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Improving network industries regulation

Affordability of utilities' services: extent, practice, policy

Research Paper 13: Review of Evidence on the Effectiveness of Policies Tackling Fuel Poverty and Digital Exclusion

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1. Executive Summary

This research paper goes beyond the review of affordability policies in Research Paper 3 to provide an initial evaluation of the success of policies to tackle affordability related issues. The paper focuses on two specific sets of policies: (i) those to tackle fuel poverty and (ii) those to tackle digital exclusion. The evaluation is based on a representative, but not exhaustive, review of the literature relating to each of these policy areas. The policy topics for evaluation were chosen because they have each stimulated extensive discussion and the differing nature of the two problems allows interesting contrasts to be drawn between the two literatures.

Despite the issue of digital exclusion being more sociological in nature than that of fuel poverty, both evaluations emphasise the importance of understanding the real behaviour of intended beneficiaries rather than relying on assumptions of 'optimal' behaviour when designing interventions. The focus of the review regarding fuel poverty reduction schemes is energy efficiency investments, although the impacts of tariff structures and metering technologies are also considered. The evidence on digital exclusion policies is structured to consider different types of equipment investments and to compare these with efforts to encourage the use of Information and Communications Technology (ICT).

Key messages from this research paper include:

- There are many reasons why individual householders may not make energy efficiency investments and some of these, such as positive externalities, justify government support
- While environmental gains are a major potential benefit of energy efficiency schemes, the desirability of such schemes as an effective tool to tackle affordability is much less clear.
- Not only may the private financial gains not offset the investment costs, the reductions in energy consumption achieved by efficiency schemes have often proved disappointing relative to predictions based on engineering models and assumptions about behaviour.
- Getting householders to accept energy efficiency improvements even when they are free has often been challenging, highlighting the importance of effective targeting.
- It is difficult to make detailed conclusions with general applicability about 'what works' regarding efficiency investments; the nature of the housing stock, intended recipients, climate and regulatory environment can have a significant impact on the results.
- The evidence reviewed suggests that the direct savings to householders of time of use tariffs and smart meters are small and may not outweigh the costs of investment.
- Turning to digital exclusion, large scale infrastructure investments beyond those providing initial access are unlikely to prove effective in tackling digital divides.
- Use of technology is as important as providing access to a connection; providing home computers and free Internet access to disadvantaged families appears to be successful, but providing this assistance on a large scale is likely to prove very costly.

- To understand usage of ICT, the wider social context of individuals needs to be understood with motivations to use ICT created or reinforced.
- Without conscious efforts to overcome digital exclusion, the digital space may simply become an arena into which existing social divides are extended.
- The research into digital exclusion is often qualitative rather than quantitative in nature and is frequently reliant on small sample sizes.

2. Introduction

In this document we provide an overview of evidence evaluating the effectiveness of policies related to the affordability agenda. We focus on measures tackling fuel poverty and digital exclusion because they allow contrasts between two distinctly different sets of policies and two literatures which adopt differing methodologies reflecting variations in the nature of the problems being addressed. The papers reviewed should be seen as representative of the literatures in these two arenas rather than an exhaustive summary.

A well-developed literature exists which considers the effectiveness of different energy efficiency policies. When assessing policies with a bearing on fuel poverty it is important to investigate whether energy efficiency measures designed to reduce carbon emissions and improve health outcomes can also cut energy bills via reduced consumption. A difficulty of energy efficiency policies having objectives beyond affordability is that the resulting policy evaluations do not always assess the purely financial gains of interventions accruing to private households. The policy evaluations may be limited to measuring energy usage reductions or may focus on total social benefits which include environmental gains. From a policy perspective, the more serious issue is that policies claimed as having an impact on improving affordability may be designed primarily to meet other objectives and so may not represent the optimal approach to tackling questions of fuel poverty. Furthermore there is a major methodological point that many policy evaluations calculate benefits on the basis of estimates from engineering models describing optimal energy usage/temperatures. There appear to be discrepancies between the predictions of these models and the realised behaviour and experiences of households. Claimed energy efficiency gains may prove illusory because prior to the intervention households were under-heating their homes and post-intervention households increase the temperature in their living areas.

The literature on digital exclusion policies is rather different to that on fuel poverty because the underlying problem is more disparate: there are many pathways for digital exclusion to affect individuals and, unlike fuel poverty, commonly defined metrics against which the policy interventions can be assessed do not really exist. In essence, digital exclusion is a social problem, albeit potentially with an economic cause, rather than a defined economic or engineering problem. This difference is reflected in the methods used to evaluate digital exclusion interventions which frequently involve small samples and qualitative studies. An important message from the literature is that overcoming digital exclusion is not simply about providing access to IT equipment and the Internet, it is also about encouraging individuals to use such facilities. For such use to occur an individual's wider social context needs to be considered and their motivations for engaging with ICT.

The policy evaluation literatures on fuel poverty and digital exclusion both make the same key point: for policies to be effective the behaviour of intended recipients, and its complexity, must be

understood. Policies that simply involve large investments based on strong assumptions about the response of recipients are likely to underperform compared to expectations. The challenge is that large investments may be politically attractive due to their appearance of strong decisive action.

Maximising the impact of interventions is heavily reliant on effective targeting mechanisms, so that support and resources are received by those most in need. For fuel poverty measures this means understanding the condition of housing at the local level. For digital exclusion it means recognising the difference between investments which help those left behind and investments which improve the experience of existing users.

Policy evaluation articles do exist relating to affordability questions in the water and transport sectors. We do not review these literatures for reasons of brevity and because there are fewer opportunities for clear cross-sector comparisons. The policy evaluations found in the water sector, although valuable, have a relatively narrow focus. They consider the implementation of increasing-block tariffs and either demonstrate how such tariffs can offer equity improvements over existing tariffs, or how increasing-block tariffs, as implemented, differ from an optimal tariff. Evaluating policies tackling transport affordability is challenging because the literature is very broad. The articles found generally do not evaluate policies directly relating to public transport. Instead, they either look at how the negative impacts of congestion charges on equity can be mitigated or consider city planning options where affordable housing is located next to public transport hubs.

3. Evidence Regarding Fuel Poverty Policies

3.1 Energy Efficiency Investments

Most of the papers which explicitly evaluate policies tackling fuel poverty and energy affordability evaluate the effectiveness of investments in energy efficiency improvements to domestic dwellings. The key lesson from these papers is how heavily reliant estimates of the attractiveness of different energy efficient investments are on various assumptions. These assumptions fall into two categories: (i) assumptions about policy incentives and market prices, and (ii) technical assumptions regarding the extent of energy use required to heat homes to an acceptable level. The first set of assumptions mean that the attractiveness of energy efficiency investments to householders varies considerably through time as energy prices fluctuate. It also indicates that energy efficiency investments are risky investments: if energy prices fall post-investment, individual householders may face a financial loss if they have funded the investment themselves. The second set of assumptions regarding engineering models represent a serious methodological concern about the validity of the results being obtained and whether the models' results lead to the best policies being adopted.

3.1.1 Why Individual Householders May Not Invest

Before reviewing the various policies used to support energy efficiency investments we first explore why householders may not make investments that are desirable from a policymaker's perspective and why some form of government intervention is often required. A broad overview of the reasons why energy efficiency measures are more attractive to governments than private households is provided by Clinch and Healy (2000). These authors explore the issue by considering a hypothetical programme of retrofitting the entire Irish housing stock with energy efficiency measures. From the view of society such a programme was estimated to offer net social benefits of £3.1bn, an internal rate of return of 33% and a cost-benefit ratio of 3. Firstly, the benefits to individual householders are lower as they are unlikely to consider the 'external' environmental benefits of reduced energy consumption. Secondly, householders may ignore the reduced risk of illness associated with improved heating as the benefit is non-monetary in nature and difficult to perceive/value at the individual rather than population level.

Clinch and Healy also place a lot of emphasis on the difference in discount rates between governments and individuals. At the time of writing their paper, Clinch and Healy (2000) note that the calculation of net social benefits used the Irish government's discount rate of 5%, however, the

market interest rates on consumer loans were often above 9%.[1] The authors report that such a change in discount rate would mean the net private benefit of the proposed scheme for individual householders is negative, i.e. undertaking the housing improvements would make them worse off financially. Furthermore, those in fuel poverty are likely to be on low incomes and potentially have poor credit histories, further increasing their discount rate above that of a standard consumer loan's interest rate.

Private householders are also likely to be deterred from making energy efficiency investments if they do not own their own home, but instead rent it. The obvious problem here is that a tenant is unlikely to occupy a dwelling long enough for energy expenditure reductions to offset the initial cost of the energy efficiency improvements.[2] The lengthy payback periods[3] required for substantial energy efficiency investments are highlighted in the Canadian setting by Guler et al (2001). These authors estimated that substantial ceiling insulation upgrades and window upgrades had payback periods in the region of 7-17 years. The other problems facing tenants are that they probably do not have the right to approve energy efficiency investments (because they require their landlord's permission) and that 'free-rider' issues might emerge in properties with multiple occupancy.

The existence of these issues explains why governments frequently provide support to encourage individual householders to undertake energy efficiency improvements. One of the notable features of the evidence presented below is that even when householders are offered considerable assistance (or, indeed, all of the cost) to make energy efficiency improvements, most householders choose not to take part.

3.1.2 Policies to Overcome Investment Disincentives

To tackle some of the issues of financing identified by Clinch and Healy (2000) the Green Deal Finance scheme was introduced in England and Wales in 2012.[4] As described by Guertler (2012), this scheme allowed households to install a package of energy efficiency measures at no upfront cost. Instead, the scheme provided financing with repayments arranged as an additional charge on a household's energy bill.[5] Crucially, the financing arrangement was attached to the dwelling where the energy efficiency scheme was installed rather than to the individual deciding to invest, thereby removing the risk of a householder moving out of a dwelling before the ongoing energy

[1] A higher discount rate means the value of future savings from reduced energy bills will be lower when viewed from the present.
[2] A similar problem will exist for owner-occupiers who wish to move after only a couple of years unless the property market correctly values the benefits of the energy efficiency measures that have been installed.
[3] A payback period is the length of time required for the benefits of an investment to equal the total cost of the investment which was incurred upfront.
[4] It was announced at the end of July 2015 that the UK government would end funding for this scheme due to poor take up and concerns about the quality of the retrofits completed.
[5] Subsidies for the fuel poor and/or difficult to treat houses could be incorporated into these financing arrangements.

expenditure savings had offset the initial investment cost. Additionally, the annual repayments required under the Green Deal Finance scheme were capped according to a 'Golden Rule'. This meant that the annual repayment figure should not exceed the **expected** annual saving on energy expenditure which **typical** occupants could receive from the installed energy efficiency measures. As Guertler notes, since any reduction in energy expenditure is offset (for a period of time) by the charge to repay the investment, this financing scheme by itself was unlikely to offer marked improvements in affordability for the fuel poor. It is also questionable how effective the 'Golden Rule' was in ensuring that the finance repayments did not exceed the actual energy expenditure savings achieved by the household, since the cap was based on a set of modelling assumptions. The evidence presented below suggests that estimates of energy consumption savings from models often vary considerably from the savings which are realised.

Another approach to tackling the problem of frequent home moves restricting investment incentives is to encourage the property market to incorporate the value of energy efficiency into house prices. Amecke (2012) investigates the potential for such an approach by looking at the German implementation of the European Energy Performance Certificate (EPC). In Germany this certificate became compulsory for all new-build homes at the start of 2009 and must also be provided on request for pre-existing dwellings. To judge the impact of EPCs on the German property market, Amecke conducted a survey of property buyers who had engaged with Germany's main online property portal. Amecke found that while 78% of homebuyers had viewed an EPC at some point, only 35% had viewed one for the home they actually bought. Even more significantly, only 44% of respondents expressed agreement with the statement that the information contained in the EPC was 'trustworthy'. Similarly the survey respondents thought the EPC was the least useful way to understand the financial implications of energy efficiency; information about actual energy bills was thought to be far better. These findings, combined with the fact that buyers reported energy efficiency to be only a minor influence on their purchasing decision, leads one to question whether EPCs, at least in Germany, can create strong market incentives for energy efficiency investments. However since the survey was conducted only one year after EPCs became compulsory, the value of EPCs might improve over the long-term as they become more embedded in the home purchasing process.

3.1.3 Regulations Requiring Improvements

One approach to encouraging energy efficiency improvements is to require them through building regulations. These regulations can be introduced solely for new-build properties or also for buildings undergoing refurbishment. While it may be substantially cheaper to incorporate energy efficient technologies into new homes than retrofitting existing homes, the cost still has to be borne by someone.

When considering the relative effectiveness of regulations requiring energy efficiency improvements it is necessary to consider the wider policy and technological environment in which

the regulations were introduced. For example, Leth-Petersen and Togeby (2001) conclude that building regulations in Denmark that favoured energy efficiency and district heating schemes played an important role in reducing the energy consumption of Danish apartment blocks. They contrast this relative success of building regulations against the relative ineffectiveness of fuel taxes due to the weak response of households to increases in energy costs. However, Leth-Petersen and Togeby recognise that these findings are probably closely linked to the fact that individual flats within Danish apartment blocks often did not have their own energy meters.[6] The lack of individual meters would mean individual households would only have an indirect financial incentive to limit their energy use. The direct impact on affordability of energy bills being related to the energy consumption of an entire apartment block rather than an individual's own flat is unclear. One would expect the less direct link between charges and consumption to lead to increased consumption and higher bills; however within individual apartment buildings social pressures to conserve energy might offset this to some extent.

Another evaluation of regulations is provided by Beerepoot and Beerepoot (2007) who consider regulations introduced by the Dutch government in 1996. The authors look at a small sample of energy efficiency submissions to the Dutch authorities to analyse the technology used to achieve the reported energy savings. The authors find that achieving the required energy efficiency standards did not stimulate the installation of water heating technologies defined by the authors as 'radical', such as the installation of solar panels or heat pumps; instead more incremental measures were sufficient to meet the regulations. While this provides some evidence that energy efficiency regulations may not drive innovation, from the perspective of reducing bills whether a technology is new or old is not important. To deliver improved energy affordability, policymakers should be technology neutral, selecting technologies solely on the basis of those offering the greatest return in terms of energy savings compared to initial costs.

Galvin (2012) looks at the challenge of using compulsory regulations to motivate private householders to install energy efficiency upgrades when renovating existing dwellings. Galvin (2012) considers the case of Germany's Energieeinsparverodnung (EnEV). Under the EnEV policy when a householder repairs or improves 10% of a particular feature of their home the work on the feature, e.g. a single wall, must include upgrading to new-build energy efficiency standards. The policy is based on the observation that energy efficiency improvements are likely to be delivered most cost effectively as part of a broader renovation.

Unsurprisingly Galvin (2012) warns against relying on regulations to enforce the upgrade of buildings to higher energy efficiency standards. The cost of renovating old buildings to higher energy efficiency standards often increases in a non-linear fashion i.e. a small improvement in energy efficiency may be very cheap, but a large increase in energy efficiency will be

[6] Leth-Petersen and Togeby (2001) report that meters for individual flats in apartment blocks only became compulsory in 1999.

disproportionately, and potentially prohibitively, expensive. If energy efficiency improvements are made compulsory when renovations occur, the increase in costs may mean that householders simply choose to leave their properties unrenovated. While the EnEV policy is supposed to require only energy efficiency improvements which are 'economically viable' the calculation of what constitutes 'economically viable' is controversial. Also, setting the minimum standard for improvement centrally may stop individual householders from adopting less ambitious energy efficiency improvements which offer a better monetary return in their specific set of circumstances. This failing probably results from the policy being motivated by a desire to cut greenhouse gas emissions rather than as a tool to increase energy affordability.

3.1.4 Policies Subsidising Investments and the Potential for Disappointing Results

A paper considering the broad range of factors that can influence the attractiveness of energy efficiency investments, even when supported by subsidies, is Amstalden et al (2007). These authors estimate the returns available to households from improving the energy efficiency of Swiss homes built between 1948 and 1975. The modelling is based on a range of Swiss measures to incentivise energy efficiency investments, namely the MINERGIE subsidy scheme, the tax deductibility of energy efficiency investments and a tax on fuel oil linked to carbon-dioxide emissions. These latter two incentives mean that the rate of income tax and the tax rate for carbon dioxide are key policy variables that determine the financial viability of energy efficiency investments. Amstalden et al (2007) consider a range of efficiency packages which vary according to the level of insulation fitted and, therefore, the size of predicted energy savings. Depending on assumptions about energy prices and the efficiency package chosen, estimated internal rates of return vary between 3.3% and 12.1%. Critically these rates of return incorporate all of the support policy described above. None of the individual support policies incorporated into the estimations by Amstalden et al can make the energy efficiency schemes viable for individual households on their own; only the cumulative impact of all the support policies is sufficient to do this.

Rather than estimating the financial gains from energy efficiency savings under different scenarios, Fowlie et al (2015) look at the realised returns achieved by US households receiving funds from the Federal Weatherization Assistance Program (WAP). This program began in 1976 and for the period 2009-2012 the funds allocated expanded significantly from $450m to $5bn. On average each household received $5,000 of investment at no upfront cost. Looking at a sample of 3,000 households in Michigan, Fowlie et al find that the upgrades cut household energy consumption by around 10-20%, however, the cost of the installation was found to be double the value of the $2,400 in lifetime energy savings achieved. Fowlie et al also compared the projected returns to the investments calculated using engineering models with the realised returns. While the realised returns were negative, the engineering models had suggested that the annual return to the investments would be 11.8%. If this over-estimation of financial savings by engineering models is a

general finding, as much evidence suggests, policy decisions may be being made on rather shaky foundations. Fowlie et al reach similar conclusions, arguing for more robust evaluations of energy efficiency projects and that improvements should be made to engineering based models.

Howden-Chapman et al (2012) confirm that large falls in energy consumption are possible with appropriate home improvements, reporting the results of an experiment involving a randomly selected intervention group as part of New Zealand's Housing and Health Research Programme. Insulation was installed at no cost to the participants between two consecutive winters. Compared to the control group, a 19% drop in energy consumption was recorded with the intervention, while household temperatures post-intervention were slightly higher, as were self-reported perceptions of health. In a second trial, where heating systems were upgraded in homes that had already been insulated, the drop in energy consumption observed post-intervention was not statistically significant. Unfortunately, Howden-Chapman et al do not attempt to establish whether the interventions were financially viable as purely energy conservation measures.

Compared to most of the evaluations of energy efficiency programmes which focus on quantifiable outcomes, Gilbertson et al (2006) provide a small scale qualitative assessment of England's 'Warm Front' scheme. This scheme provided significant energy efficiency investment in homes, including new heating systems. The 49 households responding to Gilbertson et al were very satisfied with the scheme's impact on their home environment. This improved living environment was associated with 20-25% of respondents reporting an improvement in their physical health and around 25-55% reporting an improvement in their mental well-being.[7] However, the intervention's success with regard to reducing energy expenditure seems to have been less obvious; only a quarter of respondents thought they had saved money.

The 'Warm Front' scheme is also quantitatively analysed by Hong et al (2009) who surveyed 2500 dwellings in five major English cities during the winters before and after the 'Warm Front' intervention. Hong et al find that after the 'Warm Front' intervention the mean indoor temperature was 19°C compared to only 17.1°C before the intervention. Corresponding to this increase in temperature, the proportion of households describing the warmth of their home as "comfortable" rose from 36.4% to 78.7%. However, the crucial finding is that no reduction in energy consumption was observed after the Warm Front scheme. Instead it was noted that participants reduced their level of clothing so that the average temperature at which the indoor temperature appeared 'neutral' rose slightly from 18.9°C to 19.1°C. Nevertheless these temperature figures show a discrepancy with the standard engineering model of thermal comfort used in the scheme which assumed a higher ideal temperature of 20.4°C. The authors and their results again emphasise that energy efficiency gains do not necessarily lead to reductions in energy expenditure. Since householders may choose to live in a warmer home rather than keep their home at its pre-

[7] The unknowable is to what extent this increase in perceived comfort is 'real' or a 'placebo' resulting from the activity of the intervention. This is why recording actual household temperature is valuable.

intervention temperature and save money, it is difficult to measure the true welfare effects of policy interventions solely through energy expenditure; however a revealed preference argument suggests that households are still experiencing a welfare gain, even if energy expenditure does not fall.

In a different environment, Lloyd et al (2008) report results from a study of energy efficiency improvements to social housing in New Zealand. The study revealed a small but non-statistically significant reduction in energy consumption after intervention.[8] As with Hong et al, Lloyd et al report an increase in household temperature post-intervention, but that householders consistently under-heated their homes. Lloyd et al report that on average for around 12 hours per day the indoor temperature in homes was below 12°C, a figure well below the WHO's recommended temperature. If these 12 hours corresponded to periods when individuals were out of the house this finding would not be particularly concerning. However, other data reported by Lloyd et al suggests that daytime occupancy was around 65-70% of total household members, implying that these low temperatures were not just occurring in empty homes.

The apparent 'under-heating' of homes is not just a New Zealand phenomenon, as Critchley et al (2007) found amongst 'Warm Front' recipients in the UK. Critchley et al suggest a number of reasons for this phenomenon. Firstly, this behaviour may occur because, even after a policy intervention, a dwelling remains difficult/expensive to heat. Critchley et al found that those who continued to live in cold homes post-intervention tended to live in older homes and reported draughts, alongside dissatisfaction with their heating system. Easier to use heating systems may allow householders to achieve a more desirable level of heating. However 40% of respondents living in cold homes reported a preference for the lower indoor temperature. This presents further evidence challenging models built around 'ideal' temperatures. Indeed Wright (2004) found that a common practice among elderly interviewees in the UK was to sleep in an unheated bedroom with a window open during winter. Again this suggests that estimated rates of fuel poverty based on required consumption to achieve an 'optimal' temperature may be inappropriate and that this may lead to systematic mis-estimation of the benefits of energy efficiency investments.

3.1.5 The Importance of Effective Targeting

Not only are the financial returns to energy efficiency programmes questionable, but getting householders to participate, even when they face no upfront costs, is often difficult. Fowlie et al (2015) conduct an experimental intervention where some households received aggressive outreach programmes and personal assistance. This engagement intervention lead to a sixfold increase in the percentage of households taking part in the WAP energy efficiency scheme, but this increase was

[8] Some of this statistical insignificance was due to the small sample size of 100 homes, although, the small magnitude of the drop in energy consumption again suggests the limited impact of energy efficiency schemes on affordability.

only from 1% to 6%. Indeed, Fowlie et al estimate that the cost of recruiting a single additional household to install energy efficiency measures as the result of outreach activities was $1,000.

Armstrong et al (2006) look in greater depth at the barriers to households taking up subsidised energy efficiency upgrades, exploring a scheme offering free installation of central heating to all tenants aged 70 or over in social housing which did not already have full central heating in an area of London. Out of roughly 1,200 tenants approached about the scheme, only 26% had received a central heating system within one year. Armstrong et al find that the low uptake could be explained by a combination of poor targeting by the council and the attitudes of those being approached. Unsurprisingly, householders who perceived greater benefits from improved heating were more likely to have it installed. The householders who accepted the offer were also more likely to think that their existing heating system was inadequate on the coldest days and that there were health benefits from improved heating. Of the householders who explicitly rejected the offer, and provided a reason, 60% thought they already had effective heating and one-third expressed worries over the upheaval associated with the installation process. A small number of additional respondents worried about the risks of increased heating costs. From a policymaker's perspective the challenge is to understand how many of these concerns result from a lack of information or misinformation, and how many represent judgements of risk and genuine preferences. Such a separation of reasons requires contact with individual households. Armstrong et al conclude that successful implementation of renovation schemes is heavily reliant on having local resources capable of engaging with householders in an effective manner.

The improved targeting of support measures to focus on the fuel poor rather than householders in general must be a key objective if the impact of funds available from government to address fuel poverty is to be maximised. For example, Guertler and Jansz (2012) report that only around a third of the funding dedicated to tackling fuel poverty and reducing energy bills in the UK actually reaches households who are fuel poor. 64% of the funds identified by Guertler and Jansz as being claimed to assist fuel poor households in the UK in 2013 were allocated to the Winter Fuel Payments scheme, whose eligibility is based on the age of householders rather than whether or not they are fuel poor.[9]

Another perspective on the challenges of effectively targeting fuel poor households is provided by Walker et al (2013). These authors evaluate the Warm Homes scheme in Northern Ireland, where households self-refer to the scheme, by comparing it against a system of geographic targeting devised by the authors. Targeting by geographic area has the advantage of being proactive and relying less on individual householders' activity, but it creates issues regarding the accuracy of the targeting mechanism. Walker et al base their geographic targeting model on a multidimensional approach to construct an index of fuel poverty risk for different areas. Statistical analysis of the

[9] Winter Fuel Payments are available to all pensioner households

Warm Homes scheme shows that while there was a positive relationship between the number of refurbishments and the extent of need in a particular area, the relationship was weak.[10] There also appeared to be considerable leakage of resources to areas where Walker et al's model predicted a low rate of fuel poverty. A key message from Walker et al's work is that effective targeting requires reliable information on the quality of the housing stock in particular areas, as well as the socio-economic position of householders.

Walker et al (2014) further develop these themes, reporting that in 2006-07 30% of the households helped through the Warm Homes scheme were not at risk of fuel poverty and, of the recipients, only 16% were classed as living in 'energy inefficient' households and at a heightened risk of fuel poverty. The authors note that in the UK there is a lack of pre-existing data to identify households experiencing fuel poverty. The main survey of housing conditions in England, the English House Conditions Survey, has a sample which is too small to identify localised areas of increased need. The authors also report that, at least in the UK, receipt of state welfare benefits is an unreliable proxy indicator for fuel poverty due to the weak correlations involved. Further detail on the issues of using 'passport benefits' to target support is provided by Wright (2004).

The optimal method of targeting energy efficiency investments to maximise the reduction in fuel poverty is likely to vary significantly between countries, depending on the type and accuracy of the data available. Walker et al note that even 'area-based' targeting is far from perfect as it only characterises areas where there is a heightened risk of fuel poverty, rather than identifying the specific households within an area who need support: the expensive and laborious task of engaging with individual households is not removed, merely reduced. One particular issue Wright (2004) reports as complicating targeting efforts was that government support schemes in the UK did not support provision of insulation for 'solid wall' properties despite these dwellings having inherently poor insulation and often housing elderly individuals. The exclusion of particular types of properties/ efficiency schemes is a difficult topic. On the one hand, it makes sense for governments to target their resources at those technologies, solutions and properties which offer the greatest return on the investment made. On the other hand, concerns about energy affordability are fundamentally distributional in nature and there may be particular properties where, although interventions are very costly, the depth of fuel poverty experienced by the inhabitants is particularly severe and may justify intervention.

[10] A similarly weak relationship was found when looking at the amounts of money allocated to different areas according to the Warm Homes scheme.

3.2 Energy Policies Beyond Energy Efficiency Investments

3.2.1 Alternative Tariff Structures

Allcott (2011) reports a randomised field experiment to assess the impact of real-time electricity pricing on residential consumers in Chicago, which involved randomly assigning consumers to either a real-time tariff or a standard flat rate tariff. Allcott finds that the impact of real time pricing is to encourage overall energy conservation rather than the shifting of demand between time periods. The results of the experiment do not suggest that real time pricing will substantially improve the affordability of electricity. Compared to those households on the flat rate tariff, those facing real time pricing were estimated to have an annualised consumer surplus figure that was only $10 higher, a figure equivalent to 1-2% of households' electricity expenditures. These savings appear small once the one-off cost of installing the smart metering infrastructure of around $150 per household is considered. Furthermore while participants were randomly assigned between the control and treatment groups, they had to opt-in to the programme to take part, raising the question of whether the act of volunteering renders the subjects representative of the population as a whole. An assumption that those who opted in thought they would be particularly likely to gain from real time pricing reinforces the conclusion that real time pricing only has a limited ability to reduce energy bills.

Rather than observing the actual behaviour of consumers, Leautier (2012) estimates the impact of introducing real-time pricing to the French electricity market using a demand model. Despite the different method, Leautier reaches the same conclusion as Allcott (2011), that the savings real-time pricing delivers are insufficient to justify the infrastructure costs of rolling out smart meters. For the majority of consumers who do not have a very high peak energy demand, Leautier estimates that the annual welfare gain for a consumer with a low elasticity of demand is only €1 and for high elasticity consumers it is still only €4.

Another variation in tariff options is whether to include a fixed 'standing charge'[11] as an element in the tariff structure. Bennett et al (2002) consider changes to the tariffs offered by two large gas suppliers in the UK. British Gas offered a general tariff where the standing charge was removed and replaced with a two-part tariff where the per-unit cost was higher for the first block of energy consumed. TXU Energy took an alternative approach introducing a 'Social Action Tariff' targeted specifically at (and only available to) low-income customers. This tariff involved a fixed charge which was linked to house size and the number of occupants rather than actual energy usage. Bennett et al note that removing the standing charge directly benefits households with low consumption rather than low income households per se. Since consumers classified as being in fuel

[11] A 'standing charge' is a fixed fee all consumers on the tariff have to pay and which remains constant regardless of the amount of energy used.

poverty have relatively high consumption, a tariff which removes a standing charge is unlikely to benefit them. Bennett et al go on to calculate the likely gains and losses of consumers switching to one of the two tariff designs under a series of assumptions.[12] The authors find that more fuel poor consumers benefit from the Social Action Tariff. In terms of targeting fuel poor individuals the British Gas approach of removing the standing charge means there are fewer errors of inclusion (non-fuel poor households benefitting) but more errors of exclusion (fuel poor households not benefitting). The clear lesson is that to help the fuel poor it is best to target them as directly as possible.

3.2.2 The Impact of Metering Technologies

The potential impact on energy consumption/expenditure of smart meters is often split into two components: (i) the potential for real-time pricing, and (ii) an improved user interface which increases consumers' awareness of energy consumption. Gans et al (2013) provide some evidence relating to the second impact by considering what the authors term a natural experiment in Northern Ireland. In 2002 all customers in Northern Ireland using a prepayment meter (PPM) for electricity were switched to an advanced meter allowing real-time tracking of energy usage under the Home Energy Direct scheme. Gans et al argue that the introduction of the new metering device led to a 10-13% reduction in energy usage which was equivalent to an annual saving of £54.81-£93.18 in 2009 prices. However there are potential reasons why this result might be viewed with caution. Firstly, as actual energy consumption is being reduced it is difficult to know if this is a desirable policy outcome.[13] Following a revealed preference argument, one would say that such a change in consumption must raise consumer welfare unless it is negated by concerns about the consequences of self-disconnection by PPM users. One possible limitation of Gans et al's methodology is that they do not observe individual households pre- and post-intervention, relying instead on cross-sectional analysis with data pooled across multiple years.

A final measure that could be a tool to reduce fuel poverty is to encourage the fuel poor to switch to lower cost providers. In the UK many fuel poor individuals use prepayment meters because they have previously fallen into debt regarding their energy bills. Without a mechanism to move individual householders' debts between energy suppliers, an indebted consumer would be unable to switch supplier and so might be charged prices above the best available on the market. The UK's energy regulator, Ofgem, introduced a system called the Debt Assignment Protocol (DAP) to overcome this problem, allowing consumers with a debt below £200 to switch supplier. However, Ofgem (2012) reports that few consumers seem to be taking advantage of DAP. By interviewing

[12] Many of these assumptions relate to the process for estimating the gas consumption of households from the expenditure data available to Bennett et al.
[13] With energy efficiency improvements this concern does not arise because the thermal standards of a home will increase implying the heat-cost trade-off will have improved.

indebted PPM customers Ofgem discovered that few potential beneficiaries knew about the scheme and that those who did had generally found out about it through a doorstep sales person. Another limitation with the scheme was that the maximum £200 debt threshold had not kept pace with the average debt levels of PPM consumers, which had increased to around £350 by 2012.

4. Evidence Regarding Digital Exclusion Policies

4.1 Policies Providing Access to ICT

4.1.1 Investments in Infrastructure

A traditional way for the state to support increased access to new technologies is to assist in the financing of infrastructure on which the new technology relies. A range of papers assess the factors that have influenced the rate of roll-out of broadband across countries. For example, Yates et al (2010) explore why different percentages of a population in different countries subscribe to broadband. Unsurprisingly, Yates et al find that increases in GDP and urbanisation lead to a higher percentage of broadband subscribers. More relevant to policymakers is that an increase in the competitiveness of markets measured by a 'competition index'[14] leads to increased broadband penetration, a reduction in the price of broadband and an improvement in the affordability of broadband according to the International Telecommunications Union's affordability metric. Countries devoting greater financial resources to ICT are also found to have increased broadband penetration.

Gulati and Yates (2012) provide additional details on the policy features which can be associated with increased broadband diffusion in both developed and less developed countries. Focusing on advanced developed countries, Gulati and Yates note that devoting increased financial resources to developing and promoting ICT is particularly important in increasing the number of broadband subscriptions, but that the effect of competition in supporting broadband diffusion depends on the countries studied. While competition is not associated with increased broadband diffusion in developed countries, it is linked to broadband diffusion in less developed nations. Gulati and Yates find that the presence of a telecoms regulator or a national broadband plan is not associated with broadband diffusion.

The importance of finance as a stimulant to the roll-out of broadband is also highlighted by Belloc et al (2012) who consider a wide range of policies that might support broadband penetration using data for the OECD over the period 1995-2010. Despite highlighting the role of finance, Belloc et al's analysis also separates interventions into supply-side and demand-side policies. The authors find that once the broadband market is sufficiently advanced, only demand-side policies have a positive impact on the annual change in broadband subscriptions. In contrast to Gulati and Yates (2012),

[14] This index is based on the situation in 6 markets within the broader communications industry. However, rather than using a measure such as the Herfinadahl-Hirschman Index (HHI) to measure competition the authors simply rely on a categorical variable identifying whether a particular market is a monopoly, partially competitive or fully competitive.

Belloc et al (2012) find that competition does have a positive effect on increasing the number of broadband subscriptions within a sample of developed nations.

Since the policy question being considered is one of digital exclusion, rather than simply the roll out of broadband, it is important to consider the distribution of broadband access across different groups. Helsper (2011) emphasises this point when analysing UK government policies relating to the digital world. Helsper's concern is that as technology advances, the opportunities for divisions to develop regarding what can be afforded grow. For example, the speed of connection may become a new source of division as the roll out of 'Superfast' broadband becomes more widespread in the UK. Helsper highlights that the wider is the availability of a technology, the more likely are differences in actual connections and usage according to socio-economic characteristics.[15] Helsper's argument is that spending large amounts of money on infrastructure does not necessarily lead to increased usage by all members of society.

Townsend et al (2013) provide further detail on the divisions which can emerge in terms of broadband speed, noting that in 2013 Ofcom reported that 5% of the UK population were not able to access broadband of at least 2Mbps. However, these individuals were not distributed evenly across the country: 60% of the premises which did not receive broadband were in rural locations because of the higher cost of upgrading rural infrastructure as greater distances exist between households. Townsend et al criticise the UK government for focusing funds on the roll-out of even faster broadband in certain areas rather than tackling the lack of broadband in some rural areas.

4.1.2 Provision of ICT in Community Based Facilities

Although considering a country (Mexico) which is less developed than most of the EU, Mariscal et al (2011) highlight some of the issues which may occur when relying on centralised facilities to provide ICT access. Mariscal et al describe how in the early 2000s the Mexican government introduced the 'National e-Mexico System' which involved the creation of 7,200 Digital Community Centres (DCCs) across the country. These DCCs provided access to computers, software, the Internet and, in theory, training. Mariscal et al evaluate the effectiveness of these DCCs in tackling digital exclusion by analysing 116 interviews conducted at 23 DCCs. The authors find that while DCCs were used, there were issues which limited their effectiveness at tackling digital exclusion. Firstly, 73% of the users surveyed were students. While one expects the young to be particularly keen users of IT, this characteristic does raise questions about the ability of the DCCs to reach other groups suffering from digital exclusion. Secondly, the distribution of DCC users did not seem to

[15] For example, if a lack of infrastructure meant that Superfast broadband could be accessed by at most 5% of households in a country, that only 2.5% of households actually paid to use Superfast broadband is likely to be considered a relatively minor issue. However, if infrastructure was in place to allow 100% of households to access Superfast broadband but only 50% of households could afford to access Superfast services this is likely to be far more concerning in terms of the potential divisions introduced into society.

overcome socio-economic divides, since those at the lowest socioeconomic levels reported low rates of attendance. Lastly, and perhaps most tellingly, 53% of the users surveyed already had a computer in their home. These results highlight the potential limitations of interventions which do not target specific groups or require individuals to opt-in: those who engage with the intervention had previously only faced an intermediate level of exclusion.

Turning to the service delivered through the DCCs, Mariscal et al (2011) highlight two further issues. Firstly, only 5% of the surveyed DCC managers taught a formal course on how to use computers, thus limiting the service provided by the DCCs to those willing to self-learn or with some pre-existing IT competency. Secondly, some users noted that the appeal of the DCCs was limited by the low-speed of the broadband services offered. As ever faster broadband services are marketed to private individuals it is an interesting question as to what the minimum standard of broadband should be in public locations such as libraries. Another question is how satisfactory or attractive centralised public IT provision is when mobile broadband availability leads the digitally included to take advantage of the Internet at any place and any time.

Lying between the centralised approach of DCCs and improving ICT provision in individuals' homes, Polat (2012) discusses the Fatih Project which was designed to provide Turkish schools with a comprehensive package of IT equipment. The programme has been very ambitious with the aim of equipping 620,000 classrooms with projectors and laptops, together with providing tablet computers to 12m students. The intention was that by the end of 2013 the programme would be completed, although the first phase of the project only involved providing 12,000 tablets to 52 schools. Based on the first phase roll-out, Polat expresses a number of criticisms of the programme. Firstly, the tablets rely on Wi-Fi for communications rather than a 3G connection, so students can only use the tablets to access the Internet at school. By not enabling home use, the true ability of the project to tackle the whole spectrum of digital exclusion is limited. Polat also suggests that basic educational infrastructure in impoverished sections of Turkey is lacking, so the resources invested in advanced technology might have been better used to improve other aspects of the education system. These general issues with the Turkish education system probably also reduce the likelihood of students receiving high quality IT lessons that could enable them to maximise the benefit of the tablet computers.

4.1.3 Support for ICT in the Home

Moving beyond IT provision in public facilities, the UK government ran a £300m scheme called the Home Access Programme (HAP) where low income households with children could obtain an internet connected computer for their home for 1 year. This programme not only provided hardware but also Microsoft software bundles, free internet access and technical support. Jewitt

and Parashar (2011) report results from a survey of 400 households[16], evaluating the HAP pilot in 2009. Firstly, monitoring data showed the pilot was popular, with grants being taken up by 93% of eligible households, compared to a target of 65%. Furthermore participants survey responses point to the positive effects of IT access within the home: 65% of parents reported children spending more time on school homework than before the programme, 81% of parents thought the package would improve their confidence in using IT and 62% of parents reported being more interested in the Internet than before they had received the computer. However given the generous nature of the programme perhaps one should ask what participant experiences would have led to negative answers or, alternatively, how do we assess 'how good' these positive responses are. While the non-monetary benefits of policies may be their primary objective, only having self-reported perceptions of benefits may make it harder for policymakers to select between different schemes which are all likely to perform well.

Yelland and Neal (2013) take a more quantified approach to identifying the benefits of the Tech Pack scheme to provide free internet connected computers to households in Australia, conducting surveys over a 3 year time period to understand the computer use of participants both before and after the intervention. An even better methodology, although not always possible, would have been to conduct randomised control trial where the outcomes of randomly selected households who received the intervention are compared with the changes experienced by households who, by chance, did not receive the intervention. Correctly identifying the counter-factual is a significant point for IT interventions, as in any specified time period increasing penetration of particular technologies is likely even in the absence of government interventions. While bearing this point in mind, the households who received a Tech Pack did report large increases in usage post-intervention. For example, the daily use of computers increased from 22.4% to 57.3% while the percentage of non-users decreased from 36.3% to 5.6%. The perceived benefits of this increased usage identified by participants included greater engagement with their communities, assistance with children's' education (83% of children listed a significant use of the computer as homework) and that it saved time and money. However, issues were identified that initially undermined the potential of the scheme, including connectivity and the quality of computers as well as inadequate initial training of participants.

The perceived benefits for participants of another Australian scheme are reported by Broadbent and Papadopoulos (2013), who reviewed the Wired Community@Collingwood project which aimed to provide a free networked computer to all 950 dwellings on the Collingwood estate, one of the most deprived neighbourhoods in Australia. Broadbent and Papadopoulos's interviews with 22 beneficiaries found support for the project's main aims with health and well-being outcomes being improved, as well as increased engagement by participants with employment opportunities.

[16] 200 of the households were known to have applied for a HAP grant and 200 households were randomly selected from the most deprived neighborhoods in the pilot areas.

4.2 Policies Supporting the Use of ICT

4.2.1 Increasing ICT Usage

Sinclair and Bramley (2011) report UK initiatives to tackle digital exclusion among young people via a twin-track approach of both providing access to ICT and training to enable the effective use of ICT resources. Sinclair and Bramley argue that increasing ICT use by disadvantaged persons requires policymakers to take into account the wider cultural and social capital of the environments in which young individuals live. The social frameworks of families and communities can contribute to or impede young people's engagement with ICT. Neither public access nor training in schools alone are sufficient to embed ICT in young people's everyday lives; rather this requires the communities and home lives of individuals to reinforce the relevance of ICT. Similar points are made by Hseih et al (2008), who note that emphasising the entertainment options offered by the Internet may be a particularly effective way to motivate engagement and use by the disadvantaged.

The idea that individuals require a clear motivation for engaging with ICT is reinforced by Ferro et al (2011). Based on a survey in the Piedmont region of Italy Ferro et al suggest that the acquisition of basic IT skills mainly occurs through a process of 'self-learning', which occurs either because the individual has an innate interest in technology or because a need to use ICT related to school or work prompt skills acquisition. As a result policymakers should consider using levers that increase the incentive for individuals to engage with ICT.

4.2.2 The Digital World as a New Venue for Social Exclusion

A related question to digital exclusion is whether digital technologies can help to overcome the general social exclusion of vulnerable groups or whether the digital world is simply a new domain where people experience pre-existing social exclusion. In 2006 the UK city of Sunderland received £3.5m to improve the position of socially excluded individuals and communities through technological solutions. Focusing on deprived geographic areas, Macdonald and Clayton (2013) report survey results considering the engagement of disabled people with digital technologies. The results show that even when compared to a deprived general population disabled people faced particular difficulties. For example, while 48% of the deprived control group reported never having used a computer, 71% of disabled people reported being in the same position. This suggests that rather than technology being a means to tackle general social exclusion among the disabled, it instead presented an additional sphere of society from which the disabled might suffer exclusion.

Those who were disabled did not view their disability as the main barrier to the use of IT, and only 5% reported that this was the case. Instead, the authors conclude that the lack of IT engagement was driven by general poverty limiting ownership of IT equipment, limited knowledge of IT and ICT facilities being inaccessible. As an example, Macdonald and Clayton report that while only 5% of the

control group reported having no confidence in their ICT skills, 18% of disabled people reported the same lack of confidence.

Further evidence that digital technologies may just provide a new venue for existing forms of social exclusion is provided by Polat (2012). When evaluating e-government initiatives in Turkey Polat notes that as government websites are provided solely in Turkish significant ethnic groups face a serious linguistic barrier to obtaining government information from digital sources. Foteinou (2010) provides further evidence of ICT providing a new venue for existing discrimination by considering the digital divide present in Greece along the gender dimension. Foteinou looks at the Greek Taxation Information System (TAXIS) and the ability for individuals to access their taxation data through a website. For married couples it is only the husband who has the right to enter information into the system and declare the family income, and wives have only 'access rights'. Giving control only to husbands is a direct extension of Greek taxation laws where the husband is always defined as 'the taxpayer' and wives are only as the 'spouse of the tax payer'. The gender division of the Greek taxation system is continued into the digital domain.

5. Conclusions

This paper has reviewed a range of evidence on two issues inherently linked to the affordability of utilities: fuel poverty and digital exclusion. While each of these policy areas has a different emphasis, financial returns in the case of fuel poverty and social considerations in the case of digital exclusion, both highlight the need to understand the behavioural response of individuals if policies are to achieve successful outcomes. For fuel poverty, a key issue is the potential mismatch between estimates of potential savings generated by engineering models targeting an 'optimal' household temperature and the actual savings obtained by householders who may prefer a lower temperature, or increase the targeted temperature after an intervention. For digital exclusion the key issue is that simply providing advanced infrastructure is insufficient; individuals also require incentives and support to develop the skills that allow IT to be used to its full potential.

The second key lesson is that targeting is key to maximising the impact and cost effectiveness of policy interventions. In relation to fuel poverty, the challenge is to identify individual households which are fuel poor and can receive a cost-effective intervention. Without very detailed administrative records accurate targeting is likely to be costly and reliant on the utilisation of local knowledge. This need for local knowledge probably means that detailed recommendations regarding the best targeting methods and most cost-effective technical solutions cannot be made at the European level. It is unclear that energy efficiency schemes designed to cut greenhouse gas emissions will be optimal from the perspective of promoting measures which deliver the greatest financial savings to householders. For digital exclusion the targeting message is simpler: prioritising the roll-out of ever faster infrastructure in areas which are already well served, rather than increasing access and engagement in areas which are lagging, will fail to close digital divides and may well exacerbate them.

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