Institute for Transport Studies
FACULTY OF ENVIRONMENT

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Commissioned title: Assessing the distributive Impacts of a CC using a synthetic population model

ITF Roundtable Social Impact of Time and Space-Based Road Pricing 30 November – 1December 2017 Auckland

Professor Jillian Anable (ITS Leeds) & Emeritus Professor Phil Goodwin (UCL & UWE)

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Final title: Assessing the Net Overall Distributive Effect of a congestion charge

ITF Roundtable Social Impact of Time and Space-Based Road Pricing 30 November – 1December 2017 Auckland

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Paper objectives

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1. To offer new conceptual and methodological insights into the definition, measurement and operationalisation of dimensions of social vulnerability to road user charges
2. To explore the methodological challenges that flow from intervention designs that account for the *'Net Overall Distributional Effect'*

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Assessing SDIs is too hard …

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"Problems of the distribution of income – who would and who would not be harmed by the policy advocated – will not be considered here. The general ramifications of such a policy are reasonably clear, but the detailed analysis would be cumbersome and boring."

Walters (1961)

Walters, A. A. (1961) The theory and measurement of private and social cost of highway congestion. *Econometrica*, 29, pp. 676-99.

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The classical case

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The classical economic case for road user charging:

1.Focuses on congestion

2.Has depended on a **theoretical rationale which justified ignoring distributional consequences** because the economic advantages apply independently of the effects on distribution

Any loss in utility to the 'losers'* will be exactly compensated by those who receive the revenue, who ever they might be.

* i) those who continue to make journeys and pay the charge albeit with less congestion (ii) those whose journeys are deterred by the extra cost

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But, the classical case breaks down in practice

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Challenges to the classic case:

- **Studies of the relative benefits of investment in different modes** leads to a more strategic view of the interaction between public and private transport
- The **range of problems goes beyond traditional concerns of congestion and traffic accidents**. This puts more attention on behaviour change and the need to reinforce the case for road pricing through investment in different modes
- **Public acceptability** becomes dependent on what other policies would be implemented

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Various types of charging strategy are now considered

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Consequently the ‘Pareto Optimum’ assumption is no longer universally accepted. Instead, various options are considered, each with different distributional consequences:

- **Return of charging revenue to road users in the form of reductions in other road taxes**
- **Spending the revenue on increased road capacity**
- **Spending the revenue on Public Transport, Walking and Cycling**
- **Putting the revenue in to general taxation**

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Return of charging revenue to road users in the form of reductions in other road taxes

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- Road users as a whole would be collectively compensated for the charge.
- Reduction in congestion on most congested streets, thus benefitting bus users, local residents
- Possibly some shift in net benefit to those living in rural areas who did not commute into towns

But

- No direct match between the amount paid by individual road users on existing road taxes and amount in the C-charge = distribution of income
- No additional revenue available for other transport or social improvements

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Spending the revenue on increased road capacity

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- Some benefit to the road users paying the charge
- Particular gain to car owning residents in non-urban areas who drive on the expanded roads

But

- Induced demand could lead to additional emissions in urban areas and reduction in PT services
- Reduced congestion would reduce the revenue from the charges

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Spending the revenue on Public Transport, Walking and Cycling

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- Urban drivers will benefit from reduced congestion and emissions (more so than in the road building case)
- Those who changed modes would benefit from better health
- Those who did not drive would have better environment and travel conditions

But

- Benefits to urban motorists would be less in value than the charge paid on average (with a net benefit to those with high values of time)
- Motorists on congested roads paying more

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Putting the revenue in to general taxation

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Increase tax on activities which cause damage and reduce taxes on activities which cause good – independently of what sector they are in

- Main beneficiaries could be different groups entirely to the charge payers as they have a reduction in some other class of taxation

But

- Drivers who pay the charge may not be happier

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NODE (Net Overall Distributional Effect)

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Assessment of the distributional impacts involves evaluating the pattern of:

- Who pays and who receives the revenues collected
- Who receives the benefits of reduced congestion
- Consequential changes in pollution, quality of life + others impacts
- How these impacts change over time

NODE itself will vary by income, gender, car ownership, location of home, work and other activities

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The methodological challenge

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1. Assessing who pays/ does not pay is not enough

   – need an assessment of the net impacts of both the new charges and the new patterns of benefits from the revenue spend

2. Burden of the charge is determined not only by ability to pay (income) but also the pattern of journeys made &, ability to adapt

   --yet the benefits (eg air quality, property value increase) will be affected by geographical location which will affect people of different incomes and car use patterns

Assessment = complex disaggregation of distributions by economic, social, travel and geographical variables

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Microsimulation

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- Generation of a population of simulated individuals which corresponds with the overall statistical properties of the real population
- Clone or match households in surveys with small area Census data
- From this: the RUC and its related effects on travel and other benefits/ losses can be considered for any subgroup of interest at fine spatial resolution

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Bonsall & Kelly (2005) (1 of 2)

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- Generated a synthetic population for Leeds (UK) from the probabilities of traveler characteristics from the UK Census*
- This was linked to a traffic assignment package to identify the spatial patterning and characteristics of those impacted by 6 different charging regimes
- Looked at impacts on ‘at risk groups’

ELSEVIER

Transport Policy 12 (2005) 406–418

TRANSPORT POLICY

www.elsevier.com/locate/tranpol

Road user charging and social exclusion: The impact of congestion charges on at-risk groups

Peter Bonsall*, Charlotte Kelly

Institute for Transport Studies, University of Leeds, Leeds LS2 9JT, UK

Accepted 24 June 2005
Available online 31 August 2005

Abstract

The importance of social exclusion in the context of congestion charging is discussed, and the groups most particularly at-risk identified. A new technique, based on generation and investigation of a synthetic population is introduced and used to establish the impacts on at-risk groups of six congestion charging schemes in Leeds. The distribution and severity of impacts are seen to depend crucially on the precise definition of the charge area, the basis of the charges and exemptions provided. Using the new technique, it can be seen how the impact on at-risk groups could be minimized without compromising the overall objectives of congestion charging. Further potential applications of the new technique are outlined.

1. Road user charging and social exclusion

1.1. Introduction

Our investigation of social exclusion and equity issues in the context of road user charging was stimulated by the observation that current government policy contains elements from two contrasting ideologies. On the one hand, government is placing increased emphasis on the needs and rights of vulnerable groups, and on the other hand, it is contemplating the widespread use of increased charges as a means of managing the demand for travel. The introduction of charges gives additional choice to affluent groups but may present serious problems to those for whom the new charges represent a significant part of their available income.

1.2. Road user charging

The idea that road users should be charged for their use of the road network at the point of use has a long history and is the norm in many countries for use of interurban motorways, bridges and tunnels. The current interest in urban road charging is associated with theoretical arguments about system efficiency and the need to charge users the full cost of the congestion and other externalities which they cause. The success of the Singapore scheme and the development of technologies which allow automatic collection of tolls put the idea very firmly on the traffic engineer’s agenda. The revenues generated by the Norwegian toll rings put it on the political agenda and the initial success of the scheme introduced in London in Spring 2003 (TfL, 2003) has given it a very high profile. Several UK local authorities are considering the introduction of charging schemes in their areas—although the Edinburgh electorate have voted to reject proposals for a scheme in that city—and the UK government is letting it be known that it is seriously considering the introduction of a national scheme, based on GPS technology, within the next ten to fifteen years (DfT, 2004). This surge of interest makes it important to consider issues such as the impact on equity and social exclusion before plans become too concrete.

1.3. Social exclusion and transport

The modern concept of social exclusion was developed in France from the 1960s onwards and has recently become a central concern of social policy in many European countries and, increasingly, in other parts of the world (Rodgers et al., 1995). Social exclusion has long been

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doi:10.1016/j.tranpol.2005.06.007

*Using Popgen-T proportional fitting and monte carlo simulation

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Bonsall & Kelly (2005) (2 of 2)

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- Looked at absolute numbers & proportions of ‘at risk’ people affected and the extent of the impacts
- Applied exemptions to those at risk and set charges to meet target revenues accordingly
- Found ‘at risk’ groups to be spread across the city – thus spatially specific solutions not possible

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Enhancing microsimulation with novel data

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"When [microsimulation] model estimates are benchmarked against real-world data, the models are typically well behaved and very robust, but they can struggle to capture the diversity of spatial variations shown by observed data."

Birkin and Clarke (2012, p515)

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“MOT” dataset

MOT
Motoring and Vehicle Ownership Trends in the UK

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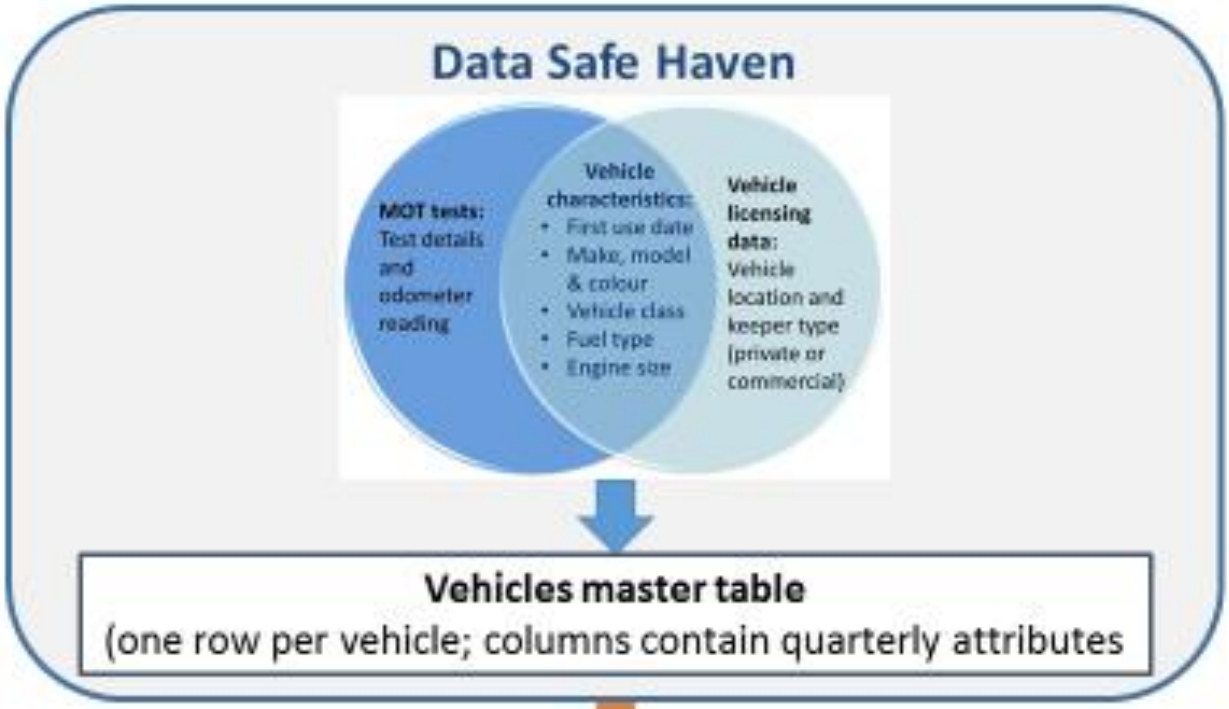

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The (t)ERES project (2014-2016) (Giulio Mattioli, ITS)

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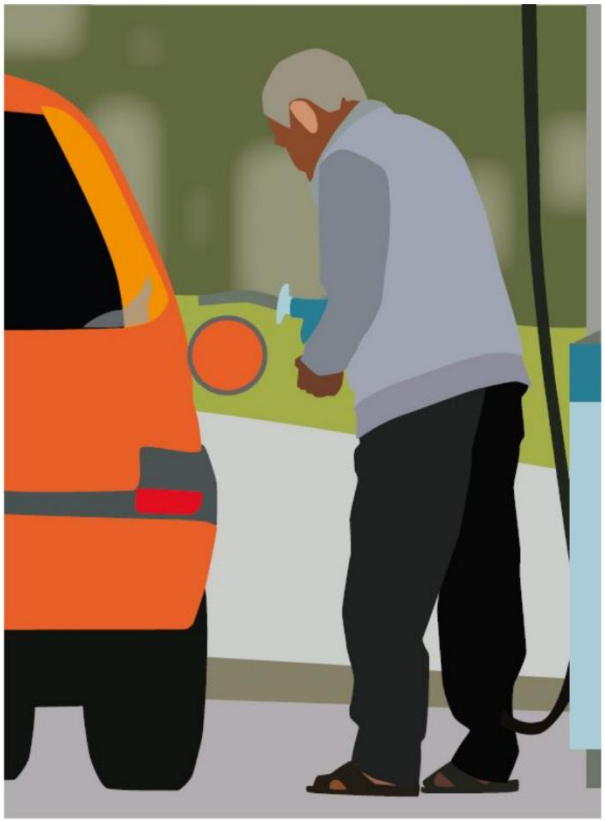
RESEARCH INSIGHT

CAR RELATED ECONOMIC STRESS IS THERE A TRANSPORT EQUIVALENT OF FUEL POVERTY?



'Car-owning households who need to spend a disproportionately high share of their income to get where they need to go, with negative consequences in terms of restricted activity spaces and/or spending cuts in other essential areas'

≈ 'forced car ownership', 'transport poverty'…

https://teresproject.wordpress.com/

Note: Special Issue of Transport Policy "Household transport costs, economic stress and vulnerability"

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3 spatial components of vulnerability to fuel price increases - England

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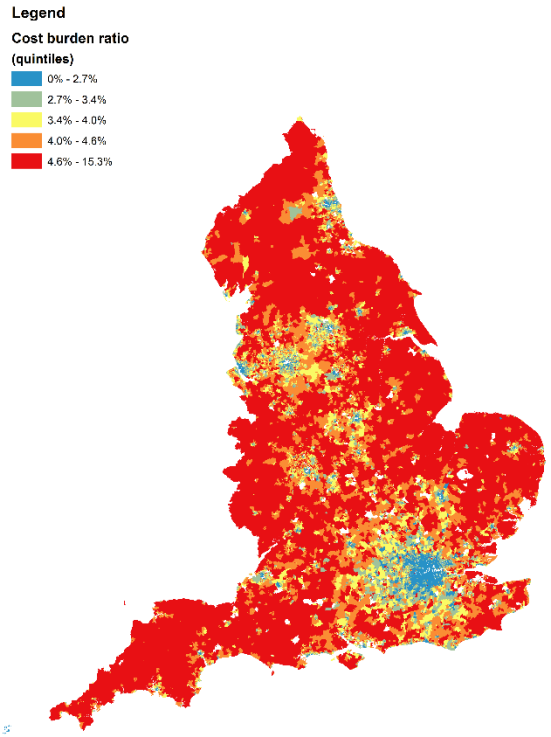
1. Exposure:

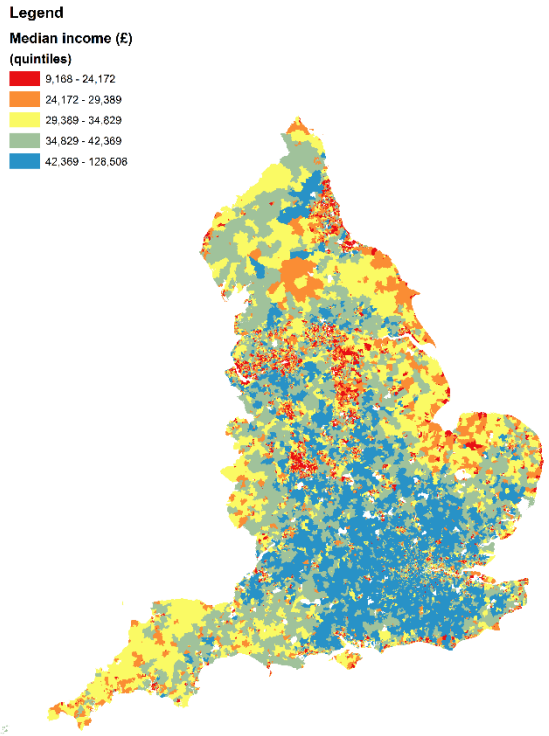
Cost burden ratio = per household expenditure on fuel / median income



(Anonymised MOT tests and results)

2. Sensitivity

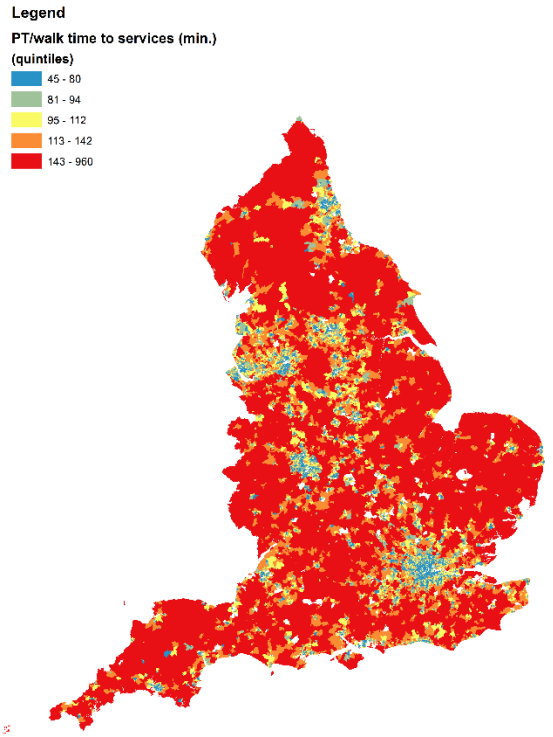
Median household income



(Experian Median Income data)

3. Adaptive capacity

Travel time to 8 key services by public transport / walking



(UK Government Accessibility Statistics)

A spatial index of vulnerability to fuel price increases - England, 2011

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- Standardise each component variable (z-scores)
- vulnerability to fuel price increases (VFP)
- **VFP = f(Exposure , Sensitivity , Adaptive Capacity)**
- **VFP = cost burden – income + travel time**

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A spatial index of vulnerability to fuel price increases - England, 2011

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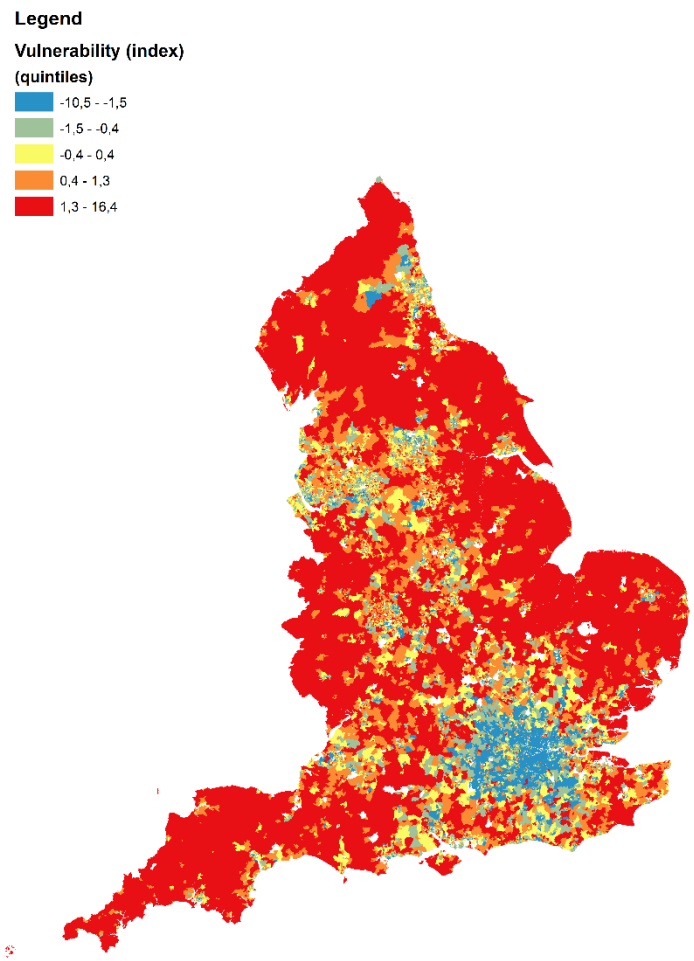

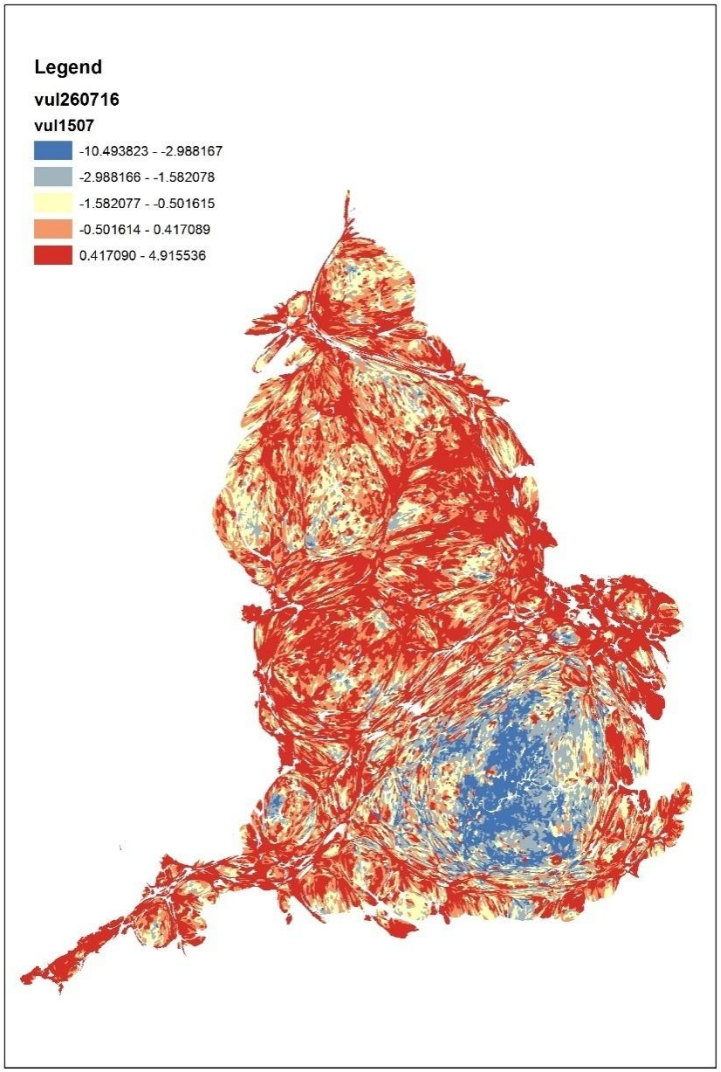

English city regions, 2011

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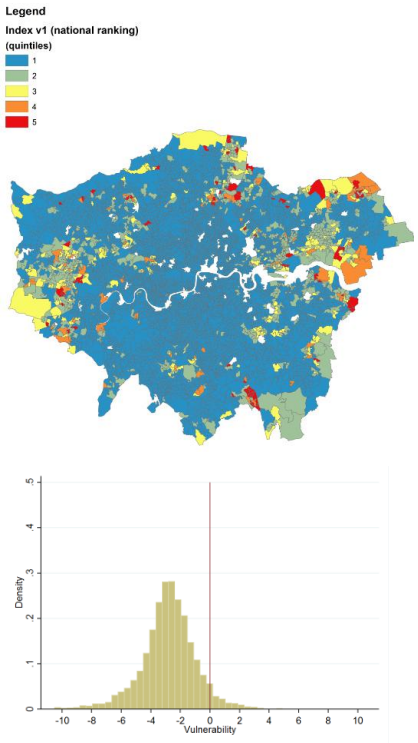
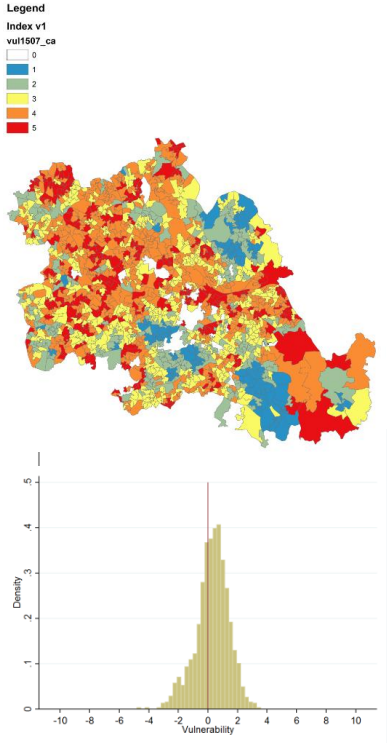
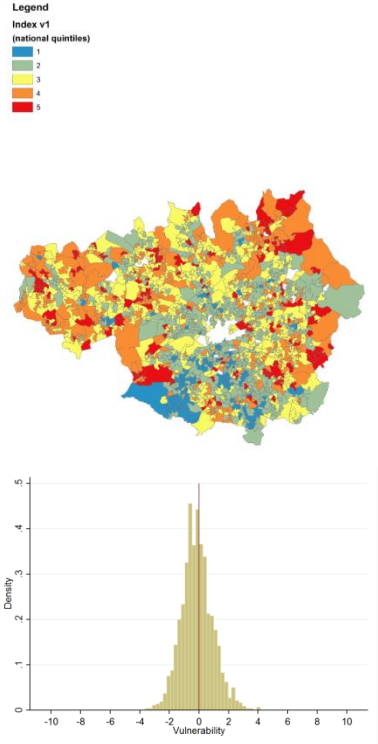
London



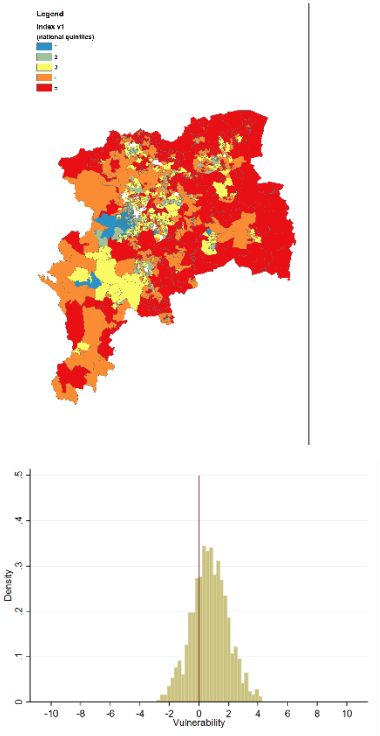
West Midlands



Greater Manchester



Sheffield CR



https://www.researchgate.net/publication/312472775_Developing_an_index_of_vulnerability_to_motor_fuel_price_increases_in_England

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Hypothetical Low Emission Zone for Edinburgh

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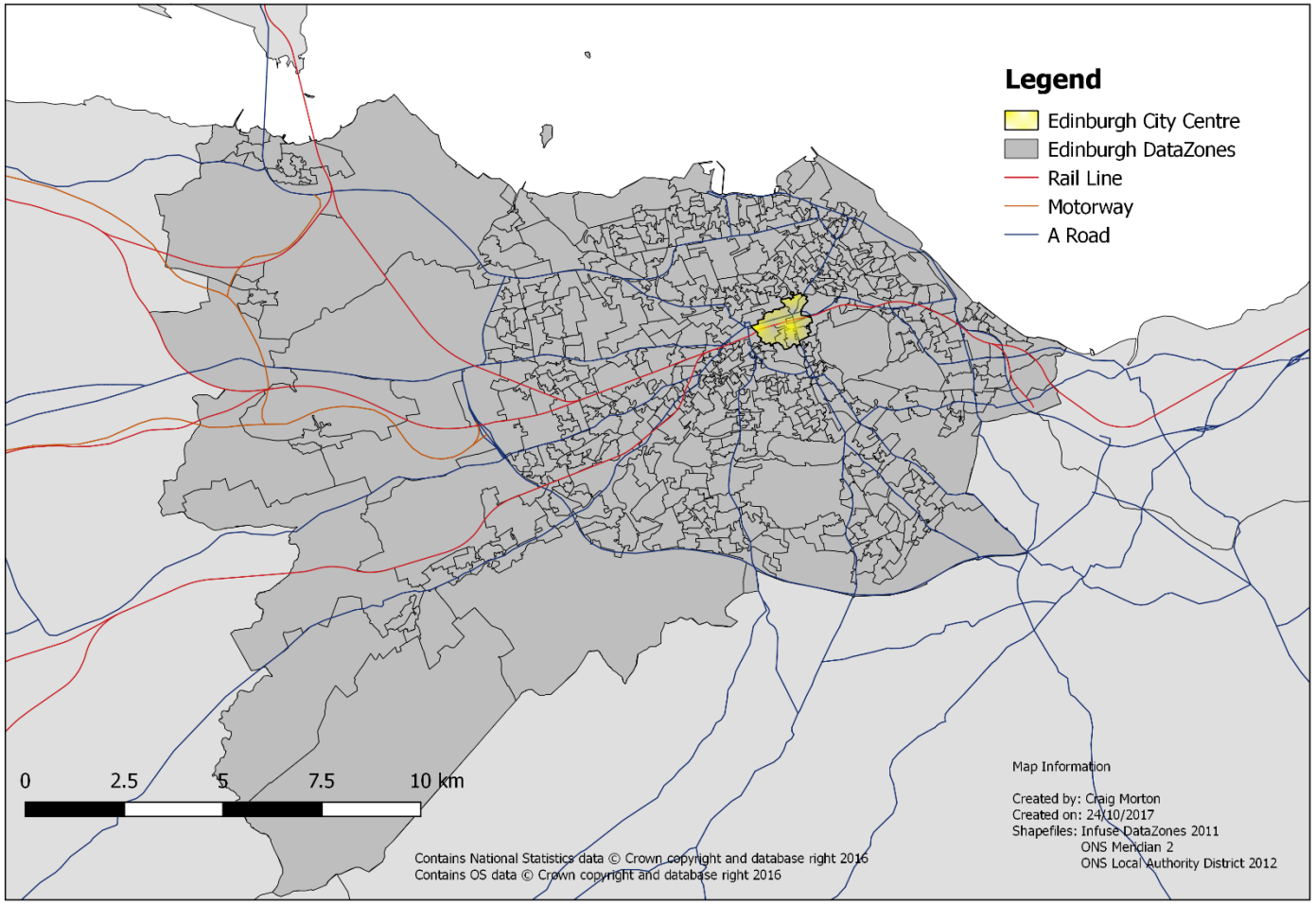

Morton, C., Mattioli, G. and Anable, J. (2018) A Framework for Assessing Spatial Vulnerability in the Introduction of Low Emission Zones: A case study of Edinburgh, Scotland. Proc. *50th University Transport Studies Group Conference*, January 2018, London.

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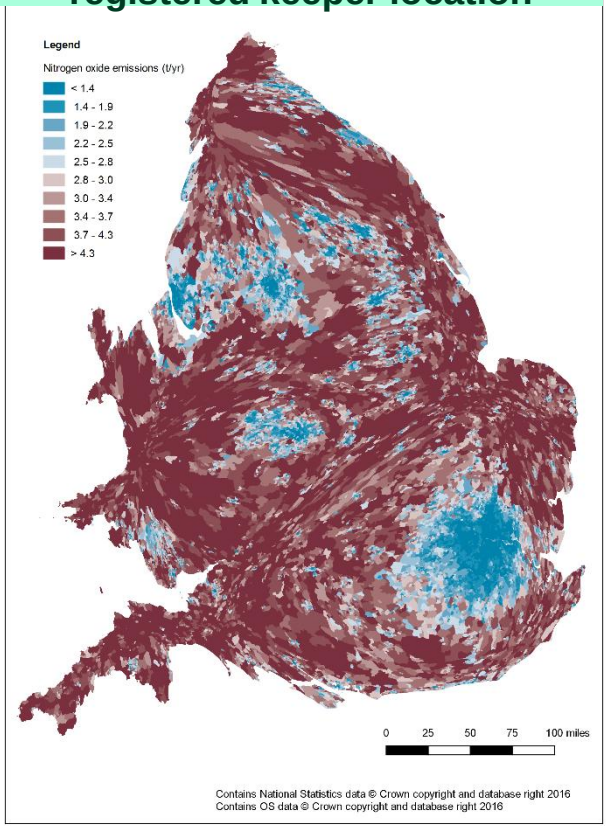
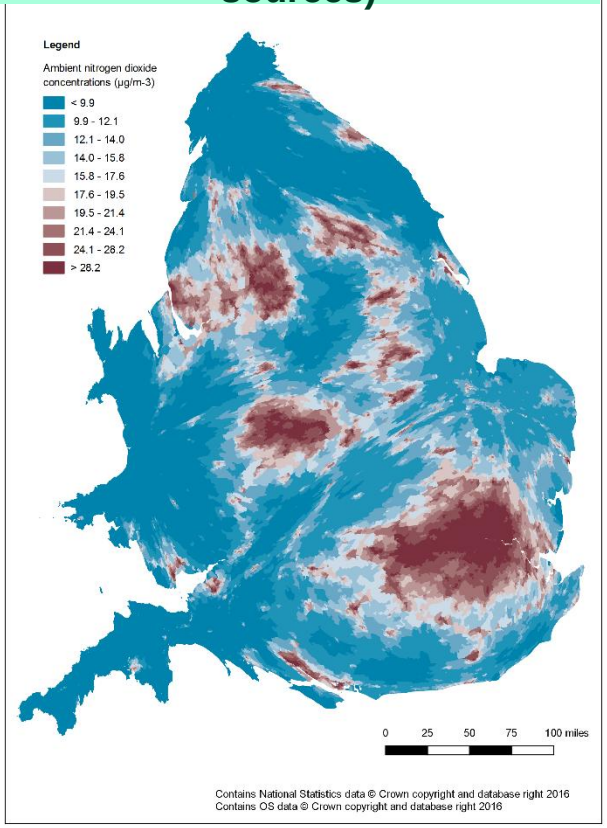
The *polluters* (those responsible for emitting high amounts of pollutants from vehicles) are generally not co-located with the *polluted* (those exposed to high ambient concentrations of pollution).

Emissions of nitrogen oxides from all private vehicles by registered keeper location



Ambient concentrations of nitrogen dioxide (from all sources)



Where mean ambient NO_2 concentrations are higher, the:

- **mean age** of vehicles is **higher**
- proportion of **diesels** is lower
- Average **NO_x emissions** factor is lower
- Average **distance per vehicle** is lower

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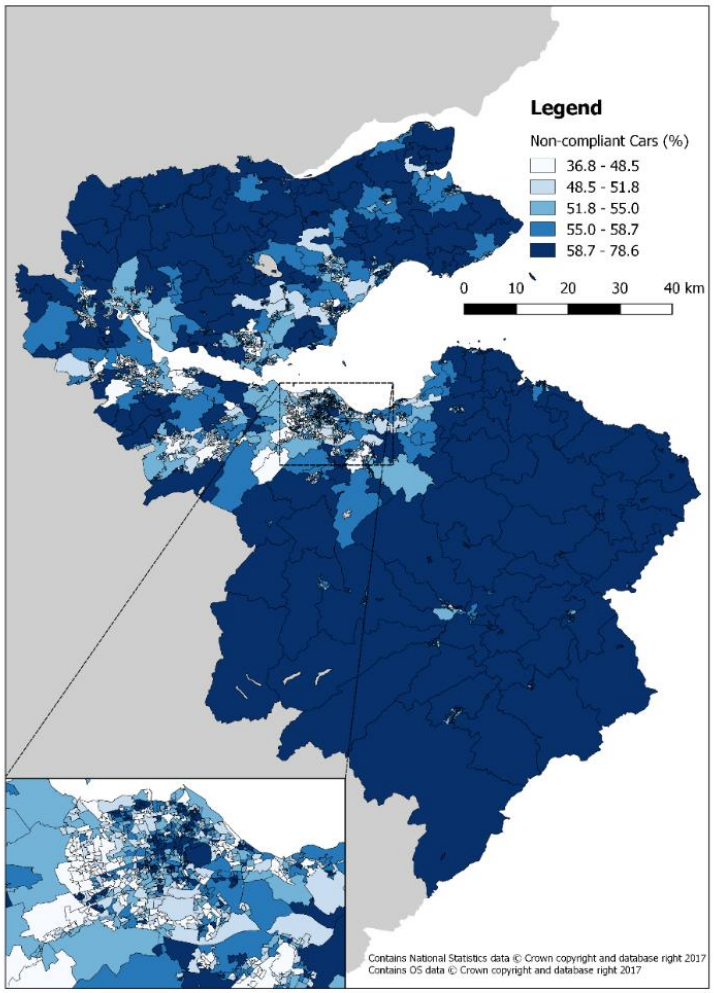
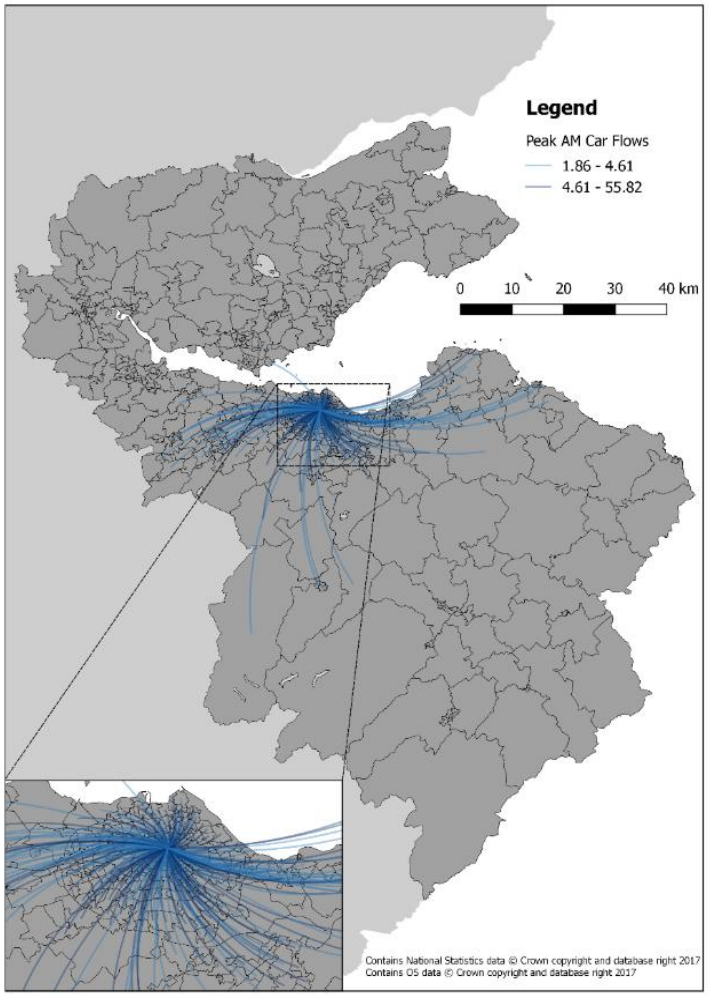
Private car fleet compliance to the LEZ emission standard



Car trips in the AM Peak to Edinburgh City Centre



Key methodological considerations (1)

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The distributional impacts must be analysed in terms of the net impacts

- Just looking at incidence of payments is insufficient
- Need to look at net impacts of new charges and patterns of benefits arising from use of revenue
- Not just about how progressive or regressive the charge is in relation to income
- Also have to look at cost burden, location, access and range of choices

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Key methodological considerations (2)

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Net impacts will change over time depending on behavioural response

- Allow consideration of second order impacts of charges and any linked policies
- But this will add uncertainty – so need to add second order impacts to modelling

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Key methodological considerations (3)

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Impact is related to adaptive capacity; but adaptive response is not in itself an indicator of a gain or a loss

- Impacts of the charge on car users is not directly in proportion to how much cars were used before the charge
- Car users have different opportunities to adapt
- NODE assessment must include some measure of adaptive capacity
- And some understanding of dynamic behavioural responses
- Accessibility indicators assess quantity rather than quality of services and focus on modal shift and not other adaptations
- Different behavioural responses take different times to embed

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Key methodological considerations (4)

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The identification of gainers and losers demands a complex pattern of joint distributions by economic, social, travel and geographical variables

- Income is not the best way to identify gainers/ losers
- Amount of payment will vary according to patterns of journeys
- Benefits (eg less congestion, pollution) will impact people on certain roads with a different income profile
- Low income and high car dependence can be located at the urban periphery – but patterns vary
- Becomes far more complex if the charge has multiple objectives e.g. congestion + emissions reduction

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Conclusions

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There is no generic well-defined distributional impact of CC, but a series of different distributional impacts specific to the policy and design decisions taken. Distributional consequences will be primarily impacted by:

- **Whether a scheme is designed to be revenue neutral**
- **Decisions about the use of that revenue**
- **Deciding which impacts are most important/ the benefits sought**
- **The sensitivity of the charge and revenue allocation to changes over time**

Methodological innovation can only go so far as to inform/determine these political decisions

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So do you agree that assessing SDIs is too hard?

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