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ASSESSING THE EQUITY OF CARBON MITIGATION POLICIES FOR TRANSPORT IN SCOTLAND

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Research Highlights

1. The case study focuses on new policies for carbon mitigation in the domestic transport in Scotland.
2. It develops an appraisal framework to assess the social equity impacts of these policies.
3. It tests the framework using three different policy examples taken from the Scottish Strategy.
4. It finds that data is extremely limited data for the robust evaluation of their social equity effects.
5. Social groups already at risk of transport exclusion may become further marginalised.

Abstract

Different social groups exhibit diverse travel behaviours and will thus experience very different outcomes in adapting to any changes to the transport system. This paper is concerned with making more transparent the equity implications of transport policies that are designed to change people's travel behaviours; explicitly those designed to mitigate the carbon impacts of the domestic transport sector. This is a relatively new area of transport policy delivery within the United Kingdom and elsewhere and, as yet, social equity considerations appear to be largely absent from the policy debate. This is in part due to a lack of suitable policy appraisal tools to identify their social consequences of such policies at the national and local level.

To this end, we have developed an evaluation framework to test the social equity effects of the carbon mitigation policies for transport. The paper offers an example analysis of three policy measures that selected from Scotland's strategy for mitigating climate change in the transport sector. The case study has been chosen because the necessary strategy and policies are already well developed and so sufficient information is available to evaluate its likely behaviour changes outcomes. The paper concludes that there is a significant gap in both scientific and policy knowledge in this area and that a universal lack of data (i.e. not only in Scotland but internationally) is a major barrier to the robust analysis of the equity impacts of climate change mitigation measures. It also identifies some potential avenues for future research.

Keywords: transport policy, social equity, appraisal methodology, carbon mitigation, Scotland

INTRODUCTION

The aim of this paper is to explore the likely social equity implications of carbon mitigation in the domestic transport sector using the example of policies proposed for Scotland within the United Kingdom (UK). The paper is set in the wider context of the global imperative to reduce the total energy use and carbon intensity of our everyday social practices. As Anable et al (2012) have noted, there is currently general failure amongst policymakers to recognise the potential inequities and potential social exclusion implications that are embedded within the policies adopted in the UK to reduce transport-related carbon. We would argue that one of the key reasons behind this failure to identify the potential equity implications of carbon mitigation measures for domestic transport lies in the absence of suitable methods to systematically identify the social and distributional impacts (SDIs) of different policy measures. Despite the considerable attention of the academic environmental justice literatures, formal social impact appraisal (SIA) has no statutory status in the UK and is used very rarely within policy appraisals (Walker, 2010). Furthermore, a study for Friends of the Earth which evaluated 16 different tools for policy impact assessment noted that all the current methods used were weak on establishing the distributional of effects of policies across different groups and areas (Walker et al 2007).

This is becoming an increasingly important policy agenda not only in the UK but worldwide in light of the recent announcement by the Head of the World Bank that climate change will lead to battles over water and food over the next ten years unless more radical policies and measures are put in place to mitigate and adapt to its impacts (The Guardian, 3 April 2014). The domestic transport sector is likely to become a focus for such policies because people's current transport practices are extremely carbon intensive. However, the risk of social inequities arising from the implementation of these policies is very high because of the already extremely uneven distribution of transport 'goods' and 'bads'. For example, within the UK 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 as many journeys as those in car-owning households (Department for Transport, 2011). These inequities are often geographically specific in many instances, concentrating in social housing estates on the urban periphery (Sterrett et al., 2012; Power, 2012) and in older, more isolated rural settlements (Owen, et al., 2012; Velaga et al., 2012), that are less well-served by public transport.

It is within this wider social context that we place our paper with the aim of offering policymakers a simple but effective way to evaluate the potential SDIs of their carbon mitigation policy interventions. Although we have used a Scottish example within the paper, the framework should be broadly transferable to other geographical contexts and is applicable at either local or national scales. It is also relevant beyond the climate change mitigation policy arena and could be used to evaluate the potential SDIs of transport projects and programmes targeting other objectives (which also may be a subset of the measures for carbon mitigation), such as major infrastructure investments, parking policies or pricing mechanisms.

DETERMINING THE EQUITY IMPLICATIONS OF CLIMATE CHANGE POLICIES FOR TRANSPORT: POLICY CONTEXT

To assess the equity implications of climate change policies for transport, it is first important to understand the nature and scale of the problem posed by transport in relation to climate change. Globally, transport accounts for about 19% of total energy use and about 23% of energy-related CO_2 emissions. This is because transport is almost completely dependent on fossil fuels: in OECD countries nearly 60% of oil consumption fuels mobility, which is a significant driver of increasing oil demand. The International Energy Agency (IEA) predicts that transport energy use and associated CO_2 emissions will have increased by 50% by 2030, and by more than 80% by 2050 on current trends (IEA, 2009). Policy reliance on technological optimism assumes that efficiency will

improve, but in the UK the current trend is that transport is increasing in energy intensity (up 3% between 1970 and 2010) (DECC, 2011). To reverse this trend will be challenging and potentially unpalatable policy frameworks will be required.

In 2008, the UK government set a binding commitment to decrease greenhouse gas (GHG) emissions by 80% (on 1990 levels) by 2050 through the 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 UK has a devolved political structure, and London, Scotland, Wales and Northern Ireland have their own policy frameworks in place to meet the UK commitment. In England, responsibility for delivery of carbon mitigation in transport policy has been passed to local transport authorities via the Carbon Plan (HM Government, 2011) To support transition in England (not London, Scotland and Wales), the UK Government has earmarked a total of just under £1 billion, spread across a mix of consumer incentives, the Local Sustainable Transport Fund for active travel and public transport measures, small local transport improvement schemes, and a Green Bus Fund to stimulate purchase of low carbon buses.

To assess the likely equity impacts of this new focus in transport policy, it is important to understand the context of the current status quo in the distribution of travel behaviours in the UK. 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% compared with nine per cent (Dainton, 2008). However, for low-income car-owning households, the impact of travel expenditure is much higher. 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 maintaining car mobility (Lucas et al, 2001, Sustainable Development Commission 2011). Roughly half of households in the lowest income quintile now own at least one car (DfT, 2011). As fuel prices have started to rise significantly, recent analysis by the RAC Foundation (2012) estimates that as many 21 million UK households (i.e. 80%) could be described as being in 'transport poverty' through spending more than 10 per cent of their income on transport. The concept of transport poverty has been borrowed from the long-established concept of 'fuel poverty', which was formerly defined as existing if a household expends 10% of its income on maintaining an acceptable level of heat in the home. Obviously, 10% for a high income household is much more affordable than 10% of income for the poorest household. The new definition of fuel poverty used by the UK government states that fuel poverty exists if a household pays more than the national median level for domestic fuel and paying those higher costs leaves household residual income below the official poverty level. In 2010 2.5 million English households were in fuel poverty by this Low Income High Costs indicator (DECC 2013). In relation to mobility, there is no official definition of transport poverty, and setting a percentage level would have the same drawbacks as was the case for fuel poverty. More conservatively, Sustrans estimate that 1.5 m people are at risk of some kind of transport poverty (in England), using an appraisal method that overlays areas with low incomes, areas with a high population more than a mile from a public transport route and areas where it takes more than an hour to access essential goods and services by public transport, walking or cycling (Sustrans 2012).

Therefore, at the very least transport policies that increase the cost of everyday travel by car put low-income car dependent households at risk of social exclusion. While it is usually still possible to access employment and other key activities by public transport within most UK metropolitan areas, at least during the day, public transport privatisation outside of London during the mid-1980s has played a role in reducing levels of accessibility for non-car owning households outside the major conurbations. Consequently, access to a car has become almost essential to reach a wide range of essential and leisure activities (Power, 2012). To relate this back to carbon mitigation policies for transport, at the other end of the income spectrum research shows that the richest ten percent of the population may be responsible for more than 80% of the total greenhouse gas emissions from

personal travel in some parts of the UK (Brand and Boardman, 2008). This is clearly important in terms of evaluating the equity of carbon mitigation policies because it highlights that it would be both fairer and more efficient to introduce polices that target these higher consumers.

PAST RESEARCH ON THE EQUITY EFFECTS OF TRANSPORT POLICIES

The concept of equity relates to how social benefits and disbenefits are distributed across society and space. However, there are mutually exclusive principles of what constitutes equity; for example, utilitarian, equal shares, Rawlsian, egalitarian, minimum floor and maximum range (Thomopoulos and Grant-Muller, 2013). For the purposes of this paper we are agnostic about the underlying principle by which equity should be decided, as our aim is that our framework should transparently disaggregate the distribution of impacts. It is for policy-makers to decide on what principle should be used to decide on equitability. For the purposes of this paper, we refer to the range of social and distributional impacts (SDIs) as 'equity effects'. Identifying the 'equity effects' of policies is not straightforward. Several bodies of research are useful to this line of enquiry. The first 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). This literature highlights that there is both considerable ambiguity about what constitutes a social impact and confusion between direct social impacts and distributional impacts that are the indirect effects of environmental and economic impacts (Jones and Lucas, 2012). Whilst SDIs are related, they are not the same.

A second fruitful source of information is the research examining transport-related social exclusion. Lucas (2012) offers an overview 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 goods, services, life chances and social support. Her research suggests that the wider policy context in which these groups operate is important 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. As such, policy-makers not only need to understand the impacts of their intended policies but also the wider economic, environmental, social and political contexts in which they will be enacted. Martens (2006) attempts to take this one step further in exploring what transport planning would look like if it was based on achieving social equity.

The third body of relevant research has explored the distributional and equity impacts of different types of transport policies. Few studies specifically focus on the equity effects of carbon mitigation policies for transport, we were able to identify only two (Santos and Catchesides, 2005 and Bureau, 2011) both were looking at carbon taxation policies.

A final body of research considers the health impacts of transport. This is much better developed in terms of understanding the direct and indirect impacts of transport on health, and Health Impact Assessment has developed as a distinct application field. However, there is a suggestion that this largely repackages other impact assessment methods under the 'health' label, and it is generally carried out separately to other SDI evaluations (Markovich and Lucas, 2011).

It is reasonable to conclude, therefore, that no studies are entirely comprehensive in terms of both their coverage of the range of equity effects (impacts on accessibility/social inclusion, health and wealth) and of a full range of carbon mitigation policies for transport. Nevertheless, there is general agreement across the literatures that important factors to consider are the impact of fiscal measures on transport affordability for low-income groups, whether accessibility to activities is undermined for people at risk of social exclusion, and whether health and safety considerations are observed. For example, Harrison and Shepherd (2013) have studied the short-term (to 2020) impacts of introducing low carbon vehicles (LCV), in a Californian (USA) context. They identified uneven

distribution of the burden of cost in shifting to LCV and a reduction in the affordability of vehicles as a result of pursuing such a shift in order to mitigate carbon emissions.

With regards to fiscal policy measures such as road pricing, congestion charging and parking charges, these are broadly considered to be socially progressive, in that higher income groups own and use cars more than those on low incomes, and can afford higher costs. However, this is a very weak progressiveness, as there is a risk that low-income drivers can be very adversely affected, e.g. those who work in a charging zone, but live outside of this area and are car-dependent to access their job. 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), but fiscal measures can promote take up of energy efficient transport. Stimulating the purchase/use of energy efficient private vehicles could marginally improve the affordability of new car purchases for some low-income households. However, increasing the cost of 'ordinary' vehicles would impact negatively on lower-income households. There could also be short-term, knock-on effects that increase second-hand car prices, again adversely affecting lower income households who are more likely to purchase second-hand vehicles (which are generally less fuel efficient than new car stock) (AEA Group, 2011).

There are 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) and on equity appraisal of transport infrastructure investments (e.g. Thomopoulos and Grant-Muller 2013). Policies to encourage modal shift onto public transport are generally considered not very efficient for carbon mitigation because they mainly lead to increased use by existing users and the high income, highest emitters are often the most resistant to modal shift (Brand and Boardman, 2008). Whilst low-income groups (particularly lone parents, young people, disabled and the elderly) benefit more from bus service improvements than from rail service improvements, 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. 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.

METHODOLOGICAL APPROACH

Our theoretical analysis was stimulated by two government-commissioned consultancy projects in which the authors were involved as independent academic advisors. The first of these was for the DfT conducted by AEA Group (2011) and the second was for the Scottish Government (SG), conducted by Atkins and the University of Aberdeen (UoA) (2009). Both studies were limited in their assessment of the social equity implications of the policies that were reviewed and we wanted to improve on this. Our method involves three main stages described in more detail below: i)select the assessment criteria, ii) develop a framework to assess and visualise the results and iii) test the framework on a set of 'real world' policies, which we now describe in more detail.

Stage 1: identifying the assessment criteria

The assessment criteria for the framework were selected from three systematic reviews of the relevant literatures (Atkins and University of Aberdeen, 2009; Parkhurst and Shergold, 2009; AEA Group, 2011) (see Table 1)). We used the 22 key transport policies for carbon-mitigation identified in the Scottish report (Atkins/UoA 2009) (column 1 and 2) as our exemplar policies to test the assessment criteria via our proposed framework because this report represents the first comprehensive effort to create packages of transport policy measures by their carbon mitigation potential.

Using the literature (including the report for the DfT, AEA, 2011), we then identified 25 potential social and distributional impacts (SDI) relevant to carbon mitigation policies for transport (column 3). In the aggregate, these SDIs will affect overall wealth, health and accessibility. Therefore in our framework we provide an aggregate assessment of the impacts of the policies under those three headings, which are commonly found in the social exclusion and transport appraisal literatures: i) wealth impacts – to denote any significant changes to the cost of transport (e.g. a significant increase to household transport budgets could tip more households into transport poverty), ii) health impacts – to denote any positive or negative health affects (e.g. accident reduction, overall improvements in air quality 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).

However, an aggregated evaluation can obscure significant disbenefits to sub-groups in the population. To control for this in our framework we also disaggregate these social impacts in three ways to capture the multiple dimensions of impact: i) according to the differential impacts across income quintiles (where 1 is the lowest income quintile in the population, and 5 is the highest), ii) according to different vulnerable 'at risk' groups (i.e. by age, gender, disability and ethnicity); these selected groups align well with the different equality groups considered in the Equalities Measurement Framework advocated by the Equality and Human Rights Commission (Alkire et al, 2009), itself generally compatible with the Equalities Impact Assessment procedures adopted by UK governments, and iii) according to geographical vulnerability. This third dimension is not worked through in this paper, but the intention here is to also be able to incorporate consideration of the needs of areas particularly vulnerable to the effects of climate change (e.g. coastal area or flood plains) in addition to the pre-existing fine-grained geographic context in which the policies are to be delivered (e.g. if anti-car measures are proposed in areas that are inadequately served by public transport with no accompanying boost to that provision).

Critically, we also add a fourth criteria, 'temporality', to uncover how the dynamics of positive/negative impacts for different groups change over time across four time periods (immediate, short term (1-5 yrs) mid-term (6-10 yrs), long (11-25 yrs). 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 potentially link the continuing effects of policies to the unfolding impacts of climate change itself, such as increased flooding on coastal floodplains damaging public transport infrastructure. However, that exercise is beyond the scope of the present paper.

Table 1 near here.

Stage 2: establishing the evidence-base for impact assessment

The Atkins/UoA (2009) study provided a detailed modelled assessment of the likely contribution to carbon reduction of the 22 Scottish policies. This provided worked-through predictions 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 coercion to implement. The Scottish study also included measures of cost effectiveness and marginal cost abatement.

The available evidence-base to assess the social equity impact of the changes in travel behaviours that will arise from such policies was much less robust. This was largely drawn from a review of

more than 200 relevant documents describing research findings from past travel behaviour change experiments and demonstration projects (AEA 2011). However, the review concluded that the results of these programmes were often poorly recorded, rarely subjected to systematic evaluation of the direct and indirect effects on different social groups. The degree of programme success often appears to be based on conjecture rather than actual data. This remains a problem for our own analysis, which was not able to greatly improve upon this evidence base despite a considerable further review effort. A key finding of our research, therefore, is that a much more sustained effort is needed to collect empirical data and systematically identify the SDIs of transport interventions with carbon mitigation objectives.

Stage 3: testing the framework

Next we conducted an exercise to operationalise the equity framework by applying the available evidence-base (and drawing on our own judgement where that evidence base is lacking) to climate change mitigation policies taken from the Scottish study. The intention is that more detailed actual information can be provided as a supplement to this traffic light system and can be referred to by the policymaker. This was not possible within the scope of our own enquiry because in most instances the statistical evidence is unavailable and would require further empirical research.

In the interests of brevity, we discuss the outcome of our assessments for just three different examples of transport policy from the Scottish Study (see Figures 1-3 below), although all 22 measures were analysed in the same way in our study. We recognise the limitations of this partial analysis, but it is not possible to report in detail on all 22 measures in the strategy and so we have selected those that were earmarked as having the greatest potential social impact implications (positive and negative) by the Atkins/UoA (2009) study. These three policy packages usefully cover three types of mode that commonly feature in transport policies around the world – cars, public transport and cycling, and there is sufficient variety between them in terms of the outcome of our assessment to illustrate our point. We acknowledge that the measures we evaluate all happen to be 'pull' (or carrot) measures rather than 'push' (or stick) measures, which arguably would have much greater negative impacts for some groups. However, 'pull' measures are often thought of in a positive light which characterises them as progressive in comparison to push measures, and it is useful to highlight that the reality is more complex.

One of our objectives was to give the framework a strong visual quality for policy-makers, so we devised a colour-coded system to indicate 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). This can be altered to distinctive symbols where the use of colour is not appropriate.

In our discussion of the SDIs of specific policy packages that follows, we have used our best judgement and knowledge in a qualitative manner based upon an extensive evidence review of the available literatures (AEA Group, 2011). We have not applied any specific statistical modelling techniques or analyses, as we were more concerned to draw up a specification of the research that is needed for more systematic equity assessment of these policies. Our own desk-research has shown that in most instances the necessary quantitative evidence for populating these assessment frameworks is largely absent and that further data collection and analysis is needed. However, we take the Scottish context of relative poverty as our baseline (using Scottish Government 2013). In 2011-12 around 15% of the population was experiencing relative poverty (an income lower than 60% of the median income). This equates to 710,000 individuals (150,000 children, 420,000 working age adults and 140,000 pensioners (15% of total pensioners in Scotland).

In the visualisation framework, our choice of colour/symbol for the indicator is a subjective one based on our assessment of available literature and data. Regarding the temporal distribution of impacts, we have assumed that as time passes, the impacts of policy introduction will change. Policy types that are known to take time to take effect might have more positive impacts for more groups in the medium term rather than in the short term for example. Other policies have their largest impact at introduction, and make less difference going forward. However, it is harder to foresee very long-term impacts. As climate change is progressive, we have attempted to address inter-generational equity by including a row for 'future generations'. However, our assessment is highly speculative. Sometimes we have chosen to leave a cell in the matrix blank in the absence of any information. If this was to occur in a real exercise, this would clearly signal to policy makers that there is a signification data gap that needs to be filled or that they must make their decision in full awareness of areas of inevitable uncertainty.

DISCUSSION OF EXAMPLE EQUITY ASSESSMENTS

In the section that follows, we work through three examples from the 22 polices in the Scottish Strategy. The examples have been selected because they demonstrate a range across the different types of interventions in that i) is car-based - the National Motoring Package, which is a package of measures aimed at reducing fuel use by cars and motorcycles whilst driving (also referred to as 'eco-driving'), ii) is public transport-based - the Light Rapid Transit/Bus fare reduction measures and iii) focuses on cycling infrastructure investment policies. They also offer a broad demonstration of the SDIs that are likely to arise from different types of policy mechanisms, e.g. pricing, voluntary behaviour change, infrastructure provision, etc.

Example 1: National Motoring Package (eco-driving)

Adoption of eco-driving techniques, which combine driver behaviour and vehicle maintenance measures, can reduce fuel consumption by between 10-15% (e.g. Barkenbus, 2010). In-vehicle tools, such as tyre pressure gauges, gear shift indicators and fuel consumption information, can deliver further improvements (Wu et al 2011 estimate between 12 and 31%). Therefore, this transport carbon mitigation policy is given quite a high priority in the Scottish report.

Figure 1 near here.

Social Impacts

We could find no specific material considering the social impacts of eco-driving, therefore assessment has to be pieced together through inference from what has been investigated in relation to eco-driving. By definition the policy is aimed at drivers, who would be the primary beneficiaries.

Wealth

An eco-drive policy accompanied by subsidies for in-car instruments such as fuel-economy meters, gearshift indicators, tyre pressure gauges etc. could reduce the cost of motoring considerably through the initial fuel savings. There would be a certain amount of induced driving in a rebound effect, which could cancel out the savings overtime – Beusen et al (2009) estimate that rebound occurs within 1 year. Over the longer term therefore, the net benefits vanish and become negative impacts as no shift away from driving has been achieved, and long-term trends in carbon-based vehicle fuel prices are upwards. This will impact more immediately on lower income households who have remained car dependent as a result of the short term financial amelioration of the eco-driving measures.

Health

Lowering the cost of motoring maintains sedentary practices, and does not encourage active travel. Aggregate health impacts are negative due to the increased driving, though there could be some

reduction in accident rates and severity from moderated driving styles. The negative psychological impacts of community severance from busy roads is not addressed by eco-driving measures, though there is some evidence that adoption of eco-driving is likely to have some positive external health, social and economic effects through a reduction in road traffic noise (Schlacter et al 2012).

Accessibility

Lowering the cost of motoring improves local accessibility for car drivers, but not for other groups, as local accessibility and public transport accessibility is either unchanged or reduced through congestion. Rural car drivers would benefit temporarily as a result of a lowering in cost of motoring, and the effect on fuel efficiency of eco-driving styles for their typically longer journeys would have stronger benefits than for town dwellers with very short journeys. As indicated above, this would be a short-lived benefit as it does not address the long term difficulties with rising fuel prices and does not support modal shift.

Disaggregated impacts

Income quintiles

Groups with higher mileages will benefit the most, therefore the policy could benefit higher mileage low-income car owning households in the short-term. However, overall higher income individuals and households tend to drive more than those on lower incomes, and will therefore benefit disproportionately.

Vulnerable groups

Socially disadvantaged groups are unlikely to specifically benefit from such a policy, whether because of age, gender, disability or ethnicity. However, there does not seem to be any evidence of direct disbenefits.

Recommendations

Eco-driving is a weak option in relation to its equity impacts and would primarily be a short-lived benefit for higher income groups. Low-income drivers with older vehicles could utilise eco-driving to achieve a 10% saving, but would have to maintain their behaviour change in order to maintain the reduction. Continued rises in fuel prices would make any benefits short-term, but it provides a stop-gap measure as vehicle fleets shift to new fuels and power sources (such as electric vehicles) in the longer term. By itself this policy does not address the distributional balance in terms of access to transport and it is important that policy-makers should be aware of this.

Example 2: Bus/LRT Fares Reductions

ECMT (2007) found that whilst a reduction in fares of 10% can boost patronage by between 5-9% on average, between 10-50% of that increase comes from diverting people from away from active travel modes, making it counter-productive for both climate change mitigation and health-related policies. The UK experience free concessionary bus travel tends to result in a 30% increase in patronage by those entitled to the concession (Currie and Wallis, 2008). However, some evidence does suggest that cheaper, simpler fares can attract car users to public transport, though those car users are quite likely to have been passengers rather than drivers (Bristow et al 2008). Longer term benefits to land use and travel patterns can be underpinned by the increase in public transport patronage (Atkins/UoA 2009). Reducing public transport fares is an expensive policy to implement.

Figure 2 near here

Social Impacts

Wealth

Reducing the cost of bus and light rail services is potentially most beneficial to existing public transport users, as it reduces their expenditure on travel, and could liberate latent demand, something that has been found where free bus travel has been introduced for people over 60 yrs (Rye and Mykura, 2009; Andrews et al, 2012).

Health

The policy is not beneficial overall to health, as it could have a negative impact on the health of those who switch from active travel modes (as noted above), though those transferring from car travel would experience a marginal improvement to health from additional walking or cycling to access public transport. Those whose mobility is improved by the policy would probably experience improved well-being, but there is not yet enough empirical data about the scale of the effect.

Accessibility

We have assumed that benefits build up over time as land use and travel patterns are altered by increased public transport patronage. Currie and Wilson (2008) report that growth in bus patronage as a result of bus service improvements (including fare reductions) are greater in the long term than in the short term. However, the increased cost of administration of a subsidy system to reduce fares could result in some peripheral services being cut to focus expenditure on core routes, which would further disadvantage communities already affected by lower service levels.

Disaggregated impacts

Income quintiles

This policy would benefit lower income groups who are already dependent on public transport by lowering costs. Higher income quintiles, which make less use of public transport, would experience fewer economic benefits, except where car users are attracted to frequent or regular services (i.e. where there are at least two services an hour) (Currie and Wilson, 2008).

Vulnerable groups

Age, gender, ethnicity: This policy would be good for younger people, women and ethnic groups who are greatest users of public transport but currently do not receive concessionary fares in most places. Young people in London do have free bus travel, and it has been shown that this has positive impacts on their wellbeing (Jones et al 2012).

Disabled groups would not be specifically benefited by this policy, as it does not address the physical accessibility of public transport, only its cost.

Recommendations

Reduced fares are likely to benefit existing bus/LRT users and so would most positively benefit low income and some socially disadvantaged groups living in inner urban areas (not the older or disabled people who already have free fares, nor those living where bus/LRT services are sporadic or absent). Additionally, it could also encourage new patronage through modal shift, though as noted above that shift is not necessarily from cars, and could generate health disbenefits. We would also recommend assessing the indirect SDIs arising from the likely high cost of implementing this policy package.

Example 3: cycling infrastructure investment

Evidence about the effectiveness of cycling interventions is patchy and collected in non-commensurable ways. A number of studies find a 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. Here, 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 Atkins/UoA (2009) 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.

Figure 3 near here

Social Impacts

Wealth

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 generally greater amongst affluent white men than amongst other social groups. Therefore this level of aggregation hides the potential for inequitable distribution of this benefit. Over time, the wealth benefits of increasing cycling would trend towards neutrality.

Health

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). We have assumed that the increased numbers of cyclists also make cycling safer overall as accidents will be reduced with less motorised traffic on the road and more of a cycling culture is established. We also assume that the health benefits of increasing cycling would at some stage in the future plateau as the number of cyclists within the population stabilises over time.

Accessibility

A relatively small investment in cycling infrastructure can improve local accessibility and access to public transport if integrated with stations and other transport hubs. However, to be fully effective they must be supported by targeted travel-awareness and cycling promotion and training initiatives to encourage their wider take-up. Over time the behaviours can become.

Disaggregated 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 Cycling to Work Alliance (2011) shows that most participants in Cycle to Work schemes are between the ages of 25-45. Evidence on cycling to school shows that cycling levels are very low and static amongst the young (Steer Davies Gleave, 2012). Cycling at least once a week amongst all age groups in England has dropped slightly, to 14.7% (DfT, 2014).

Gender: Cycling in the UK is overwhelming male in character (Ogilvie and Goodman 2012, DfT/Sport England 2014). 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 (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 tasks, 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. 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.

Ethnicity: Non-white ethnic groups also have lower levels of cycling (Steinbach et al 2011, DfT, 2014). Our appraisal assumes that promotion campaigns are generic rather than targeted at specific groups, therefore no specific benefits accrue to non-white ethnic groups.

Recommendations

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 the distribution of 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.

In our view it is also important that the range of reasonably priced cycling hardware available in the UK should be more appealing to 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.

CONCLUSIONS AND NEXT STEPS

We can conclude that the equity impacts of climate change mitigation measures for transport, and indeed of transport policy intervention overall, are poorly understood by policymakers. This is in large part because standard assessment of these impacts is not a statutory requirement of current policy and is rarely applied within the UK. There is also an absence of suggested methods and an absence of reliable evidence to enable policymakers to more systematically identify how different social groups may be affected by the different available policy options. Our research has found that, whilst it may be relatively easy to construct such a methodology in theory, such assessments (either ex ante or post hoc) rarely take place in practice.

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. As such, there is very little data available for robust evaluation and this is a serious oversight in the current policy process as the intention is to scale-up these programmes over time. Our desk-based research is inevitably limited due to its reliance on this partial data, which limits our ability to establish an underlying methodology for populating the visualisation framework. Nevertheless, on the basis of a search of existing literature we are able to confirm that different social groups are likely to experience very different outcomes in adapting to

the significant changes to the transport system these polices will evoke. Furthermore, to be effective these policies will need to be hard-hitting and unilaterally applied to all travel activities and across all population sectors. Understanding the nuances in equity implications of such policies for different population groups and areas is therefore of critical importance to future policy-making.

Our method requires further empirical research and evidence-gathering, most importantly to test it on the ground with policy-makers. Such an exercise would be used to trial the effectiveness of the visualisation framework, but also to establish candidate methodologies to underlie that framework. For example, our 'age' category combines all age groups into one indicator, which could be misleading as the impacts on children could be opposite to those on the elderly. This 'stakeholder' work is a proposed next stage for the study, for example via a Delphi approach. We also hope to build on the current evidence-base through controlled data collection on the new local transport demonstration projects that are being delivered by local authorities across the UK. Finally, we would like to develop an computer-assisted tool analogous to the VIBAT model to allow policy-makers to select different policy packages (see Givoni et al, 2010 for more on this approach) so as to minimise the negative equity effects of their carbon mitigation strategies and to widen the distribution of positive social impacts.

Finally, the effect of climate change itself will almost inevitably have severe equity effect outside the transport sector, causing population dispersal and disrupting travel patterns if large numbers of households are temporarily or permanently displaced. Extreme weather effects of climate change will also affect the resilience of the transport network, causing temporary disruption or permanent changes, e.g. to coastal railway routes, bus routes, etc. 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 assessed in evaluating the social justice of policy interventions. And this will be upon us much sooner than we have previously anticipated; within the next ten years if the head of the World Bank is to be believed. Acting now to improve the equity outcomes of the policies that are urgently needed to mitigate and adapt to these impacts is in everyone's best interests if the transport system is to continue to function under these extreme pressures.

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Table 1: Policies and assessment criteria

Carbon Mitigation Policies for Domestic Transport (based on the Scottish Government Strategy (Atkins and University of Aberdeen, 2009))		**Impacts with social and distributional implications** (based on AEA Group (2011) and from an overview of the broader literatures (e.g. Guers et al (2009)	**Vulnerable social groups** (based on Parkhurst and Shergold, 2009)	**Vulnerable geographic areas** (based on Parkhurst and Shergold, 2009)	**Timescales**
Policy Package	**Individual policies**				
A. Technology	1. Electric car technology and network development 2. Procurement of low carbon vehicles	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	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). 3. Black and minority ethnic groups. 4. Disabled people. 5. Older people.	1. Identified areas of deprivation, especially urban peripheral estates 2. Rural areas, particularly small villages and remote communities 3. Coastal flood plains	1.Immediate 2. Short term (1-5 years) 3. Mid term (6-10 yrs) 4. Longer term (11 – 25 yrs)
B. Driving Style (eco-driving)	3. Active traffic management 4. National motoring package 5. Speed reduction on trunk roads				
C. 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	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	6. Women		
D. Car Demand Management: Smart Measures	17. Bus quality contracts/statutory partnerships 18. Widespread implementation of travel plans 19. Provide community hubs				
E. Freight	20. Freight best practice				
F. Land Use Planning	21. Urban density increases				
G. Aviation	22. Improve public transport surface access at airports				

Figure 1: Assessment of equity of National Motoring Package policies

Policy Package: National Motoring Package				**Description:** This policy consists of a package of measures aimed at reducing fuel used by cars and motorcycles during driving ('eco-driving').								
	Aggregate social impacts			**Income Quintiles**					**Vulnerable groups**			
Timescale	**wealth**	**health**	**accessibility**	**1**	**2**	**3**	**4**	**5**	**Age**	**Gender**	**Disability**	**Ethnicity**
Immediate	●	●	●	●	●	●	●	●	●	●	●	●
Short term (1-5 years)	●	●	●	●	●	●	●	●	●	●	●	●
Mid term (6-10 yrs)	●	●	●	●	●	●	●	●	●	●	●	●
Longer term (11 – 25 yrs)	●	●	●	●	●	●	●	●	●	●	●	●
Future generations	●	●	●	●	●	●	●	●				

Figure 2: Assessment of equity of bus/LRT fare reductions policies

Policy Package: Bus/LRT fare reductions				**Description:** This policy assumes that a concessionary fares scheme for over 60s is supplemented by a reduction in fares on all buses and light rail services for everybody, by 15% in the Central Scenario and 30% in the Ambitious scenario.								
	Aggregate social impacts			**Income Quintiles**					**Vulnerable groups**			
Timescale	**wealth**	**health**	**accessibility**	**1**	**2**	**3**	**4**	**5**	**Age**	**Gender**	**Disability**	**Ethnicity**
Immediate	●	●	●	●	●	●	●	●	●	●	●	●
Short term (1-5 years)	●	●	●	●	●	●	●	●	●	●	●	●
Mid term (6-10 yrs)	●	●	●	●	●	●	●	●	●	●	●	●
Longer term (11 – 25 yrs)	●	●	●	●	●	●	●	●	●	●	●	●
Future generations	●	●	●	●	●	●	●	●				

Figure 3: Assessment of equity of cycle infrastructure investment policies

Policy Package: Cycling infrastructure investment				**Description:** 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.								
	Aggregate social impacts			**Income Quintiles**					**Vulnerable groups**			
Timescale	**wealth**	**health**	**accessibility**	**1**	**2**	**3**	**4**	**5**	**Age**	**Gender**	**Disability**	**Ethnicity**
Immediate	●	●	●	●	●	●	●	●	●	●	●	●
Short term (1-5 years)	●	●	●	●	●	●	●	●	●	●	●	●
Mid term (6-10 yrs)	●	●	●	●	●	●	●	●	●	●	●	●
Longer term (11 – 25 yrs)	●	●	●	●	●	●	●	●	●	●	●	●
Future generations	●	●		●	●							