term those higher-order, economy-wide effects of climate policy.
- *long-term effects*, when innovation and the development of new technologies create opportunities for investment and growth. Fankhauser et al. (2008) call this the dynamic effect of climate policy.

Whilst we have considered the short-term and medium-term effects as defined by Fankhauser et al., we have only assessed a snapshot of one fiscal year rather than the long-term dynamic effects of providing subsidies for energy efficiency technologies. Future research could help develop a better understanding of the dynamics in terms of innovation in the longer term and its impact on public budgets.

In this study, we assumed that investment in solid wall insulation does not displace other investments. In reality, investments in solid wall insulation are likely to displace at least some alternative investments and in an ideal world those opportunities would be evaluated on a like-for-like basis. However, there are different policy goals and objectives at play and job creation is only one of many aspects. We therefore argue that it is justified to assess the employment impact of an energy efficiency programme in isolation for the purpose of assessing the fiscal impacts.

We also based our analysis on the presumption that no substitution and/ or deadweight losses of jobs take place. Substitution effects are defined as jobs attributed to the programme being taken up by workers who would otherwise have worked in other parts of the economy. Deadweight losses encapsulate the phenomenon of some workers being hired even in absence of the subsidy scheme which are still classified as new jobs created as a result of the programme (Calmfors 1994). At the time of writing the economic situation in the UK was starting to improve again after the recession with relatively high levels of unemployment and previous job losses in the energy efficiency industry as a result of policy changes. We therefore assumed that all jobs created through investment in solid wall insulation would be additional. In future years some displacement effects would need to be accounted for should the economic situation improve further with higher levels of employment. Some commentators even reject the idea of job creation through supporting green technologies entirely calling it the 'myth of green jobs' (Hughes 2011) arguing that 'special interest groups promoting the green job agenda employ dubious assumptions and techniques in their analyses. Their recommended policies could lead to a smaller economy and a restructuring of society that will lessen the wellbeing of most people' (Morris et al. 2009, p. 1). However, those statements are cited from non-peer-reviewed sources published by groups representing partisan interests rather than pursuing rigorous academic research. A systematic review of the evidence on green jobs by the UK Energy Research Council (UKERC 2012, p. 10) concludes that 'a substantial fraction of the green employment studies are "grey literature" from industry, government or NGO sources. Many of these appear partisan and reach predictable conclusions given the source. There is a clear need for a greater number of peer-reviewed studies in this area.' We agree with their findings and support the call for more peer-reviewed research on employment impacts of policies supporting green technologies.

4.2 Consistency of multipliers

In our analysis we used various multipliers in order to estimate the employment effects resulting from subsidising solid wall insulation. There are, however, consistency problems when combining different sets of multipliers for such purposes. We already stressed the uncertainties associated with induced effects and the inconsistencies we found between the various studies on the ratio of direct and indirect jobs supported, largely a result of inconsistent classifications of direct versus indirect jobs in the literature. Also, for induced effects we used a multiplier provided by the Scottish government for the construction industry. In reality there are regional differences and the energy efficiency retrofit industry differs from the construction industry overall. Ideally, dedicated input-output multipliers would be calculated focusing on energy efficiency retrofits. Furthermore, input-output tables are usually based on historic data (if they are survey based in particular) and may not reflect the current situation accurately. However, within the scope of this study this was not possible due to the considerable effort required in order to establish survey-based input-output tables (Miller and Blair 2009). Our analysis should therefore be interpreted as an indication and illustrative example of the fiscal effects of energy efficiency programmes rather than a precise measurement of all the effects.

4.3 Additionality and free-rider effects

Another aspect we have not considered in our analysis is free-rider effects. Free-riders are defined as homeowners who would have refurbished anyway, whether or not subsides were on offer (Joskow 1993, Kreitler 1991, Malm 1996). Therefore, it is argued, even if we accurately estimate the total amount of refurbishments in which subsidies have a role, this will not tell us how much additional economic activity the subsidies triggered, as a portion of it would have been taken place anyway. Evaluations of energy efficiency programmes not always consider free-rider effects appropriately (Rosenow and Galvin 2013). A recent systematic review of energy efficiency obligations (Rohde et al. forthcoming) has shown that the degree of free-ridership depends largely on the materiality of the subsidy i.e. the extent to which the subsidy was essential for the investment decision. In case of solid wall insulation the total cost of the technology are very high and most households are unlikely to invest without any financial support.

However, this is context dependent and will differ between countries. Ideally, analyses of the effects of energy efficiency subsidies should take country- and context-specific evidence on free-riders into account where this data is available. A common approach for addressing free-riders is to compare the level of activity after the subsidy to a baseline i.e. the situation prior to the subsidy (e.g. Lees 2008). The solid wall insulation market in the UK has historically been relatively small and estimates for 2008, where no significant subsidies for solid wall insulation existed, range from 25,000 to 35,000 solid walls being insulated per year (Purple Market Research 2009). Therefore, for a programme supporting the insulation of 100,000 solid walls a maximum of 25-35% free-riders can be assumed. We note that the estimates of historic activity are associated with substantial uncertainties further research is required to derive a more accurate estimate of free-ridership.

Free-rider effects are also offset to some extent by so-called 'free-driver effects' which encompass additional uptake of energy efficiency measures due to non-participants of the subsidy programme installing energy efficiency measures after hearing about them from subsidy recipients (Blumstein and Harris 1993, Eto et al. 1996). Spill-over effects might also occur where subsidy recipients install other energy efficiency measures as a result of learning about potential energy efficiency improvements from installing the subsidised measure.

4.4 Rationale for subsidising energy efficiency technologies

Some commentators question the rationale for subsidising energy efficiency technologies altogether, not so much because of potential free-rider effects but because of the economic efficiency of such programmes.

There is a rich body of literature on the cost-effectiveness of energy efficiency around the concept of the so-called 'energy efficiency gap', also sometimes called the 'energy efficiency paradox' (Jaffe and Stavins 1994). The energy efficiency gap describes the discrepancy between the potential for cost-effective energy efficiency technologies and actual market uptake. Following the idea of the rational consumer one would expect cost-effective energy savings to be realised. However, the debate around the existence or non-existence of the energy efficiency gap stretches back almost 40 years and remains largely unresolved (for a comprehensive review see

Sorrel et al. 2004). Some economists have argued that there is no such thing as an energy efficiency gap and that consumers are simply applying very high discount rates (e.g. Sutherland 1991). It is, however, remarkable that the implicit discount rates used when deciding about implementing energy efficiency measures are much higher than those applied for other similar purchasing decisions. As Jaffe and Stavins (1994) have pointed out quite rightly, the observation that consumers apply high discount rates when making energy efficiency decisions is simply a restatement of the energy efficiency gap and does not explain why consumers use such high discount rates.

Hence there have to be other factors that can explain the energy efficiency gap which some scholars have called such as market failures and barriers as well as 'behavioural failures' i.e. 'consumer behavior that is inconsistent with utility maximization or, in the current context, with energy-service cost minimization' (Gillingham et al. 2009, p. 10). For a comprehensive discussion of behavioural failures also see Shogren and Taylor (2008).

Reviewing the evidence on energy efficiency and government intervention including subsidies we agree with Tietenberg (2009, p. 318) who concludes that 'the literature makes it quite clear that any second-best policy mix in the face of bounded rationality, nonoptimizing behavior, and volatile prices must recognize a role for more prescriptive strategies, such as targeted subsidies, efficiency standards, and/or tradable white certificates'.

4.5 Additional fiscal impacts

Finally, we did not assess all potential fiscal impacts of programmes subsidising solid wall insulation. This includes both negative fiscal impacts beyond the programme cost as well as additional positive fiscal impacts. For example, in case of inadequate installation of solid wall insulation negative health impacts from mould can potentially offset some of the savings due to positive health impacts resulting from higher indoor temperatures. This can be mitigated against by setting and enforcing technical standards requiring that all solid wall insulation is installed in a way that prevents mould growth. Other positive fiscal impacts arise for example from the regeneration of previously deteriorated areas associated with a reduction in crime rates (and the cost of dealing with crime). Data availability is scarce on those issues and future analyses should attempt to collate more evidence on those wider costs and benefits.

5 Conclusions and Policy Implications

Programmes supporting the installation of energy efficiency measures typically incur a cost in the form of subsidies as well as lost VAT income due to reduced energy consumption. However, those costs are to some extent offset by tax receipts and other revenue streams generated as a result of the activities promoted under the programme. The main contributors to those positive fiscal impacts are value added tax paid by households taking up energy efficiency measures, income tax paid by employees working along the supply chain, additional corporate tax paid by the companies indirectly benefiting from the subsidies through reduced relative cost of the technologies they supply/ install, and the avoided cost of paying unemployment benefits to workers who were not working previously. Hence most of the fiscal benefits are a result of increased employment.

To contribute to a small but growing evidence base on the fiscal effects of subsidies we focused on one particular energy efficiency measure in the UK context – solid wall insulation. Our analysis shows how, if the Exchequer receipts from solid wall insulation investments are taken into account, the cost to government of supporting the technology is significantly lower than might otherwise be assumed. We find that programmes with a high degree of leverage such as loan schemes are likely to deliver the largest net fiscal effects due to relatively low subsidy cost compared to the same level of revenue and savings generated.

Whilst for some of the key parameters considered such as tax income generated through value added tax, income tax, and corporation tax the evidence is robust, there are uncertainties associated with a number of aspects. Further research should investigate the effects of increased consumer spending as a result of avoided energy cost and the tax income generated. Furthermore, the impacts on health budgets of increased energy performance of buildings require additional analysis. Also, reducing energy consumption decreases the need to other subsidies for example for reducing carbon emissions elsewhere in the economy which has positive fiscal effects. For a more granular analysis the value chain of energy efficiency technologies needs to be understood better both geographically as well as structurally. This includes the importance of indirect and induced employment effects of subsidising energy efficiency where the evidence base is less strong.

Even though the potential benefits in terms of fiscal effects are substantial, programmes providing support to energy efficiency technologies may not necessarily be perceived in this way given that the costs are concentrated (in the form of a fixed sum of money allocated to the programme in the public budget) whereas the benefits are dispersed across multiple revenue streams and parts of the supply chain. The fiscal benefits are therefore less visible and are likely to not receive the same degree of attention in the process of designing public budgets. Furthermore, some of the benefits associated with more uncertainty may be disregarded by the Treasury and perceived as unreliable. Those effects make public subsidies for energy efficiency a more difficult sell compared to subsidies where the benefits are concentrated and the fiscal impacts highly certain.

In the future, policy makers should assess more systematically the fiscal impacts of energy efficiency programmes beyond the programme cost in order to get a better understanding of the impact of such programmes on the public budget. Whilst such an analysis is associated with uncertainties us highlighted in this paper it would provide a more robust basis for deciding on the size and design of energy efficiency programmes.

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