Report two: REA - understanding the social and distributional impacts of road pricing

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Understanding the social and distributional impacts of road pricing

Report two: Rapid Evidence Assessment

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Executive Summary

ES1. Overview

In January 2006 the Department for Transport (DfT) commissioned a rapid evidence assessment of the Social and Distributional Impacts of Road Pricing. The overall aim of the study was to evaluate the available evidence on the social and distributional impacts of existing and 'near market' road pricing schemes. Taken together, the evidence describes the state of international knowledge about the likely distributional effects that result from road pricing schemes, as people alter the extent to which (and/or way in which) they meet their needs and aspirations for travel.

It is emphasised that the DfT's concern regarding social and distributional impacts is not restricted to assessing monetised costs and benefits to different population groups. Assessing the impacts encompasses mapping the range of social groups that are (or may be) affected and identifying the nature of the impacts that different road pricing schemes have for different population groups.

The review is based on the existing international evidence and is confined to what was readily available in Jan to Mar 2006 - it doesn't attempt to reflect the ongoing work being done by the Dept. in this area. All evidence reviewed in the report is already in the public domain and readily accessible. Whilst there are some new insights, there are no new data reported on here.

The published research reviewed hasn't indicated that there is conclusive evidence that road pricing will have impacts on particular groups: rather that there is a lack of published work on this issue. DfT has a broad programme of research in progress on these issues which will increase the Dept's understanding of the potential social and distributional impacts of road pricing.

ES2. Methodology

Research literature and information were collected through two main lines of enquiry. First, a search of academic and policy literature was conducted, using relevant proprietary databases and open-access internet search engines. Three particularly fruitful resources were the 'Transport' bibliographic database, the ISI Web of Knowledge, and the CORDIS website. Second, direct contact was made with electronic (international) networks of transport professionals, including the Universities Transport Study Group, with specific requests for assistance in identifying further bibliographic listings and potentially relevant literature. Reference was also made to recent conference proceedings.

Consequently, the review has covered over 100 reports, papers and other articles addressing research in the UK and Europe, North America, and Asia. In examining the assembled literature, each article was assessed for relevance, and most were summarised and catalogued in a compendium, which formed the resource for preparing the current report. The report draws on most items included in the compendium (but excludes some items found in practice to be less relevant or robust than expected when sourced).

ES3. Key findings from the literature on Social and Distributional Impacts

The presentation of the evidence is organised around discussion of a broad range of topics that impinge on the issue of road pricing's social and distributional impacts. Nine key themes are drawn out, covering:

- Income groups,
- Age,
- Gender,
- Ethnicity,
- Household type,
- Disabilities,
- Scheme design and boundary questions,
- Spatial issues, and
- Transport modes.

For each theme the report assesses the coverage, findings and limitations of research to date. In some areas a paucity of research is highlighted. In the light of the findings of the review, and an assimilation of key issues, research recommendations are put forward for each area.

It is important to emphasise that the evidence base on social and distributional impacts is extremely limited, and little literature exists of which social and distributional impacts are the primary focus of research. Thus it is imperative not to make sweeping general conclusions from this limited evidence base. Nevertheless, the emerging body of research on existing (or near market) road pricing schemes does provide some valuable guidance on the interrelationships between type of scheme and social and

distributional impacts, together with implications of road pricing at different life stages, and consultation and public acceptability.

Income groups

Road pricing, to date, has principally targeted peak periods and/or urban centres. Those typically travelling in the peak are more affluent, as are those travelling further distances into urban centres. Accordingly, those paying the charges tend to be on higher than average incomes and often male and middle-aged.

The evidence base concerning income groups suggests that where there is a charged route alongside an un-priced alternative route, the charged routes show greater use by people on higher incomes. Hence, it cannot be assumed that **only** the relatively wealthy would choose to pay the toll. More evidence is needed on the reasons why those on low incomes might choose to pay despite this having difficult financial impacts for them.

In terms of the social and distributional impacts of road pricing and matters of social exclusion this suggests that it is people with no alternative to using the car who are the most vulnerable to the imposition of a regular road user charge payment. Existing studies focus heavily on those who choose to pay, and so there is, in general, a serious lack of analysis on the impact of road pricing on low-income groups.

Age

With regard to age, there is a persistent finding across a range of pricing projects that users of tolled roads come chiefly from the middle-aged group, whilst older and younger car drivers are more likely to be responsive in their behaviour to variable pricing [1] .

Other evidence indicates that older people are more car dependent than other age groups. The social and distributional impacts on older people who are car dependent and on low income are yet to be explored. Limited evidence also suggests that younger people may be more negative towards pricing than other age groups. It is theorised that this may be because they find it less affordable. Again, there are significant research gaps in assessing the causal relationships between age and road pricing impacts.

Gender

On the topic of gender, several USA studies show that, other things being equal, women are more likely than men to choose the toll road. It is also found that women place a much higher value on reliability of journey time than men; roughly twice as high as the value they place on saving time (although the evidence doesn't explore why). It is hypothesised that the reason is that women have more child-care responsibilities, which reduce their scheduling flexibility. However, there is also contradictory evidence from the USA that women are more likely than men to adopt behavioural adjustments to congestion. It is likely that the differences in the findings reflect different social and economic circumstances (*e.g.* different types of economic activity). Nevertheless, there is a lack of understanding of the underlying reasons that can explain gender behaviour differences.

Ethnicity

There is also a paucity of research concerning ethnicity and the social and distributional impacts of road pricing. However, UK research based on travel diaries in the Bristol area indicates that people from some Asian [2] groups can be more dependent on car travel than the population of the City as a whole, and so potentially more vulnerable to the effects of pricing. It is also concluded that some elderly Asians, who described unfamiliarity with bus use at associated focus groups, may end up forfeiting journeys if they cannot afford the increased travel costs associated with a cordon charge and are unable to use the bus services.

In addition, there is a connection to gender issues here in that four-fifths of the trips made by Asian men from the study were as car drivers, in contrast to Asian women who made approximately a quarter of their trips by this mode, relying on travel as a car passenger for three in every four trips instead. It is therefore argued that the dependence of some Asian women on lifts may mean their travel opportunities are particularly affected by road-user charging. Journeys facilitated by a lift may involve twice the number of car trips as do car driver or car passenger journeys, as the lift-driver may not wait at the destination, but return to the origin (or travel somewhere else) and return later to collect the person receiving the lift. Depending on how a charge is levied, this could mean the number of times a toll is paid is higher, and these trips become less readily available because of financial constraints on family budgets. Consequent suppression of trips or enforced mode change may follow.

Household composition

With regard to household type, findings in the USA suggest that the majority of toll road users come from relatively small middle class households. This is often linked to families with above-average incomes. For example, in the case of the *Port of New York and New Jersey Time of Day Pricing Initiative*, it was concluded that the fact most respondents report having high household income and car ownership hints that tolls may not have a significant influence in changing their travel patterns, as they are likely to represent a relatively small portion of travel costs. However, it should be noted that those on lower incomes might have used the road more regularly prior to the imposition of the toll. Significantly, in the case of the Houston tolled lanes, where only vehicles with two or more people are allowed, those who perceived higher travel-time savings, and travelled most frequently on the corridor, usually carpooled with an adult family member. Given that the majority of Houston tolled lane users come from smaller than average households, but with above average education and income, this suggests that carpooling is more prevalent in households of this type.

Evidence from the *London Congestion Charge* (LCC) indicates that pricing can have adverse impacts on families and social networks. For example, a MORI survey found that, inside the zone, 43 per cent of respondents believed family and friends were now finding it more difficult to visit them, although half did find that visits had not been affected. Norway provides one of the few examples where the wider social needs of families have been considered. Thus the ’one hour’ rule in Trondheim means that only one passage per hour across the cordon is charged. This is partly due to claims that parents bringing children to kindergarten before travelling to work would be unduly penalised if charged for several crossings. Nevertheless, there is a lack of knowledge on road pricing impacts with regard to the dynamics of family life, including life-course changes, such as the consequences for those with young dependent children.

Disability

There is also a notable lack of research on the impact of road pricing on disabled people, particularly in the context of the LCC. In a survey of disabled people prior to implementation of the Charge, particular concern was expressed about the impacts on low paid essential workers such as carers and nurses, who would suffer financial hardship. However, there are no findings on the actual impact of the Charge on disabled people.

Boundaries and spatial issues

Boundaries to any scheme (spatial, temporal, or relating to concessions and exemptions) may be inevitable, but are a natural target for controversy, and evidently can govern whether the argument for pricing is won or lost. A good example here is provided by the proposed (but heavily defeated in a 2005 referendum) Edinburgh congestion charge. A key exemption added at a late stage by Edinburgh Council was that residents of the administrative area of the City who lived outside the proposed outer cordon would not be liable for the charge. However, this gave rise to beliefs amongst residents of neighbouring local authorities, who would have to pay the charge, that the approach was unjust. Although only Edinburgh residents voted in the referendum, it was widely believed that opposition from surrounding areas affected publicity about the scheme, and influenced opinion within the city.

Boundary issues can also arise from environmental problems. For example, a survey of the *LCC* found that respondents from Hoxton were particularly negative about accessibility, reporting an increase in cars parked in their area. This was related to a rise in the number of drivers from outside the community parking their vehicles and completing journeys to the zone on foot or by public transport, rather than paying the Charge or travelling by public transport from further afield. Attention needs to be given to the often complex but important questions of how charging boundaries may impact on social equity, and the environment.

Where travel and congestion is focussed in space, and the overall cost of travel in terms of time and money are also influential in the relationship between residential location, road pricing, and wider social and environmental issues, such as air quality. Understanding, in particular, of the consequences of road pricing for those living in rural areas is lacking, such as the implications for rural residents with limited public transport services, and no clear alternative to car use. Either a network-wide national pricing scheme or a more local one covering a nearby urban area on which rural residents are reliant for obtaining goods and services by car could theoretically create disproportionate disadvantage for this group.

Understanding travel behaviour

With regard to transport modes, a lesson derived from the *LCC* is that travel behaviour can change more quickly and sharply than expected. There needs, therefore, to be greater understanding of the underlying factors that may induce people to switch modes as a result of road pricing. Evidence from the *LCC* also suggests that more needs to be understood about the relationship between mode switch from cars to two-wheeled vehicles and the related implication for road casualty figures.

ES4. Relevance of evidence on Social and Distributional Impacts

Types of Scheme

Questions of Equity

Until quite recently, the complex range of possible effects of road pricing on social groups has not been given nearly as much consideration as the effects on traffic distribution, particular economic activities and travel behaviour at the aggregate level. This in part reflects the fact that road pricing has tended to be perceived predominantly as being used by particular groups of people (often male and middle class) at particular times of a *working* day (often the peak home-work travel times). This type of finding reflects the fact that much of the evidence base on social and distributional impacts concerns either cordon/area charging or route charging, where an un-priced alternative of some sort exists. In turn, there is often an implicit assumption that those who pay will be those who can afford to pay. The difficulty in narrowly defining the use of road pricing is that not only is the scope for flexibility in use and price overlooked, but also the problems and needs of the atypical user can be ignored (such as those on low incomes with no alternative to car use). However, in recent years there does appear to be at least an emerging awareness that successful scheme design must take into account key distributional social and economic impacts.

In turn, this brings to the forefront the importance of equity (and perceptions of equity) in the public acceptability of road pricing, and this can be reflected in scheme design. For example, the cross-national significance of equity is indicated by a comparative study that examined car owners' perceptions of fairness with regard to road pricing in Sweden (Gothenburg), Japan (Kyoto), and Taiwan (Taichung). The results showed that fairness increased acceptance in all samples, and it was concluded that the importance of fairness may transcend cultures.

The difficulties in finding any sort of equilibrium on equity issues has led to several studies concluding that there can be no fixed rules on the subject. Thus a study of the global relevance of recent road pricing developments in the UK concludes that the equity implications of road pricing schemes over physical space are shown to be sensitive to the specifications of the scheme. Consequently, stakeholders in some areas are likely to be affected differently to those in other areas, and the degree of inequity may vary significantly across potential schemes.

The relationship between scheme type and road pricing objectives and priorities is particularly well illustrated by the case of Norway, where urban toll cordons have become relatively common over the past two decades. For many years, the specific aim of road pricing in Norway was to impose tolls for a specific period of time, in order to raise revenue for earmarked new road infrastructure, and not for reasons of reducing congestion or on environmental grounds. However, in recent years the dynamics of Norwegian policy has led to greater consideration of the benefits of urban cordons in reducing traffic congestion, and with this has come an awareness of socio-economic impacts and the importance of reconciling efficiency and equity in scheme design.

The evolution of road pricing policy in Norway reflects a wider trend, in that the focus hitherto has been on those who choose to pay, whilst there is little evidence relating to those who may be unwilling or unable to pay, and what impact this has on their quality of life. In particular, evidence suggests that lower income groups are less likely to use roads where and when pricing applies to them. However, there is little evidence that specifically explores why this is so. For example, non-use of road pricing might be for

reasons other than income, and here there may be a close link between the location of a charging zone, and where those on lower incomes live.

The location of potential social exclusion problems can therefore be susceptible to scheme design. For example, a study of proposed road pricing schemes and social exclusion in Leeds emphasises that one of the main reasons for identifying the at-risk groups before implementing a road user charging scheme is that it might be possible to modify the scheme design, so as to reduce the likelihood of those people becoming socially excluded. If it is possible, by moving the boundary, by redefining the basis of the charge, by allowing different methods of paying the charge, by providing exemptions for certain groups, or by using the revenues to improve the provision of alternative modes of travel in order to reduce the impact on at-risk groups, then this should be given serious consideration right from the outset.

Flexible Pricing

The Value Pricing programme in the USA has made a particular feature of examining how flexible pricing may mitigate adverse social and distributional impacts. One significant study observes that recent pricing experiments in the Los Angeles (*SR91*), San Diego (*I-15*) and Houston areas give motorists the option to travel free on regular roads, or to pay a time-varied price for congestion-free express travel on a limited part of their journeys. The authors found that, compared to a uniform price, varying road prices can significantly reduce the distributional disparities between groups of motorists. They also find great heterogeneity in motorists' preferences for speed and reliability.

At the time of writing, US-style toll lanes and High-Occupancy Toll (HOT) lanes [3] were being given considerable attention in the UK. Considering the relevance of the above evidence, an analogy with densely populated areas of the UK can be made: the American authors conclude that one possible explanation for this heterogeneity is that, in very expensive and congested areas such as Southern California, consumers face significant constraints in trading off housing expense for commuting time. In such a situation, there is an opportunity to design pricing policies with a greater chance of public acceptance by catering to varying preferences. They argue that, by reducing the adverse impact of combined tolls and time-savings on consumer surplus, differential pricing enhances the political viability of road pricing because policy makers must apportion only a modest fraction of toll revenues to fully compensate road users. Differential pricing, embedded in both the design and marketing of recent experiments, may thus be the key to addressing the stalemates that impede transportation policy in congested cities.

Wider Social Impacts

Although relatively little is known about the possible first-order effects of scheme design, such as impacts on different income and social groups, virtually nothing is known about the second-order effects. These less direct impacts can nevertheless be highly important in safety and quality-of-life terms. For example, a study in Leeds shows that there is social inequity in the distribution of nitrogen dioxide (NO_2) in Leeds, with deprived areas experiencing significantly higher atmospheric concentrations than communities of average or above average affluence. However, it was found from simulation studies that proposed road pricing schemes would reduce inequity in exposure to NO_2, with the extent of the reduction in inequity varying according to the charge option. It was also found that road user charging may be more effective than low emission zones in addressing environmental inequity.

Similarly, a study of the effects of the *LCC* on road casualties illustrates that social and distributional impacts can be more complex than might initially be expected. Thus, although overall accident figures are stable since implementation of the Charge, there have been increases in motorcycle casualties within the Inner London area. This could be a result of the incentive to use motorcycles, as riders do not pay the Charge, and may reflect the inexperience of travellers that are new to motorcycling, in which it could be a short-term effect, or may simply reflect the higher incidence of motorcycling and the changed road traffic conditions, in which case it could be more permanent.

The drawing of road pricing boundaries and their social and distributional impacts can also have particularly salient political and social effects. Consequently, the relationship between gainers, losers and income will depend critically on where different income groups live in relation to the charged areas. This is likely to vary from place to place. As outlined earlier, in the case of Edinburgh, a key exemption added at a late stage apparently had an impact on the result of the 2005 referendum. Another study makes the telling comment that there are poor neighbourhoods just outside the Edinburgh boundary which would have had to pay the charge, whereas more affluent neighbourhoods within the City boundary would have been exempt. It is hard to be certain that the referendum result would have been different in the absence of these boundary effects, but it may have been significant.

Implications of Road Pricing at Different Life Stages

Very little is known or understood about how and why people respond or adapt to road pricing at different life cycle stages. It must be emphasised that this is not just a matter of age in itself, but can be combined with economic and family circumstances, as well as being a function of a range of social groups, such as gender and ethnicity. Consequently, generalisations about how road pricing impacts people at different life cycle stages can be deceptive, as social groups are far from homogenous.

For example, the USA evidence on gender and road pricing offers tantalising glimpses of possible important findings for road pricing policy that describe social, rather than economic, needs. Thus, as noted above, the *Value Pricing Programme* consistently found that women are more likely than men to choose toll roads. There is therefore an urgent need to understand more clearly the causes for this type of behaviour, and the implications for such policies as variable pricing and separately tolled lanes.

In general, we do not have the evidence as to why lower income people do not use road pricing, and the degree to which this does or does not inhibit mobility and accessibility. At the same time, there is also little understanding generally of the precise reasons why some lower income people are apparently so dependent on car use, *e.g.*, for reasons of accessibility, perceptions of public transport quality, or fears of personal safety.

Assessments of the social and distributional impacts of road pricing on stages in the lifecycle are undoubtedly significant in determining criteria for equity, and considering policies of mitigation. However, there is a paradox in that the lifecycle itself is only meaningful as a unit of analysis when it is placed in the context of a range of other key social factors. This inevitably provides a more subtle and complex picture, but is necessary in order to understand the dynamics between road pricing and the development (or constriction) of social networks. It is in the rich texture of these interactions that road pricing schemes must be placed, and much more needs to be understood about how individuals respond and adapt to the problems presented by charging.

Consultation and Public Acceptability

It cannot be assumed that a consultation exercise in itself will be sufficient to deal satisfactorily with important matters of social exclusion. The *I-15 Congestion Pricing Project* in San Diego, California, provides an example of this type of credibility gap. Here, statutory requirements necessitated feedback from the low income/minority segments of the affected public. However, the public response was poor, and from this it was officially inferred that the project was not unfair to any constituent group.

Nevertheless, it can be argued that this type of consultation exercise is inadequate, and that hard-to-reach groups at risk of social exclusion must be actively engaged in consultation.

ES5. Conclusion and recommendations

The concluding commentary of the main report outlines the chief evidence gaps, the key lessons learnt, and the key recommendations. The latter include the following overall priorities:

1. Proposals for new road pricing schemes need to involve consideration of equity issues from the earliest stage. This 'equity proofing' process will need to be based on the systematic gathering of clear evidence across all important segments of society, defined in terms of social group, economic status, demographic, and ethnicity criteria. The analyses will need to cover established travel patterns and modal dependencies, and take into account spatial variation in location and needs, including phenomena such as boundary effects. As part of the process, both quantitative and qualitative research will be needed to *explain* such patterns and dependencies and explore the anticipated behavioural responses to, and consequences of, road pricing.
2. In depth insights are lacking across all areas touched by this review; a further debate on social and distributional impacts could be informed by the use of qualitative scenario-planning exercises.
3. There is a need to research the interplay between different demographic variables (*e.g.* age, gender and ethnicity) and also social and economic circumstances, as opposed to reporting on social groups as if they were homogenous in nature.
4. Consultations on road pricing schemes must be proactive, and involve those at-risk groups in danger of social exclusion, such as those on low incomes who are disengaged with the political process, and those who cannot travel to consultation locations.
5. It is therefore important to find the means to construct a dialogue with at-risk people and groups. Hence it is not acceptable for minority groups subject to potential adverse effects to go unheard or unseen, or to be 'lost in aggregation'.

[1] Charges which vary in time, usually according to the period of day or week, or according to the level of traffic or congestion. There may also be a variation to reflect the occupancy of the vehicle.

[2] Unfortunately, the study does not disaggregate findings by ethnic background and these distinctions are likely to be important. It is known that British white and British black and minority ethnic respondents as well as immigrant populations were involved in the study. The sample for the whole study included people from Indian, Pakistani, Bangladeshi, Somali, Sudanese, and African-Caribbean backgrounds.

[3] Whilst toll lane schemes generally operate by levying a fee per car, regardless of occupancy, HOT lane schemes may require multiple occupancy of the vehicle as well as levying a fee per car, or may levy a discounted fee or give a complete exemption for multiply-occupied vehicles. Where a lane is available

only for multiple-occupancy vehicles and no fee is charged, they are generally known as High-Occupancy Vehicle (HOV) lanes.

1 Introduction: Background to the Review

One of the policies that the Department for Transport (DfT) is considering in relation to its objective of reducing congestion is the possibility of national and /or local road pricing. As a result of a 2003 discussion paper, *Managing Our Roads*, a programme of research was conducted in order to assess the feasibility of road pricing as a sustainable solution for reducing congestion. The feasibility study [4] noted that road pricing schemes should seek to promote social inclusion and accessibility, and concluded that road pricing could provide a number of benefits for different population groups suffering from social exclusion and/or limited accessibility to services.

Further, an influential Social Exclusion Unit (SEU) report [5] highlighted that those on low incomes often live in the most congested areas, and as a result suffer disproportionately from the ill effects of congestion, including poorer air quality and higher levels of traffic noise. In contrast, the benefits of reducing congestion through road pricing are typically taken to include more reliable bus journeys, improved air quality, and reductions in traffic noise and community severance. The SEU report also indicates that motoring costs account for 24 per cent of the weekly expenditure of households in the lowest quartile who have cars, compared with 15 per cent for all households in the UK.

However, the national feasibility study concluded that more work is needed to understand fully the potential impacts on different types of road user. For example, evidence is required on how changes in the costs of motoring might differently influence people's choices about how, when and where to travel, and what the wider implications for any changes in travel behaviour might be, such as in terms of people's ability to access work, schools, high quality food shopping and health facilities.

In January 2006 the Department for Transport (DfT) commissioned the Centre for Transport & Society (CTS) at the University of the West of England, Bristol (UWE) to undertake a Rapid Evidence Assessment (REA) review of the empirical research findings available regarding the social and distributional impacts of road pricing.

The overall aim of the review was to evaluate the available evidence on the social and distributional impacts of existing and 'near-market' [6] road pricing schemes. Hence, this existing evidence could begin to inform an understanding of the likely road pricing distributional effects that result from people altering the extent to which (and way in which) they meet their needs and aspirations through travel as an expressed behaviour.

Road pricing was defined for the study as *"a scheme which levies a per vehicle charge on some or all groups of road users specifically for accessing a private or public part or whole of a road network, explicitly for use of that network for a quantity of time or distance travelled, and in distinction to charges paid for related services such as car parking or related producer costs such as vehicle fuel or maintenance"*.

Hence, the review did not seek to address phenomena such as the distributional effects of parking levies, but was open to evidence related to charges such as annual network access charges (such as, for example, the UK Vehicle Excise Duty).

In terms of types of road pricing scheme - each of which could theoretically create subtly different distributional effects - evidence relating to five kinds of scheme was expected:

6. **Fixed area charging** applied to all or part of an urban area *e.g.* as implemented in London (with the charge waived at night and weekends). Behavioural responses with distributional consequences associated with this kind of charge include rescheduling, and rerouting around the charge zone, changing mode (including car sharing), suppressing travel (thus possibly restricting access) or paying the fee. Other conceptual concerns include the fact that the charge may not be related to the amount of travel within the zone or number of entries into the zone, in a given period.
7. **Fixed cordon charging** applied around an area [7] *e.g.* as rejected for Edinburgh but applied in Durham and several Scandinavian contexts. Although behavioural responses are likely to be similar in several respects to the area charge, the cordon charge usually creates winner and loser groups more sharply, as travel within the cordon is not priced, whilst all journeys across the cordon may be individually charged (although technology exists to offer alternative charging approaches). Hence, issues regarding those whose key locations (home, work premises etc.) lie near a charging zone boundary are particularly important in this context.
8. **Route-based charging** affecting a specific section of route or routes, with opportunities to avoid the charge either by taking an alternative route (*e.g.* UK M6Toll), or using a different, uncharged, lane on the same road (*e.g.* US HOT lanes). Although the schemes may be limited to a few kilometres or tens of kilometres and have mainly local effects (as in the case of those schemes identified above), where many toll lanes or roads are created they have significance at the national level, as in the case of the dense, high quality networks of toll-motorways which parallel free-at-the-point-of-use networks in France, Italy, and other states. The key distributional impact considerations relate to whether the practice of reserving a higher quality of road service to those able to pay is equitable. Separate tolled routes may provide better design characteristics (*i.e.* in terms of speed and safety) than the alternative route, and possibly a lower level of congestion. In general they will provide a quicker journey and less stressful driver experience. The potential for HOT lanes to create social and distributional impacts through their design is more limited: they generally have similar physical characteristics as the other lanes on the road, but offer faster journey times due to lower congestion. In the case of tolled routes, there are also significant potential distributional effects due to traffic diversion, affecting local traffic and non-travellers carrying out activities near the uncharged 'alternative' routes. Diversion (or simply the choice not to pay for higher quality travel) may result in unsuitable traffic volumes and therefore higher congestion and pollution on the other route. In states such as France and Italy, substantial differences in design standards and speed limits implemented over decades of infrastructure supply, combined with modest levels of toll mean diversion effects are effectively restrained [8] .
9. **Nationwide congestion charging** delivered through high-technology has been proposed as an ultimate solution for making better use of the UK road network by raising the fiscal pressure on motorists at times when the costs of congestion not currently met by the travellers themselves are relatively high. Studies of various scheme options have suggested that the dominant behavioural effect would be rescheduling (provided that the scheme is implemented so as to discourage rerouting onto unsuitable routes). Rescheduling could have significant distributional effects on households by altering when activities take place, who is able to participate in them, and transport choices at the level of the household. The 'school run' is one obvious class of journey that is complex - perhaps involving several members of a household, time critical and often part of a trip chain, and regarded by many travellers as essentially car-dependent. More generally, there would be some reduction in the car trip rate, and more efficient average vehicle loadings during congestion periods. A large

uncertainty raised by the congestion-related approach to tolling, however, is the spatial distributional effects. Tolls in some rural areas might be negligible, probably linked to actual reductions in the levels of existing motoring taxes. Hence car use in these areas, and possibly migration into them, may potentially be encouraged, initially bringing benefits to existing residents and businesses, but with spatial-economic pressures which could in the long-term encourage longer-range commuting, urban-rural migration and business relocation, to take advantage of the relative change in transport costs.

10. **Nationwide universal distance-rated charging** delivered through a range of possible technologies ranging from GPS to an annual check of the vehicle odometer. Important, growing, advantages over Fuel Excise Duty (FED) - the current distance-related charge - are that it would include all vehicles, whether powered by a fuel attracting FED or not, and would prevent the reinvestment of travel cost savings from the acquisition of more fuel efficient vehicles in additional car travel. The primary intention would be to raise fiscal pressure on motorists, as is the same broad aim of congestion-related pricing, perhaps by replacing VED with a distance-related charge, but in such a way as to address a wider set of objectives than congestion alone; to reduce the full range of costs road users impose on wider society (*i.e.* including climate change, pollution, severance, etc.). Indeed, an advantage of the distance-related approach over congestion charging is that it would not expose uncongested areas to falling travel costs which could encourage traffic growth and perhaps the relocation of activities in the longer-term. Those that prefer distance-related charging to congestion charging tend to rate some of these latter 'externalised costs' not paid by road users (*e.g.* spatial impacts of transport costs, climate change emissions, air pollution) as more important than those who believe congestion is the fundamental problem. Distributional consequences would depend on the level of charge, but this type of road pricing would be more likely to result in modal shift or trip suppression as, in its purist form, rescheduling would not be an option, and hence the car trip rate, and possibly the all trip rate, would fall. As with congestion charging, car occupancy can be expected to increase, but more uniformly across the 24 hour period, as the higher price would apply to all periods of travel.

The remit of the review was to extend beyond only assessing economic measures of redistribution as a result of road pricing, and to also encompass matters of equity. Previous research [9] has identified two broad categories of equity in relation to road pricing: spatial equity, relating to the geographical location of the individual or organisation affected; and social equity, concerning impacts that relate to the personal, economic or social characteristics of an individual, organisation etc. These categories of equity are factors which contribute to judgements by individuals and society as a whole about whether a road pricing scheme is considered 'fair'.

A key concept in understanding equity and fairness in contemporary policy discourse is that of social exclusion. Importantly, 'social exclusion' cannot be considered as synonymous with any of the terms 'deprivation', 'underclass', 'marginalisation' or 'poverty', with a multifaceted definition usually preferred, referring to physical, geographical, distance-based, economic, time-based, fear-based, spatial and other types of exclusion [10] .

Studies of transport and travel have been important within the developing literature surrounding the phenomenon of social exclusion. 'Travel poverty', or lack of access to transport services as a means to access the wider opportunities of society, is often presented as a specific, important mechanism within the overall complex of exclusion. Indeed, some definitions particularly emphasise the spatial basis of exclusion, in observing

"a process, which causes individuals or groups, who are geographically resident in a society, not to participate in the normal activities of citizens in that society" [11] .

Notably, then, as transport is a 'derived demand' - not often an end in-itself, but usually a facilitator of other activities - it may have both a direct or indirect influence on participation. If walking is not a feasible option and no vehicle transport available, then travel exclusion presents as a direct effect, but there may be more subtle indirect exclusion effects, e.g., if a transport service exists, but is too slow for the time available (a combination of transport and time-based exclusion) or exists, but is too expensive to be affordable (a combination of transport and economic-based exclusion).

Hence, road pricing can in theoretical terms be presented as both potentially increasing and reducing exclusion. In increasing the money costs of road travel, it may increase the economic exclusion of those who must continue to travel by road but can only afford to pay by reducing expenditure on another good or service generally regarded as a basic of life, resulting in a negative distributional effect. However, if introducing a congestion charge results in lower time costs of travel for those that pay the toll, it may enable those previously excluded from participation in certain activities, due to the length of journey to reach them and limitations on time to spend travelling (travel budget), to take part, so having a positive distributional effect. Similarly, there may be positive distributional effects for bus users in terms of temporal exclusion, if the services become quicker or more reliable as a result of decongestion. Transport exclusion may also be reduced if the improved operating conditions result in more, different bus services being introduced, creating mobility opportunities for those desired journeys not previously served by a route.

With the objective of describing such possible outcomes in practice, evidence for the REA was sought relating to behavioural, social, and economic outcomes from RPSs, whether negative, positive, or neutral. Evidence relating to a range of social groups was also sought. This was then analysed with a view to responding to the following research questions:

- What does the evidence (both UK and international) on existing schemes tell us about the social and distributional impacts of road pricing?
- What methods and metrics have been used to date to assess social and distributional impacts of existing schemes?
- Are there any important differences in the social and distributional impacts for different types of scheme (e.g. distance based, cordon based, or peak-time based schemes etc.)?
- In addition to social groups, what are the impacts on geographically defined communities, particularly deprived areas?

The study informs other work by and for the DfT, including further development and testing of the National Transport Model in respect of road pricing simulations, support for the development of the DfT's key social inclusion policy of accessibility planning, and the preparation of guidance for the assessment of bids to the Transport Innovation Fund, several of which will concern RPSs.

The following Section 2 provides a brief summary of the methodology of the study. Section 3 then describes what impacts were identified in relation to the social groups for which there is evidence, and also seeks to explain how these impacts differ between groups, going beyond the immediate impacts on their travel behaviour to examine how road pricing might affect other aspects of their lives. Section 4 considers the relevance of the findings, and Section 5 provides a summary of the evidence gaps and

lessons learnt, together with recommendations about further research required.

Annex A to the report provides a list of the documents reviewed for this study. Those that have been used in preparation of the report are referenced in Sections 3-5 using the list index numbers inside square brackets. The Harvard system is also used to indicate the authors of the evidence quoted.

[4] DfT, (2004). Feasibility Study of Road Pricing in the UK. DfT, London.

[5] Social Exclusion Unit, (2003). Making the Connections. SEU, London

[6] I.e., schemes which have reached an advanced state of planning, but have not yet been implemented, or will not be implemented due to policy reversal, but for which relevant and reliable information about distributional effects is available from the associated implementation studies. Examples would include Stockholm (not yet implemented) or Edinburgh (rejected at referendum).

[7] Usually part of an urban area, although in some cases environmentally-sensitive rural areas, such as National Parks.

[8] A large proportion of the dual-carriageway route-km in France and Italy is part of the tolled motorway networks. These tend to duplicate single-carriageway âA-roadsâ in a more comprehensive way than in the UK, where the motorway and general-purpose road infrastructure is more integrated. Permitted speeds for cars on French and Italian motorways are higher than in the UK (81 mph in dry conditions rather than 70), whilst the national limits on single carriageway roads are lower (56 mph rather than 60), which means the journey time benefits of choosing the motorway may be greater than in the UK. Toll levels are around Â£0.03 per mile for cars in France, and sections providing orbital bypass routes around major towns are sometimes toll-free (where the incentive to divert to avoid the toll is high and the social benefit justifications for preventing diversion also high). In the UK, there are more high-quality non-motorway roads and no speed limit differential between motorways and non-motorway dual-carriagways, and only 10 mph difference with these and unrestricted single carriageways. Combined with high levels of congestion on several parts of the motorway network, it is possible that diversion could be more of a problem. Toll levels may also be set higher, in order to influence congestion or maximise revenue. The M6Toll costs Â£0.13 per mile for cars, more than four times higher than the typical continental prices.

[9] Jones, P., (2004). Addressing Equity Concerns in Relation to Road User Charging. CUPID project report.

[10] Church, A., Frost, M., Sullivan, K., (2000). Transport and social exclusion in London. Transport Policy, 7 (3), 195-205. Kenyon et al. have extended this approach since, placing mobility exclusion as a particularly important category amongst a total of nine (the others being economic, societal, social network, organised political, personal political, personal, living space and temporal exclusions) [Kenyon, S., Lyons, G., Rafferty, J., 2002. Transport and social exclusion: investigating the possibility of promoting inclusion through virtual mobility. Journal of Transport Geography, 10 (3) 207-219.]

[11] Gaffron, P., Hine, J. P., Mitchell, F., (2001). The Role of Transport in Social Exclusion in Urban Scotland: Literature Review. Scottish Executive Central Research Unit, Edinburgh, p4.

2 Methodology

The overall approach to the study was guided by Chapter 2 of the *Magenta Book* [12] , which presents REAs as an accelerated application of the systematic review process.

The review sought evidence of:

- post-implementation data [13] relating to distributional effects arising from actual road pricing schemes and, to a secondary extent,
- pre-implementation data [14] from schemes which have undergone detailed planning and consultation prior to implementation.

2.1 Identification of Social Groups

Social groups can be comprised of people with similar socio-demographic or socio-economic characteristics such as age, gender, ethnicity and income, but also of 'experience' based groups such as car drivers, public transport users or people with caring responsibilities. A number of social groups were identified *a priori*, as being likely to be affected in distributional terms by road pricing. These included:

- Demographic groups
  - Different genders
  - Children and young people (up to the age of 25)
  - Middle generational people (aged between 26 and 50)
  - Older people (aged over 50)
  - Families (with dependent children aged 15 and under).
- Groups prone to social exclusion on accessibility grounds
  - Disabled people
  - Households without access to cars
  - People unaware of travel opportunities
  - Low-income households
- Geographically defined groups
  - Rural
  - Suburban/peripheral estate
  - Urban core
- Economically or occupationally-defined groups
  - using Socio-economic Classification occupation classes
  - People in education
  - People in unpaid or voluntary work
  - People seeking work
  - Part-time workers
  - Key workers
  - Home makers
  - Those with long standing illness/disability
  - Carers
  - Retired people

- Groups defined through their transport choices
  - Bus users
  - Car users
  - Pedestrians
  - Cycle users
  - Users of powered two-wheel vehicles

It was expected that little or no evidence might be identified for some of these specific groups, but that additional groups, not identified *a priori*, might be described in the evidence.

2.2 Identification of literature for inclusion in the compendium

The review sought "readily available" [15] evidence identified by keyword searching from:

- academic journals, books and other papers in physical or electronic libraries accessed through proprietary databases of abstracts; and
- institutions' websites, accessed via public-domain search engines, notably Google.

In addition, the review was supported by experience-guided searching, particularly by consultations with the DfT and a project team brainstorm of bespoke sources, in the form of particular countries, institutions, individuals, or publication series or websites known from past work to be good sources of information on road pricing.

Full details of the keywords employed and publication series consulted are available in a separate *REA Protocol* document, which also records the success rate of specific searches.

Taken together, the systematic searching backed by experienced-guided searching and consultation provided a check of the quality of the review. In general, quality was confirmed by the finding that the experience-guided searches tended to identify very recent items, as these had not yet been catalogued by the systematic databases, although an additional search was thought necessary to cover the Japanese literature, little of which is published in English. This was achieved by contacting four Japanese academics with established links to the UK, and asking them to use their experience to identify any relevant items.

2.3 Use of the identified sources

The REA was based on the principle that research quality and relevance (defined in terms of reliability, validity and generalisability) would be paramount, as it would be better to identify evidence gaps (and areas of limited understanding) than misleading evidence.

In essence, a two-stage process was followed, whereby all items which appeared relevant from initial inspection were read in detail, and a compendium summary prepared. At this stage, then, some items, although accessed, were not considered sufficiently relevant in practice for inclusion.

Around one hundred sources were, however, summarised for the compendium, with details input in the following four areas of information:

- administrative details enabling document identification;
- nature of the studies described giving rise to relevant evidence, including methodology employed;
- dimensions of distributional effect covered;
- quality of evidence and whether peer-reviewed.

Having prepared the compendium, the report of evidence was prepared, with the inclusion of compendium items being subject to their

- *generalisability* - whether the evidence was generalisable to the population it was drawn from, and whether that population is similar to that of the UK,
- *reliability* - whether the research design as reported [16] was of sufficient integrity to generate stable data over time (if repeated with the same population), and
- *validity* - whether the study genuinely involved data collection and analysis relevant for the dimension of distributional effect it claimed to describe.

To assist with this decision, a project team member was dedicated to conducting a quality review of the proposed attributions within the compendium made by the main reviewer in respect of these three dimensions. Some revisions were made as a result.

In practice, around four-fifths of the items included in the compendium were felt to have sufficient merit as to be sources of evidence for the present state-of-evidence report.

2.4 Overview of characteristics of evidence base identified by REA

One hundred documents were identified from the literature search as likely to be relevant and of sufficiently high quality to be included in the literature compendium, with a summary prepared for each. Of these, the majority were found in practice, upon detailed inspection, to be relevant and high quality. A minority was summarised but did not then appear in the report.

Figure 1 indicates the country of location of populations studied in the compendium literature. Around a third or reports had studied UK contexts (with studies of London dominant within these). Another third referred to the US and Norwegian schemes; mainly HOT lane and toll cordon schemes respectively. The final third referred to existing or proposed schemes in Singapore, Sweden, Hong Kong, and the Netherlands, or other countries. A small number of studies are not included in Figure 1 because they were general, theoretical papers.

The review was conducted in English only. Some studies may not have been published in full or summary in English, in which case these would not have been identified. Publishing in English-as-a-second-language is more common in countries with languages spoken by small shares of the world population. In some, notably Scandinavia and the Netherlands, English exists as a parallel second technical language. In contrast, it is possible that the Francophone, Hispanic, Portuguese, and Japanese literatures have been under-represented.

Figure 1: Country Location of Study Populations in Compendium Literature

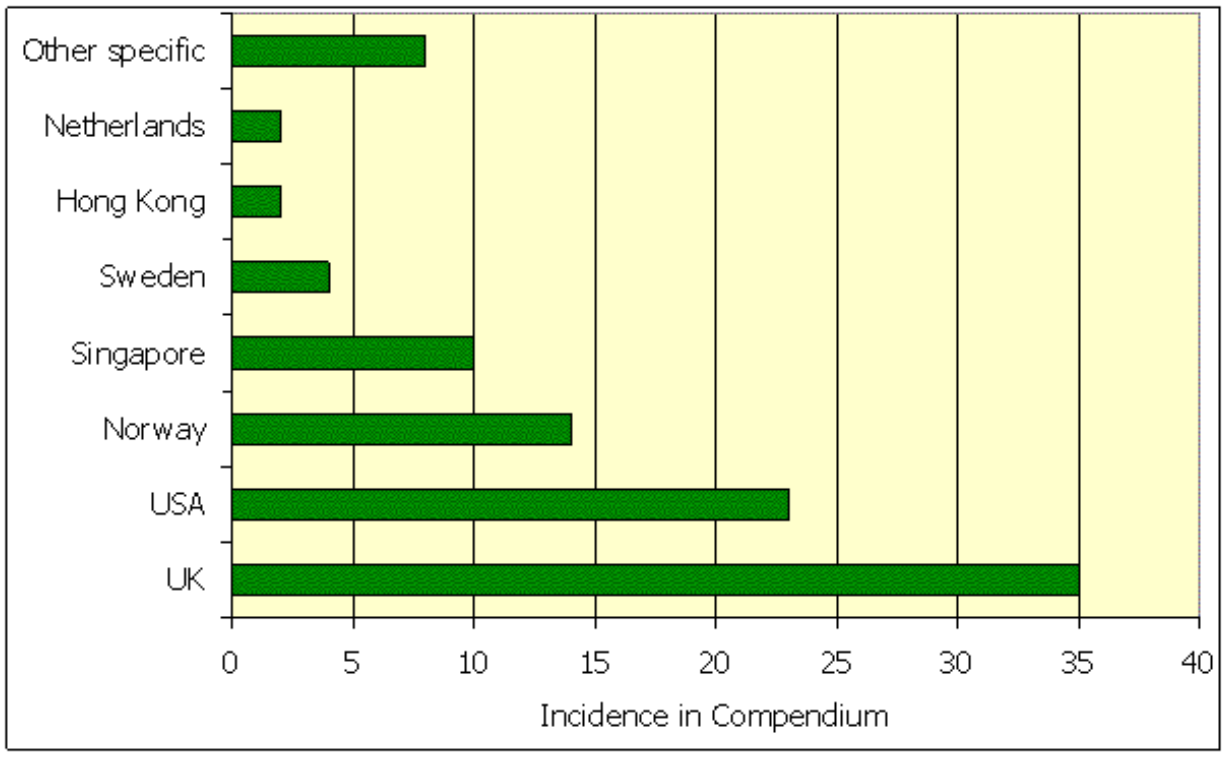
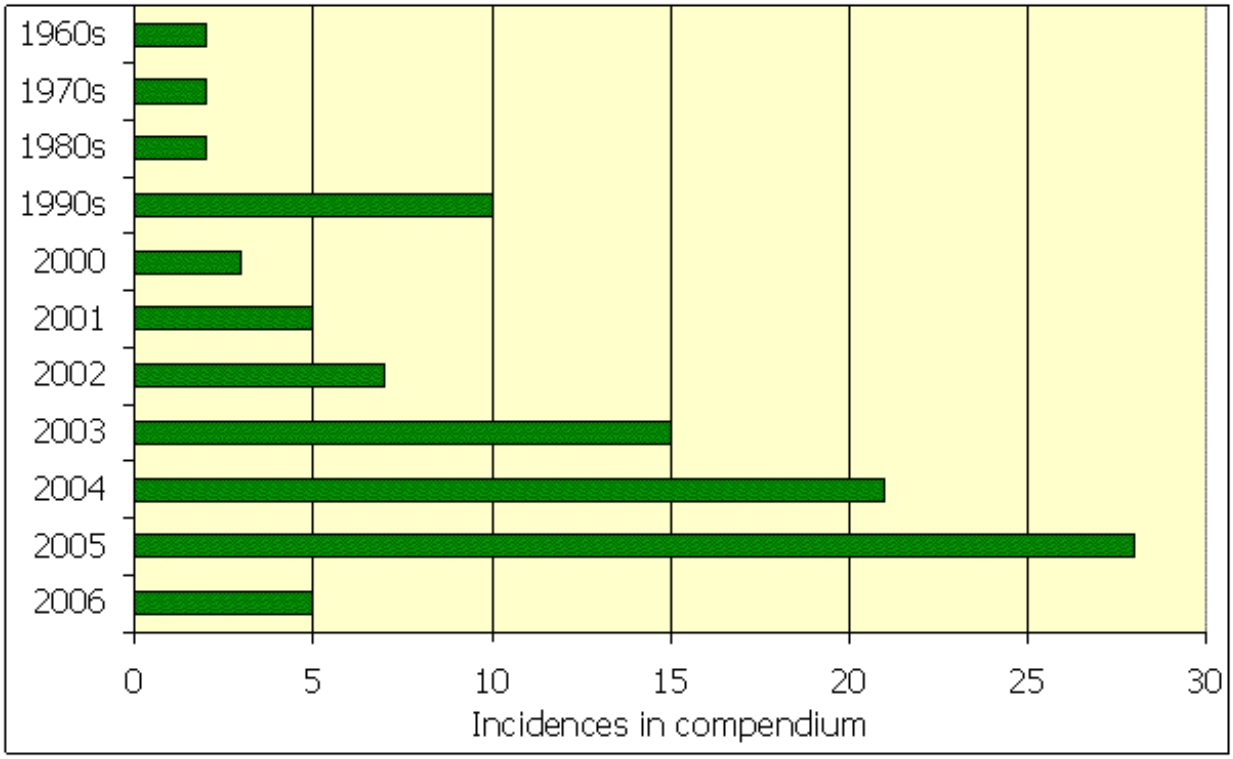


Figure 2 locates the studies in time. Most are from the last five years, with around a fifth dated from the period 1960-1999. More than a quarter had been published in the year prior to the preparation of the current REA.

Figure 2: Date of Publication of Compendium Items



[12] Government Social Research Unit (2003). The Magenta Book: Guidance on Policy Evaluation & Appraisal. UK Government Cabinet Office, London.
http://www.policyhub.gov.uk/magenta_book/index.asp

[13] I.e. Data in which information about attitudes and behaviour formed following exposure to actually implemented road pricing schemes is collected.

[14] I.e. Data collected about attitudes towards schemes not yet implemented, and expectations about future behavioural response should they be implemented.

[15] In the specific sense of the Magenta Book pp. 18-19, e.g. not including systematic hand searching of journals and textbooks, or searches of the grey literature, although relevant items identified in this way in a non-systematic way were included.

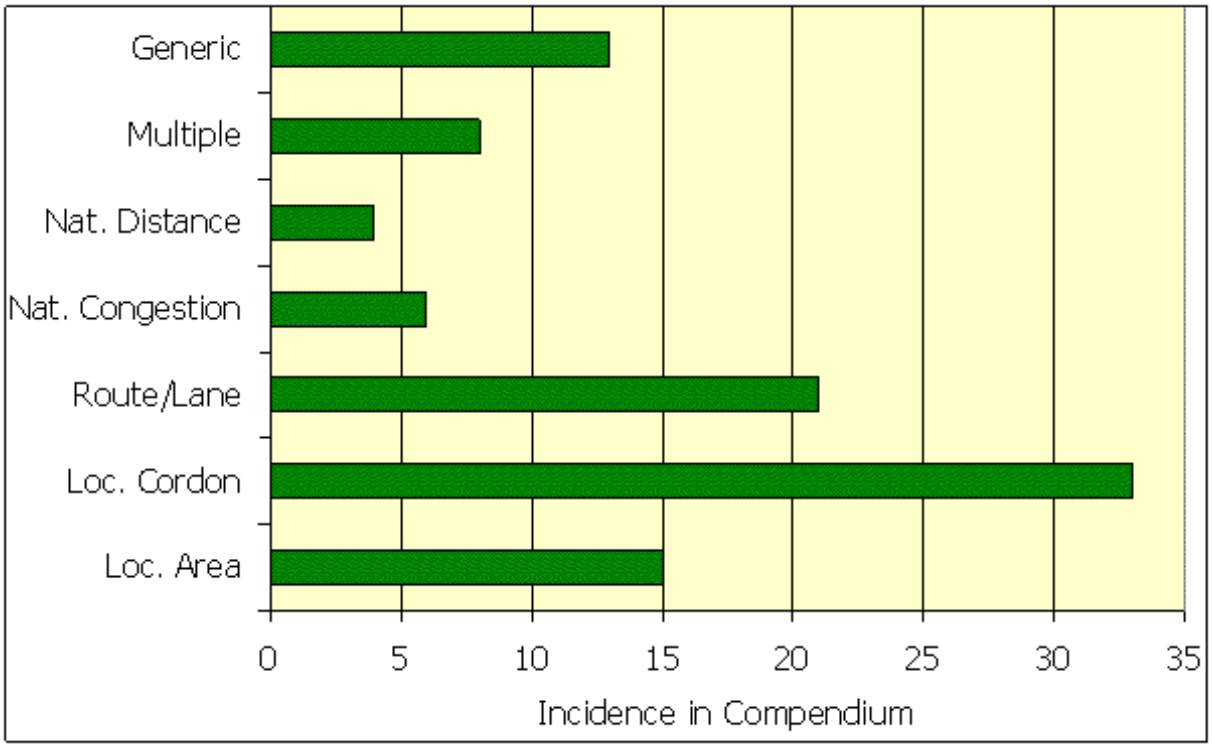
[16] An important qualification: a particular source of evidence might have to be categorised as poor even if it offered a limited write-up of an underlying study which was in fact conducted to high standards of research integrity.

The REA process is mainly based on searching of electronic databases and websites. Hence, it will tend only to identify abstracts and full documents which have been published electronically. Although much effort has been made by publishers to add back-numbers to their electronic catalogues, it can be assumed that at least some relevant older studies have been missed as they did not feature in modern databases. However, given that most of the extant RPSs have only been implemented in recent years, and that the study focused on evidence of actual schemes, then it is very likely that most of the relevant literature is in

fact very recent.

For the same reason, most of the studies referred to small and local schemes - particular toll roads, toll lane schemes or cordon or area schemes for particular cities - rather than national schemes (Figure 3). Indeed, the only implemented genuinely national schemes are the Swiss and Austrian network-wide pricing arrangements for vehicles of 3.5 tonnes weight and over, with a scheme for Germany still undergoing implementation. A few studies compared different types of scheme ('multiple' in the Figure), or were 'generic' studies, relevant to a range of road pricing schemes.

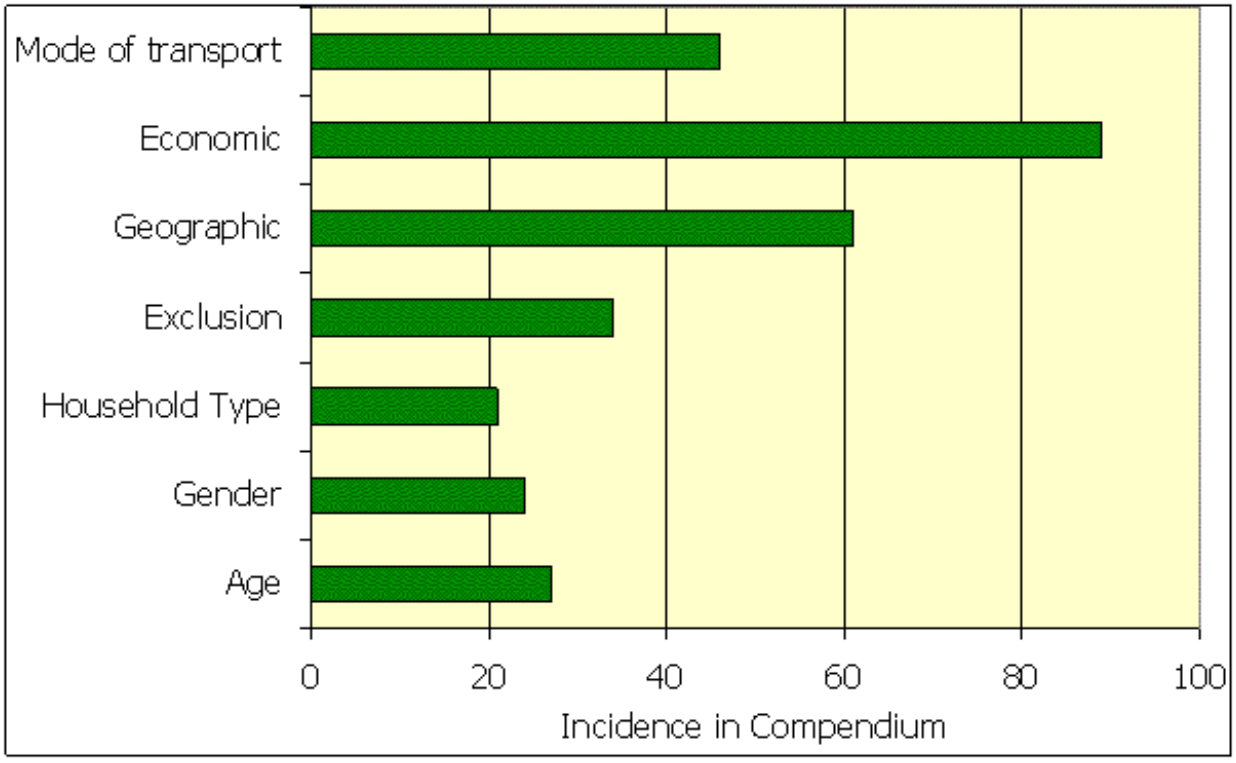
Figure 3: Importance of Local and Specific Route Schemes in the Literature



The majority of the studies that were consulted had used mixed methodologies, *i.e.*, both quantitative and qualitative, although of those using just one of these, more were quantitative studies. Of the 80 compendium entries that could be classified as belonging to a particular tradition of academic study, somewhat more than half were drawn from economics. The others were contributed in roughly similar numbers by geographers, sociologists, engineers, and political scientists.

The range of topics addressed by the studies reflects this discipline split to some extent, with most of the studies making some reference to economic-financial issues. Many also identified geographical variables as important, such as settlement pattern and boundary effects. Around half examined the consequences for the different modes of transport and their users whilst around a quarter considered at least one of the more sociological variables: exclusion, household type, gender, and age (Figure 4).

Figure 4: Frequency of Identification of Types of Distributional Impact



3 Evidence

3.1 Income and Ability to Pay

Impacts on Travel Behaviour

The overwhelming evidence from around the world is that road user charging schemes tend to be used predominantly by those on higher incomes. As an overview by Lee concludes, those travelling on urban highways at peak periods in the peak direction are substantially more affluent than the population as a whole, and those who choose to pay the toll more affluent still (Lee, 2003) [50]. For example, in the case of by far the largest application of road pricing in the United States, the *Port of New York and New Jersey Time of Day Pricing Initiative* (with approximately 125 million vehicles using the crossing annually), the typical toll payer is found to be a middle-aged white man with above-average education and household income (Holguin-Veras *et al.*, 2005) [2]. Similarly, on *State Route (SR) 91* in California, a public-private partnership providing variable-toll express lanes, surveys (based on users of all lanes of the road) show that commuters in high-income groups are just over twice as likely as commuters in the low-income group to be frequent toll-lane users, and about half-as-likely to be non-users (Sullivan, 1998) [37]. In the case of the Oslo toll cordon in Norway, it was found that the motorists crossing the cordon at peak periods have higher-than-average incomes, although some of these motorists are driving company cars, and have employers who are paying the toll (Larsen and Ostmoe, 2001) [45].

However, evidence from the US demonstrates that it cannot be assumed that only those on high incomes are prepared to pay tolls when there is an un-priced alternative. For example, in the case of *SR91*, whilst 50 per cent of the highest-income travellers reported that they never or infrequently use the toll lanes, 25 per cent of the lowest-income travellers report that they use the toll lanes on a frequent basis (Sullivan, 1998) [37].

In the six months after opening of the express lanes, the average typical delay in the evening peak period on the freeway fell from 30-40 minutes to less than 10 minutes per trip. A year later, at the end of the observation period, the same peak-period delay had increased by about 5 minutes to around 13-14 minutes, reflecting both time shifts in travel demand and the effect of the underlying long-term trend for traffic-growth, which meant there were an increased number of users of the road. Notably, a small reduction in travel time of about 6 minutes per trip was observed on one of the parallel, alternative main routes. It is claimed that the amount of daily traffic diverted from the free lanes to the express lanes during the first year closely matched the increase in the total *SR91* two-way average daily traffic. Apparently, traffic has redistributed between the free lanes and express lanes, so the time saving of express travel is just worth the toll [17] . One result of the new distribution was that, during the first half of 1997, average monthly growth in average daily traffic for the entire *SR91* highway (averaging 500 vehicles per day each month) was about equal to the average monthly growth in express lane traffic; in other words drivers making new trips immediately selected the tolled routes, or new trips on the untolled routes added some delay and made it worthwhile for some existing travellers to switch to paying, with little extra overall traffic on the untolled route as a result. It is concluded that there is a strong correlation between express lane patronage and travel-time savings (Sullivan, 1998) [37].

An overview of the USA Value Pricing Programme therefore argues that the income equity issue may in many cases be more one of high income individuals receiving greater benefits, particularly when time savings are factored for the different travellers' *value-of-time* (VoT) [18] , than one of negative effects on any group, although it is acknowledged that this conclusion is based on the limited project parameters, and that there may be wider negative social impacts here for those on lower incomes (Evans *et al.*, 2003) [64]. Similarly, in the case of the *Interstate-15 (I-15)* tolled lanes in San Diego, California, experience has shown that both high-income and low-income groups use the express lanes (USA Department of Transportation, 2000) [58], and US experience also suggests that lower-income motorists can favour the principle of High Occupancy Toll (HOT) lanes being opened up to lone motorists for a fee. Thus a survey found that 80 per cent of the lowest-income motorists using the *I-15* corridor agreed with the statement that: "People who drive alone should be able to use the *I-15* Express lanes for a fee." (Slater, 2005) [18].

The evidence relating to incomes is also complicated by apparent contradictions in the responses by people to changes in the level of tolls. For example, in the case of HOT lanes in Houston, Texas, inelastic responses were identified to small changes in toll, *i.e.*, proportionately little change in user demand at this level of toll [19] . Taken together with responses to a survey question regarding participants' feelings towards the $2 toll, the evidence suggested that this toll was not a major deterrent (Appiah, 2004) [1]. On the other hand, a different picture is presented for differential time-of-day tolls on two bridges in Lee County, Florida. Here, the monetary incentive was only 25 cents for the majority of variable-pricing participants. Nevertheless, quite significant changes in travel behaviour were observed (Burris and Pendyala, 2002) [39]. A possible explanation of this observation is that people in general exhibit a non-rational preference to save money over time, or perhaps that people exaggerate their perceived monetary VoT when responding to questions, such as those in willingness-to-pay surveys, and so motorists subsequently fail to behave in the way that VoT calculations predict they will. It may also be

that there are particular local conditions which cause people to value time more highly, such as location of centres of employment.

However, the reverse effect was demonstrated in a survey of the *I-15*, which found that users had a median willingness to pay of $30 to reduce travel time by one hour, *i.e.*, when all the survey responses were ranked, the respondent providing the middle value was prepared to pay this much to save an hour. However, it is particularly intriguing here that these results, based on actual observed behaviour, were significantly higher than earlier results, based on people's statements concerning their preferences (Brownstone *et al.*, 2003) [56]. Thus actual behaviour was different from stated preferences, but in the reverse direction to Lee County. The explanation may lie in the nature of the journeys being made by the potential users of the two toll schemes; how time constrained they were and whether the costs were being met by the travellers themselves, or their employers or clients.

This technical discussion notwithstanding, problems (and perceptions) of equity can act as serious obstacles to the implementation of RPSs. These concerns with equity were the chief reasons for failure to implement pricing schemes in Maryland and Minnesota (DeCorla-Souza, 2004) [82]. At the same time, several studies suggest that the problems for those on lower incomes should be put in context. For example, an assessment of the proposed (but eventually aborted) congestion charging scheme in Edinburgh on low income households found that people with lower incomes were significantly less likely to cross a cordon and be charged than people with higher incomes. This situation is linked to lower car ownership levels and higher use of non-car modes of transport, and particularly for journeys during work hours. The interpretation given was that those on lower-incomes were less likely to be affected by the proposed charge. Furthermore, as revenues were to be spent on transport, and mostly on public transport, lower income and socially excluded people would primarily benefit. This analysis is based on travel diaries of the Scottish Household Survey (SHS) data for Edinburgh in 1999 and 2000. The SHS is a continuous survey commissioned by the Scottish Executive to provide information on the composition, characteristics and behaviour of Scottish households at national and local level. Nevertheless, it is stressed that individuals on low incomes, with no alternatives to using private car transport, would have been disadvantaged, particularly if they are made more vulnerable through poor access to public transport (Sinclair, 2002) [67].

Similar conclusions are reached for a study which considers the possibilities for variable peak-time charging on the Oslo cordon ring to combat congestion. Here, it is acknowledged that some lower-income people will have to cross the cordon at peak periods in order to take children to kindergarten *etc.* A 1997 survey tried to assess this problem, via a travel survey with more than 20,000 respondents in the Oslo area. In this survey, it was not possible to find more than a handful of these lower-income people among the respondents. In fact, the great majority of motorists crossing the cordon at peak times are middle-aged men with above-average incomes. It is recommended that, in addition to compensatory measures, variable pricing could be introduced over 3-5 years, in order to allow people to adapt their travel patterns over time (Larsen, 2001) [89].

In the case of the *London Congestion Charge* (LCC), a qualitative survey of low-paid workers by the Commission for Integrated Transport in 2003 found that most low-paid workers who took part in the research were not significantly affected by the Charge. This was due to the interrelated factors of a high preponderance of workers living in close proximity to their work, and the low incidence of car ownership. However, this group had relatively few things to say in favour of the congestion charge, and most had migrated to using public transport (CfIT, 2003) [6].

However, a warning note on the LCC is sounded by Richards, who critically observes the lack of analysis in the Transport for London Annual Reports on the impact of the charge on low-income groups. He concludes that, although it has been argued that the charge has benefited, on average, those on lower incomes, as they are more likely to be bus users, there is little doubt that it has adversely affected those who need to use a car. He notes that, with less ubiquitous public transport outside London, given the impacts of poor access to work, education, health and shopping on social exclusion, there may well be much greater concern about the impacts of charging on those with lower incomes (Richards, 2006) [13].

A further slant on the equity impacts of spending revenues from RPSs on greater subsidies for public transport is provided by Lee, who observes that this may be inefficient if these sectors receive more funds than they can use to increase overall economic welfare [20] (Lee, 2003) [50]. In short, from a perspective led by economic theory, there is no point providing additional bus services unless sufficient new trips are made on them, creating sufficient new consumer benefit, to equal the resource costs of providing the services.

Alternative solutions considered in the US to addressing problems of equity concern some kind of explicit compensation to low income groups, such as toll credits, similar to credits provided to low-income utility customers; tax credits to low income commuters for tolls paid by them on value priced lanes; or toll credits provided to those who choose not to use value-priced lanes, this latter a component of the FAIR lanes concept. This concept has been constructed by an official of the Federal Highways Agency, based on his interpretation of findings from the Value Pricing Programme (DeCorla-Souza, 2004) [82].

An original contribution to the debate on equity and compensation to losers is provided from a study of Singapore, where spatial restrictions have led to the imposition of restricted vehicle ownership permits. These permits are currently based on vehicle size, but it is suggested that they could be replaced by a block of usage. Thus in the Singapore context, the 10-year lifetime of the ownership permit would be replaced by an allowance for a certain amount of vehicle usage. Instead of bidding via a state-run auction for a licence that gives the right to own and use a vehicle for ten years, bidding would be for the right to own and use a vehicle until the allowance of usage is exhausted, after which a new allowance would need to be purchased. It is argued that paying a lump sum for a block of usage should make motorists aware that each unit of usage has a price. This could be made more explicit with an in-vehicle display of the remaining tax-paid usage as it runs down. The system would arguably also enhance equity through the user-pays principle (Barter, 2005) [34], although this view focuses on a view of equity which emphasises correlations between the amount of travel consumed and the amount paid towards the costs of providing for the travel, and rather ignores the sharper equity concern that *need* to pay for essential travel may not be matched by *ability* to pay for essential travel.

Wider Social Impacts

A persistent theme concerning road pricing and matters of social exclusion is that it is people with no alternative to using a car who are the most vulnerable. Thus a study of the motoring poor (although theoretical and not explicitly about road pricing) is particularly salient here. It is emphasised that maintaining a lifestyle including car ownership is a struggle with limited resources. There are difficult choices to be made for lower-income households in those areas where limited local employment opportunities, the rise of irregular and anti-social work hours, and inadequate public transport facilities force them into running a car at considerable expense.

In lifecycle terms, the long-term outcome for them could be a reduction in car access and reduced social participation in old age. But, it is not just a question of access. For many, motoring remains the price of participation, and policy must recognise it (Froud *et al.*, 2002) [23]. Nevertheless, lower income people with no car access can also suffer from the wider effects of road pricing. For example, in his assessment of the *LCC*, Richards notes that there is evidence that the arrangements for the reimbursement of those who are seriously ill and need to visit medical facilities within the charged area are creating difficulties, and that the charge is also creating problems for those requiring support from the voluntary sector (Richards, 2006) [13]. In addition, the qualitative study of the impact of the *LCC* found that most of those participating in the study had migrated to using public transport, and here there are a number of concerns relating to service frequency, reliability and, to a lesser extent, personal security (CfIT, 2003) [6]. However, in monitoring the social impacts of the Congestion Charge, Transport for London reports that, at least in the charging zone itself, most respondents had not perceived any change in their accessibility to local shops, facilities and services. Of those who did, three times as many said accessibility had got better than said it had deteriorated (19 per cent compared to 6 per cent) (Cairns, 2005) [78].

Nevertheless, TfL does acknowledge that the monitoring programme has proven to have a number of shortfalls and limitations, including flexibility to incorporate new and emerging requirements; representative samples of Londoners or users of the zone; and inclusion of various groups of policy interest. Initial plans are now to incorporate a larger number of smaller surveys, both quantitative and qualitative. Some will adopt sampling procedures to ensure they are representative of Londoners, residents and others who use the zone, and be large enough to be segmented by the various specific interest groups. There will also be opportunities to include in-depth qualitative analysis of any particular group of interest, or to follow up areas highlighted within other surveys that require further explanation (Cairns, 2005) [78].

A study that makes particularly significant points concerning the wider context of equity and road pricing involves focus groups for ExpressPass users on *I-15*, California. It finds that most focus group respondents identified justice, fairness and accountability as key concepts that directly impact their impression of the ExpressPass program. The study concludes that, more often than not, citizens do not consider these concepts when purchasing consumer goods, but the ExpressPass should not be viewed as a pure consumer good. Instead, the program is a hybrid good that requires more than the traditional benefit statement used to promote a consumer product. It requires a clear mission statement that addresses the moral and ethical implications of a product that flies in the face of a public that argues against the pricing of highways and the selling of limited highway space to a select group (Godbe Research, 1997) [59].

In the context of these conclusions, the *I-15* pricing proposal itself required feedback from the low income/ethnic minority segments of the affected public, in compliance with the Environmental Justice requirements. However, despite broad announcements in the media, all the public hearings were poorly attended; one even with no member of the public showing up. From this, Supernak (2005) infers that the project was commonly perceived as non-controversial, and not unfair to any constituent group. This could be compared with the idea to increase the price of ExpressPasses, which caused so many complaints that the idea was abandoned (Supernak, 2005) [4].

Other studies would not be so sanguine about assessing the wider social implications of road user charging. For example, a study of equity and efficiency for the proposed Edinburgh congestion charge emphasises that, on matters of social exclusion, several reports and stakeholders argue that access to low cost nutritional foods is becoming more difficult for low-income families, with the siting of major retail

facilities away from the most socio-economically disadvantaged areas, leaving very limited shopping choices. It is also noted that there are growing accessibility problems with regard to health facilities. The authors argue that identifying the charting of the cordon against known areas of social exclusion and transport deprivation was a necessary component of an equitable congestion charging scheme. However, they observe that there is no current evidence to suggest that this exercise or any similar form of mapping has been undertaken (RajÃ© *et al.*, 2004) [16].

Income and Ability to Pay: Key Evidence Gaps
• Little is known about the impact of road pricing on low income groups, and associated problems of accessibility and participation. Thus, although the payment of the toll is not a problem for most people, it can be a big problem for a small proportion.
• There are major gaps in understanding the reasons why people on low incomes do not have (or consider themselves not to have) an alternative to car use.
• There are significant gaps in discovering why lower-income people might choose not to pay a toll, other than for economic reasons.

3.2 Demographic Groups: Age

Impacts on Travel Behaviour

A persistent finding across a range of studies of road pricing projects is that there is a tendency for users of tolled roads to come chiefly from the middle-aged group. For example, this was observed in an overview of the US *Value Pricing* program. However, it is concluded that the implications for equity remain an open question, lacking explicit determination of whether the users and non-users within the age (and gender) classifications are being benefited or disbenefited (Evans *et al.*, 2003) [64]. Thus, in the case of HOT lanes in Houston, it was found that most users were between 45 and 54 years old, and that age (as well as household type and education) was one of the socio-economic factors that had a significant effect on trip frequency. Thus survey participants between 25 and 54 years of age were more likely to use the HOT lanes than both young adults and persons over 54 years of age (Appiah, 2004) [1]. Similarly, in the case of the *Port Authority of New York and New Jersey Road Pricing Initiative*, a survey of regular and former users found the average age to be 45.2 years (Holguin-Veras *et al.*, 2005) [2]. For *SR91* in California, the youngest and oldest travellers are significantly less likely to be frequent toll lane users than travellers in intermediate age categories. In contrast, bus users in the *SR91* corridor are significantly younger, less affluent, and less likely to be engaged in home-to-work travel than users of the other modes (Sullivan, 1998) [37].

Nor is this phenomenon restricted to the US. As previously noted, a large-scale survey in the Norwegian capital, Oslo, found that the great majority of motorists crossing the cordon at peak times were middle-aged men with above-average incomes (Larsen, 2001) [89]. Nevertheless, another Norwegian survey raises a fresh perspective by finding that, in terms of age groups, the youngest car users seem to be the most negative towards tolling. The authors find this surprising, as a commonly-held perception is that younger people are more flexible in their behaviour when compared to older age groups, including in respect of travel decisions (Kjerkreit and Odeck, 2005) [3]. No explanation is offered for this phenomenon, although it might be argued that younger car users are more negative because they find the

toll less affordable than those of middle age. The stereotype that younger people are more flexible across a range of behavioural contexts may also simply be an over-generalisation, or wrong; young people are also generally held to be more concerned by image and fashion, with both attachment to the car and attachment to particular patterns of travel for these 'non-rational' reasons, perhaps limiting effective travel choices more than for older travellers. It could also be said that the emphasis in Norway on tolls to pay for infrastructure restricted perceptions of individual benefits. This was in contrast to the *LCC* where there were wider and more immediate benefits to the individual, in the form of reduced traffic and better public transport.

In the case of the *LCC*, the question of age and approval is expressed in terms of those less likely to pay the charge having the most positive feelings towards it. Thus, in the charging zone, young people and older people were more likely to say that they had gained from the scheme or that it had made no difference to them, at 73 per cent and 77 per cent respectively. In Inner London, young people, those on a low income and older people were more likely to say that they had gained from the scheme, or that it had made no difference to them, at around 75 per cent (Cairns, 2005) [78].

One survey with findings that apparently go against the general trend is for the variable pricing Lee County toll bridges. When compared to the average resident of the area, survey respondents (*i.e.*, users of the toll bridges) were younger, better educated, more affluent and more likely to have full-time jobs. It was considered that this was to be expected, since the toll bridge travellers did not represent the County as a whole, but were expected to more closely represent the workforce of Lee County (although it was also noted that this did not guarantee that the survey results were representative of all such travellers). On the other hand, Lee County respondents who altered their time of travel to obtain the variable pricing discount on a regular basis were significantly different from respondents who had not. Thus they were significantly: less likely to be on a commuter trip; more likely to have flexibility in their time of travel for the trip; more likely to be retired and older; more likely to have flexible working hours; and less likely to belong to the highest household income category (Burris and Pendyala, 2002) [39]. These findings would appear to suggest that the relationship between age and use of tolls is more a function of economic circumstance and *value-of-time*, rather than being a function of age *per se*.

Wider Social Impacts

As noted at the beginning of this section in the context of the US *Value Pricing* program, there appear to be few studies that attempt to place age and use of road pricing in a wider social context, and to examine the equity implications. However, one study that attempts to examine the implications of proposed road charging schemes for Leeds notes that, in addition to those on low incomes with no alternative to the car, the indicators for being at risk of social exclusion include disability, age, gender, membership of an ethnic minority, and responsibilities for the transportation of others (Bonsall and Kelly, 2005) [31].

Another study that at least makes reference to age in this context examines social inclusion/exclusion impacts of road user charging and a workplace parking levy in the cases of proposals for Bristol and Nottingham. In the Bristol study, it is observed that elderly people's travel patterns indicate a high level of car dependence. Although people in this age group make the least number of trips, it would appear that most of these are by car and therefore liable to charging. This could place a strain on limited budgets (RajÃ© *et al.*, 2003) [51].

Age: Key Evidence Gaps
• There is only limited understanding of the social and economic context of the links between age and road pricing. Thus the life cycle can only be understood if we recognise the heterogeneity of all age groups.
• For each age group, more insights are required on personal perceptions and experiences of road pricing benefits and penalties.

3.3 Demographic Groups: Gender

Although there appear to be relatively few studies that examine questions of gender as an explanatory variable for impacts on toll use, there are some US studies that attempt to place findings on this subject in a wider social context, particularly from the perspective of attempting to explain why women use toll lanes.

For example, the major evaluation of the *SR91* variable-toll express lane facility in Orange County, California, found that 42 per cent of female commuters on *SR91*, compared to 28 per cent of male commuters, said that they were frequent users of the express lanes (more than 50 per cent of trips). The percentage of females in two-person High Occupancy Vehicle (HOV) groups who were frequent express lane users exceeded that of females in Single Occupancy Vehicle (SOV) groups, and both female groups reported significantly higher frequencies of express lane users than the corresponding male groups. Following the opening of the express lanes in 1995, relatively more women than men switched to lower occupancy modes (8 per cent of all female commuters compared to 4 per cent of all male commuters). About a third of peak period travellers on *SR91* are females, whilst higher proportions of women use the transit modes, especially bus (Sullivan, 1998) [37].

It is suggested that a higher *value of reliability* [21] provides one possible explanation for the consistent findings across nearly all studies on both the *SR91* and *I-15* corridors that, other things equal, women are more likely than men to choose the toll road. A possible reason is that women have more child-care responsibilities, which reduce their scheduling flexibility (Brownstone and Small, 2005) [42]. However, one cautionary note should be sounded here, in that a 1996 survey attempting to explain HOT lane use found, in the case of *SR91*, that gender and trip length made no significant difference in HOT lane use, after controlling for other important explanatory variables, including age, household size and income, household type, vehicle occupancy, trip purpose, and frequency of travel on SR91. (Li, 2001) [17].

Another piece of apparently conflicting evidence is provided by the Lee County variably-priced bridges. Here it was found that female travellers were more likely to take advantage of off-peak discounts, and so were less likely to choose use of fully-priced, peak-hour travel (Evans *et al.*, 2003) [64]. It could be argued that women were demonstrating a greater flexibility in terms of their perceived *VoT*, with willingness to pay varying with factors such as journey purpose.

Gender: Key Evidence Gaps
• Little is known about the causal reasons for gender differences on use of road pricing. For example, the USA Value Pricing Programme found that, other things equal, women are more likely to use the toll road. However, no research has been undertaken on why this might so be.
• No research appears to have been undertaken on gender differences with regard to road pricing and VoT.

3.4 Demographic Groups: Ethnicity

There is undoubtedly a general paucity of research concerning ethnicity and road pricing social and distributional impacts. One of the few studies to examine this subject in depth involved qualitative research on the impacts of hypothetical road user charging and a workplace parking levy on social inclusion/exclusion. The case studies concerned Bristol and Nottingham, where these schemes had been proposed, but were subsequently not progressed for implementation. Of particular interest here are the travel diaries from Bristol. It was found that the reliance on car/van for trip-making is particularly marked amongst people from some Asian groups [22] , where travelling as a car/van passenger was the second most frequent mode. The report notes that if Asian residents are, as the evidence implies, most likely to be affected by road user charging because of high levels of car/van dependence, it follows that they could be most vulnerable to the exclusionary effects of the charge. It is also concluded that the Asian elderly, who described unfamiliarity with bus use at associated focus groups, may end up forfeiting journeys if they cannot afford increased travel costs associated with a cordon charge, and are unable to use the bus services. This indicates the need for hypothecated revenue spending to be directed towards educational and marketing campaigns, including travel training, in appropriate languages to make public transport alternatives more accessible to this population.

The report also highlighted significant issues of ethnicity and gender. Thus it was considered significant that four-fifths of the trips made by Asian men in the study were as car drivers, in contrast to Asian women who made approximately a quarter of their trips by this mode, relying on travel as a car passenger for three in every four trips instead. It is emphasised therefore that there may be gender differences in vulnerability to impacts within this ethnic group, as the dependence of some Asian women on lifts may increase their exposure to the deleterious effects of the charge, since increased travel costs could mean that lifts become less readily available because of financial constraints on family budgets. Consequent suppression of trips or enforced mode change may follow (RajÃ© *et al.*, 2003) [51].

These findings are perhaps borne out by Transport for London's survey responses to the *LCC*. For example, across all groups of outer London residents who made trips into the charging zone, at least half of all respondents said they had gained from the scheme, or that it had made no difference to them. However, it was the black and minority ethnic respondents who were the least likely to agree, although 50 per cent still did (Cairns, 2005) [78].

As noted previously, in the United States, Environmental Justice requirements necessitated the *I-15* Congestion Pricing project in California requiring feedback from the low income/minority segments of the affected public. However, the impact here was nullified because of an extremely low public response (Supernak, 2005) [4]. In contrast, the Bristol/Nottingham study recommends a checklist for local authorities that surveys gender, ethnicity and income issues related to congestion charging. It would not

be a one-off task at the scheme conception stage, but a continuous process, that allowed iteration through a number of number of rounds over a scheme's life (RajÃ© *et al.*, 2003) [51].

Ethnicity: Key Evidence Gaps
• Little is understood about the links between road pricing and the travel behaviour of ethnic minority groups. For example, research in the Bristol area suggests that a significant proportion of Asian women are dependent on lifts, and so could be vulnerable to trip suppression as a result of road pricing. However, there is an evidence gap in discovering if this hypothesis is true in practice, perhaps to be filled by studying the case of the London Congestion Charge.
• More needs to be understood about how to overcome barriers to public transport use for some ethnic minority groups.

3.5 Household Type

For two of the most prominent urban pricing schemes in the US, findings suggest that the majority of users come from relatively small middle-class households. Thus, for the Houston HOT lanes, known as QuickRide (QR), the average household size of users was 2.99 persons, and an average 2.32 vehicles were available to each household. In addition, most users who responded to the survey were between 45 and 54 years old, and/or married, had at least a college degree, had professional or managerial careers, and had annual household incomes of $50,000 or more. However, an important feature of the case of Houston is that Single Occupant Vehicles are not allowed to use the QR lanes, and carpools of two or more persons are required (two person vehicles pay a fee, whereas vehicles carrying three or more travel for free). The carpool stipulation is regarded as the chief reason for the relatively low levels of use. For an average QR trip of 45.3 minutes, participants spent 4.3 minutes on carpool formation. Those who were more likely to be QR users included people who usually carpooled with an adult family member, spent much time on carpool formation, and/or shared the toll with their carpool partners. These findings suggest that carpools are more likely to arise from people in the same household. Given that the majority of Houston tolled-lane users come from smaller than average families, but with above average education and income, this suggests that carpooling is more prevalent in families of this type (Appiah, 2004) [1].

For the *Port of New York and New Jersey Time of Day Pricing Initiative*, it was found that households captured in the survey (of users and former users) had relatively small families, with 2.5 adults and 1.1 children on average, and the average number of licensed drivers per household was 2.3 (as was noted in the earlier section on incomes, the users of these tolls also tended to have above average incomes). It was found that respondents from New Jersey and Staten Island shared similar distributions of household structure. The number of licensed drivers per household followed a similar distribution to number of adults, whilst the average number of cars per household (2.3) correlated with licensed drivers per household. The authors conclude that the fact most respondents report having high household incomes and car ownership hints that tolls may not have a significant influence in changing travel patterns, as they are likely to represent a relatively small portion of transport costs (Holguin-Veras *et al.*, 2005) [2]. However, in the case of a survey of HOT lane users on *SR91* in California, although income was found to be a strong determinant of usage, household type and size in themselves did not have a significant effect on lane use (Li, 2001) [17].

The subject of household type, and the related one of nature of social networks, does not appear to have received a great deal of attention in the design of toll schemes, although pricing can apparently have some adverse social effects. For example, a MORI survey on the impacts of the *LCC* found that meetings with family and friends had clearly been affected. Thus, inside the zone, 43 per cent of respondents believed family and friends were now finding it more difficult to visit them, although half did find that visits had not been affected. Perhaps significantly, this type of experience shifted perceptions, in that respondents were more negative about the impact of the charge on their household than their own personal experience (MORI, 2004) [10]. Norway appears to be one country where the wider social needs of households have been considered in setting the tolls. For example, due to the 'one hour' rule in Trondheim, only one passage across the cordon per hour is charged, partly due to claims that parents bringing children to kindergarten before travelling to work would be unduly hurt if charged for several crossings (it could also be said that this is a weakness of cordons when compared with area-wide schemes) (Langmyhr, 1997) [53].

Household Type: Key Evidence Gaps
There is little evidence on how road pricing impacts on family travel behaviour, such as co-ordinating work, school and leisure trips, and making visits across toll barriers.
More needs to be understood about the links between household type and the propensity to carpool.

3.6 Disabilities

One of the few studies that examine the implications of road pricing on disabled people was instituted by Transport for London, as part of enquiries it undertook prior to the introduction of the *LCC*. The aim was to investigate the impacts of the scheme upon groups that were likely to provide insights into congestion charging. Generally, the work took the form of focus groups or discussions following a qualitative methodology. It was found that disabled people had a fairly positive attitude towards congestion charging, and many hoped that it would deter private car journeys. Respondents felt that the scheme would not work as well as greater pedestrianisation and restrictions on private car use, because the charge was too low and people would continue to use their cars. They were particularly concerned about the impacts on low-paid essential workers like carers or nurses, who would suffer financial hardship. Some anticipated that, if the scheme worked, there would be a greater demand for public transport, and that this would have a negative impact on disabled people, some of whom are dependent on these transport modes. They felt that their needs were already often not met, and if a situation of growth in demand for public transport did arise, it would be exacerbated by disabled peoples' needs not being considered a priority by policymakers and operators. No follow-up study is available, however, to test whether these fears were realised.

For the most part, the Blue or Orange Badge exemption from the charge was welcomed, although one respondent pointed out that 'special treatment' could make non-disabled people antagonistic towards disabled people. Several non-drivers without Blue or Orange Badges considered applying for these to allow friends and carers, who gave them lifts, to claim exemption from the charge (TfL, 2003) [8]. In addition to this research, Richards notes that 2004 evidence to the London Assembly indicated that the scheme favoured people with disabilities (Richards, 2006) [13]. The issues raised here about what constitutes fair treatment are sharp ones, and conflicts raised by policymaking towards the disabled car user are likely to be sharpened by the trends for an ageing population, which suggests the share of motorists eligible for 'blue badge' exemption will grow.

Disabilities: Key Evidence Gaps

- No research appears to have been undertaken on the impact of the London Congestion Charge on disabled people. For example, a survey prior to implementation of the Charge found that disabled people feared the impacts on low paid essential workers, such as carers or nurses, who would suffer financial hardship, and perhaps be less willing to work on those roles. Concern was also expressed that 'special treatment' of disabled people, through exemptions, could antagonise non-disabled people. However, no follow up research has been conducted.

3.7 Spatial Impacts: Boundary Questions

The most salient issue with regard to road charging boundary issues and social and distributional impacts undoubtedly concerns the aborted congestion charging proposal in Edinburgh. Here, a key exemption added at a late stage by Edinburgh Council was that residents of the administrative area of the City who lived outside the proposed outer cordon would not be liable for the outer cordon charge (Â£2 between 7am and 10 am) [23] . The exemption was justified by the Council on the grounds of fairness for all Edinburgh residents. However, it gave rise to considerable concern to residents from neighbouring council areas. In the 2005 referendum on the charge, 25.6 per cent voted 'yes' and 74.4 per cent voted 'no.' One of those integrally involved in the design of the scheme believes that one reason for the defeat was the exemption decision: although only Edinburgh residents voted, opposition from surrounding areas affected publicity about the scheme, and influenced opinion within the City (Saunders, 2005) [72].

Another study that specifically examined the Edinburgh boundary problem and issues of equity and efficiency makes the telling point that there are poor neighbourhoods just outside the Edinburgh boundary where the residents would have been liable to pay the charge, whereas more affluent areas within the City boundary would have been exempt (RajÃ© *et al*., 2004) [16].

Boundary problems have also been found in the case of the *LCC*, although here findings so far emphasise effects on environment and accessibility, rather than cost. For example, a report from MORI (which conducted the impact monitoring for TfL) found that respondents from Hoxton were particularly negative about accessibility, reporting an increase in cars parked in their area, as well as concerns about 'strangers' parking in their neighbourhoods. This was related to a rise in the number of drivers from outside the community parking their vehicles and completing journeys to the zone on foot or by pubic transport rather than paying the congestion charge (MORI, 2004) [10]. However, there appears to be some discrepancy here between MORI and TfL, as the latter claimed that evidence to date from a comprehensive study of impacts in the boundary zone just outside the charging zone indicated that these impacts are largely neutral, with some transport gains and a general absence of traffic, congestion and environmental problems attributable to charging. Nevertheless, TfL acknowledged that the social and economic aspects required further study (TfL, 2005) [11].

In some cases the relationship between charging boundaries and social and distributional impacts may have important equity effects. For example, a study of proposed road pricing options in Leeds, and their impacts on at-risk groups, concludes that a policy under which charges are proportional to distance driven within the charge area would have less serious consequences for at-risk groups and that, although the number of affected drivers is higher when the charge covers a large area of the city, the number of low income drivers having to pay significant daily charges is less than when the charge area is restricted to the city centre (Bonsall and Kelly, 2005) [31]. A somewhat analogous point is made in a study of a proposed

charging scheme for Northern Virginia in the United States. It is argued that poorer households would benefit from less-congested regular lanes and side roads, even if the toll revenues are not redistributed. However, the benefits are concentrated where the policy is implemented. Travellers living elsewhere tend to see a negative welfare change (Safirova *et al.*, 2003) [25].

A distinctive but important type of boundary problem is illustrated by the example of an urban road pricing scheme in Lyon in France. Here, the tolled Boulevard PÃ©riphÃ©rique was opened in 1997. The total length of the road is 10km, and because it runs through a highly urbanised zone, almost two-thirds of the road is underground. However, from the outset, it was fiercely rejected by motorists, as they were confronted by not only the new toll road, but also severe capacity restrictions on the parallel roads. These restriction measures were considered necessary to guarantee a minimum flow of paying customers from the outset, in order for the scheme to achieve financial equilibrium. There was a movement to boycott the new road, accompanied by weekly demonstrations at the toll barriers. Legal actions followed, leading to the State Council cancelling the concession contract. The local authority repurchased the road, and it is now run by a public corporation. The authors conclude that the scheme, with its fatal inability to reconcile equity at the boundaries, violated principles of economic efficiency (efficiently managing demand), spatial equity (guaranteed access), and vertical equity (the welfare of the most underprivileged) (Raux and Souche, 2004) [38].

Boundary Questions: Key Evidence Gaps
• There is only a limited understanding of the implications of toll boundaries on problems of social exclusion, and also environmental impacts.
• More insights are required on how to reconcile considerations of economic efficiency and social equity with regard to boundary issues.

3.8 Spatial Impacts: Other Findings

Transport for London has placed particular emphasis on assessing the differential impact of the Congestion Charge on the charge zone itself, Inner London, and Outer London. For example, in the Third Annual Report of 2005, it was reported that respondents living inside the charging zone were most positive about the change in their local area as a result of the scheme, particularly the reduction in congestion. Respondents to separate surveys on-street also perceived improvements in the general amenity of the area, air quality, noise, traffic levels, and public transport provision. The majority of all respondents felt that the charge was affordable. However, more respondents living within the zone reported finding the charge difficult to afford than respondents living in Inner London, despite being in receipt of the 90 per cent residents' discount, presumably reflecting the frequency of actual charge payment (TfL, 2005) [12].

The example of London highlights the sensitive but vital question of where and how a charge is imposed. In considering a national pricing scheme, Glaister and Graham recommend that the marginal benefits of collecting low charges in non-congested areas should be compared with the marginal cost of collection: this would, in turn, depend on the technology used. Most of the benefits of user charging arise in relatively small areas of the country at particular times of the day. In the context of equity and concessions, it is argued that there will have to be a careful analysis of the effects on different groups. For example, if revenues were used to reduce taxes on fuel and vehicle ownership, this could benefit

lower-income car users in rural areas, who have no realistic public transport alternatives. This might therefore make a valuable contribution to the avoidance of social exclusion in rural areas. In urban areas, the relationship between gainers, losers and income will depend critically on where different income groups live in relation to the charging areas. This is likely to vary from place to place (Glaister and Graham, 2004) [61]. Other UK studies concur in concluding that the site-specific elements of any charging scheme are crucial in determining its feasibility and success, for both urban and rural areas (Santos, 2004; Roberts *et al.*, 1999; Santos and Rojey, 2004) [19, 24, 29].

Spatial factors can also be influential in the relationship between road pricing and wider social and environmental factors. For example, a paper investigates the relationship between urban air quality, represented by *nitrogen dioxide* (NO_2) concentrations, and social deprivation for the city of Leeds. Air quality was assessed through a range of road policy options, including user charging. The data revealed that inner city Leeds is the most deprived part of the City, and the suburbs the most affluent (although this was something of a generalisation). The analysis indicated that there is social inequity in the distribution of NO_2 in Leeds, with deprived areas experiencing significantly higher ambient concentrations than communities of average or above-average affluence. However, it was found that road user charging reduced inequity in exposure to NO_2, with the extent of the reduction varying according to the charge option. It was also found that road user charging may be more effective than low-emission zones in addressing environmental inequity. In contrast, road network developments increased environmental inequity in Leeds, the only transport option investigated to so do (Mitchell, 2005) [47].

Spatial Impacts: Key Evidence Gaps
• Little research has been undertaken on the implications of road pricing for those living in rural areas. For example, any national scheme of road pricing will have important implications for those living in rural areas that use a car, but have poor accessibility to public transport.
• More needs to be understood about the links between road pricing and wider environmental and social impacts, such as on air quality in urban areas.

3.9 Transport Modes

Behavioural Impacts

The *LCC* provides a notable example of a major switch of transport mode from private to public transport. Thus, a year after implementation, Transport for London reported that the biggest change prompted by the Charge was the transfer of car users. Surveys indicated that, for 40,000 to 45,000 terminating car movements, the drivers had transferred to another mode of transport. A follow-up survey suggested that 35 to 40 per cent of those same car drivers had transferred to bus; 45 to 50 per cent had transferred to underground or rail; and 10 to 20 per cent had transferred to walk, cycle, motor cycle, taxi, or minicab. However, TfL considered that this survey understated the proportion that had transferred to bus (TfL, 2004) [9]. In this context, Goodwin notes that the traffic effects were greater, and the revenue produced inevitably less, than the simulation models had predicted. A most important lesson is that travel behaviour does change, and this principle should feature strongly in the planning of future RPSs (Goodwin, 2004) [83].

The need to invest congestion charging revenues in major public transport improvements is also perceived in other countries, although in some places with somewhat different policy emphases to London. For example, in Singapore, there is apparently a greater re-distributive emphasis, with motoring a preserve of the rich, but the government ensuring that less wealthy households have access to high quality public transport (Santos *et al*., 2004) [81]. In the case of Stockholm, where a six-month pricing experiment commenced in 2006, it is observed that where, like London, most commuters already travel by public transport, it can be politically wise to take any measures that are needed to maintain the quality of public transport services during a implementation of a RPS (Armelius and Hultkrantz, 2005) [22]. In Norway, road pricing schemes have been instituted to pay for specific road improvements (Bekken and Ossland, 2005) [77], but the emphasis is also switching in that country. Thus, it is argued that, if revenues are allocated in such a way that they are not only returned to the transport sector but also used to compensate 'losers' (for example through subsidised public transport fares), the problem of potential inequity can at least, in part, be solved (Ramjerdi *et al.*, 2004) [80]. In Oslo, a switch to greater public transport investment and operating subsidies has seen a development in traffic that has countered stagnating national trends (Lian and Fearnley, 2005) [76].

Wider Social Impacts

It is also important to note some limits to the success of schemes which seek to redistribute the benefits of RPSs. For example, the revenue raised from *I-15* in California was successful in funding the new express bus service called *Inland Breeze*. However, it is noted that the high proportion of Inland Breeze riders who were in any case dependent on public transit in general to meet their travel needs suggests that the service is primarily reaching segments of the population with traditionally higher levels of bus ridership, rather than attract non-traditional bus riders. Whilst this still results in redistribution to a group which is likely to be on relatively low incomes, the benefits are apparently not being extended to the car dependent on low incomes. Significantly, only few respondents knew that the program had been used to fund the Inland Breeze service, and both program participants and car-poolers favoured the opinion that the revenue should be used to add or extend and maintain the carpool lanes (Supernak, 2001) [35].

There may also be both positive and negative 'side effects' as a result of mode switches in response to urban congestion charging. In a positive vein, several studies have noted the potential health benefits of a switch to walking and cycling (*e.g.* Vold *et al*., 2001; Grayling *et al*., 2004) [20, 36]. On the other hand, one paper argues that the impact of the *LCC* on traffic casualties has not been analysed. Less car travel within the charging zone may result in fewer traffic collisions. However, as the number of pedestrians, cyclists and motorcyclists increased after the introduction of the Congestion Charge, the number of traffic casualties associated with these groups may also have increased. As reductions in congestion can also lead to faster speeds, there could be increases in injury severity for those crashes that do occur.

The authors' analysis suggests that, although total casualties show no significant change within the charging zone, there have been increases in motorcycle casualties within Inner London. This could clearly be a result of the incentive to use motorcycles, riders of which do not pay the Congestion Charge. TfL data has shown an increase in motorcycle trips within the charging zone of about 15 per cent. In addition, the authors speculate that increases in bicycle casualties in the Outer London zone may be due to increased commuting, perhaps to rail and underground stations (Noland *et al.*, 2006) [65].

Transport Modes: Key Evidence Gaps
• Little is known about the underlying reasons that may induce people to switch modes as a result of road pricing.
• Only limited research has been undertaken on the social and distributional impacts of charging on road casualties.

[17] Each time a traveller pays to switch to the tolled route, the untolled route will be slightly less congested, and the tolled route slightly more congested. Switches will continue up until the point that the benefit of switching matches the amount those still on the untolled route would be willing to pay (so there is then no point in them switching). This point can be referred to as equilibrium. Where and when it arises depends on the overall amount of travel demand, the level of toll, and willingness/ability to pay.

[18] An economic measure of the value in monetary terms of time lost or gained, in this case as a result of changes in the time required to complete a particular journey. In UK Government cost-benefit analysis procedures, the value-of-time of people who are travelling in the course of their paid employment is valued as equivalent to the market cost of providing their labour per hour, essentially assuming that time spent travelling is entirely unproductive, and the wages paid by the employer during travel time wasted. People travelling in their âownâ time â the majority of travel - are for the most part assumed to have a standard, much lower, value of time, reflecting evidence about their willingness to pay more to save travel time. The exception is that a slightly higher value is applied for trips to and from work, which are frequent, non-discretionary trips, made by wage-earners (on average wealthier than the population as a whole). There is also a higher penalty for lateness at the destination than with some other journey types. Taken together, a premium is placed on commutersâ willingness to pay to travel to and from work more quickly.

[19] An elasticity is an economistâs measure of how responsive consumer demand towards a good or service is with respect to a range of supply and demand factors such as market price, disposable income, and the attractiveness of substitute goods (i.e., goods or services that can satisfy the same broad consumer demand). An elasticity is described as small or weak if a given proportion of change in the market variable results in a much smaller proportion of change in consumer behaviour, suggesting that consumersâ willingness or ability to alter their level of consumption is limited.

[20] The total amount of âutilityâ or âbenefitâ that society enjoys as a whole, reflecting the extent to which individuals can satisfy their various demands (taken as indicating their overall quality of life).

[21] A similar concept to VoT but with the difference that the travellerâs perceived value of reliability is expressed in terms of greater willingness to pay extra for a more certain journey time, rather than necessarily a shorter journey time.

[22] As mentioned previously, the study does not disaggregate findings by ethnic background but it is known that it included British white and British black and minority ethnic respondents as well as immigrant populations. The sample included people from Indian, Pakistani, Bangladeshi, Somali, Sudanese, and African-Caribbean backgrounds. These distinctions are likely to be important.

[23] An inner cordon fee was also proposed, and also to be set at Â£2, but would have operated between 7am and 6.30 pm.

4. Discussion: Scope, Quality, and Relevance of Evidence

It is important to emphasise that the evidence base on social and distributional impacts is extremely limited, and little literature exists of which social and distributional impacts are the primary focus of research. Thus it is imperative not to make sweeping general conclusions from this limited evidence base. Nevertheless, the emerging body of research on existing (or near market) road pricing schemes does provide some valuable guidance on the interrelationships between type of scheme and social and distributional impacts, together with implications of road pricing at different life stages, and consultation and public acceptability.

4.1 Types of Scheme

Scheme Type and the Social Definition of Road Pricing

Until quite recently, the complex range of possible effects of road pricing on social groups has not been given nearly as much consideration as the effects on traffic distribution, particular economic activities and travel behaviour at the aggregate level. Consequently, it has been perceived predominantly as being used by particular groups of people (often male and middle class) at particular times of day (often the peak home-work travel times), as evidenced by some of the studies considered in Section 3.1.

This type of finding reflects the fact that much of the evidence base on social and distributional impacts concerns either cordon/area charging or route charging, where an un-priced alternative of some sort exists and no user should experience a worse level of road service as a result of some travellers buying a better service; indeed, all may benefit if the toll lane represents additional capacity. In turn, there is often an implicit assumption that those who pay will be those who can afford to pay. However, setting the price of road use must acknowledge the distinctions between willingness to pay, necessity of paying, and ability to pay. The difficulty in narrowly defining the use of road pricing is that, not only is the scope for flexibility in use and price overlooked, but also the problems and needs of the atypical user can be ignored, for example, the needs of those on low incomes with no alternative to car use. The evidence review identifies the existence of this important group, but little is known about its actual size and travel behaviour. However, in recent years there does appear to be at least an emerging awareness that successful scheme design must take into account key distributional social and economic impacts.

In turn, this brings to the forefront the importance of equity (and perceptions of equity) in the public acceptability of road pricing, and this can be reflected in scheme design. Crucially, Jones emphasises that it is questions of social equity that particularly emerge in public debates, rather than issues relating to the primary objectives of introducing a RPS; usually to reduce traffic or congestion levels. He argues that social equity is likely to be correlated with population characteristics, such as gender or ethnic origin, although it would be politically, and practically, difficult to discriminate positively along such lines. He outlines a range of five factors that may mitigate or aggravate questions of equity: the basis of charging; the area covered by the charge; the time period covered by the charge; discounts or exemptions; and linkages to other transport charges (Jones, 2004) [57].

The cross-national significance of equity is indicated by a comparative study that examined car owners' perceptions of fairness with regard to road pricing in Sweden (Gothenburg), Japan (Kyoto), and Taiwan (Taichung). The results showed that fairness significantly increased acceptance in all samples. None of the country differences were accounted for by the same sample differences in age and gender. However, there was a significant difference in how income affected acceptance. In the Taiwanese sample, people with a high income were more inclined to accept road pricing than people with a low income, whereas there was no such effect related to income in the Japanese and Swedish samples. Nevertheless, it was concluded that the importance of fairness may transcend cultures (Fujii *et al.*, 2004) [55].

The difficulties in finding any sort of equilibrium on equity issues has led to several studies concluding that there can be no fixed rules on this subject. Thus, a study of the global relevance of recent road pricing developments in the UK concludes that equity of road pricing schemes over physical space is shown to be sensitive to the specifications of the scheme. Consequently, stakeholders in some areas are likely to be impacted differently to those in other areas, and the degree of inequity may vary highly across potential schemes (Hensher and Puckett, 2005) [41]. For example, a study of the lessons to be learned from the *LCC* concludes that any city considering the introduction of a road pricing scheme, be it area or cordon-based, will need to estimate the incidence on each group, and even investigate different scheme designs and their impacts, before making a decision. The social and distributional impacts are therefore town and scheme specific (Santos and Fraser, 2005) [14].

Equity and Scheme Design

A linked study of social and distributional impacts for road pricing options in eight English towns and cities comes to similar conclusions. Thus, in one study, administrative wards were assessed in Cambridge, Northampton and Bedford to examine the toll implications of vehicle trips from each ward crossing a hypothetical cordon. The wards were grouped according to a four-way typography of predicted effects: (1) low income and few crossings; (2) low income and many crossings; (3) high income and few crossings; (4) high income and many crossings. Categories 1 and 4 are progressive in terms of fairness, whilst categories 2 and 3 are regressive for fairness. It was found that five wards in Cambridge would experience progressive effects, whereas nine would experience regressive effects. The overall effect of a cordon toll for Cambridge would therefore be expected to be regressive for fairness. However, given similar analyses, the overall effects in Bedford would be progressive, and those in Northampton neutral. The analysis did not, however, take into account possible compensation to poorer groups through redistribution of the benefits (Santos, 2004) [19].

Also concerning scheme design, a study that compares the lessons to be learned from London, Cambridge and Hong Kong argues that flexibility is a key to success, as evidenced by the operating specifics in London: the 07.00 to 18.30 hours operating period was designed to account for the West End entertainment industry, whilst there is a wide range of discounts and exemptions from the charge. It was this flexibility that smoothed the way to implementation (Ison and Rye, 2005) [87].

The relationship between scheme type and road pricing objectives and priorities is particularly well illustrated by the case of Norway, where urban toll cordons have become relatively common over the past two decades. For many years, the specific aim of road pricing in Norway was to impose tolls for a specific period of time, in order to raise revenue for earmarked new road infrastructure, and not for reasons of reducing congestion or on environmental grounds. Tolls were therefore set at a relatively low level, in order to encourage use and maximise revenue. This meant that, although general public acceptability was

regarded as important, more subtle and complex social and distributional impacts and implications were overlooked.

One early example of an awareness of social and distributional impacts in Norway demonstrates the policy priority of maximising revenue. A toll ring was introduced in Trondheim in 1991, but surveys suggested that too few drivers were contributing to toll revenues, and that only about one third of Trondheim's drivers paid tolls regularly. The answer here was to introduce new toll cordons that divided the town into several zones, so that payment of tolls was spread more evenly. Distributional impact was therefore seen in a spatial, rather than in socio-economic, terms (Meland, 1995) [71].

However, in recent years the dynamics of Norwegian policy has led to a greater consideration of the benefits of urban cordons in reducing traffic congestion, and with this has come an awareness of socio-economic impacts, and the importance of reconciling efficiency and equity in scheme design. Thus, a 2002 road law amendment has provided the statutory basis for congestion pricing. Under this amendment, the proceeds of a scheme must be used for local road and public transport purposes. One paper argues that, in this context, the design of the integrated policy instruments should take account of the negative social and distributional impacts by providing the necessary compensation to losers. Nevertheless, it is emphasised that this alone might not create a political consensus for congestion pricing, and further incentives to overcome inequities might be both politically necessary and good public policy (Ramjerdi, 2003) [49].

Lower Income Problems in Scheme Design, and Evidence Gaps

The evolution of road pricing policy in Norway reflects a wider trend, in that the focus hitherto has been on those who choose to pay, whilst there is little evidence on those who may be unwilling or unable to pay, and what impact deciding not to pay has on their quality of life. In particular, evidence suggests that lower-income groups are less likely to use roads where and when pricing measures are in force. However, there is little evidence that specifically explores why this is so.

For example, non-use of road pricing might be for reasons other than income, and here there may be a close link between the siting of a charging zone, and where those on lower incomes live. Qualitative research on the *LCC* found that a significant number of lower-income people live in relatively close proximity to their places of work, and so do not need to pay the charge (Commission for Integrated Transport, 2003) [6]. It can also be that people travel to work outside the charging hours and have nearby access to essential services, so don't need to use cars during the hours of operation either. In the case of the proposed Edinburgh Congestion Charge, it was found that lower-income people were significantly less likely to cross the cordon, mainly through lower use of cars for work trips. However, this was interpreted in a positive way, by arguing that lower income people would benefit from the Charge, as a result of toll revenue expenditure on public transport redistributing the benefits to them (Sinclair, 2002) [67]. On the other hand, another Edinburgh study believed that the Congestion Charge would have exacerbated problems of accessibility for low-income families having to make cross-city journeys for shopping and access to medical facilities (RajÃ© *et al.*, 2004) [16].

The location of potential social exclusion problems can therefore be susceptible to scheme design. For example, a study of proposed road pricing schemes and social exclusion in Leeds emphasises that one of the main reasons for identifying the at-risk groups before implementing a road user charging scheme is that it might be possible to modify the scheme design, so as to reduce the likelihood of these people

becoming socially excluded. If it is possible, by moving the boundary, by redefining the basis for the charge, by allowing different methods of paying the charge, by providing exemptions for certain groups, or by using the revenues to improve the provision of alternative modes of travel in order to reduce the impact on at-risk groups, then this should be given serious consideration right from the outset (Bonsall and Kelly, 2005) [31].

From the Leeds case study, it appears that a policy under which charges are proportional to distance driven within the charge zone would have less serious consequences for at-risk groups and that, although the number of affected drivers is higher when the charge covers a large area of the city, the number of low income drivers having to pay significant daily charges is less than when the charge area is restricted to the city centre (Bonsall and Kelly, 2005) [31]. However, it must also be noted that, in other cities, lower income people may not be so concentrated in the city centre, and so there may be a site-specific element here. It should also be noted that even those living within a charging zone and receiving exemptions may find more difficulty in paying than those living outside the zone. Thus, Transport for London reports that more respondents living within the Congestion Charging zone reported finding the charge difficult to afford than respondents living in Inner London, despite being in receipt of the 90 per cent residents' discount, presumably reflecting the frequency of actual charge payment (Transport for London, 2005) [12].

Differential Pricing and Social and Distributional Impacts

The Value Pricing programme in the USA has made a particular feature of examining how flexible pricing may mitigate adverse social and distributional impacts. One significant study observes that recent pricing experiments in the Los Angeles (*SR91*), San Diego, and Houston areas give motorists the option to travel free on regular roads, or to pay a price which varies in time according to traffic levels, for faster travel on a lane with lower congestion available for a part of their overall journeys. In a study of *SR91*, the authors found that commuters vary substantially in how they value travel time and travel time reliability. They find that, compared to a uniform price, differentiated road prices can significantly reduce the distributional disparities between groups of motorists. They also find great heterogeneity in motorists' preferences for speed and reliability. An analogy with densely populated areas of the UK is possible given their conclusion that one possible explanation for this heterogeneity is that, in very expensive and congested areas such as Southern California, consumers face significant constraints in trading off housing expense for commuting time. In such a situation there is an opportunity to design pricing policies with a greater chance of public acceptance by catering to varying preferences. They argue that, by reducing the adverse impact of tolls on consumer surplus [24] , differential pricing enhances the political viability of road pricing because policy makers must apportion only a modest fraction of toll revenues to fully compensate road users. Differential pricing, embedded in both the design and marketing of recent experiments, may thus be the key to addressing the stalemates that impede transport policy implementation in congested cities (Small *et al.*, 2002) [15].

There are indications in the USA that attempts are being made to learn from the evidence of the *Value Pricing Programme*, and construct packages of scheme-design proposals that combine variable pricing with an awareness of mitigating socio-economic social and distributional impacts. One such example is an integrated package known as *Fair Highway Networks* (evolved from the FAIR lanes concept). This would convert the entire existing freeway network during peak-periods only into a premium-service freeway network that provides new and frequent bus services, a free premium service for carpools, and a premium service for SOV riders paying a toll which varies, in order to manage demand and keep the highway free

of congestion. In addition, there would be credits or refunds of peak charges for low-income commuters to address equity impacts and reduce the incentive for them to divert to an alternative free route. (It is intended that there would be an improved network of free arterial routes.) It is claimed that the FAIR network would be self-financing and provide significant social benefits, although it is acknowledged that it may be difficult to get public acceptance, due to the complexity of the scheme and public mistrust of government (DeCorla-Souza, 2005) [85].

Wider Social Impacts and Scheme Design

Although relatively little is known about the possible first-order effects of scheme design, such as impacts on different income and social groups, virtually nothing is known about the second-order effects. These more indirect impacts can nevertheless be highly important in safety and quality of life terms. For example, the study in Leeds of air quality responses to road user charging highlights the potentially beneficial environmental effects road pricing may have on areas of deprivation. Poverty was measured using the Townsend Material Deprivation Index, including levels of unemployment, overcrowding, car ownership, and home ownership. Although it is something of a generalisation, the data reveal that inner-city Leeds is the most deprived area, and the suburbs the most affluent. Through application of a series of linked dynamic models of traffic simulation and assignment, vehicle emission, and pollutant dispersion, the environmental equity implications of a series of urban transport strategies are assessed, including road user cordon and distance-based charging, road network development, and emissions control.

The analysis shows that there is social inequity in the distribution of NO_2 in Leeds, with deprived areas experiencing significantly higher atmospheric concentrations than communities of average or above-average affluence. The analysis shows that environmental inequity in Leeds is reduced by all but one of the strategic transport options investigated. Thus, road user charging also reduces inequity in exposure to NO_2, with the extent of the reduction varying according to the charge option. It was also found that road user charging may be more effective than low-emission zones in addressing environmental inequity. In contrast, the road network developments increased environmental inequity in Leeds, the only transport option investigated to do so (Mitchell, 2005) [47]. Nevertheless, it should be noted that there is a site specific element here, as air quality improvements for central deprived areas may be less relevant where areas of deprivation are located outside the city/town centre.

The Leeds study is hypothetical, but the thorough analysis does illustrate well how road pricing can have indirect social impacts, beyond immediate concerns of traffic and congestion. Similarly, the study of the effects of the *LCC* on road casualties illustrates that social and distributional impacts can be more complex than might initially be expected. The authors hypothesise that, as reductions in congestion can also lead to faster speeds, there could be increases in injury severity for those crashes that do occur. An intervention analysis was conducted to investigate the effect of the Congestion Charge on traffic casualties for motorists, pedestrians, cyclists and motorcyclists, both within the charging zone and in areas of London outside the zone. This was done for killed and serious injuries and for slight injuries, to examine whether there were any shifts in severity outcomes.

As noted in an earlier section, the analysis suggests that the safety impacts of the Congestion Charge are not conclusively beneficial. Although the reduction in car occupant casualties suggests that changes in severity levels from changes in relative speed had no effect, there have been increases in motorcycle casualties within the Inner London area. Transport for London data show an increase in motorcycle trips

within the charging zone of about 15 per cent. It is speculated that the recent increases in the Congestion Charge to Â£8 per day could further increase the incentive for some commuters to shift to motorcycles (Noland *et al.*, 2006) [65].

Boundary Design and Equity

The drawing of road pricing boundaries and their social and distributional impacts can have particularly salient political and social effects. Consequently, the relationship between gainers, losers and income will depend critically on where different income groups live in relation to the charging areas. This is likely to vary from place to place. As we described in Section 3, in the case of Edinburgh, decisions made on drawing the boundaries of the proposed congestion charge and who should pay apparently had a vital impact on the result of the 2005 congestion charge referendum. Although only Edinburgh residents voted, it was concluded that opposition from surrounding areas affected publicity about the scheme, and influenced opinion within the city (Saunders, 2005) [72]. In this context, another study makes the telling comment that there are poor neighbourhoods just outside the Edinburgh boundary who would have to pay the charge, whereas more affluent neighbourhoods within the city boundary would be exempt (RajÃ© *et al.*, 2004) [16].

A more endemic characteristic of boundary issues is illustrated by findings from the *LCC*, where respondents from Hoxton were particularly negative about effects on accessibility, reporting an increase in cars parked in their area, as well as concerns about 'strangers' parking in their neighbourhoods. This was related to a rise in the numbers of drivers from outside the community parking their vehicles and completing journeys to the zone on foot or by public transport rather than pay the Congestion Charge (MORI, 2004) [10].

This type of parking displacement effect indicates that more needs to be understood about both the primary and secondary boundary impacts. In addition, the boundary impacts of separately priced lanes are also under-researched. Thus we understand very little about the reasons people may not use such innovations as High Occupancy Toll (HOT) lanes. For example, the motivations and mechanics of carpooling can be problematic, whilst there may be perceptions of inequity in allowing SOVs into HOT lanes.

4.2. Implications of Road Pricing at Different Life Stages

Group Heterogeneity and Behavioural Causes

Very little is known or understood about how and why people respond or adapt to road pricing at different life cycle stages. It must be emphasised that this is not just a matter of age in itself, but can be combined with economic and family circumstances, as well as being a function of a range of social groups, such as gender and ethnicity. Consequently, generalisations about how road pricing impacts on people at different life cycle stages can be deceptive, as social groups are far from homogenous. For example, we might assume that younger people would be more positive and flexible about the use of road pricing. However, a Norwegian survey found that it was younger people who were the most negative towards road pricing (Kjerkreit and Odeck, 2005) [3]. The study finds this surprising, although no explanation is offered. It might be hypothesised that younger people are likely to be poorer than those in middle age, and that economic circumstances here outweigh potentially more flexible attitudes. However, the lack in understanding the reasons not only why a finding might be so, but also how it impacts on other social

phenomena, severely restricts the ability to take mitigating action.

For example, apparently conflicting evidence is found in the case of the variably priced bridges in Lee County, Florida. Here, when compared to the average resident of Lee County, survey respondents (*i.e.* bridge users) were younger, better educated, more affluent, and were more likely to have full-time jobs. The study notes that this was expected, as bridge users were likely to reflect the Lee County workforce rather than the population as a whole. On the other hand, respondents who altered their time of travel to obtain the variable pricing discount on a regular basis were significantly different from those who did not, and included those more likely to be retired and significantly older than the average users. The findings indicated that special characteristics, such as flexitime availability at the traveller's place of employment, and being retired, both increased the likelihood of the driver altering his or her time of travel to obtain the toll discount. Conversely, having a high household income or being on a commute trip decreased the likelihood (Burris and Pendyala, 2002) [39].

The situation with regard to life stages is therefore complicated by the interaction of a wide range of variables. It is not just a matter of economic circumstances, but can include factors such as *value-of-time*, personal mobility, and accessibility of services. Hence, there is a need to understand how the factors interact, and to establish which of them should be of primary concern.

Again, the USA evidence on gender and road pricing offers tantalising glimpses of possible important interactions for road pricing use that are dependent on social, rather than economic, needs. Thus the *Value Pricing Programme* consistently found that, other things equal, women are more likely than men to choose the toll road. However, there is no concrete evidence on why this is so, although it is speculated that women have more child-care responsibilities, which reduce their scheduling flexibility (Brownstone and Small, 2005) [42]. There is therefore an urgent need to understand more clearly the causes for this type of behaviour, and the implications for such policies as variable pricing and separately tolled lanes.

Life Cycle Paradoxes

Trondheim in Norway provides a relatively rare example of an urban cordon policy attempting specifically to cater for family needs through the 'one hour' rule, whereby only one passage per hour across the cordon is charged, partly due to claims that parents bringing children to kindergarten before travelling to work would be unduly hurt if charged for several crossings (Langmyhr, 1997) [53]. Nevertheless, another Norwegian survey found that few lower income people used the cordons at peak times, and that the great majority of motorists here were middle-aged men with above average incomes (Larsen, 2001) [89]. Once again, however, we do not have the evidence as to why lower income people do not use the cordon at peak times, and the degree to which this does or does not inhibit mobility and accessibility.

A suggestion that this can be a serious problem is provided by a Leeds study on congestion charging and at-risk groups. This study concludes that the groups most at-risk are those on low incomes who have no realistic alternative to make particular journeys by car (Bonsall and Kelly, 2005) [31]. Similarly, an assessment of the effects of the proposed congestion charge in Edinburgh on lower income households concluded that individuals on low incomes with no alternative to using private transport would be hard hit (Sinclair, 2002) [67]. In addition, a Bristol study found that elderly people's travel patterns indicated a high level of car-dependence. Although people in this age group made the least number of trips, it was concluded that, as most of these trips are by car and therefore liable to charging, this could place a strain

on limited budgets (RajÃ© *et al.*, 2003) [51]. However, there is still little understanding generally of the precise reasons why some lower income people are apparently so dependent on car use, *e.g.* for reasons of accessibility, perceptions of public transport quality, fears of personal safety etc.

Disability can also clearly transcend questions of age and gender, and the road pricing social and distributional impacts here can go well beyond the immediate person involved. Significantly, a Transport for London Survey on the Congestion Charge found that disabled people were particularly concerned about the impacts on low paid essential workers like carers and nurses, who would suffer financial hardship. Several non-drivers without Blue or Orange badges considered applying for these to allow friends and carers, who gave them lifts, to claim exemption from the Charge (TfL, 2003) [8]. Disabled people are therefore particularly vulnerable to the potential breakdown of social networks, and more needs to be understood about how these are affected by road pricing schemes over time.

Ethnicity is another area where impacts may not be immediately obvious, but can nevertheless carry important implications for accessibility that reach beyond economic criteria. Thus a study based on travel diaries in Bristol found that four-fifths of trips made by Asian men in the study were as car drivers, in contrast to Asian women who made approximately a quarter of their trips by this mode, relying on travel as a car passenger for three in every four trips instead. It was concluded that there may be gender differences in vulnerability to impacts within this ethnic group, as the dependence of some Asian women on lifts may increase their exposure to deleterious effects of a charge. This is because increased travel costs could mean that lifts become less readily available, because of financial constraints on family budgets (RajÃ© *et al.*, 2003) [51]. However, more evidence is needed on this subject, for example with regard to the impact of the *LCC*, in order to understand better the connections between charging and potential restrictions on quality of life.

Assessments of road pricing social and distributional impacts on stages in the life cycle are undoubtedly significant in determining criteria for equity, and considering policies of mitigation. However, there is a paradox in that the life cycle in itself is only meaningful as a unit of analysis when it is placed in the context of a range of other key social factors. This inevitably provides a more subtle and complex picture, but is necessary in order to understand the dynamics between road pricing and the development (or destruction) of social networks. It is in the rich texture of these interactions that road pricing schemes must be placed, and much more needs to be understood about how individuals respond and adapt to the problems presented by charging.

4.3. Consultation and Public Acceptability

The case of Edinburgh and the boundary issue illustrates how a gap between official decisions and public perceptions of equity (or the lack of it) can have overwhelmingly negative effects on public acceptability. Boundaries to any scheme (spatial, temporal, or relating to concessions and exemptions) may be inevitable, but are a natural target for controversy, and evidently can govern whether the argument for pricing is won or lost. As this study has shown, both direct and indirect effects can be a source of public concern. Consequently, it cannot be assumed that a consultation exercise in itself will be sufficient to deal satisfactorily with important matters of social exclusion.

An example of this type of credibility gap is provided by the case of the Interstate 15 Congestion Pricing Project in San Diego, California. Here, in compliance with Environmental Justice requirements, the *I-15* project needed feedback from the low income/minority segments of the affected public. However, despite

broad announcements in the media, all meetings were poorly attended, with no one attending at one of them. From this, it was inferred generally that the project was not controversial and not unfair to any constituent group (Supernak, 2005) [4].

Nevertheless, it can be argued that this type of consultation exercise is inadequate, and that hard to reach groups at risk of social exclusion must be actively engaged in consultation, by sampling people from these groups and actively seeking out evidence on their travel behaviour/needs. It is likely that hard to reach groups, such as people on low incomes disengaged with the political process, and those who cannot travel to consultation locations, are hard to engage in public consultation, even when they are directly affected by the issues. In addition, it is difficult to gauge whether a representative sample of people has engaged in a public consultation, unless some form of robust sampling has been conducted. It is also possible that people may adopt a passive attitude, and assume that the people in charge will automatically make the right decisions.

It is therefore important to find the means to construct a dialogue with at-risk people and groups, such as those with access to transport problems, or people who are 'time inflexible' when they make trips and have to rely on their cars, such as workers travelling in to a charging area at the peak hour from an area with poor transport provision. Hence it is not acceptable for minority groups subject to potential adverse effects to go unheard or unseen, or to be 'lost in aggregation.'

[24] A measure of the benefit a consumer derives from a good or service which he or she is not asked to pay for, but which it is assumed he or she would pay for if asked. (However, no allowance is made for the ability to pay.)

5 Summary and Recommendations

The review of material identified within the Research Compendium has served to highlight a series of issues across a number of topic areas. An assessment of the evidence has been provided for a range of socio-economic themes and research gaps identified. In addition, an analysis of the UK relevance of the research highlighted the complexity of group heterogeneity, and the considerable evidence gaps in understanding the causal reasons of behaviour. The review has been extensive in its coverage, and serves to highlight a range of areas where greater knowledge and understanding is required in order to enhance the quality of the public debate on road pricing.

The concluding commentary outlines the chief evidence gaps, the key lessons learnt, and the key recommendations.

5.1 Chief Evidence Gaps

- Little is known about the impact of road pricing on low-income groups, and associated problems of accessibility and participation. Thus, although the payment of the toll is not a problem for most people, it can be a big problem for a small proportion.
- There are major gaps in understanding the reasons why people on lower incomes do not have (or consider themselves not to have) an alternative to car use.
- There are significant gaps in discovering why lower-income people in particular might choose to pay, or not to pay a toll, other than for financial reasons. Indeed, relatively little is known more generally about these mechanisms, for example, the specific mechanisms that induce people to

switch modes as a result of road pricing, rather than pay the fee.

- There is only limited understanding of the social and economic context of the links between age and road pricing. Thus the lifecycle can only be understood if we recognise the heterogeneity of all age groups.
- Little is known about the causal reasons for gender differences on use of road pricing and there are some contradictions amongst the empirical evidence that does exist. For example, the USA *Value Pricing Programme* found that women are more likely to use a toll road, but as with a large proportion of social group evidence and road pricing, the findings are reported, but no underlying reasons are given on why this is the case. One reason for this, is that such findings are unexpected products of research conducted towards other objectives, rather than hypotheses which are subject to specific, analytical investigation.
- Little is understood about the links between road pricing and the travel behaviour of ethnic minority groups. For example, research in the Bristol area suggests that a significant proportion of women from Asian backgrounds are dependent on lifts, and so could be vulnerable to trip suppression as a result of road pricing. However, there is an evidence gap in discovering if this hypothesis is true in practice, such as in the case of the LCC.
- There is little evidence on how road user charging impacts on families' travel patterns, requiring the co-ordination of work, school and leisure trips, often requiring lift-giving by members of the household with driving licences.
- No research appears to have been undertaken on the impact of the LCC on disabled people. For example, a survey prior to implementation of the Charge found that disabled people feared the impacts on low paid essential workers, such as carers or nurses, who would suffer financial hardship. Concern was also expressed that 'special treatment' of disabled people, through exemptions, could antagonise non-disabled people. However, no follow up research has been conducted here.
- There is only a limited understanding of the implications of toll boundaries on problems of social exclusion, and also environmental impacts.
- Little research has been undertaken on the implications of road pricing for those living in rural areas. For example, any national scheme of road pricing will have important implications for those living in rural areas that use a car, but have poor accessibility to public transport.
- Only limited research has been undertaken on the social and distributional impacts of charging on road casualties.

5.2 Key Lessons Learnt

Who Pays the Toll?

- Worldwide, road pricing is predominantly defined quite narrowly in social terms, i.e., as being aimed at particular groups of people at particular times. As one overview of road pricing concludes, those travelling on urban highways at peak periods in the peak direction, are substantially more affluent than the population as a whole, and those who choose to pay the toll more affluent still.
- For example, in by far the largest application of road pricing in the USA, the *Port of New York and New Jersey Time of Day Pricing Initiative* (with approximately 125 million vehicles using the crossings annually), it was found that the typical toll payer is a middle-aged white man with above average income and education.
- However, other evidence from the USA illustrates a key point that we should not fall into the trap of thinking in terms of discrete and homogenous groups. Instead there is considerable heterogeneity.

For example, the USA *Value Pricing Programme* found that, other things equal, women are more likely to use the toll road.

What is Known About Those Who Do Not Pay the Toll

- There is the basic fact that lower income groups are less likely to pay the toll, but little is known on why this is so.
- For example, it may be for reasons other than income. Here, in the case of the LCC, qualitative research found that a significant number of lower-income people live in relatively close proximity to their work, and so do not need to pay the Charge. It may also be that potential affected people travel by car outside the charging hours.
- In the case of the proposed Edinburgh Congestion Charge, it was found that lower income people were significantly less likely to cross the cordon, mainly through lower use of cars for work trips. This was interpreted in a positive way, by claiming that people would benefit from the Charge, through toll revenue expenditure on public transport.
- On the other hand, a persistent theme of the research generally is that it is lower income people with no alternative to car use who are the most vulnerable.

Evidence on Vulnerable Groups

Low Income Groups

- A Transport for London survey found that more respondents living within the Charging zone reported finding the Charge difficult to afford than respondents living in Inner London, despite being in receipt of the 90 per cent residents' discount. It was considered that this reflected the frequency of actual charge payment.
- For a given price, those paying with a higher income who value their time more highly, stand implicitly to benefit more than those on lower incomes who choose to pay. In some cases, time may in practice be shown to be valued more highly than people suggest in stated preference surveys. For example, a San Diego *I-15* toll lane survey found that users had a median willingness to pay of $30 to reduce travel time by one hour. Significantly, these results, based on observed behaviour, were significantly higher than earlier results based on people's statements about preferences.
- Those 'choosing' to migrate to public transport (which may include low income car drivers) may face concerns over service frequency and reliability and, to a lesser extent, personal security. For example, a qualitative survey of low paid workers on the effects of the LCC found that most of those interviewed had migrated to public transport, but had significant concerns about travel time and convenience.

People with Restricted Physical Mobility

- Older people are more car dependent than other age groups, and this may pose a problem if essential journeys (e.g. to health appointments) are avoided due to financial constraints. For example, a critical evaluation of the *LCC* finds that the arrangements for the reimbursement of those who are seriously ill and needing to visit medical facilities within the Charging area is causing difficulties, and that the charge is also causing problems for those requiring voluntary sector support.
- In addition, evidence from a Transport for London study suggests disabled people are concerned about whether nurses/carers can travel to them by car. Several non-drivers without exemption

permits ('blue badges') have considered applying for these to allow friends or carers, who give them lifts, to claim exemption from the Charge. It might be a relatively straightforward research task to establish whether the number of disabled exemption permits has shown such an increase.

Black and Minority Ethnic Groups

- There is some evidence that there is a high dependency on car use by people from some Asian groups. In particular, women from some ethnic/faith groups rely on lifts for the majority of their travel. This may make them vulnerable because increased travel costs mean that lifts become less readily available because of financial constraints on family budgets. Consequent suppression of trips or enforced mode change may follow.
- Some tentative endorsement of the previous finding is provided by a Transport for London survey that found, amongst Outer London residents, black and minority ethnic groups were most likely to report that they had not gained from the pricing scheme.

Wider Social Impacts

Impacts on Accessibility

- Few London Charging zone residents reported deterioration in their accessibility to local shops, facilities and stores. In contrast, concerns in Edinburgh were raised regarding access to low-cost nutritional foods and to health facilities. This appears to reflect a more dispersed pattern in Edinburgh for access, and emphasises that there are no fixed patterns to social exclusion, and many elements can be site specific.

Social Networks

- It appears that the *LCC* has had a greater impact on social networks than accessibility. A MORI survey reported that, inside the Charging zone, 43 per cent of respondents believed family and friends were now finding it more difficult to visit them, although half did find that visits had not been affected.

Air Quality

- A study in Leeds revealed that the inner city is the most deprived, and here there is social inequity in the distribution of NO_2, with deprived areas experiencing worse pollution than the wealthier suburbs. However, it was found that a road user charge would significantly reduce the effects of this inequity. Nevertheless, it should also be noted that this type of effect could be site specific. For example, in some cities the more deprived areas may be on the outskirts.

Road Safety

- A *LCC* study has found that, although total road casualties showed no significant change after implementation, there had been increases in motorcycle casualties within Inner London. Significantly, motorcyclists do not pay the Congestion Charge.

5.3 Importance of Effective Public Consultation

- Some groups vulnerable to adverse effects may not engage in public consultation even when directly affected, which may result in complacency amongst the professionals (e.g., the I-15 California case). There is a need for the relevant professionals to be proactive in addressing social and distributional impacts, and to seek evidence about needs and risks in an active way.
- Ironically, as the earlier evidence quoted from Edinburgh suggests, those from deprived areas can significantly benefit from road pricing, through such measures as greater investment in public transport.
- If income is taken as a proxy for likelihood of paying there is a risk that concerns of sub-groups (such as low income essential car users) will be overshadowed, and predictions about their travel behaviour may be incorrect.

Boundary Design and Equity

- A key factor in the public acceptability of road pricing is whether people perceive a scheme to be fair to those on low incomes. Boundary issues can represent a particularly thorny issue here.
- The relationship between gainers, losers and income will depend critically on where different income groups live in relation to the charging area. This is likely to vary from place to place.
- Boundary issues in Edinburgh were significant in the 2005 ’no’ outcome to the referendum. The City Council proposed that residents of the City who lived outside the cordon would not be liable to the charge. This caused great resentment in neighbouring authorities, where people would have to pay the charge. Although only Edinburgh residents voted, opposition from outside the area affected publicity, and influenced public opinion in the City.
- One study noted that there were poor neighbourhoods just outside the Edinburgh boundary who would have to pay the charge, whereas more affluent City areas would be exempt.
- Environmental boundary impacts have been found in the case of the LCC. For example, Hoxton residents reported an increase in cars parked in the area, with outsiders then completing journeys by foot or public transport rather than pay the Charge.

Scheme Refinements

- There are a few examples of measures proposed or taken as mitigation for social impacts, e.g., the ’one hour’ rule in Trondheim, Norway, and the complex range of discounts and exemptions available in London. The US approach also shows sophisticated application of the various HOT-lane options, with exactly which vehicle occupancy level being required to use the lane for a charge, or alternatively use it with the charge exempted, varying with the conditions of the locality.
- It may not always be appropriate to direct hypothecated funding (entirely) at public transport improvements. For example, ’compensation’ to low-income groups may be better offered through toll or mobility credits. Linked to this, in the USA, explicit compensation to low-income groups has been considered in the form of toll credits, similar to credits provided to low income utility customers. These include tax credits to low income commuters for tolls paid by them on variably priced lanes; or toll credits provided to those who choose not to use the toll lanes.

5.4 Key Recommendations

Overall Priorities

- New scheme developments need to gather clear evidence across all important segments of society on current travel patterns and modal dependencies.
- Such evidence must be accompanied by qualitative research that seeks to explain such patterns and dependencies and explore the anticipated behavioural responses to, and consequences of, road pricing.
- In-depth insights are lacking across all areas covered by this review. A further debate and social research on social and distributional impacts could inform and be informed by the use of qualitative scenario-planning exercises.
- There is a need to research the interplay between different demographic variables (e.g. age, gender and ethnicity) and also social and economic circumstances, as opposed to reporting social groups as if they are homogenous in nature.
- Consultation on road pricing schemes must be proactive, and involve groups 'at-risk' of social exclusion, such as those on low incomes disengaged from the political process, and those who cannot travel to consultation locations.
- It is therefore important to find the means to construct a dialogue with at-risk people and groups. Hence it is not acceptable for minority groups subject to potential adverse effects to go unheard or unseen, or to be 'lost in aggregation.'

Specific Areas of Research

- More needs to be known about road pricing impacts on low-income groups, and particularly vulnerable people such as those with no alternative to car use. Insights are required on their travel patterns, and the reasons for them.
- Research is also needed on the reasons why lower income people might choose not to pay a toll, other than for economic reasons.
- Analyses of the impacts of road pricing on the life cycle need to reflect the heterogeneity of all age groups.
- Research is required on the underlying causal reasons for differences in gender behaviour.
- More needs to be known about the impact of road pricing on family travel behaviour. This could include key subjects such as the propensity to carpool.
- More insights are required on the impact of existing road user charging schemes, such as the LCC, on potential at-risk groups such as ethnic minorities and disabled people.
- Greater understanding is required on the political and social implications of toll boundaries on social exclusion and environmental impacts.
- Research is required on road pricing implications for those living in rural areas, particularly with regard to those people with no alternative to car use.
- Greater knowledge is required on the under-researched wider social impacts of road pricing, such as environmental effects and road safety.
- Social and distributional impacts are therefore town and scheme specific. Whilst studies - including the present literature review - seek to provide normative evidence about the equity effects of road pricing, one clear such finding is that the 'devil will be in the detail' and that specific analyses will be required at the design stage to a greater or lesser extent with every new application of the policy.

Annex A: Reference Details of Compendium Items

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