A FRAMEWORK FOR EQUITY-PROOFING CLIMATE CHANGE MITIGATION POLICIES IN TRANSPORT

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ABSTRACT

In the current environment of reduced public subsidies for transport services and yet ever increasing demand for mobility, equity considerations are beginning to play a constitutive role at every level of transport policy decision-making. This paper is particularly concerned with making more transparent the equity implications of policies to reduce the climate change impacts of the transport system. It is clear that different social groups experience very different outcomes in accessing transport and adapting to changes to the transport system, whether these are uniquely targeted towards individuals or more fundamentally and systemically applied. It is therefore essential that any new areas of policy delivery, such as those to reduce transport-related climate change, also consider the 'winners and losers' and equity-efficiency trade-offs that will arise from their policy actions.

As yet, however, social equity assessments are largely absent from this policy-making arena. To this end, we identify an equity-proofing framework that can be easily applied by policy-makers for this purpose. Development of the framework draws on two government commissioned evidence reviews of the likely impacts of policies to reduce climate change in the domestic transport sector, in which two authors were involved. Both were undertaken in the United Kingdom, one in England and the other in Scotland, which is unique in being the only country in the world that has introduced a legally-binding framework for the reduction of CO2 emissions (Committee on Climate Change, 2008).

Keywords: transport, climate change, policy impacts, equity assessment, United Kingdom

INTRODUCTION

Persistent poverty and rising inequality are generally recognised as undesirable by governments in most advanced societies and this is reflected to a lesser or greater extent within their public policy agendas via various commitments to tackle social inequities and protect vulnerable and disadvantaged population groups. There are also strong environmental, economic and political reasons for these equity concerns, as Haughton identifies (1999:234):

> The unjust society is unlikely to be sustainable in environmental or economic terms; the social tensions that are created undermine the recognition of reciprocal rights and obligations, leading to environmental degradation and ultimately to political breakdown.

As such, social impact appraisal is often integral to the policy process and can be included at different stages of its delivery, i.e. during its design, development, implementation and evaluation. Equity 'proofing' is particularly important when there are already inequalities in the current market and/or system of public policy delivery, as is the case within the transport sectors of most contemporary societies.

A wide body of literature has already established that in most developed and developing societies low income populations generally have less access to transport services and so fewer opportunities to be mobile in order to access essential goods and services (see Social Exclusion Unit, 2003 and Dimitriou and Gatenheimer, 2011 respectively). The same population groups are also disproportionately exposed to the negative health outcomes associated with road transport. For example, in the United Kingdom (UK), the poorest fifth of households are concentrated in areas that produce the least pollution from car exhausts but inhale the most from them (Mitchell and Dorling, 2003). It has also been broadly established that these unintended negative consequences of the present system of delivery can also have wider adverse social consequences for these populations, such as reducing their ability to fully participate in the economic and social opportunities that are enjoyed by the rest of society (Social Exclusion Unit, 2003). Banister (2008) also notes that most transport infrastructure and service investment, wherever it takes place, benefits the rich more than the poor. Furthermore, as Dorling (2010) highlights transport consumption is unevenly distributed across different sectors of the population.

It is within this wider social justice agenda for transport that we offer our paper. We focus particularly on climate change policies for transport because they are a relatively new but increasingly important area of policy delivery internationally, but, as yet, the equity outcomes of their enactment are under-explored within the transportation literatures and so deserve fuller scrutiny by researchers, policy makers and practitioners.

In the next section of the paper, we offer a brief overview of the UK policy context for reducing the climate change impacts of transport. We then consider the published evidence that considers the likely equity and social justice implications of such policies. In section four we present the methodological approach for our paper. We then present the framework that we have developed to equity proof these new climate change policies for transport sector using on a 'real world' case study example. Finally, we critique our approach and discuss the broad lessons that can be drawn from the application of our methodology for academics and policymakers elsewhere who are interested in developing more socially just climate change policies for the domestic transport sector.

THE POLICY CONTEXT FOR REDUCING THE CLIMATE CHANGE IMPACTS OF DOMESTIC TRANSPORT IN THE UK

Our paper is set in the context of the global imperative to reduce the energy and carbon intensity of our practices. Transport practices are significantly energy intensive, and here we set out the scale of the problem that underlies the effort to introduce climate change mitigation policies in transport, as the global scale and potentially extreme consequences of climate change tend to make it a 'higher level' priority than social equity 'at home'. Globally, transport is using about 19% of total energy and is responsible for about 23% of energy-related CO_2 emissions. This is because transport is almost completely dependent on fossil fuels: in OECD countries, transport accounts for nearly 60% of oil consumption, and is the main driver of increased oil demand. It is predicted that on current trends transport energy use and CO_2 emissions will have increased by 50% by 2030, and by more than 80% by 2050 (IEA, 2009).

In 2010, the UK's total final use energy consumption was 150,071 thousand tonnes of oil equivalent (TTOe), 5 per cent higher than in 2009. Between 1990 and 2009 both the transport and domestic sectors have increased their energy consumption, at 7.5 and 2.3 million TTOe respectively (DECC, 2011a) but transport is the only sector that increased in energy intensity: by 3% between 1970 and 2010. Since 1970, energy consumption in the rail transport sector has dropped by 38%, whereas road has increased by 91%, water by 14% and air by 218%. Total UK transport fuel usage in 2010 was 55,704 TTOe, of which 40,955 TTOe was for road transport: 68 per cent for cars, 32 per cent for freight vehicles and the remainder for buses and motorcycles (DECC, 2011b). Geographically, the South East region of England has the highest transport fuel consumption (more than 5,000 TTOe). Scotland consumed 3,000 TTOe, Wales a little less than 2,000 TTOe and Northern Ireland just over 1,000 TTOe. Fuel consumed for personal travel accounts for well over half of total consumption in all cases (Rose and Nikiel, 2011).

In response to the climate change challenge, the UK government set a binding commitment to decrease greenhouse gas (GHG) emissions by 80% (on 1990 levels) by 2050 through the 2008 Climate Change Act (Great Britain Parliament, 2008). It was the first nation state to respond with such a firm policy commitment and is still unique in this respect. The Carbon Plan published by the Coalition Government in December 2011, supersedes the previous guidance (HM Government, 2011). In relation to transport, the promise is that new car emissions will be cut by a further third by the same date through the introduction of electric and hybrid vehicles. The Government is providing around £300 million this Parliament for consumer incentives, worth up to £5,000 per car. It is also providing a £560 million Local Sustainable Transport Fund (LTSF) over 5 years to support cycling, walking and public transport and a further £50 million to be used by local transport authorities for small transport improvement schemes of less than £5 million, as well as up to a further £25 million for the Green Bus Fund for the purchase of low carbon emission buses.

However, there is general failure by UK Government to recognise the potential inequities and potential social exclusion implications that are embedded within such policies (Anable et al, 2012). This is a serious oversight in the context of the extremely uneven distribution of transport provision within the UK. For example, roughly half of all lowest income quintile households in the UK do not have access to a car, and people living in carless households make half the number of journeys as those in car owning households (Department for Transport, 2011). These trends are also often geographically specific in many instances, in that they are concentrated in social housing estates, many of which are located in the urban periphery of major towns and cities (Sterrett et al., 2012; Power, 2012) and in older and more isolated rural settlements (Owen, et al., 2012; Velaga et al., 2012).

Whilst it is usually still possible to readily access employment and other key activities within metropolitan areas, development planning trends over the last thirty years combined with public transport privatisation outside of London during the mid-1980s has had a significant role in reducing levels of accessibility for non-car owning households outside these major conurbations. As such, it has become increasingly necessary to have access to a car in order to reach a wider range of essential and leisure activities (Power, 2012). At the other end of the income scale, case study research has demonstrated the richest ten per cent of the population may be responsible for more than eighty per cent of the total of greenhouse gas emissions from personal travel in some parts of the UK (Brand and Boardman, 2008).

Analysis of the 2007 UK Family Expenditure Survey (FES) confirms that households in the highest income group spend a larger proportion of their weekly budgets on transport than those in the lowest income group, 16 per cent compared with nine per cent (Dainton, 2008). However, travel expenditure can significantly increase for lowest income car-owning households: previous analysis of the FES has shown that car-owning households in the lowest income quintile may spend as much as a quarter of their weekly budgets on motoring (Lucas et al, 2001). Recent analysis by the RAC Foundation (2012) estimates that as many 26 million UK households could be described as being in 'transport poverty' (i.e. they spend more than 10 per cent of their income on transport), with the poorest fifth of car-owning households spending an average of 17 per cent of their income on driving and maintaining their vehicles.

However, whilst there are fairly robust appraisal tools for UK policy makers to evaluate the economic cost and environmental benefits of climate change policies, very little attention has been given to their equity and distributional effects. This is despite introduction of the UK Equality Act in 2010, which prohibits unfair treatment in the exercise of public duties (Government Equalities Office, 2011).

DETERMINING THE EQUITY IMPLICATIONS OF CLIMATE CHANGE POLICIES FOR TRANSPORT: LITERATURE REVIEW

It is against this policy background that we offer our equity proofing approach. To do this we first need to define what we mean by an 'equity effect' of transport policy, as well as to identify potentially vulnerable population sectors. There have been several areas of research in recent years that are useful to this line of enquiry. The first of these is the work that has been undertaken to conceptualise and identify the social impacts of transport (e.g. Burdge, 1987; Forkenbrock et al, 2001; Sinha and Labi, 2007; Geurs et al, 2009). An overview of these literatures identify that not only is there considerable ambiguity about what constitutes a social impact but also overlaps in terms of what should be considered as a social impact and what are the distributional effects of environmental and economic impacts (Jones and Lucas, 2012). Nevertheless, there is general agreement that the important areas of transport policy to consider in terms of social equity are those that affect affordability, accessibility, health and safety.

A second fruitful area of literature for understanding the likely equity implications of climate change policies for transport is that pertaining to inequalities in access to transport and the associated travel behaviours of different population groups, with a particular focus on low income and disadvantaged groups. There is now a substantial body of literature in this field much of which is directly relevant to the UK context and the focus of this paper. Lucas (2012) offers an overview diagram of the many ways in which transport disadvantage can contribute to the social exclusion of already socially disadvantaged and vulnerable groups by reducing their access to good, services, life chances and social support (see figure 1). Her diagram also suggests that the wider policy context in which these actors operate is fundamental to the creation, exacerbation or mitigation of these important social outcomes, as are the accepted social norms and values of the society in which they are embedded. It is for this reason that policy-makers need to understand not only the impacts of their intended policies but also the specific economic, environmental, social and political contexts in which they will be enacted or operationalized.

The third area of research that we have considered is work that has been undertaken to understand the distributional and equity impacts of different types of transport policies. However, few studies focus specifically on the equity effects of climate change policies for transport. We were able to identify two notable exceptions within the literature considering carbon taxation policies (Santos and Catchesides, 2005 and Bureau, 2011).

Having reviewed and synthesised these wider literatures, we would suggest that few studies are entirely comprehensive in their coverage of the social impacts of climate change policies for transport or the social groups that might be affected. Nevertheless, it is possible to draw a few generalised conclusions about their likely equity impacts. With regards to fiscal measures such as road pricing, congestion charging and parking charges, these can broadly be considered as socially progressive, in that higher income groups own and use cars more than those on low incomes. However, there is a risk that low-income drivers who do not have alternatives to using their car can be very adversely affected, e.g. those whose jobs are in a charging zone, but who live outside of this area. Much of the literature has focused on the equity implications of road pricing schemes (e.g. Bureau and Glachant, 2008; Graham et al., 2009; Levinson, 2010). Policies to stimulate the purchase/use of energy efficient private vehicles could marginally reduce the affordability of new car purchases for some low-income households. There could also be short-term, knock-on effects on the second-hand car market, as second-hand cars might also become more expensive, again adversely affecting lower income households (AEA Group, 2011).

Policies that aim to encourage modal shift from cars are generally not very cost efficient or well targeted towards the highest emitters, who are most usually those on the highest incomes (Brand and Boardman, 2008), but these groups are often the most resistant to modal shift policies. As such, many policies to encourage the increased use of public transport are more likely to benefit the existing users of these modes. There is a smaller subset of literatures focusing on the equity effects of public transport infrastructure or policies (e.g. Bureau and Glachant, 2011; Nuworsoo et al., 2009). Public transport improvements are more likely to benefit low-income groups (particularly lone parents, younger, older and disabled people) when they involve improvements to bus rather than rail services. Policies to reduce the cost of public transport (e.g. concessionary fares) can help some groups to gain better access to employment and other opportunities and services. However, they are largely targeted towards older and disabled people and can also have rebound effects by providing a perverse incentive of encouraging more overall travel by all groups, which may not be desirable if the overall aim of the policy is to reduce CO_2 emissions from the transport sector as a whole. Planning policies and other ‘soft’ measures may also have a strong potential to reduce the use of motorised transport (Atkins and University of Aberdeen, 2009). This encapsulates a wide range of policy-based approaches, from work place and school travel plans to individual travel planning to local cycling and walking schemes. We pick up on these themes in greater detail later when we discuss the operalisation of our equity-proofing approach. We outline our methodology in the next section of the paper.

METHODOLOGICAL APPROACH

The methodological approach for our paper was developed in response to an opportunity to develop and disseminate the findings of two government commissioned consultancy projects and so deviates in some respects from the more considered approach that can be adopted in traditional academic studies. The authors have drawn upon and supplemented the evidence created by these two studies in order to development their conceptual approach the full rationale for which can be found in Lucas and Pangbourne (2012).

The first of these evidence-gathering studies was conducted by Atkins and University of Aberdeen for the Scottish Government (SG) (2009). It involved assessment of 22 policies for the domestic transport sector in Scotland in terms of their: i) carbon abatement potential, ii) technical feasibility, iii) cost of implementation, iv) political and public acceptability, v) impact on accessibility and social exclusion (see table 1 for the full list of polices). This study is hitherto referred to in the paper as 'the Scottish study'. The second study was for the Department for Transport (DfT) and was conducted by a research consortium led by AEA Group (AEA Group, 2011). It predominantly involved a desk-based review of the published research evidence on the likely social and distributional impacts (SDIs) of the UK's climate change strategy for transport concentrating on the four main categories of climate change policies that fell within the remit of the DfT's climate change delivery strategy, i.e. i) reducing trips, ii) improving vehicle utilisation, iii) encouraging the purchase of more efficient vehicles, iv) encouraging use of alternative fuels (see table 2 for the full list of policies.

We felt that there were some specific limitations to these two studies in terms of their ability to assess the likely equity outcomes of the policies that were reviewed, as well as having some more generic concerns about their scope and methodological approaches. In this paper, it is our intention to combine the core strengths of these two previous studies, whilst also aiming to address these methodological weaknesses. We seek to achieve this through the development of a more systematic 'equity proofing' framework for use by policy makers to determine the likely social impacts and distributional effects of their policy decisions. We undertook the development of our equity proofing approach in three main stages described in more detail below: i) identifying the assessment criteria, ii) establishing, and then iii) testing the framework using a real world worked example.

Stage 1: identifying the assessment criteria

We subsumed a long list of potential social and distributional impacts as identified in the DfT study (see Table 1) into three core criteria: i) wealth impacts – to denote any significant changes to the cost of transport (e.g. a significant increase to household transport budgets could tip them into transport poverty), ii) health impacts – to denote any positive or negative health affects (e.g. accident reduction or increases in physical activity), and iii) accessibility impacts – to denote any improvements or reductions in access to services (e.g. through improved transport services or new land use developments). These core criteria are aggregated across the geographic population affected by the proposed policy.

We considered the social distribution of these impacts in two key ways, i) to consider the differential impacts across income quintiles and ii) to disaggregate the impacts across different vulnerable 'at risk' groups (i.e. age, gender, disability and ethnicity). The choice of vulnerable groups aligns well with the eight equality groups considered in the Equalities Measurement Framework advocated by the Equality and Human Rights Commission (Alkire *et al*, 2009), which is generally compatible with the Equalities Impact Assessment procedures adopted by governments in the UK.

Thirdly, we include an optional notion of geographical vulnerability, which is intended to capture the likely effects of policies at the aggregate neighbourhood or community level in order to enable spatial disaggregation and area effects of a proposed policy. The intention here is to also consider the vulnerability of particular areas (e.g. coastal area or flood plains) as well as the cumulative effects of policies across different sectors (e.g. housing, health, planning) and the pre-existing fine-grained geographic context circumstances in which the policies are delivered (e.g. if proposed cuts to public transport services are intended in areas that are already inadequately served by such provision).

Finally, we added criteria for considering the temporality of the impacts of policy change across four time periods (immediate, short term (1-5 yrs) mid-term (6-10 yrs), long (11-25 yrs), because it will uncover how the dynamics of positive/negative impacts change over time. For example, a group that is disadvantaged by an intervention in the short-term may ultimately benefit greatly over the longer term once adjustment has occurred. This potential is currently obscured, yet it is an important consideration in policy decision-making that needs to be transparent. The temporal dimension also makes it possible for the analysis to link the effects of policies to the developing impacts of climate change itself, such as increased flooding or heat-waves. Another benefit of including temporal change is it highlights when our knowledge 'runs out' as areas of the matrix have to be left blank. Such refinement is very important for decision-makers to make fully informed decisions as well as in guiding research efforts.

Stage 2: establishing the evidence-base for impact assessment

This framework identifies the explicit policy measure or package by name and with a description that outlines its climate change mitigation potential and specifies the geographic scope of the policy. The evidence to assess these impacts was largely drawn from the reviews of the relevant academic and grey literatures undertaken as part of the DfT and Scottish commissioned studies. The DfT study identified more than 160 relevant documents across the academic and grey literatures on the basis that they contained research findings, rather than offering more general conceptual or theoretical/methodological discussions. It synthesised the evidence of these research terms in terms of their likely social and distributional impacts on different vulnerable population groups and geographical areas and then related these to DfT's proposed policy measures for climate change mitigation based on qualitative assessment of the evidence (see Table 1).

The Scottish study provided a detailed modelled assessment of the likely contribution to carbon reduction of the 22 policies that are devolved to the administrative functions of the Scottish Parliament (these are shown in columns 1 and 2 of Table 2). In column three we expand on the likely SDIs of the policy options. This allowed a much more accurate prediction of the likely abatement potential of different climate change policy packages against baseline 'do nothing' projections of CO_2 emissions from the transport sector in the case of two alternative scenarios,: i) Central Scenario – measures that could feasibly be deployed within the realm of public acceptability, ii) Ambitious Scenario – measures that would require a degree of 'forcefulness' to implement. The Scottish study also included measures of cost effectiveness and marginal cost abatement.

Stage 3: operationalizing the framework

We then operationalized the equity-proofing framework by applying this evidence-base and drawing on different climate change mitigation policies taken from the Scottish study. To give the framework a strong visual quality for policy-makers we devised a colour-coded system to indicating whether the overall effects under each criteria are strongly negative (Red), slightly negative (Amber/Orange), neutral (Blue) or positive (Green). This type of system is sometimes called a traffic light system and is likely to be well understood in policy circles, as it is found in measurement and indicator exercises such as performance assessment and State of the Environment reporting (Bell and Morse 1999). The intention is that the more detailed factual information sits behind this traffic light system and can be referred to if greater detail is required. In the interests of brevity, in this paper we demonstrate the approach using just one policy example. We then offer a critique of our approach and consider some next steps for its further advancement.

TESTING THE FRAMEWORK

The Scottish study calculated Marginal Abatement Curves for the 22 policy options. Cycle Infrastructure Investment had a Present Value per tonne of CO_2 abated of £170, which is considerably cheaper than measures for Active Travel management or investment in Bus/Rapid Transit Investment, for example. Therefore, we decided to use this policy as our example because cycling measures are frequently promoted as ‘low hanging fruit’ in different policy areas and by lobby groups as a *panacea* for a number of societal ills, such as health and obesity, providing low cost accessibility or tackling congestion, as a leisure and quality of life measure and as a measure that can reduce air quality problems in urban areas, including GHG emissions. Coupled with ease of implementation, this makes support for cycling politically attractive. However, there is also some research that suggests that there is differentiation on take up of cycling by the social groups that we are interested in, as identified in the next section of the paper.

Background evidence on take-up of cycling

Evidence about the effectiveness of cycling interventions is patchy and collected in non-commensurable ways. A number of studies find that correlation between cycling investment, and increases in cycling. However, as noted by Pucher *et al* 2010, there is a general lack of baseline assessment hampering firm conclusions about whether the increase is displacement of cycling from unimproved to improved routes, or represents an overall increase in levels of cycling. Findings from Wardman *et al* (2007) suggest that up to half the measured growth in cycling replaces car trips. Analysis of the UK National Travel Survey undertaken for the DfT study (AEA group, 2011) also demonstrates cycle use to be extremely unevenly distributed across the UK population. On average women make half as many trips by bicycle as men, a proportion that does not vary significantly by age. Higher income groups are more likely to cycle than their lower income counterparts and use is also extremely low amongst ethnic minority population groups. This makes it an interesting case study for an equity analysis of policies to increase cycling provision.

Operational assumptions

We had to make some basic assumptions in order to operationalize our framework. First we assess the SDIs of the selected intervention as if it was being applied consistently across the UK, rather than varying it by local authority as the data was not available at this geographical scale. We assume that policy support for the measures introduced remains in place in the short and medium term, and that the benefits/impacts of immediate adoption continue to be felt in the long term. We acknowledge that in the real world support for cycling falls into the remit of local authorities, and is thus not homogenous in the UK. In relation to uptake of cycling as a result of applying the measure, we think it is reasonable to assume that average cycling levels in the UK are unlikely to increase beyond the current Danish level of c. 25% of work commuter trips of less than 5 miles (current assumption of the ECI Transport Model). Thus 75% of commuter trips up to that distance would still be conducted by other means. The Central scenario of the Scottish study assumes cycling levels are increased fivefold to 10% mode share over all trips, 13% for those <7.5 miles, and in the Ambitious scenario, levels increase tenfold, to 20% mode share over all trips, 25% <7.5 miles. In the UK context, the Central scenario is probably the most feasible. Finally, our assessments for the defined time frames are for the current population as it ages, and those born up to 25 years from now. The matrix is left blank where there is a lack of such evidence and/or where we feel it is inappropriate to make an assessment due to conflicting expert views.

Social impacts

Overall, an investment in cycling infrastructure could be seen to be beneficial to individual or household wealth by reducing the cost of transport for those taking up cycling. However, take up of cycling is greater amongst affluent white men, than amongst other social groups. Therefore this level of aggregation hides the potential for inequitable distribution of this benefit. The impact of increasing cycling would improve physical fitness for new cyclists. A great number of studies have concluded that bicycling is healthy, as cited by Pucher *et al* (2010) and Ogilvie & Goodman (2011). Increased numbers of cyclists also make cycling safer as accidents reduce. Investment in cycling infrastructure potentially improves local accessibility for cyclists, and can also improve accessibility of rail transport providing parking provision is made for cycles at train stations and cycles are allowed to be carried in rail carriages.

Disaggregation of impacts

Income quintiles

Evidence suggests that lower income groups are less likely to cycle. Access to a bicycle is a prerequisite for cycling and lower income groups are less likely to be able to afford a bicycle. Therefore pursuit of this policy option will not immediately benefit these groups until easy-access cycle hire schemes become widespread. Work by Ogilvie and Goodman (2012) suggests that the London bicycle sharing scheme goes some way towards improving accessibility for those on lower incomes, as those from more deprived areas, though further from docking stations, actually undertake more trips. This suggests that there is latent demand in lower income areas, which should be prioritised in further expansion of the cycle hire scheme.

Vulnerable Groups

Age: Evidence from the Cycle to Work Alliance (2011) shows that most participants in Cycle to Work schemes are between the ages of 25-45. Evidence, such as data on cycling to school, shows that cycling levels have been dropping amongst younger age groups.

Gender: Ogilvie and Goodman (2012) also confirmed other research that finds that cycling in the UK is overwhelming male in character. Cycle to work schemes were introduced in 1999 and enable employees to purchase bicycles in a tax efficient manner. However, by definition they only benefit those who are employed and whose employer offers the scheme. Since 1999 only 400,000 people have taken up the scheme, through a total of 15,000 employers. Cycle To Work Alliance (2011) suggests that increasing safe cycle routes and providing changing facilities at work could encourage more women to participate, but do not consider other important factors, such as the increasing likelihood of female employees having escort trips or other errands, such as household shopping, embedded in their journeys to and from work.

Disability: Disabled individuals and households with a disabled resident may struggle to adopt cycling, depending on the nature of the disability. Disabilities are so diverse, that we were unable to find any academic literature focusing on disability and utilitarian cycling. On the whole, we must find that initial investment in cycling infrastructure has a negative impact on disabled groups as they are effectively excluded from it as a practical mode of transport, though a number of voluntary groups exist to encourage disabled people to take up cycling.

Ethnicity: Non-white ethnic groups also have lower levels of cycling (AEA Group, 2011). Our appraisal assumes that promotion campaigns are generic rather than targeted at specific groups.

Temporality: We have assumed that the full effects of increased provision of cycling facilties and targeted promotion build up over time, as Pucher and Buehler (2008) highlight that the successful and widespread adoption of cycling in the Netherlands, Germany and Denmark has taken three decades to achieve, but against a context that was otherwise similar to the drop in cycling that was seen in the UK between the 1950s and the 1970s.

Area effects: Rural communities will tend to lose out on these measures party because it is difficult to introduce bespoke cycling infrastructure on rural highways and partly because many rural communities in Scotland are quite isolated and so have long distances to travel in order to access local services.

Policy recommendations for improving equity outcomes

Working this evidence base through our proposed framework reveals aspects where adoption of this policy needs careful design. For example, a policy that invests in cycling infrastructure needs to be supported with targeted promotional and support programmes to encourage greater take up of cycling amongst lower income and socially vulnerable or disadvantaged groups, such as cycling initiatives in schools/youth clubs, and measures to support ethnic groups to try cycling, in order to maximise and more fairly distribute the aggregated benefits to wealth, health and accessibility. Easy to access cycle hire schemes are an important element in widening access to casual cycling, bypassing the need for personal investment in hardware. The range of reasonably priced cycling hardware available in the UK needs to appeal to a greater number of potential cyclists. For example, even a casual visitor to Denmark or the Netherlands can see that a wider variety of basic bicycles are available: cycles with provision for carrying young children and/or bulky loads such as shopping, feature prominently, and enable parents to cycle more.

CRITICAL DISCUSSIONS OF THE APPROACH AND NEXT STEPS

From the research we have undertaken to develop this paper we can conclude that the application the use of an equity-proofing framework such as the one we have presented could potentially enable policy makers to more readily identify how different social groups may affected by different climate change mitigation measures in the transport sector. Our framework would better enable them to identify the most equitable measures and to protect the most vulnerable groups from the worse effects of less equitable outcomes measures amongst candidate measures with good carbon reduction credentials. However, our research has also identified that, whilst it may be relatively easy to construct such a methodology in theory, the actual social and distributional impacts of transport decision-making, whether in the UK or elsewhere, is generally very poorly evidenced. Furthermore, at present, very little information is being gathered to robustly evaluate the actual impacts of such measures on the ground and this undermines the real world application of such a methodology.

Our limited desk-based research in this area has confirmed that different social groups do experience very different outcomes in accessing transport and adapting to changes to the transport system, whether these are uniquely targeted towards individuals or more systemically applied. We consider that the nuances of population and area-based vulnerability are of critical importance in assessing the social equity of all policies, but particularly for policies intended to address climate change, as to be effective these policies will need to be hard-hitting and unilaterally applied to all travel activities and across all population sectors, and are also being rolled out in other energy-related policy areas.

Climate change, transport, access and mobility and social inequality are all the external manifestations of complex environmental, economic and social policy systems and as such there are no simple solutions to the problems they create, let alone for the problems resulting from their interactions. There are a number of conflating factors that could result in substantial unintended social impacts from climate change mitigation. For example, the extreme weather effects of climate change will impact on the resilience of the transport network, causing temporary disruption or permanent changes, e.g. to coastal railway routes. These extreme weather effects also impact on housing, further disrupting habitation and travel patterns if large numbers of households are temporarily or permanently displaced and dispersed. This could adversely impact on the provision of bus routes, for example. At the same time transport is likely to come under increased pressure from fuel price rises as global oil resources become increasingly constrained (often referred to as 'peak oil'). Both 'peak oil' and climate change will impact on all other sectors, particularly food production, manufacturing and energy supply, raising prices and adding further burdens to household budgets, which will impact on travel behaviour in unpredictable ways and all of which need to be assess in evaluating the social justice of policy interventions.

At present a number of local transport authorities in the UK (and elsewhere) are enacting numerous policy measures in an attempt to respond to the government's climate changes mitigation strategy. Many of these projects are small-scale and piecemeal and so fall beneath the radar of any formal *ex ante* or *post hoc* impact analysis. We would suggest that this is a serious oversight in the current policy process, particularly if the intention is to scale-up these programmes over time.

Finally, it is our ambition to be able to apply our equity-proofing framework in the case of a live scenario where it can be supported by evidence of the actual impacts and social outcomes of a 'real world' project and its utility tested and discussed *in situ* with policy-makers and other stakeholders. Secondly, we feel that the methodology would be greatly enhanced if it were to be adapted to a computer software application that is capable of modelling the impacts of different policy measures against different scenarios (e.g. at different levels of intensity, spending, take-up and in different geographical settings and social contexts).

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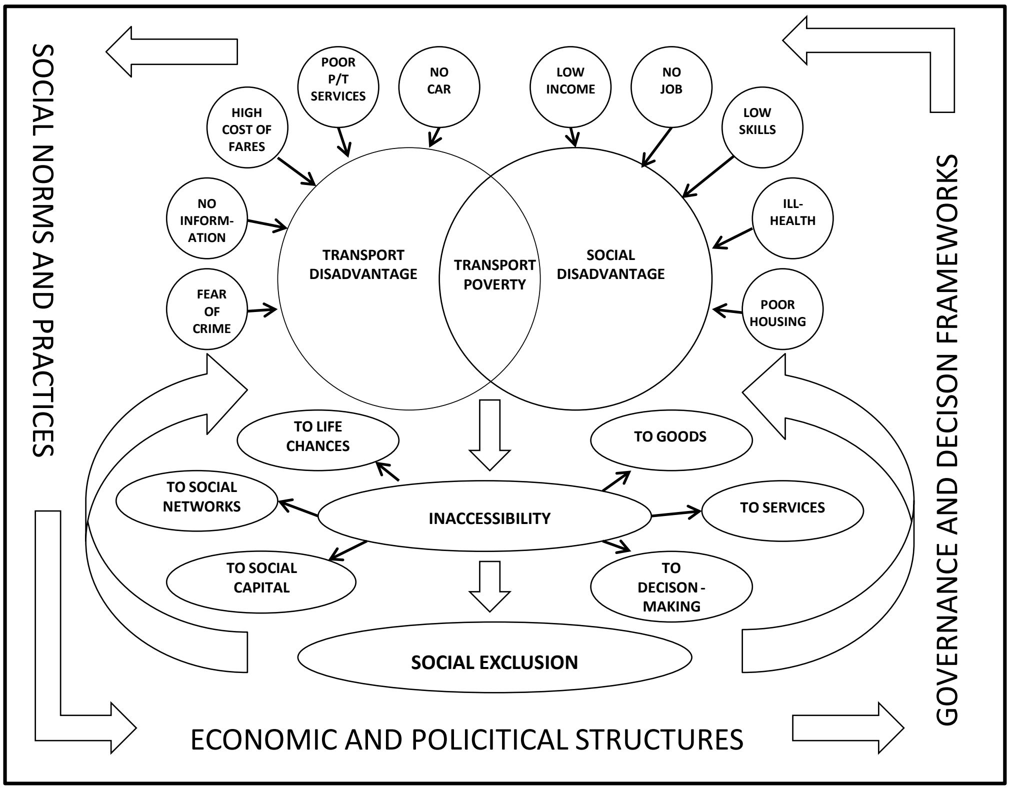
Table 1: Policies and assessment criteria for the DfT study (Source: AEA Group, 2010)

Climate Change Policies	SDIs	Vulnerable Groups & Areas (based on previous studies for DfT by Parkhurst and Shergold, 2009)
1. Reducing trips a. local road pricing, b. congestion charging c. parking schemes 2. Improving the utilisation of vehicles a. car sharing, b. greater use of public transport c. promoting walking and cycling 3. Encouraging the purchase and use of more efficient vehicles a. purchase of electric vehicles b. eco-driving 4. Promoting the use of alternative fuels a. electric vehicles b. bio-fuels	1. Risk of accidents 2. Security 3. Physical fitness 4. Local air quality 5. Terrorism 6. Noise 7. Biodiversity 8. Water environment 9. Landscape 10. Heritage 11. Journey ambience 12. Option values 13. Transport interchange 14. Townscape 15. Severance 16. Reduced journey times 17. Access to transport system 18. Regeneration 19. Regional imbalance 20. Affordability 21. Reliability 22. Connectivity 23. Housing - Land use policy 24. Resilience 25. Wider economic impacts	1. Young people. 2. Low income households, especially: i. Longer distance commuters (private car). ii. Single parent households. iii. Parents with teenage children. iv. Women in single car households (high levels of trip chaining). v. Households living in rural areas. 3. Black and minority ethnic groups. 4. Disabled people. 5. Older people. 6. Women

Table 2: Policies and assessment criteria for the Scottish study (Source: expanded from Atkins/University of Aberdeen, 2009)

Package		Policy options	Potential SDIs
1	Technology	1. Electric car technology and network development 2. Procurement of low carbon vehicles	Unaffordable for low income groups, but could have air quality benefits at point of use (but negative effects at point of generation)
2	Driving Style (eco-driving)	3. Active traffic management 4. National motoring package 5. Speed reduction on trunk roads	Less beneficial for low income groups, apart from potential for improved fuel efficiency
3	Car Demand Management: Fiscal/Infrastructure	6. Bus/rapid/mass transit infrastructure investment (inc. bus priority) 7. Cycle infrastructure investment 8. High Speed Rail links 9. National network of car clubs 10. National road user charging 11. Introduce/ increase public parking charges 12. Rail investment 13. Introduce/raise residential/private parking charges 14. Bus/LRT fares reductions 15. Walking infrastructure investment 16. Workplace parking levy	6,12 = Likely to be beneficial to low income groups if the design appropriately (i.e. right areas, right ticketing and service types) 7 = Evidence suggests these interventions favour fit professional males at present 8 = likely to be exclusive due to cost of use 9 = potential for benefiting lower income groups who cannot otherwise afford to use a car 10 = whether this is social progressive or regressive is dependent on instrument design 11,13&16 = regressive for low income/car dependent groups 14 = beneficial, but may offer perverse incentives to increase overall travel amongst all groups 15 = should be beneficial
4	Car Demand Management: Smart Measures	17. Bus quality contracts/statutory partnerships 18. Widespread implementation of travel plans 19. Provide community hubs	17&18 = Likely to be beneficial to low income groups if the design appropriately (i.e. right areas, right ticketing and service types) 19 = potentially boosts accessibility but location important
5	Freight	20. Freight best practice	Should be beneficial if leads to air quality improvements and optimises loading (reduces vehicle movements)
6	Land Use Planning	21. Urban density increases	Potential for exclusion if segregation and gated communities emerge
7	Aviation	22. Improve public transport surface access at airports	Potentially beneficial for the large numbers of low paid employees at airports, but overall SDIs hard to identify

Figure 1: Diagram to illustrate the relationship between transport disadvantage and social inequality



Source: Lucas, 2012: 107

Figure 2: Application of the equity-proofing framework for cycle infrastructure investment

Policy Package	**Description**
Cycling Infrastructure Investment	This policy targets investment in high-quality cycling infrastructure and promotion to secure mode switching from short and medium term car journeys to short cycling trips. Motivation to switch will come from travel cost reduction, time savings in congested areas, and health benefits. Investment will target the main barrier of safety concerns by developing cycle routes and lanes, advanced stop lines, cycle parking facilities, provision for bicycles on public transport, cycle rent schemes in cities, introduction and enforcement of cycling parking standards for new developments, and cycle promotion in all urban areas.

	Aggregate social impacts			**Income Quintiles**					**Vulnerable groups**				**Resilience**
	wealth	**health**	**accessibility**	**1**	**2**	**3**	**4**	**5**	**Age**	**Gender**	**Disability**	**Ethnicity**	**Cumulative effect on households**
Immediate	●	●	●	●	●	●	●	●	●	●	●	●	●
Short term (1-5 years)	●	●	●	●	●	●	●	●	●	●	●	●	●
Mid term (6-10 yrs)	●	●	●	●	●	●	●	●	●	●	●	●	●
Longer term (11 – 25 yrs)	●	●	●	●	●	●	●	●	●	●	●	●	●