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 – 1 December 2017 Auckland

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

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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’
Assessing SDIs is too hard …

“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)

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.
But, the classical case breaks down in practice

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

- 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
Spending the revenue on increased road capacity

• 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
• 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
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
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
The methodological challenge

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
Microsimulation

• 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
• 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’

*Using Popgen-T proportional fitting and monte carlo simulation
• 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
“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)
“MOT” dataset

Data Safe Haven

- MOT tests: Test details and odometer reading
- Vehicle characteristics: First use date, Make, model, colour, Vehicle class, Fuel type, Engine size
- Vehicle licensing data: Vehicle location and keeper type (private or commercial)

Vehicles master table
(one row per vehicle; columns contain quarterly attributes)

Area-average values
(anonymous area tables with one row per LSOA or Data Zone; columns contain average or total values)

Other area-based data
(E.g. Census; ONS datasets, accessibility statistics, Experian, Domestic energy etc.)
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”
3 spatial components of vulnerability to fuel price increases - England

1. Exposure:
   Cost burden ratio = per household expenditure on fuel / median income

2. Sensitivity
   Median household income

3. Adaptive capacity
   Travel time to 8 key services by public transport / walking

(Anonymised MOT tests and results)
(Experian Median Income data)
(UK Government Accessibility Statistics)
• Standardise each component variable (z-scores)

• vulnerability to fuel price increases (VFP)

• VFP = f(Exposure, Sensitivity, Adaptive Capacity)

• VFP = cost burden – income + travel time
A spatial index of vulnerability to fuel price increases - England, 2011
English city regions, 2011

London
West Midlands
Greater Manchester
Sheffield CR

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).

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**
Private car fleet compliance to the LEZ emission standard

Car trips in the AM Peak to Edinburgh City Centre
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
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
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
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 (e.g., 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
Conclusions

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
“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)