WORKING PAPER

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Identifying circumstances in which the introduction of distance-based, cordon-based, and congestion-free lane road user charge regimes garner support

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TITLE: Identifying circumstances in which the introduction of distance-based, cordon-based, and congestion-free lane road user charge regimes garner support

ABSTRACT: The most challenging transport reform has always been associated with re-pricing of car use. Despite the growing levels of congestion on our roads, there is general reluctance to support a package of pricing reforms designed to make each and every car user potentially better off financially and/or in saving time. There exist a number of systemwide charging reforms such as the Oregon kilometre-based charging regime, but they are in the main opt-in models, which offer an appealing way for politicians to support the ideals of giving everyone a choice. The cordon-based congestion charging schemes in London, Milan, Stockholm, Gothenburg, New York, and Singapore, while applying to all users who enter a specific location, are limited to one location as is the idea of a congestion-free priced lane. This paper focuses on re-pricing options (with varying charges) to identify how residents are likely to respond to peak period distance-based charging throughout an entire city, cordon-based charges in a defined geographical area, and congestion-free priced lanes on major roads. A series of road pricing initiatives were offered to over 4,000 individuals in seven countries, seeking advice on whether a particular initiative is likely to have a positive or negative impact (or none at all) on how they travel, revealing support or otherwise for a specific re-pricing regime. For each road pricing initiative, we ran a generalised ordered logit model to identify what contextual variables influence the probability of an initiative being associated with a positive impact, a negative impact, or no impact. We are especially interested in understanding how prior "windows of change" associated with lifestyle, mobility, work, commuting, and environmental preferences condition support or otherwise for each road pricing reform initiative. The findings provide suggestions on the extent to which each of the eight initiatives assessed can deliver support or otherwise for road pricing reforms from individuals whose recent past is associated with one or more of the 70 windows of change investigated.

KEY WORDS: ***Road pricing reform, distance-based charging, cordon-based charges, congested free paid lanes, peak period, user benefit, 7 country survey, windows of change influences***

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The Department of Infrastructure, Transport, Regional Development and Communications, Sport and the Arts. The findings reported are those of the authors and are not the positions of our industry and government partners; but approval to present these findings is appreciated. We thank members of the ITLS team: Corinne Mulley, Thiranjaya Kandanaarachchi, Chinh Ho, and Wen Liu. The third author gratefully acknowledges financial support from ANID/FONDAP 1523A0004 and ANID PIA/PUENTE AFB230002. We thank three referees for very supportive and insightful reviews that have materially clarified the key points of the paper.

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Abstract

The most challenging transport reform has always been associated with re-pricing of car use. Despite the growing levels of congestion on our roads, there is general reluctance to support a package of pricing reforms designed to make each and every car user potentially better off financially and/or in saving time. There exist a number of systemwide charging reforms such as the Oregon kilometre-based charging regime, but they are in the main opt-in models, which offer an appealing way for politicians to support the ideals of giving everyone a choice. The cordon-based congestion charging schemes in London, Milan, Stockholm, Gothenburg, New York, and Singapore, while applying to all users who enter a specific location, are limited to one location as is the idea of a congestion-free priced lane. This paper focuses on re-pricing options (with varying charges) to identify how residents are likely to respond to peak period distance-based charging throughout an entire city, cordon-based charges in a defined geographical area, and congestion-free priced lanes on major roads. A series of road pricing initiatives were offered to over 4,000 individuals in seven countries, seeking advice on whether a particular initiative is likely to have a positive or negative impact (or none at all) on how they travel, revealing support or otherwise for a specific re-pricing regime. For each road pricing initiative, we ran a generalised ordered logit model to identify what contextual variables influence the probability of an initiative being associated with a positive impact, a negative impact, or no impact. We are especially interested in understanding how prior "windows of change" associated with lifestyle, mobility, work, commuting, and environmental preferences condition support or otherwise for each road pricing reform initiative. The findings provide suggestions on the extent to which each of the eight initiatives assessed can deliver support or otherwise for road pricing reforms from individuals whose recent past is associated with one or more of the 70 windows of change investigated.

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David Hensher: Conceptualisation, Investigation, Methodology, Formal analysis, Writing original draft, Writing – review & editing, Project administration. **Edward Wei**: Conceptualisation, Investigation, Writing original draft, Writing - Review & Editing. **Camila Balbontin**: Formal analysis, Writing - Review & Editing. **John Nelson**: Conceptualisation, Investigation, Writing original draft, Writing – review & editing, Project administration.

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Introduction

There is an extensive literature on promoting ways to reform road usage for passenger cars, especially in the context of containing traffic congestion, be it by pricing or non-pricing initiatives. For over 70 years, the debate has ebbed and flowed as to how we could tame traffic congestion through non-pricing mechanisms; and despite some successes, they are typically limited to a few geographical jurisdictions and often relocate the problem to adjacent areas. The mere suggestion that the only way to really make a difference is through a reformed road pricing model is typically viewed with both applause and rejection, the latter primarily by politicians and bureaucrats under instruction from their political masters. The rare exceptions have been cordon-based congestion charging in Central London, Central Stockholm, Gothenburg, downtown Milan, Singapore, and recently Manhattan in New York[1]; as well as a limited opt-in kilometre-based charging in Oregon, and the HOT (High-Occupancy Toll) lanes in Southern California[2].

What we have yet to see is an initiative that is metropolitan-wide, that applies to all motorists, and that recognises that all motorists could be better off with real travel time savings that can benefit individuals and the network as a whole, especially in peak periods. The interest in this paper is on a distance-based charge during peak periods and contrasting it with cordon-based charges in a defined geographical area, and congestion-free priced lanes on major roads.

The paper is structured as follows. A literature review identifies the history of efforts, conceptually and in practice, to introduce road pricing reforms, followed by a summary of the empirical context for the seven countries included in this study (Australia, New Zealand, UK, Finland, Sweden, Singapore and USA), where eight road pricing initiatives were explored: four peak period distance-based charges (AUD 5,10,15, 20c/km), tow for congestion-free lanes paying 5 and 10 c/km, and a supplementary charge of $10 or $15 per car in a defined area around the city. We then introduce the generalised ordered logit model to estimate a series of models for each initiative where the dependent variable is an ordered response (negative impact, no impact, positive impact), extending the standard ordered logit model to allow for latent heterogeneity. A descriptive profile of the data is followed by the estimated models and the direct mean elasticities for each explanatory variable. We compare the evidence across all eight initiatives and conclude with the main findings.

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[1] https://www.youtube.com/watch?v=Mnln3R9RBh4. Since implementation in January 2025, we have seen 2.8 million fewer vehicles or 10% of cars (60,000 per day) entering Manhattan's CBD, with faster travel speeds (7.8% in weekday peak times and 10.2% weekends), and shorter river crossing times. Some drivers are moving travel to early and late of day periods to avoid the peak charge.

[2] New Zealand is moving slowly to a distance-based charging scheme with removal of fuel excise. This enables capture of both battery and petrol/diesel cycles in hybrid vehicles which has become a challenge with their popularity over pure electric cars. In 2015, there were 12,000 hybrid cars, and in 2025 there are over 350,000. See *https://www.rnz.co.nz/news/political/569149/road-user-charges-for-all-vehicles-move-a-step-closer*. Law changes the government is progressing include:

- Removing the requirement to carry or display road user charge (RUC) licences, allowing for digital records instead
- Enabling the use of a broader range of electronic RUC devices, including those already built into many modern vehicles
- Supporting flexible payment models such as post-pay and monthly billing
- Separating New Zealand Transport Agency (NZTA) roles as both RUC regulator and retailer to foster fairer competition
- Allowing bundling of other road charges like tolls and time of used based pricing into a single, easy payment.

Literature Review

An Overview of approaches to Road Pricing and Congestion

The field of road pricing is well established historically in terms of its theoretical foundations. The history and development of roading pricing have been widely reviewed by researchers (e.g., Button 2020; Anas & Lindsey 2011). Button (2020) provided a review of the history of road pricing in economics from the initial idea proposed by Pigou in 1920, to further contributions of many economists, including Buchanan, Vickrey, Solow, Friedman, Walters and many others. In practice, a seminal work by Smeed (1964) is commonly considered the first road pricing proposal to target road congestion. Glaister (2018) gave a benchmark review on road pricing development 50 years after the Smeed Report was published, covering practical road pricing schemes that involve users paying a unit price based on road usage of various forms, such as by distance, location or time of day (TOD). Anas and Lindsey (2011) reviewed both the theory and practice of road pricing. Stanley and Hensher (2011) demonstrate the under-recovery of negative externality costs such as congestion, safety, and emission costs, with congestion being the dominant underpriced externality.

In simple terms, road pricing is about allocating transportation resources covering all road infrastructure and mobility resources to road users and internalising external costs associated with using road transportation. The external costs include many types of costs, with the majority caused by road congestion. Road pricing schemes aim to internalise targeted costs with equity and efficiency, which is also the principle of public policies in transport underpinned by economic theories and practices (Anas & Lindsey 2011; Ison 2018; Falcocchio & Levinson 2015). The schemes can be revenue neutral: besides re-investing in infrastructure, any collected road pricing revenues can be returned to the public and road users (Hensher & Li 2013; Hensher et al. 2013). Road pricing schemes can take many forms, with distance-based, time-based, area-based, or a combination of these (Anas & Lindsey 2011).

The main driver for the development of road pricing is to mitigate congestion. Many factors can cause congestion. Besides the increase of travel demand and vehicle numbers due to ongoing population and area growth, there are many other reasons for congestion, such as peak hour traffic and concentration of activities, operational and physical bottlenecks, weather, events, work zones, and other causes (Falcocchio & Levinson 2015). Traffic volume, costs of car travel, road capacity improvement, and fuel prices also directly influence travel time and the incidence of induced traffic. Goodwin (1996) provided a discussion of some related elasticities of these factors. Mitigating and transferring road congestion requires careful planning and strategies in all related infrastructure and transport modes. For example, reducing car trips and freight pressure may be accompanied by improved public transport and rail freight capacities to redirect road traffic to other alternatives (Hensher 1998).

Road pricing is not the only way to alleviate congestion. There are many other ways to reduce car usage, such as through soft intervention measures in Transport Demand Management (TDM), classically defined by Meyer (1999) as an 'action or set of actions aimed at influencing people's travel behaviour in such a way that alternative mobility options are presented and/or congestion is reduced' (p 576). and many soft interventions have been proven to be effective in reducing car use to some extent (e.g., Cleland et al. 2023). Cleland et al. (2023) identified four TDM intervention approaches (i.e., active school travel, teen mobility, organisational travel plans and walking for transport) and approximately twenty components that were reported to be effective when aiming to change travel behaviour, However, car use remains a prevalent societal, environmental, economic, and public health issue. This raises the question of whether standalone interventions are sufficient to positively instigate and sustain changes in travel behaviour and in the environments, norms and habits that perpetuate car dependent behaviours in the longer term. This is where road pricing reform should be included

Ison (2018) provides detailed classifications of measures targeting congestion, split between the demand and supply sides. Whilst the supply-side measures aim to increase infrastructure capacity, the demand-side measures focus on reducing car use, including through land use design and restrictions, communications, traveller information, economic measures, and administrative measures. Road pricing is among the main economic measures. Cheng et al. (2024) discussed the effectiveness of eight types of interventions in reducing congestion, including road user charging, fuel price/tax, vehicle restrictions, high occupancy vehicle (HOV) lanes, licence plate lottery, parking restrictions, reward/incentives, and soft behavioural measures. Based on the current evidence from empirical road pricing schemes implemented in London, Stockholm, Singapore, and other locations, they concluded that road pricing schemes are effective in reducing congestion in all implemented schemes for the targeted areas at the time of day. This cannot be said for some other interventions; for example, people can have strategies in dealing with the licence plate lottery. With parking restrictions, congestion can even increase with more circulating drivers searching for parking.

Generally, implementing a road pricing scheme involves *designing it to be economically attractive and sound, and gaining public acceptance* to make it feasible and appealing for implementation. Often, a road pricing scheme fails at public acceptability (Anas & Lindsey 2011; Ison 2018). Designing a road pricing scheme requires calculating related costs and pricing them accordingly. Policymakers may focus on different costs or apply a different formula in calculating costs. As a result, the proposed schemes can vary greatly. Some of the standard cost components include the additional travel time, fuel consumption and other costs due to congestion, accidents, infrastructure, and emission and pollution (Bilbao-Ubillos 2008). Other costs, such as the loss of productivity and business costs due to congestion, are often neglected. In reality, the congestion cost for all industry sectors can be enormous. For example, Torrey (2017) provided an estimation of annual congestion costs to the US freight industry. The lost productivity is equivalent to about a quarter of a million commercial truck drivers sitting idle for an entire working year, or an additional $49.6 billion in costs. Other congestion-related costs, such as health-related costs, can also be extensive (Hosford et al. 2021). Overall, depending on the purpose of a specific road pricing scheme, the inclusion, calculation, and pricing of road use and congestion-related costs can be quite different.

Once costs are calculated and priced, the options of road pricing schemes can be decided. Ison (2018) summarised the following options, including 1) congestion metering; 2) time-based charging; 3) distance-based charging; 4) point/cordon-based charging; and 5) other forms such as supplementary licences, entry permits and area licences. Besides these options, researchers have been developing novel options for road pricing schemes. Kockelman and Kalmanje (2005) proposed credit-based congestion pricing (CBCP), which is a revenue-neutral policy where an "allowance", a form of road toll based on negative externalities associated with congestion, is used for frequent long-distance and peak-period drivers to subsidise the "average" drivers. Parry and Small (2005) demonstrate that economic welfare gains are actually higher with a vehicle mile tax (VMT) than with optimal fuel charging, presumably because external costs are more closely driven by distance than by fuel use but also because the elasticity of VMT with respect to fuel cost is quite small, making VMT a more attractive target than fuel for a Ramsey type revenue raising tax. Bliemer et al. (2024) proposed a novel road pricing approach based on a mobility consumption proposition covering both travel distance and travel time. Using an analogy of power consumption, they proposed a "mobility-based" charging method using a vehicle-specific unit charge formula, which embeds both the time and distance components. Jakob and Menendez (2021) proposed a combined parking and road pricing approach with parking (P) and road usage (R) components. Beck et al. (2011) tested variable emission charges for different energy consumption vehicles in designing a road pricing scheme. Hensher and Mulley (2014) proposed combining distance-based charges with discounted vehicle registration.

Country-Specific Road Pricing Schemes

Combined area and time-based road charging is the main form of the limited cases of real-world road pricing schemes implemented in Singapore, London, Stockholm, Gothenburg and other places. Besides these forms, the High Occupancy Toll (HOT) lanes are applied in some areas in the USA.

Singapore has been implementing cordon and expressway pricing by time of day (TOD) and vehicle class since 1998, known as electronic road pricing (ERP). Under ERP, drivers pay to be able to drive within the "Restricted Zone" during a limited time of the day (i.e., between 7:30 to 10 am and 12 to 8 pm in the CBD, and between 7:30 to 9:30 am on the expressway). Researchers have discussed and reviewed the effectiveness and impact of this scheme (e.g., Phang & Toh 2003; Olszewski & Xie 2005; Santos 2005; Falcocchio & Levinson 2015; Gärling & Friman 2018; Hosford et al. 2021; Koh & Chin 2022). Overall, this pricing scheme is effective in reducing traffic volume and maintaining the desired speed targets of 45–65 km/h on expressways and 20–25 km/h on arterials. The revenue is returned to some drivers through rebates, and investments from the revenue pool are made to improve transit and road infrastructure (Falcocchio & Levinson 2015).

London has applied cordon-based pricing in central London (known as the "Congestion Charge") since 2003. Over the years, some details of the rules and rates have been adjusted. The current charge is £15 per day for driving within the zone between 7:00 am and 6:00 pm, Monday to Friday, and 12:00 pm to 6:00 pm on weekends. The scheme and its impact have been discussed and reviewed by researchers revealing over 20% reduction in trips over the years within the cordon area, with revenues used to improve transit and other forms of transportation (e.g., Santos & Shaffer 2004; Santos 2005; Leape 2006; Anas & Lindsey 2011; Croci 2016; Ison 2018; Hosford et al. 2021).

In Stockholm and Gothenburg in Sweden, cordon and time-based road pricing schemes have been implemented since 2006 and 2013, respectively. The charge rate of entering the Inner City varies across the day, with the highest level of 35 SEK from 7:00 am to 8:29 am and from 16:00 to 17:29 on weekdays. The effects and other aspects of the road pricing schemes in the two locations have been reviewed by various authors, with over 20% of traffic reduction in the cordon area and about 15% reduction in emissions reported (Nilsson et al. 2016; Croci 2016; Börjesson & Kristoffersson 2018; Hosford et al. 2021). Net revenues are all used to invest in transit and other transportation infrastructure.

There are several other EU cities, including Milan (EcoPass), Oslo (congestion charge), and Geneva and London (Low Emission Zone), that have similar forms of road pricing schemes, targeting primarily congestion and emission costs and with positive impacts achieved (Croci

2016; Baranzini et al. 2021; Hosford et al. 2021). In the USA, the primary focus of road pricing is different, and the main form is distance and vehicle occupancy-based. These schemes apply variable pricing on lanes. A distance-based road pricing applies where High Occupancy Toll (HOT) lanes only allow low-occupancy vehicles by charging a variable rate to guarantee free flow, while permitting High Occupancy Vehicles (HOVs) to use the lane free of charge. The HOT lanes have been implemented in different parts of the USA, such as Los Angeles, San Diego, Miami, Minneapolis, Seattle, and Salt Lake City (e.g., Schweitzer & Taylor 2008; Yang et al. 2016). Cordon-based road pricing has been evaluated in recent years to analyse the feasibility of implementing it in US cities (Holguin-Veras et al. 2016; Simeone & Thornton 2023). In January 2025, a cordon-based road pricing scheme was implemented in Manhattan, New York City, and the scheme has been showing a positive impact in reducing congestion effectively based on early evidence (Cook et al. 2025).

Road pricing schemes and ideas have been tested for other countries and local areas, including Canada (Washbrook et al. 2006); United Arab Emirates (Abulibdeh 2018); New Zealand (MRCageny 2018); Israel (Cohen-Blanksshtain et al.) and Australia (e.g., Stanley and Hensher 2011; Beck et al. 2011; Hensher et al. 2013; Hensher & Mulley 2014; Sen et al. 2019; Sen et al. 2021, 2022). Road pricing is critically important for road usage reform, especially in the era of fast development in sustainable energy and electric vehicles, where fuel taxes become an increasingly lesser source to support transportation; however, the main obstacle to a wider implementation of road pricing schemes lies in the poor public acceptability, hence low political feasibility.

The Public and Political Acceptability of Road Pricing Schemes

The public acceptability of road pricing schemes is directly related to political feasibility, as demonstrated by the evidence in both successful and failed road pricing schemes, particularly so for well documented failed ones such as the Hong Kong and Edinburgh road pricing plans, where low public support directly caused the plans to be dropped by the local transport authorities (Selmoune et al. 2020). Road pricing measures have less public acceptability compared to soft TDM measures because they are often perceived as coercive measures to reduce car use. Acceptability would be higher if a road pricing plan meets several required conditions, such as good public communications, closer to public expectations, a high level of perceived effectiveness, and simpler to understand and implement procedures (Dieplinger & Fürst 2014; Fürst & Dieplinger 2014).

The barriers for implementing road pricing are not only about whether the plan is analytically sound, but also whether it is ideologically appealing (Ison 2018). In reviewing both the successful and failed cases, Selmoune et al. (2020) pointed out that the main factors influencing the outcome of the road pricing schemes are equity/fairness, privacy, risk, and difficulty in implementation, as well as administrative issues and installation costs. Hensher and Li (2013) pointed out that the two most important reasons why road pricing referenda failed are uncertainty about the scheme's effectiveness and the lack of information on it. They proposed a two-step approach to overcome these barriers, where good communications are facilitated during both the design and implementation stages, as occurred in Stockholm. Other researchers welcomed the two-step approach in improving the acceptability of road pricing (e.g., Dieplinger & Fürst 2014). Similarly, Duncan and Graham (2013) named adequacy, equity, simplicity and efficiency as key factors for higher acceptability of road pricing.

Equity or fairness has always been a top priority for road pricing acceptability. Some researchers hold that road pricing schemes are more unfair to lower-income households because they have fewer options compared to their higher-income counterparts when it comes to travel choices (e.g., Glaeser et al. 2023). This is why the distribution of costs and benefits from road pricing schemes has always been a key consideration when it comes to surveys and stated preference experiments (e.g., Beck et al. 2011; Hensher et al. 2013; Balbontin et al. 2017). It can be argued that the fundamental principle of road pricing has a level of embedded fairness because transportation resource usage is charged based on consumed units, either in distance or time. Other measures in reducing car use, such as road restrictions, do not have this characteristic because they apply to all people regardless of their needs. As put by Schade and Schlag (2003), the more people perceive that the advantages of a road pricing plan align with their expectations, the more they will be willing to accept it.

Perceived effectiveness in reducing congestion-related costs through easing congestion and increasing speed has been an important determinant for the success of implemented road pricing plans in Singapore, London, Stockholm, and other places. Reviews of the successful road pricing schemes discovered that public acceptability increased after the public noticed the effectiveness of the implemented schemes (e.g., Anas & Lindsey 2011; Gu et al. 2018; Nilsson et al. 2016). For example, using three waves of panel surveys of 4,700+ respondents before and after the Gothenburg pricing scheme, Nilsson et al. (2016) show that the positive changes in acceptance and attitudes among the public towards the scheme was mainly based on underlying value-based motives promoted by effective outcomes and simple to follow administration.

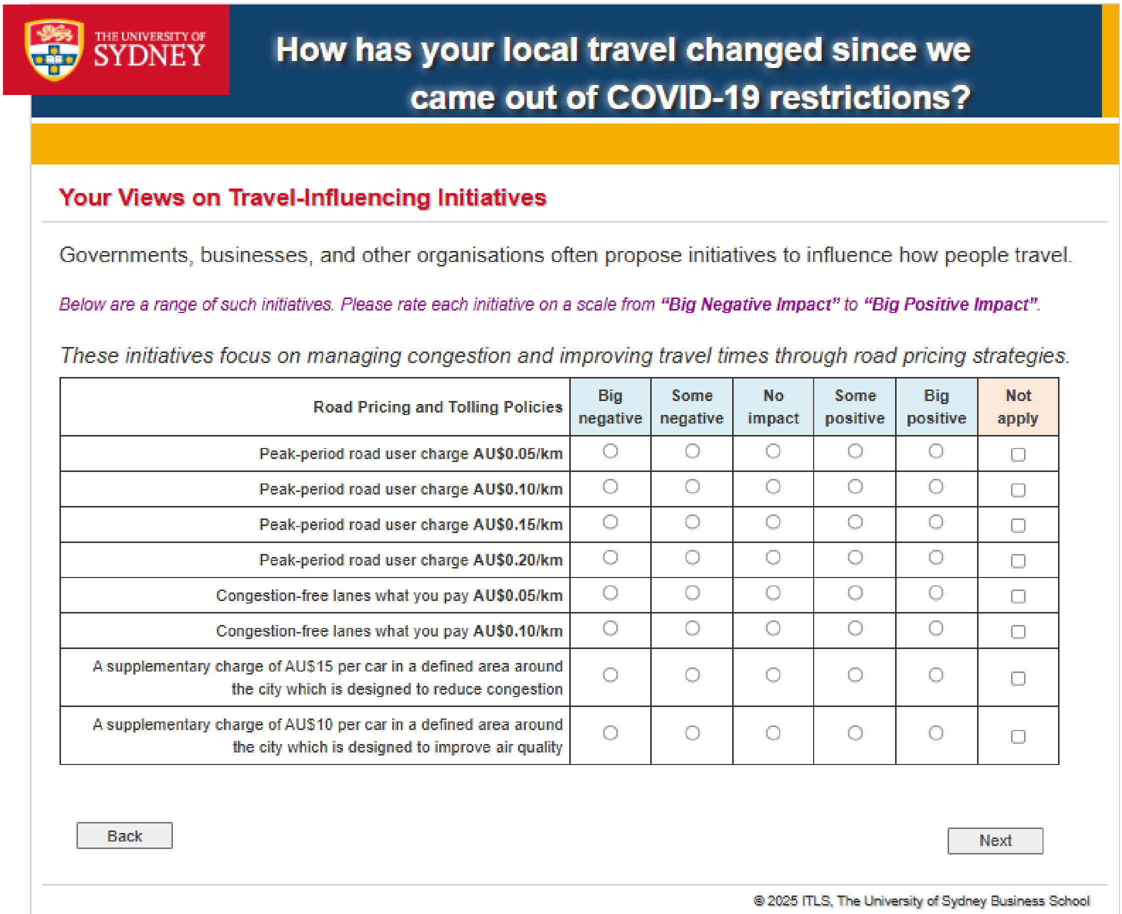
Duncan and Graham (2013) also emphasised the importance of having simple and low-tech ways of implementing distance-based road pricing charges in the US, such as the vehicle miles of travel fees (VMT-F) among the US public. They argued that low-tech and straightforward ways of road pricing implementation, accompanied by a well-developed audit mechanism, would be critical in gaining more support from the US public for road pricing to make it politically acceptable.

Most of the empirical research using stated preference methods to elicit the levels of public preference aims to enhance these above aspects, namely, a clear definition of the distribution of costs and benefits in favour of the public preference, more effective outcomes, and simplicity in the mechanism. Some studies tested innovative ways in packaging and designing the road pricing schemes in alternative approaches, different to standard distance-based, area-based or time-based charges (Hensher et al. 2013; Hensher & Mulley 2014; Hensher & Ho 2015). Using a structural equation model, Morton et al. (2021) show that public attitudes towards a Low Emission Zone (LEZ) and related charges (i.e., cordon) account for the most considerable weight in acceptability. Public attitudes are shaped by perceptions of the cost, procedural fairness, and efficacy of the scheme.

In summary, past research on acceptability has consistently indicated that equity and fairness, effectiveness in generating expected outcomes, and simplicity in implementation are essential factors in gaining higher public acceptability.

Empirical Context

A survey was undertaken in May 2025 with participants from Australia, Finland, New Zealand, the United States, the United Kingdom, Singapore, and Sweden. This cross-cultural approach aims to identify both universal and region-specific insights into behaviour change. In this paper, we draw on data items related to eight pricing initiatives (Figure 1), and “windows of change” (WoC) influences listed in Table 1 (obtained from Figure 2), which represent key moments where travel behaviour might be more susceptible to change. We also include the socioeconomic variables in the inquiry (Table 2).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How has your local travel changed since we came out of COVID-19 restrictions?

Your Views on Travel-Influencing Initiatives

Governments, businesses, and other organisations often propose initiatives to influence how people travel.

*Below are a range of such initiatives. Please rate each initiative on a scale from **“Big Negative Impact”** to **“Big Positive Impact”**.*

These initiatives focus on managing congestion and improving travel times through road pricing strategies.

Road Pricing and Tolling Policies	Big negative	Some negative	No impact	Some positive	Big positive	Not apply
Peak-period road user charge **AU$0.05/km**	○	○	○	○	○	☐
Peak-period road user charge **AU$0.10/km**	○	○	○	○	○	☐
Peak-period road user charge **AU$0.15/km**	○	○	○	○	○	☐
Peak-period road user charge **AU$0.20/km**	○	○	○	○	○	☐
Congestion-free lanes what you pay **AU$0.05/km**	○	○	○	○	○	☐
Congestion-free lanes what you pay **AU$0.10/km**	○	○	○	○	○	☐
A supplementary charge of AU$15 per car in a defined area around the city which is designed to reduce congestion	○	○	○	○	○	☐
A supplementary charge of AU$10 per car in a defined area around the city which is designed to improve air quality	○	○	○	○	○	☐

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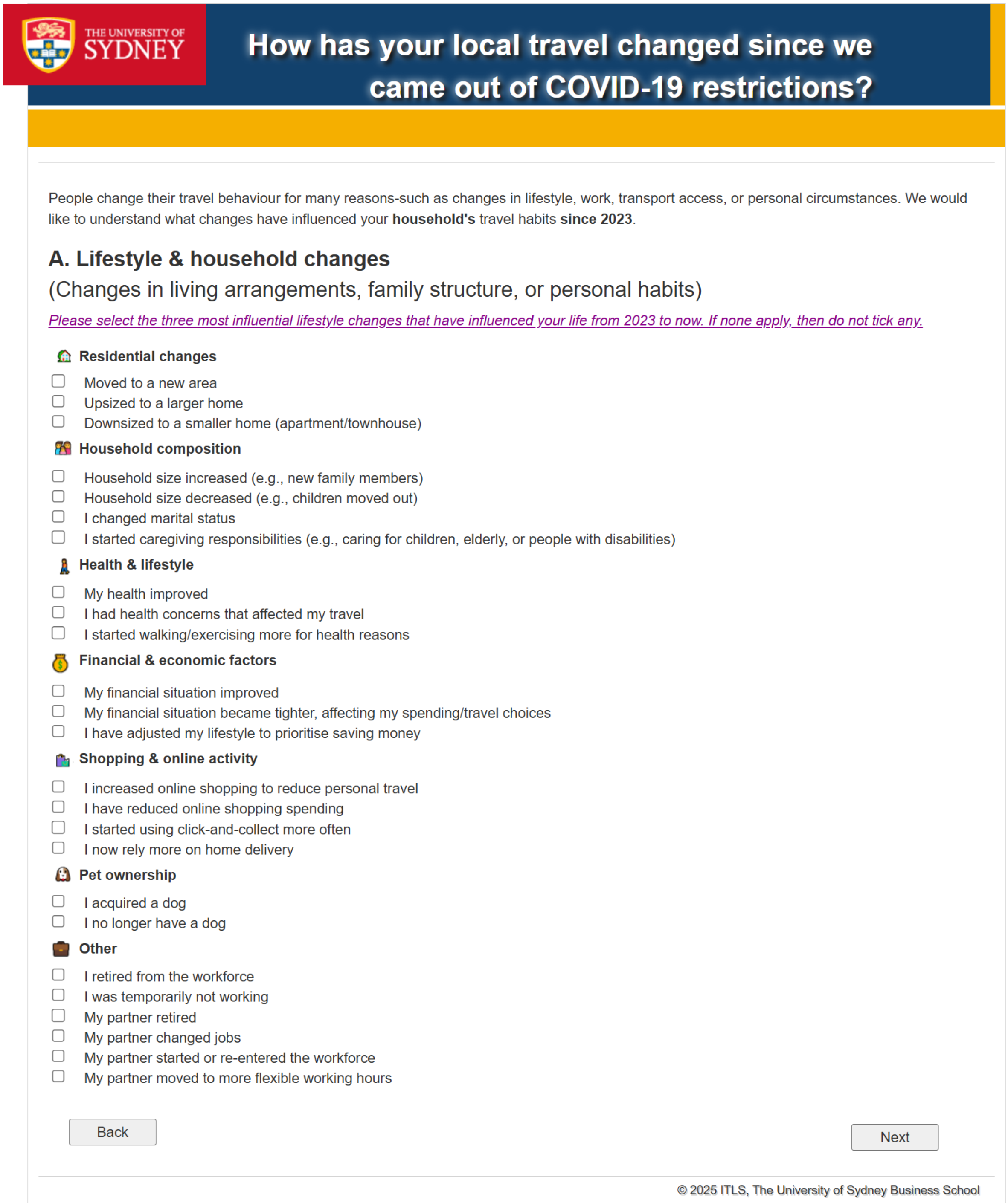
Figure 1. The series of questions on road pricing initiatives



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How has your local travel changed since we came out of COVID-19 restrictions?

People change their travel behaviour for many reasons-such as changes in lifestyle, work, transport access, or personal circumstances. We would like to understand what changes have influenced your **household's** travel habits **since 2023**.

A. Lifestyle & household changes

(Changes in living arrangements, family structure, or personal habits)

Please select the three most influential lifestyle changes that have influenced your life from 2023 to now. If none apply, then do not tick any.

Residential changes

- ☐ Moved to a new area
- ☐ Upsized to a larger home
- ☐ Downsized to a smaller home (apartment/townhouse)

Household composition

- ☐ Household size increased (e.g., new family members)
- ☐ Household size decreased (e.g., children moved out)
- ☐ I changed marital status
- ☐ I started caregiving responsibilities (e.g., caring for children, elderly, or people with disabilities)

Health & lifestyle

- ☐ My health improved
- ☐ I had health concerns that affected my travel
- ☐ I started walking/exercising more for health reasons

Financial & economic factors

- ☐ My financial situation improved
- ☐ My financial situation became tighter, affecting my spending/travel choices
- ☐ I have adjusted my lifestyle to prioritise saving money

Shopping & online activity

- ☐ I increased online shopping to reduce personal travel
- ☐ I have reduced online shopping spending
- ☐ I started using click-and-collect more often
- ☐ I now rely more on home delivery

Pet ownership

- ☐ I acquired a dog
- ☐ I no longer have a dog

Other

- ☐ I retired from the workforce
- ☐ I was temporarily not working
- ☐ My partner retired
- ☐ My partner changed jobs
- ☐ My partner started or re-entered the workforce
- ☐ My partner moved to more flexible working hours

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Figure 2. Windows of change question for the lifestyle and household changes screen (note: the same format applies for the other three classes of WoCs.)

Table 1. The list of Windows of Change potential influences

Category	**Windows of Changes**	%
Lifestyle & Household	Moved to a new area	17.7%
	Upsized to a larger home	9.1%
	Downsized to a smaller home	6.1%

	Household size increased	9.5%
	Household size decreased	8.0%
	I changed marital status	6.5%
	I started or increased caregiving responsibilities	5.4%
	My health improved	16.7%
	I had health concerns that affected my travel	10.9%
	I started walking/exercising more for health reasons	22.5%
	My financial situation improved	12.1%
	My financial situation became tighter	21.0%
	I have adjusted my lifestyle to prioritise saving money	15.3%
	I increased online shopping to reduce personal travel	13.6%
	I have reduced online shopping spending	9.2%
	I started using click-and-collect more often	5.3%
	I now rely more on home delivery	4.6%
	I acquired a dog	6.0%
	I no longer have a dog	4.0%
	I retired from the workforce	4.0%
	I was temporarily not working	3.3%
	My partner retired	1.5%
	My partner changed jobs	1.6%
	My partner started or re-entered the workforce	0.7%
	My partner moved to more flexible working hours	0.8%
Work & Commuting	I was not in the workforce during this period	26.1%
	I was looking for a job during this period	13.5%
	I changed jobs but stayed in the same residential area	12.4%
	I changed jobs and moved to a new residential area	5.0%
	I moved to flexible working hours and days	20.2%
	I recently had to work in the main office/work location more	11.1%
	Free parking	10.4%
	Charging facilities for electric cars	4.4%
	Showers for walking/cycling commuters	5.1%
	Free on-site health & wellness facilities	4.6%
	Perks for using public transport, carpooling, cycling, or e-scooters	3.5%
Transport & Mobility	Bought a car (previously did not own one)	7.4%
	Increased the number of cars in the household	5.9%
	Replaced a petrol/diesel car with an electric (hybrid or fully electric) car	6.6%
	Replaced a petrol/diesel car with a more fuel-efficient petrol/diesel car	6.2%
	Replaced a petrol/diesel car with a less fuel-efficient petrol/diesel car	3.6%
	Reduced car use due to high costs	9.9%
	We now have more cars than adults in the household	2.0%
	We now have fewer cars than adults in the household	3.1%
	I no longer own a car	5.8%
	Purchased an e-scooter	3.7%
	Purchased an e-bike	6.3%
	Purchased a regular bicycle	6.4%
	Improved accessibility of public transport in my area	8.7%
	Improved public transport routes saved me travel time	7.1%
	Public transport is less crowded since COVID-19	6.3%
	Public transport quality has worsened	5.9%
	I reduced car use for commuting	8.3%
	I started using public transport more for commuting	5.5%
	I reduced overall car use	13.3%
	I increased overall car use	5.4%
	I walk or cycle more	13.1%
	I increased my use of e-bikes or e-scooters	0.7%

	I take children to/from daycare or school on the way to/from work/home	5.9%
	I use public transport more because other household members use the car	2.3%
	I walk/cycle more because other household members use the car	1.9%
	I use e-bike/e-scooter more because other household members use the car	0.5%
Social & Environmental	I am now more conscious of the environmental impact of my travel choices	37.9%
	I am now less concerned about the environmental impact of my travel choices	10.6%
	Friends influenced my decision making	14.0%
	Family influenced my decision making	27.5%
	Public campaigns or government policies	6.6%
	Peer groups and social norms	2.5%
	I tend to use car over public transport on wet days	17.2%
	I tend to use car over active travel on wet days	12.0%
	Due to industrial action, I shifted from public transport to driving	2.4%

Table 1 summarises the incidence of each WoC influence across the all-country sample, with the influences ranked from least to most cited. The most cited influence is “I am now more conscious of the environmental impact of my travel choices” by 37.9% of the sample, with the least cited being “I use e-bike/e-scooter more because other household members use the car” by 0.5% of the sample. The majority of WoC influences mentioned by the sample are in the range between 4% and 12% which is enough to suggest that many of the influences are likely to have a positive or negative influence on changes in travel behaviour.

Some of the WoC influences are spatial such as residential and workplace relocation, suggesting the need for strategic transport models to incorporate location change choices. There are many influences associated with car ownership and use, of which no longer owning a car (5.8%) is an encouraging outcome in achieving sustainability objectives, and we also see greater use of the car (5.4%), and replacing a petrol/diesel car with an electric (hybrid or fully electric) car (6.6%) as likely to increase overall car use despite the environmental gains from electric cars. Some car use decreases due to high costs (9.9%); however, we find 13.1% of respondents reduced overall car use. Free parking provided by an employer (10.4%) is clearly a disincentive to switch to more environmentally friendly modes, although such parking is eligible for electric vehicles, but it adds to congestion while reducing emissions. So, we have a number of car-related influences which need to be assessed in the formal modelling to establish the net sustainable mobility impact of the car context.

Encouragingly, we find some positive support for public transport (PT) associated with its use in households where others have taken over the use of the available cars (2%), perks provided by an employer for using PT (3.5%), reduced crowding in PT (6.3%), improved PT routes resulting in travel time savings (7.1%), and improved accessibility of PT in the local area (8.7%); however, this is offset partially by a worsening of PT quality (5.9%).

Active mode responses include started walking and exercising more for health reasons (22.5%), increased walking and cycling (13.1%), purchased a regular bike (6.6%), purchased an e-bike (6.3%), and walking and cycling more because other household members use the car (2.8%).

Table 2 summarises the profile of the sample

Total Sample Size N = 4,088		**%**
Country	Australia	25.3%
	Finland	9.7%
	New Zealand	10.3%
	Singapore	10.1%
	Sweden	9.9%
	UK	10.1%
	USA	24.7%
Gender	Females	47.9%

	Males	51.7%
	Non binary/Prefer not to say	0.4%
Age	Average age	48
Household size	Average number of members	2.6
Household type	Family household	18%
	Couple family with no children	26%
	Couple family with children	21%
	One parent family	5%
	Other family	2%
	Single person household	22%
	Group household (i.e., shared)	4%
	Prefer not to answer	2%
Highest education	Postgraduate degrees/diploma/certificate	25%
	Bachelor’s degree	31%
	Total university degrees	**56%**
	Below bachelor degree	42%
	Prefer not to answer	2%
Average annual personal income	Australia	AUD 73,735
	Finland	40,301 €
	New Zealand	NZD 69,354
	Singapore	SGD 64,102
	Sweden	SEK 497,098
	UK	£36,393
	USA	USD 58,343
Average annual household income	Australia	AUD 117,153
	Finland	79,499 €
	New Zealand	NZD 108,886
	Singapore	SGD 102,990
	Sweden	SEK 771,972
	UK	£53,999
	USA	USD 85,023
Work status	Paid jobs	62.0%
	Looking for work	7.1%
	Students	3.1%
	Home-maker	6.1%
	Retired/not working	19.0%
	Volunteer work	0.9%
	Retired and doing casual work	1.8%
Occupation of workers	Manager	18%
	Professional	22%
	Technicians and trades	8%
	Community and personal services	5%
	Clerical and administration	13%
	Sales	8%
	Machine operators / drivers	4%
	Labourer	10%
	Other	11%
Average working hours per week (based on respondents doing a paid job)	Weekly working hours in main office/location	22.0
	Weekend working hours in main office/location	1.4
	Weekly working hours at home	7.8
	Weekend working hours at home	0.8
	Weekly working hours at other locations	2.3
	Weekend working hours at other locations	0.5
	Total number of weekly working hours	**34.8**
	Total number of weekly remote working hours	**11.4**
Weekly trips	Total number of weekly trips	18.2
	Total number of weekly trips by car	11.5
	The percentage of car trips	63%
	Average distance of car trips (km)	6.1
Average number of vehicles	Internal Combustion Engine (ICE) cars	1.12

	EV cars	0.10
	Hybrid cars	0.14
	Total number of cars	**1.36**
	Push bikes	0.63
	E-bikes	0.14
	E-scooters	0.11
	Total number of active travel devices	**0.88**

There is a good mix of males and females, with an average age of 48 years (aligned with country averages), and an expected high percentage of families and couples with and without children (65%), although the incident of a single person households (22%) is important as this market is growing. 62% of the sample are in a paid job, with a good spread of occupations and an average of 35.6% working from home out of an average 38.4 hour working week. As expected, the car dominates for all trips (63%) wit 82.4% of cars being ICEs, and there are more hybrid cars than pure electric cars. It is encouraging to see a high incidence on bicycles (average of 0.63 per household), with an average of 0.25 e-bikes and-scooters

Target Audience, Sampling Strategy and Implementation

The survey primarily targeted respondents in Australia, reflecting the local context and transport policies influencing travel behaviour. With a target sample size of 4,000 participants across all countries, it aimed to provide an understanding of local travel patterns and relevant interventions based on their experience during 2023 to now. In addition to 1,000 respondents from Australia, a comparative sample of 1,000 from the USA and 400 each from Finland, New Zealand, the UK, Singapore, and Sweden was obtained to offer a broader perspective, and enable international comparisons. These countries were selected based on their advanced transport systems, progressive policy initiatives, diverse approaches to sustainable mobility, and the ability of respondents to complete the survey in English. By incorporating insights from multiple regions, the survey sought to identify common trends, key differences, and best practices in influencing travel behaviour. This comparative approach supports the assessment of the effectiveness of various interventions and the level of awareness across different urban and policy contexts.

A third-party panel survey provider was engaged to ensure robust data collection, with flexibility in sample sizes to adapt to evolving research needs. The research team continuously monitored data quality throughout the collection period and applied checks at both the pilot and full implementation stages to ensure the validity of survey responses. Accordingly, 526 responses across all countries were excluded due to unacceptable data quality. The final sample includes 1,034 respondents from Australia, 1,009 from the USA, 397 from Finland, 423 from New Zealand, 411 from Singapore, 403 from Sweden, and 411 from the UK, a total of 4,088 respondents.

The Generalised Ordered Logit Model

The dependent variable of interest is an ordered response scale as shown in Figure 1. We ignore the 'not apply' response, which was selected by a negligible number of respondents. To represent this ordering, we use an order logit (OL) model (see Greene and Hensher, 2010). The basic ordered choice model is based on a latent regression model given as equation (1).

$$Y_i^* = \boldsymbol{\beta}'\mathbf{x}_i + \varepsilon_i, \quad \varepsilon_i \sim F(\varepsilon_i \,|\boldsymbol{\theta}), \; E(\varepsilon_i) = 0, \; Var(\varepsilon_i) = 1 \qquad (1)$$

where $\boldsymbol{\theta}$ collects the mean and threshold parameters. The observation mechanism results from a complete censoring of the latent dependent variable as follows:

$$
\begin{aligned}
Y_i &= 0 \text{ if } Y_i^* \le \mu_0, \\
&= 1 \text{ if } \mu_0 < Y_i^* \le \mu_1, \\
&= 2 \text{ if } \mu_1 < Y_i^* \le \mu_2, \qquad (2)\\
&\ldots \\
&= J \text{ if } Y_i^* > \mu_{J-1}.
\end{aligned}
$$

The probabilities which enter the log likelihood function are given by equations (3).

$$\text{Prob}[y_i = j \mid x_i] = \text{Prob}(Y_i^* \text{ is in the } j\text{th range}) = F(\mu_j - \beta' x_i) - F(\mu_{j-1} - \beta' x_i) > 0, j = 0,1,\ldots,J. \qquad (3)$$

We depart from the basic model to allow for random thresholds and heterogeneity in the preferences associated with the explanatory variables (Greene and Hensher 2010)[3]. In order to model heterogeneity in the utility functions across individuals, we construct a hierarchical model in which the parameters vary randomly due to individual-specific unobservables, v_i (equation 4).

$$\beta_i = \beta + \Gamma v_i \qquad (4)$$

Γ is a lower triangular matrix and $v_i \sim N[0,I]$. The parameter vector in the utility function, β_i is normally distributed across individuals with conditional mean given as (5).

$$E[\beta_i | x_i] = \beta \qquad (5)$$

and conditional variance as (6).

$$\text{Var}[\beta_i | x_i] = \Gamma I \Gamma' = \Omega. \qquad (6)$$

This is a random parameter formulation that is common with mixed logit models for unordered alternatives. In addition, the thresholds are modelled randomly and nonlinearly as

$$\mu_{ij} = \mu_{i,j-1} + \exp(\alpha_j + \delta' r_i + \sigma_j w_{ij}), w_{ij} \sim N[0,1] \qquad (7)$$

with normalisations and restrictions $\mu_{-1} = -\infty$, $\mu_0 = 0$, $\mu_J = +\infty$. For the remaining thresholds, we have the form in (8).

$$\mu_1 = \exp(\alpha_1 + \delta' r_i + \sigma_1 w_{j1})$$

$$= \exp(\delta' r_i) \exp(\alpha_1 + \sigma_1 w_{j1}) \qquad (8)$$

$$\mu_2 = \exp(\delta' r_i) [\exp(\alpha_1 + \sigma_1 w_{j1}) + \exp(\alpha_2 + \sigma_2 w_{j2})],$$

$$\mu_j = \exp(\delta' r_i) \left(\Sigma_{m=1}^{j} \exp(\alpha_m + \sigma_m w_{im}) \right), j = 1,\ldots,J-1$$

$$\mu_J = +\infty.$$

[3] Start values for the GoL are obtained from a previous OL model. Generally, whenever you fit a random parameter (RP) model a seed should be set. For an OL model, the slopes start at 0. Constant and cut points are also set so that theoretical probabilities match shares of outcomes. The RP start values are fixed results with zeros for variances of RPs.

This formulation ensures that all of the thresholds are positive, preserves the ordering of the thresholds and incorporates the necessary normalisations. Most importantly, it also allows observed variables and unobserved heterogeneity to play a role both in the utility function and in the thresholds. The thresholds, like the regression itself, are shifted by both observable (r_i) and unobservable (w_{ij}) heterogeneity. The model is fully consistent in that the probabilities are all positive and sum to one by construction. If $\delta = 0$ and $\sigma_j = 0$, then the original OL model is returned, with $\mu_1 = \exp(\alpha_1)$, $\mu_2 = \mu_1 + \exp(\alpha_2)$ and so on[4].

We can also allow for individual heterogeneity in the variance of the utility function as well as in the mean. The disturbance variance is allowed to be heteroscedastic, specified randomly as well as deterministically. Thus,

$$\text{Var}[\varepsilon_i|h_i,e_i] = \sigma_i^2 = \exp(\gamma' h_i + \tau e_i)^2 \tag{9}$$

where $e_i \sim N[0,1]$. Let $v_i = (v_{i1},\ldots,v_{iK})'$ and $w_i = (w_{i1},\ldots,w_{i,J-1})'$. Combining all terms, the conditional probability of outcome j is

$$\text{Prob}[y_i = j \mid x_i,z_i,h_i,r_i,v_i,w_i,e_i] = F\left[\frac{\mu_{ij} - \boldsymbol{\beta}_i'\mathbf{x}_i}{\exp(\boldsymbol{\gamma}'\mathbf{h}_i + \tau e_i)}\right] - F\left[\frac{\mu_{i,j-1} - \boldsymbol{\beta}_i'\mathbf{x}_i}{\exp(\boldsymbol{\gamma}'\mathbf{h}_i + \tau e_i)}\right], \tag{10}$$

where it is noted, once again, both μ_{ij} and β_i vary with observed variables and with unobserved random terms. The log likelihood is constructed from the terms in (10). However, the probability in (10) contains the unobserved random terms, v_i, w_i and e_i. The term that enters the log likelihood function for estimation purposes must be unconditioned on the unobservables and integrated out to obtain the unconditional probabilities in (11).

$$\text{Prob}[y_i = j \mid x_i,z_i,h_i,r_i] = \int_{\mathbf{v}_i,\mathbf{w}_i,e_i} \left(F\left[\frac{\mu_{ij} - \boldsymbol{\beta}_i'\mathbf{x}_i}{\exp(\boldsymbol{\gamma}'\mathbf{h}_i + \tau e_i)}\right] - F\left[\frac{\mu_{i,j-1} - \boldsymbol{\beta}_i'\mathbf{x}_i}{\exp(\boldsymbol{\gamma}'\mathbf{h}_i + \tau e_i)}\right]\right) f(\mathbf{v}_i,\mathbf{w}_i,e_i)\,d\mathbf{v}_i\,d\mathbf{w}_i\,de_i. \tag{11}$$

One is typically interested in the estimation of parameters such as β in (11), to learn about the impact of the observed independent variables on the outcome of interest. This generalised ordered choice model contains four points at which changes in observed variables can induce changes in the probabilities of the outcomes, in the thresholds, μ_{ij}, in the marginal utilities, β_i, in the utility function, x_i and in the variance, σ_i^2.

A Descriptive Profile of the Road Pricing Initiatives

The ordered response scale shown in Figure 1 has been aggregated into three levels – negative impact, no impact and positive impact. This decision was taken to ensure that we have enough responses for each level of the generalised ordered logit model. Table 3 assigns an acronym to each pricing initiative, used in Figure 3 to profile the incidence of responses for each impact level. We can see, for example, that as the peak period distance-based charge (DBC) increases from 5c/km to 20c/km, positive support declines (i.e., getting too expensive), and negative impact increases for the same logical reason. We find a high correlation in general between positive and negative impacts. Figure 3 is an example applicable to all initiatives, such that, after

[4] Note that if the threshold parameters were specified as linear functions rather than as in (8), then it would not be possible to identify separate parameters in the regression function and in the threshold functions.

estimation of the Generalised Ordered Logit (GoL) model for all three impact levels, we can focus on reporting and discussing only the positive impact evidence, through elasticity estimates.

A positive impact for an initiative has to be carefully interpreted. Although the meaning can vary depending on the initiative, for the introduction of a new pricing regime, if an initiative has a positive impact, it can mean that it has some support, which can vary and will be dependent on knowing what variables (including the WoC influences) are influencing the direction of positive support. A negative parameter and associated elasticity, for example, suggest that an increase in the level of a particular statistically significant influence, such as car use, *ceteris paribus*, supports reduced (positive) support for a specific pricing initiative, increasing as car kilometres increase.

Table 3. The eight pricing initiatives

Road Pricing Schemes	**Acronyms**
Congestion-free lanes what you pay $0.05/km	ICFL05
Congestion-free lanes what you pay $0.10/km	ICFL10
A supplementary charge of $10 per car in a defined area around the city	CH10CR
A supplementary charge of $15 per car in a defined area around the city	CH15CR
Peak-period road user charge $0.05/km (Distance-Based Charge)	DBC05
Peak-period road user charge $0.10/km (Distance-Based Charge)	DBC10
Peak-period road user charge $0.15/km (Distance-Based Charge)	DBC15
Peak-period road user charge $0.20/km (Distance-Based Charge)	DBC20

Note: The initiatives were expressed in the currency of each of the seven countries, but we list the $US in the table. Respondents saw the language of a peak period road user charge (RUC) which we refer to also as a distance-based charge (DBC).

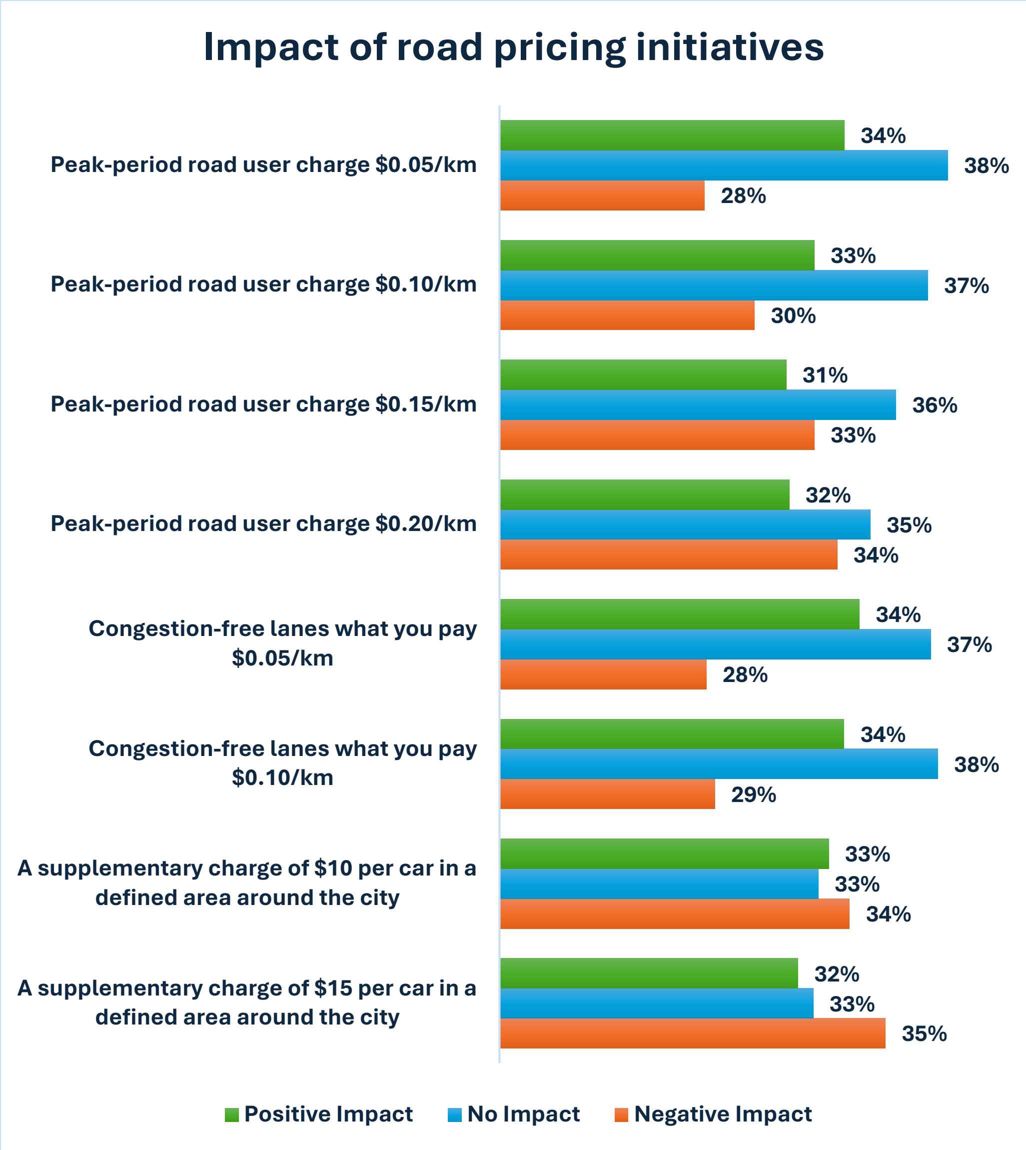

Figure 3. The overall incidence of impact of each pricing initiative

Model Estimation Results

The eight GoL models are summarised in Table 4. While we found statistically significant random parameter effects, there was no evidence of random thresholds or individual heterogeneity in the variance of the utility function or in the mean and heteroscedastic disturbance variance[i5] It is important to recognise that we can have a statistically significant standard deviation parameter, but a non-significant mean parameter estimate, suggesting that preference heterogeneity is present, and that a mean estimate alone fails to accommodate this empirical evidence.

[5] While the GoL model did not identify significant sources of behavioural variance that might be captured by random parameters and latent heterogeneity random thresholds or individual heterogeneity in the variance of the utility function or in the mean and heteroscedastic disturbance variance, the ability to identify that they play no role in the current context is important, otherwise there is always the risk of being quizzed on why we did not test for these influences. The final empirical model is then limited to a focus on selected random and fixed parameters

The influence of each WoC varies across the eight road pricing regimes, with a significant number not having a statistically significant influence. For example, age is statistically significant in all eight models, whereas personal income is only statistically significant for a $15 cordon-based charge. The sign has to be interpreted mindful of the three-point scale, and because of the possibility of a change in sign when moving between a positive and negative impact, an elasticity estimate associated with each level is behaviourally more informative. The negative sign for age in all models, however, suggests that there is an overall net support decrease as age increases. In contrast, the sign of personal income suggests greater support for a cordon-based $15 charge as income increases (individuals can afford it and presumably see a benefit through reduced traffic).

The country-specific dummy variables are very informative, with evidence that residents of Finland (where congestion charges have never been introduced), and the UK, have a significant negative parameter for all eight pricing regimes, but for Australia and New Zealand the statistically significant negative impact is found only for the $15 cordon-based charge. Swedish residents, however, show a positive significant effect for a $10 cordon-based charge, presumably because of overt experience with the schemes in Stockholm and Gothenburg, and a negative sign for a 5c/km congestion-free lane[6]. After controlling for WoCs and a few socioeconomic effects, we see that the influence of each pricing regime varies across countries, as expected.

There are five WoC influences that have a statistically significant influence on all eight pricing regimes, namely 'My financial situation became tighter' (negative parameter), 'I have adjusted my lifestyle to prioritise saving money' (negative parameter), 'My employer introduced charging facilities for electric cars' (positive parameter), 'Public transport quality has worsened' (negative parameter), and 'I am now more conscious of the environmental impact of my travel choices' (positive parameter). The signs all make good sense, suggesting that financial constraints (exacerbated by the current cost-of-living crisis being experienced in many countries) make the pricing reforms less desirable, as does the worsening quality of public transport, which makes any switch from car less desirable. We see that the employer introducing charging facilities for electric cars at the workplace is sufficiently attractive to support road pricing reforms, which might appear to be an attractive way of improving travel times to work, noting also that in many countries, electric car owners generally have higher personal incomes and a tendency to drive more once they have switched to an EV. Recent evidence from Norway which has taken up electric cars more than any other country, shows a 10-20% increase in car use and a sizeable shift away from public transport use, cycling and walking (Green and Østli 2025). Finally, we see positive support from individuals who are now more environmentally conscious. The behavioural richness of the evidence is greater when we present the elasticity estimates which we have summarised in the next section.

[6] Note that we had a fairly even split of metro (212) v regional (177) respondents in Sweden suggesting that regional residents are also responding positively

Table 4. Generalised ordered logit model estimation results

	DBC $0.05/km	**DBC $0.10/km**	**DBC $0.15/km**	**DBC $0.20/km**	**Congestion free lanes $0.05/km**	**Congestion free lanes $0.10/km**	**Cordon-based $10**	**Cordon-based $15**
Variables	**Latent Regression Equation Parameters**							
Constant	1.9558 (10.67)	2.1763 (11.88)	1.8845 (10.23)	2.1265 (10.01)	1.8328 (9.47)	1.8007 (8.96)	2.1382 (10.93)	2.1932 (11.76)
Number of ICE cars	- 0.2427 (5.63)	- 0.3597 (- 7.79)	- 0.2289 (- 5.07)	- 0.3368 (- 6.76)	-0.1975 (- 4.74)	- 0.2224 (- 4.85)	- 0.2578 (- 5.83)	- 0.2510 (- 5.87)
Total public transport trips	0.0225 (2.65)		0.0187 (2.21)	0.0170 (1.86)	0.0223 (2.52)	0.0210 (2.27)	0.0118 (1.32)	
Total E-bike trips		0.0453 (2.35)		0.0419 (1.56)	0.0522 (2.46)	0.0335 (1.50)	0.0386 (1.67)	0.0486 (2.52)
Age	- 0.0161 (- 5.91)	- 0.0183 (- 6.55)	- 0.0158 (- 5.62)	- 0.0173 (- 5.61)	-0.0123 (- 4.30)	- 0.0130 (- 4.35)	- 0.0242 (- 8.31)	- 0.0207 (- 7.46)
Personal income								0.0033 (2.27)
Australia								- 0.4916 (- 3.02)
Finland	- 0.4425 (- 3.15)	- 0.5461 (- 3.87)	- 0.3952 (- 2.75)	- 0.4603 (- 2.92)	-0.6338 (- 4.18)	- 0.5430 (- 3.38)	- 0.2589 (- 1.80)	- 0.5038 (- 3.43)
New Zealand								- 0.4311 (- 3.19)
Sweden					-0.2696 (- 1.78)		0.4039 (2.65)	
UK	- 0.4041 (- 3.02)	- 0.5233 (- 3.74)	- 0.5101 (- 3.65)	- 0.5932 (- 4.02)	-0.4059 (- 2.96)	- 0.3826 (- 2.60)	- 0.5652 (- 4.00)	- 0.7470 (- 5.02)
Upsized to a larger home	0.2534 (1.50)		0.3645 (1.93)	0.5293 (2.45)		- 8.0131 (- 3.66)		
Household size decreased		0.2657 (1.82)	0.2435 (1.66)			0.5664 (3.53)		
My financial situation improved						0.2449 (1.81)		
My health improved					0.2945 (2.29)		0.2214 (1.87)	
I started walking/exercising more for health reasons			- 0.2584 (- 2.55)	- 0.3021 (- 2.72)	-0.2099 (- 2.05)			- 0.1712 (- 1.65)
My financial situation became tighter	- 0.5498 (- 5.24)	- 0.5842 (- 5.22)	- 0.6122 (- 5.37)	- 0.6309 (- 5.02)	-0.5371 (- 4.96)	-0.5321 (3.78)	- 0.6380 (- 5.81)	- 0.6661 (- 6.22)

I have adjusted my lifestyle to prioritise saving money	- 0.3432 (- 2.76)	- 0.4972 (- 3.27)	- 0.3491 (- 2.43)	- 0.5039 (- 3.40)	-0.2850 (- 2.17)	-0.3872 (3.97)	- 0.6899 (- 4.36)	- 0.5662 (- 4.35)
I started using click-and-collect more often	- 0.3951 (- 1.98)	- 0.3037 (- 1.81)	- 0.4966 (- 2.87)	- 0.5112 (- 2.47)				- 0.3130 (- 1.81)
I acquired a dog		- 0.2644 (- 1.65)	- 0.3241 (- 1.87)	- 0.3066 (- 1.73)	-0.4014 (- 2.43)	- 0.5279 (- 2.66)	- 0.5070 (- 2.38)	- 0.6947 (- 3.80)
I no longer have a dog					-0.3305 (- 1.60)			
I started or increased caregiving responsibilities							- 0.3968 (- 2.15)	- 0.3741 (- 2.08)
My partner retired					-0.6760 (- 2.00)			
I now rely more on home delivery	0.2795 (1.48)	- 0.4806 (- 1.53)	- 0.2970 (- 0.73)					
My partner changed jobs	- 0.6038 (-1.85)							
My partner started or re-entered the workforce	1.3473 (1.42)		0.7939 (1.64)					
I changed jobs but stayed in the same residential area				- 0.3596 (- 2.41)	-0.2890 (- 2.00)			
I changed jobs and moved to a new residential area	- 0.6460 (- 2.89)	- 0.3003 (- 1.50)	- 0.5242 (- 2.41)	- 0.4998 (- 2.55)	-0.4492 (- 2.22)		- 0.5262 (- 2.08)	- 0.4501 (- 1.97)
I moved to flexible working hours and days	0.2218 (1.95)	0.2312 (2.26)		0.3039 (2.47)	0.2920 (2.56)	0.4755 (4.88)		
I recently had to work in the main office/work location more	0.2584 (2.02)				0.3477 (2.55)			
My employer introduced charging facilities for electric cars	1.0250 (3.81)	0.8134 (3.47)	0.9418 (4.63)	1.3446 (4.33)	0.9046 (3.15)	0.5890 (2.73)	0.6169 (2.82)	0.9887 (3.78)
My employer introduced showers for walking/cycling commuters			0.5223 (2.85)	0.3705 (1.64)	0.4152 (1.90)	0. 5561 (2.71)		0.4290 (2.33)
My employer introduced free on-site health & wellness facilities	0.3562 (1.83)	0.4123 (2.14)	0.4271 (2.15)	0.4142 (1.91)	0.3823 (1.92)	0.4548 (2.10)		
My employer introduced free parking at work	0.4423 (3.28)	0.3909 (2.79)	0.3124 (2.30)	0.4029 (2.59)		0.3462 (2.24)		0.2237 (1.60)
My employer introduced perks for using public transport, carpooling, cycling, or e-scooters		- 0.3283 (- 1.49)						
Bought a car (previously did not own one)					0.3139 (1.92)	0.3043 (1.76)	0.2818 (1.74)	
Increased the number of cars in the household	0.3250 (1.87)	0.5421 (3.07)	0.6028 (3.02)	0.4136 (2.15)	0.4419 (2.05)		0.3437 (1.85)	0.4346 (2.43)

Replaced a petrol/diesel car with a more fuel-efficient petrol/diesel car					-0.3848 (- 2.28)	- 0.3586 (- 1.89)		
Replaced a petrol/diesel car with a less fuel-efficient petrol/diesel car		0.3917 (1.90)	0.8040 (2.51)	0.9091 (2.96)	0.4848 (1.84)		0.7117 (3.20)	0.8149 (3.85)
I no longer own a car			0.3233 (1.73)		0.3678 (1.89)	0.4262 (2.11)		0.3717 (1.95)
Public transport quality has worsened	- 0.4280 (- 2.31)	- 0.3953 (- 2.03)	- 0.6038 (- 3.63)	- 0.6094 (- 3.39)	-0.5629 (- 3.02)	- 0.6649 (- 2.29)	- 0.7906 (- 3.89)	- 0.4498 (- 2.59)
Reduced car use due to high costs							0.2770 (1.85)	0.2258 (1.58)
I use public transport more because other household members use the car							0.9609 (3.20)	0.8224 (2.91)
Replaced a petrol/diesel car with an electric (hybrid or fully electric) car							0.4100 (2.39)	
Purchased an e-scooter							0.6193 (2.15)	
Purchased an e-bike							0.3688 (1.95)	
We now have more cars than adults in the household		0.4723 (1.62)						
I reduced overall car use			- 0.2362 (- 1.81)	- 0.3565 (- 2.16)				
I increased overall car use		- 0.4723 (- 2.29)	- 0.3162 (- 1.65)	- 0.5255 (- 2.16)				
I increased my use of e-bikes or e-scooters				- 1.0096 (- 1.74)				
I am now more conscious of the environmental impact of my travel choices	0.5188 (5.99)	0.5538 (6.09)	0.5475 (6.30)	0.5483 (5.40)	0.5219 (5.75)	0. 5128 (5.92)	0.7163 (7.33)	0.6818 (7.07)
Friends for decision making					0.3022 (2.34)			
Peer groups and social norms for decision making				0.7489 (2.50)	0.6030 (1.95)	0.7439 (2.56)		
Family for decision making	0.3714 (3.51)	0.3130 (3.06)	0.1958 (1.98)	0.2072 (1.95)		- 0.4256 (- 4.73)	0.2675 (2.57)	0.1935 (1.91)
Public campaigns or government policies						- 0.5022 (- 2.04)		
I tend to use car over public transport on wet days						- 0.1088 (- 0.83)	- 0.2768 (- 2.33)	- 0.2922 (- 2.63)
I tend to use car over active travel on wet days			- 0.2505 (- 1.95)				- 0.3228 (- 2.23)	

Due to industrial action, I shifted from public transport to driving	- 0.5989 (- 2.35)			- 0.9350 (- 2.98)	-0.7668 (- 2.75)			- 0.4208 (- 1.54)
	Intercept Terms in Random Thresholds							
Alpha-01	0.7405 (19.74)	0.7310 (17.59)	0.7033 (18.35)	0.7622 (17.55)	0.7494 (18.59)	0.8376 (20.08)	0.6615 (15.62)	0.6175 (14.42)
	Standard Deviations of Random Regression Parameters							
Upsized to a larger home	1.3973 (3.95)		2.1124 (5.43)	2.1070 (4.73)		1.0340 (3.77)		
Household size decreased						3.4741 (3.32)		
My health improved					0.8067 (2.78)			
I started walking/exercising more for health reasons								0.5751 (1.77)
My financial situation became tighter	0.8684 (3.27)	0.9610 (3.17)	1.0624 (4.17)	1.0852 (3.78)	0.8353 (3.33)	0. 7304 (4.17)		
I have adjusted my lifestyle to prioritise saving money	0.9424 (3.18)	1.4694 (5.16)	1.3631 (4.68)	1.0203 (3.52)	1.0456 (3.63)	1.4153 (4.40)	1.7006 (4.89)	1.1379 (3.51)
I started using click-and-collect more often	1.1471 (2.83)			0.9959 (2.26)				
I acquired a dog			0.7440 (1.60)			0 9696 (2.34)	1.2063 (2.52)	0.6319 (1.70)
My partner changed jobs			1.4755 (1.95)					
My partner started or re-entered the workforce	2.4074 (1.66)							
I changed jobs but stayed in the same residential area				1.0038 (2.59)	0.9904 (3.16)			
I changed jobs and moved to a new residential area	1.7123 (3.67)	0.8244 (1.99)	1.2870 (3.16)		1.3917 (2.91)		2.1320 (3.78)	1.9078 (3.38)
I moved to flexible working hours and days	0.9202 (3.36)			0.8275 (3.09)	0.6636 (2.34)	1.2.420 (4.86)		
Charging facilities for electric cars	1.0544 (1.63)	0.9686 (2.01)		1.9380 (3.80)	1.5661 (2.63)	3.0623 (2.31)		1.3060 (2.94)
Showers for walking/cycling commuters				0.7954 (1.53)	0.9885 (2.29)	0.3225 (2.46)		
Increased the number of cars in the household			1.0952 (2.41)		1.3304 (2.78)			
Replaced a petrol/diesel car with a more fuel-efficient petrol/diesel car						0.8914 (1.70)		

Replaced a petrol/diesel car with a less fuel-efficient petrol/diesel car			2.1432 (3.51)	1.7647 (2.75)	1.0320 (1.67)			
Public transport quality has worsened	1.0221 (2.43)	1.0945 (2.86)			1.0130 (2.35)	0. 7249 (2.02)	0.9942 (1.96)	
Purchased an e-scooter							1.0908 (2.09)	
I reduced overall car use				1.1121 (2.92)				
I increased overall car use		0.9767 (2.09)	0.8312 (1.69)	1.4720 (3.01)				
I am now more conscious of the environmental impact of my travel choices		0.7570 (3.36)		1.0579 (4.88)	0.5346 (2.19)	2.8897 (5.37)	1.2057 (5.52)	1.1309 (5.78)
Friends for decision making					0.6526 (2.09)			
Peer groups and social norms for decision making						0.2708 (2.11)		
Family for decision making	0.8691 (3.28)	0.9563 (3.76)	1.0303 (4.41)	0.5422 (1.65)		0.2931 (4.84)	0.9485 (3.94)	0.9950 (3.78)
Public campaigns or government policies						0. 6809 (2.12)		
I tend to use car over public transport on wet days						0. 6414 (2.58)	0.7792 (2.24)	
I tend to use car over active travel on wet days							0.9734 (2.62)	
Model Fit Statistics								
Log Likelihood	-3157.06	-3144.61	-3150.28	-3105.8	-3153.51	-3145.66	-3128.87	-3146.29
AIC	6384.1	6357.20	6380.60	6299.60	6399.00	6375.30	6333.70	6366.60
AIC/N	2.066	2.059	2.067	2.047	2.074	2.063	2.036	2.049
Base	3090	3087	3087	3078	3085	3091	3112	3107

Elasticity Evidence

The mean direct elasticities associated with a negative and a positive impact are summarised in Table 5 and for positive impacts only in Figures 4 and 5. The interpretation of a negative and a positive impact needs to be explained, and the direction of change will depend on the sign of the elasticity estimate. Taking the positive impact first (P column), an elasticity with a positive parameter estimate suggests, *ceteris paribus*, that a participant who experienced that WoC relative to one that did not, or those who have a higher value in the level of a continuous variable (e.g., are older) are more likely to perceive a positive impact, which can be interpreted as greater support for that particular pricing reform. On the contrary, a negative elasticity associated with a positive impact (P column) response suggests, *ceteris paribus,* that these participants are less likely to perceive a positive impact. That is, people could still support the reform, but not as strongly as those in the first category (who have experienced that WoC or are older in the example above).

In contrast, if there is a positive elasticity estimate in the negative impact (N column), this means participants who have experienced that WoC or have a higher value in the continuous variable (i.e., older), are, *ceteris paribus,* more likely to perceive this reform as having a negative impact. We can interpret this as a much greater negative support for that particular road pricing reform. Whereas a negative elasticity in the negative impact column (N column), suggests a reduced but still negative support for the reform. We focus on discussing the positive impacts, noting that there appears to be strong symmetry between the negative and positive impacts, albeit a negative correlation.

To take an example, for the 'total number of public transport trips' explanatory variable, we have a small positive elasticity for all levels of the peak-period road user charges (DBC) except AUD 10c/km (0.050, 0.039, 0.037), which suggests*, ceteris paribus*, that as the number of public transport trips increases by 10%, the probability of supporting a DBC at AUD 5,15 and 20 c/kmlevels increases by 0.37% to 0.5%. The elasticities associated with congestion-free lanes are 0.048 and 0.036 respectively for AUD 5c/km and AUD 10 c/km, with 0.023 for a cordon-based charge of $10 per day (not being significant for $15 per day). The smaller relative elasticity for a cordon-based charge is expected since it is limited to a smaller geographical setting than the DBC and hence it impacts far fewer residents, but interestingly, the congestion-free lane charge has a similar estimate to a DBC, partly linked to the typical length beyond the city centre. For all road pricing reforms (RPR) in Table 5, the percentage impact of the number of public transport trips, while varying from 0.23% to 0.5% for a 10% increase in the number of PT trips are not statistically significant (Table 4) for the DBC $0.10/km and the cordon-based $15 schemes. For the other five road user charge (RUC) initiatives, PT users are, on average, 'happy' for car users to be charged, possibly benefitting bus where it shares the road with cars or some view that car users do not pay for the congestion they cause.

By contrast, as the number of ICE cars (i.e., petrol/diesel cars) in a household increase, the probability of a positive impact of a DBC decreases across all levels of the DBC (-0.167 to -0.228), and much more than the PT increase (excluding AUD 10c/km where public transport trips is not statistically significant).A negative elasticity always suggests a less desirable outcome (i.e., suggesting less support for the schemes) when a variable is relevant in the case of WoCs. For example, where a worker has been offered free parking at the office, the introduction of a DBC has a positive elasticity (0.022 to 0.033) suggesting that there is greater positive impact of the DBC. This suggests that for commuters who drive to work and benefit from the free parking at work, believe DBC is likely to make a positive impact to their routine commuting possibly because it may ease traffic and congestion. This is an interesting result, indicating that individuals as commuters are positive in supporting road pricing reform but tempered, in this case, by end of trip facilities which can be influenced by an employer. In contrast, where an individual increased their car use, they have a negative elasticity response (-0.015, -0.011,-0.019) for only the DBC reforms of $0.10/km, $0.15/km and $0.20/km. This suggests that those who have increased their car use are between 1.1% to 1.9%, *ceteris paribus*, less likely to perceive a positive impact of the $0.15-0.20/km DBC reforms, and do not have a statistically significant different perception when it comes to the $0.05 DBC reforms.

The largest behavioural elasticity response associated with the WoCs is for a greater consciousness of the environmental impact of travel choices which varies between 9.67% (Congestion-free lanes $0.10/km) and 16.1% (Cordon-based $15) and are more likely to perceive a strong positive impact, followed by a person's financial situation becoming tighter (who are between 5.11% to 8.0% less likely to perceive a positive impact), and in both influences, it applies across all eight road pricing reforms. Again, it should be remembered that this relates to experiences within the last 3 years when a certain amount of lifestyle reprioritisation may have taken place following the impact of COVID-19. The majority of the other mean direct elasticities are typically at the 1% to 3% level, and as dummy variables, this is interpreted for a situation where an influence moves from being influential (1) or not (0).

The country-specific elasticities are interesting, with the statistical significance of the parameters associated with each explanatory variable varying across the eight pricing regimes. Finland is the only country where we have a significant negative relative elasticity response for positive impact across all eight pricing regimes, varying from 1.34% for a cordon-based charge of $10 to 3.65% for congestion-free lanes priced at 5 c/km. Where there is a country-specific negative effect on a positive impact, the levels vary from a high of -7.4% for Australia (cordon-based charge of $15) to a low of -1.6% in Sweden (for congestion-free lanes priced at 5 c/km).

A comparison across all pricing regimes where we calculate the ratio of the DBC over each of the other two pricing regimes (Figure 6) can provide a useful way of understanding the different behavioural responses to the pricing regimes. The evidence suggests a much higher elasticity response for a DBC, with a few exceptions, and this is expected given that a DBC is areawide, and therefore more visible, in contrast to the narrower geographical context of the other two pricing regimes. The ratio varies from a high of 6.92 for 'free parking at work' for the ratio of a DBC to cordon-based charging and 5.56 relative to a congested free pricing lane, to a low of -0.63 for "my financial situation became tighter" for the ratio of a DBC to congested free priced lanes. This negative ratio reinforces the greater lack of support for a DBC.

Table 5. The mean estimates of direct elasticities associated with the eight road pricing reform initiatives

	DBC $0.05/km		DBC $0.10/km		DBC $0.15/km		DBC 0.20/km		Congestion free lanes $0.05/km		Congestion free lanes $0.10/km		Cordon-based $10		Cordon-based $15	
Variables	N	P	N	P	N	P	N	P	N	P	N	P	N	P	N	P
Number of ICE cars	0.142	-0.167	0.245	-0.212	0.135	-0.147	0.156	-0.228	0.111	-0.133	0.137	-0.118	0.142	-0.155	0.133	-0.167
Total public transport trips	-0.043	0.050			-0.035	0.039	-0.025	0.037	-0.040	0.048	-0.041	0.036	-0.021	0.023		
Total E-bike trips			-0.036	0.031			-0.022	0.033	-0.034	0.040	-0.024	0.020	-0.024	0.027	-0.030	0.037
Age	0.389	-0.458	0.513	-0.445	0.384	-0.419	0.330	-0.483	0.286	-0.342	0.331	-0.284	0.550	-0.601	0.457	-0.571
Personal income															-0.033	0.041
Australia															0.060	-0.074
Finland	0.022	-0.026	0.032	-0.028	0.020	-0.022	0.018	-0.027	0.031	-0.036	0.029	-0.025	0.012	-0.013	0.023	-0.029
New Zealand	0.019	-0.023	0.029	-0.025	0.025	-0.027	0.023	-0.033							0.022	-0.028
Sweden									0.014	-0.016			-0.020	0.022		
UK									0.019	-0.022	0.019	-0.017	0.026	-0.028	0.033	-0.041
Upsized to a larger home	-0.014	0.016			-0.020	0.022	-0.023	0.033			0.449	-0.386				
Household size decreased			-0.014	0.012	-0.011	0.012					-0.272	0.234				
My financial situation improved											-0.018	0.015				
My health improved									-0.027	0.032			-0.020	0.022		
I started walking/exercising more for health reasons					0.030	-0.033	0.028	-0.041	0.024	-0.028					0.018	-0.023
My financial situation became tighter	0.058	-0.068	0.072	-0.063	0.065	-0.071	0.053	-0.077	0.055	-0.065	-0.594	0.511	0.063	-0.069	0.064	-0.080
I have adjusted my lifestyle to prioritise saving money	0.025	-0.029	0.041	-0.036	0.025	-0.028	0.029	-0.042	0.020	-0.023	-0.292	0.251	0.047	-0.051	0.037	-0.046
I started using click-and-collect more often	0.012	-0.014	0.011	-0.009	0.015	-0.016	0.012	-0.018							0.008	-0.010
I acquired a dog			0.010	-0.009	0.010	-0.011	0.008	-0.011	0.012	-0.015	0.018	-0.015	0.015	-0.017	0.020	-0.025

I now rely more on home delivery	-0.007	0.008														
My partner changed jobs	0.005	-0.006	0.005	-0.004	0.002	-0.003										
My partner started or re-entered the workforce	-0.005	0.006			-0.003	0.003										
I no longer have a dog									0.006	-0.007						
I started or increased caregiving responsibilities													0.011	-0.012	0.010	-0.013
My partner retired									0.004	-0.005						
I changed jobs but stayed in the same residential area							0.020	-0.018	0.019	-0.023						
I changed jobs and moved to a new residential area	0.020	-0.024	0.011	-0.009	0.016	-0.018	0.012	-0.029	0.013	-0.016			0.015	-0.017	0.013	-0.016
I moved to flexible working hours and days	-0.027	0.031	-0.032	0.028			-0.029	0.042	-0.034	0.040	-0.059	0.051				
I recently had to work in the main office/work location more	-0.017	0.020							-0.021	0.025						
My employer introduced charging facilities for electric cars	-0.029	0.034	-0.026	0.023	-0.026	0.029	-0.029	0.043	-0.024	0.029	-0.172	0.148	-0.016	0.018	-0.025	0.032
My employer introduced showers for walking/cycling commuters					-0.016	0.018	-0.009	0.013	-0.012	0.015	-0.181	0.155			-0.012	0.015
My employer introduced free on-site health & wellness facilities	-0.010	0.012	-0.014	0.012	-0.012	0.013	-0.009	0.014	-0.011	0.013	-0.014	0.012				
My employer introduced free parking at work	-0.028	0.033	-0.028	0.025	-0.020	0.022	-0.020	0.029			-0.023	0.019			-0.012	0.016
My employer introduced perks for using public transport, carpooling, cycling, or e-scooters			0.008	-0.007												
Bought a car (previously did not own one)									-0.013	0.016	-0.014	0.012	-0.012	0.013		
Increased the number of cars in the household	-0.011	0.013	-0.021	0.018	-0.021	0.023	-0.011	0.016	-0.014	0.017			-0.011	0.012	-0.013	0.016
Replaced a petrol/diesel car with a more fuel-efficient petrol/diesel car									0.013	-0.016	0.014	-0.012				
Replaced a petrol/diesel car with a less fuel-efficient petrol/diesel car			-0.010	0.009	-0.018	0.020	-0.017	0.024	-0.010	0.012			-0.015	0.016	-0.017	0.021
I no longer own a car					-0.009	0.010			-0.010	0.012	-0.013	0.011			-0.009	0.012
Public transport quality has worsened	0.014	-0.016	0.015	-0.013	0.020	-0.022	0.016	-0.024	0.018	-0.021	0.229	-0.019	0.024	-0.026	0.013	-0.016
Reduced car use due to high costs													-0.014	0.015	-0.011	0.014
I use public transport more because other household members use the car													-0.012	0.013	-0.010	0.012
Replaced a petrol/diesel car with an electric (hybrid or fully electric) car													-0.015	0.016		
Purchased an e-scooter													-0.013	0.014		

Purchased an e-bike													-0.013	0.014		
We now have more cars than adults in the household			-0.006	0.006												
I reduced overall car use					0.015	-0.016	0.018	-0.026								
I increased overall car use			0.018	-0.015	0.010	-0.011	0.013	-0.019								
I increased my use of e-bikes or e-scooters							0.003	-0.005								
I am now more conscious of the environmental impact of my travel choices	-0.108	0.127	-0.135	0.117	-0.115	0.126	-0.091	0.132	-0.104	0.124	-0.112	0.0967	-0.140	0.153	-0.129	0.161
Friends for decision making									-0.023	0.028						
Peer groups and social norms for decision making							-0.009	0.013	-0.008	0.010	-0.012	0.010				
Family for decision making	-0.057	0.067	-0.056	0.048	-0.030	0.033	-0.025	0.037			0.068	-0.059	-0.038	0.042	-0.027	0.034
Public campaigns or government policies											0.203	-0.174				
I tend to use car over public transport on wet days											0.011	-0.009	0.025	-0.028	0.026	-0.032
I tend to use car overactive travel on wet days					0.017	-0.018							0.020	-0.022		
Due to industrial action, I shifted from public transport to driving	0.009	-0.010					0.010	-0.015	0.011	-0.013					0.006	-0.007

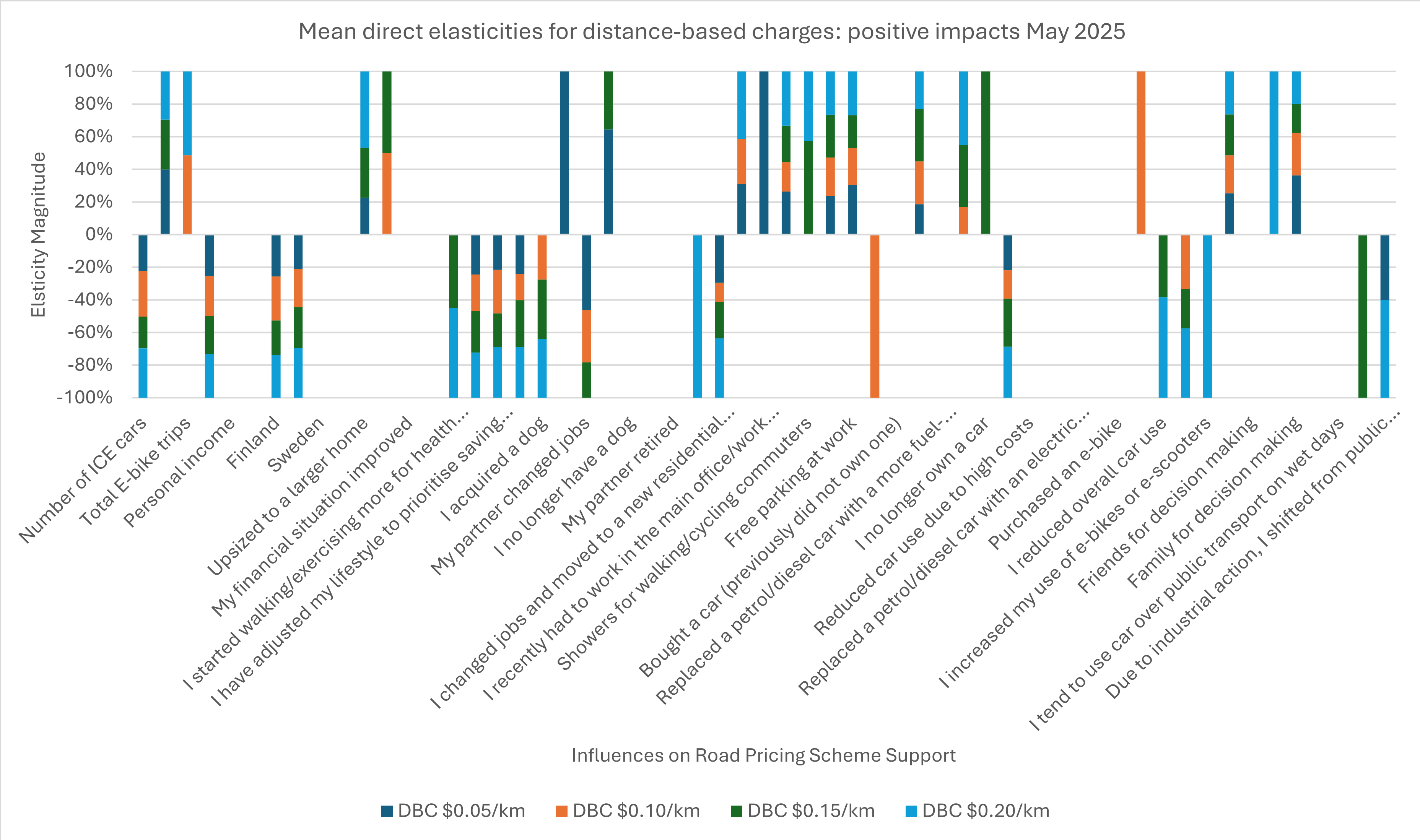

Figure 4. Graphical representation of the mean direct elasticities for the positive impact for the four distance-based charging scenarios

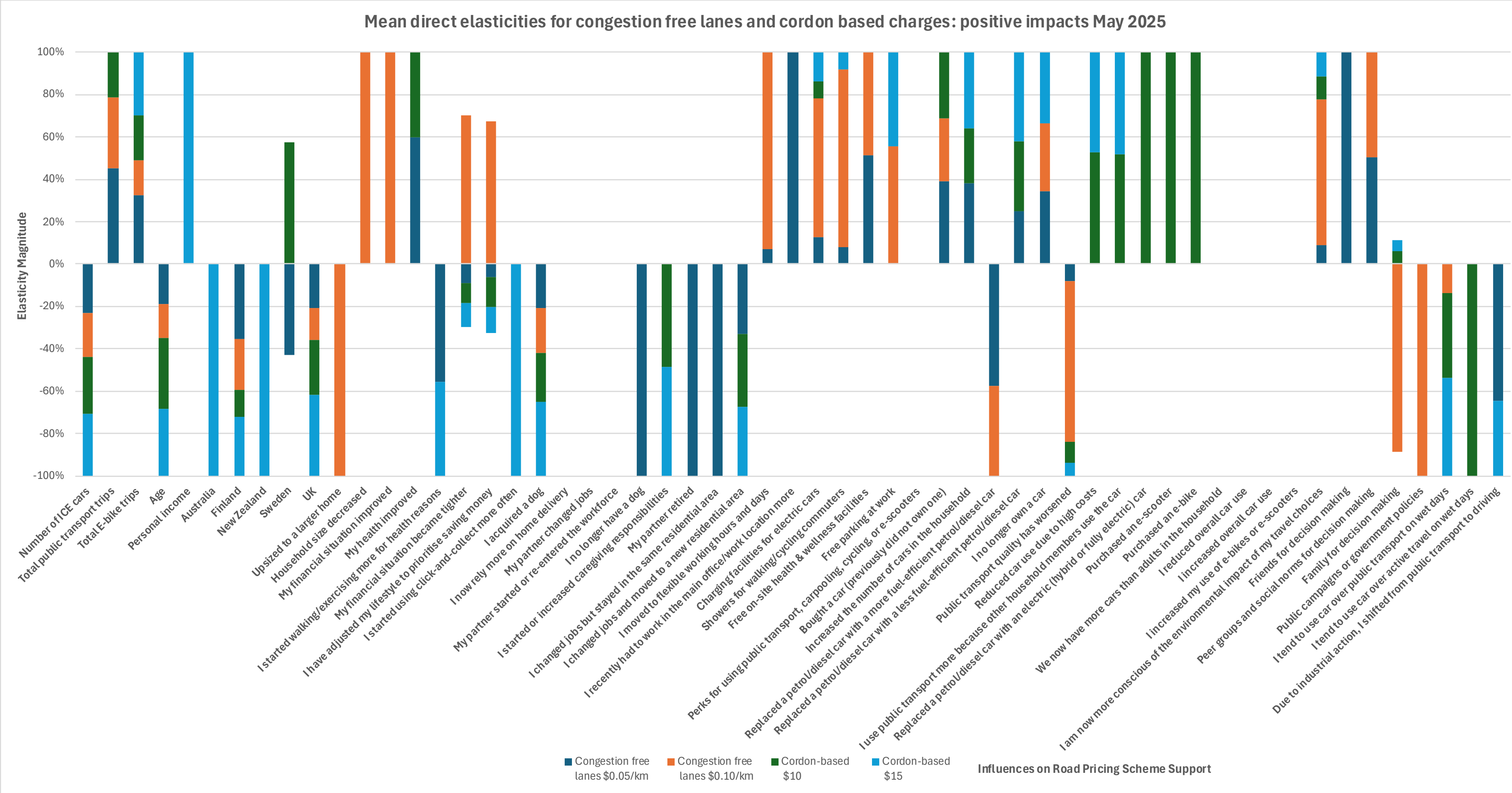

Figure 5. Graphical representation of the mean direct elasticities for the positive impact for the four congestion-free lanes and cordon-based charging scenarios

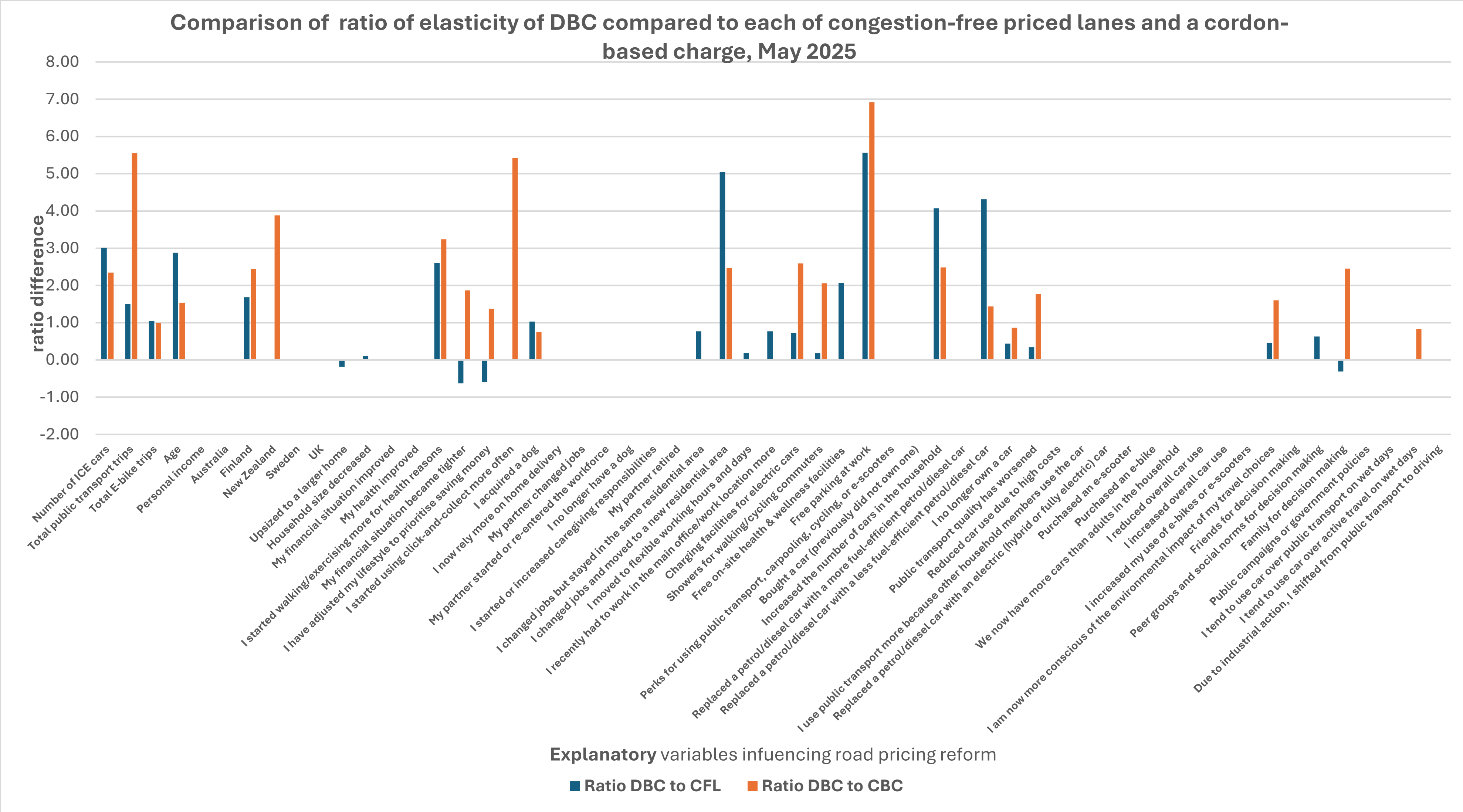

Figure 6. Comparisons of the ratio of a DBC and each of congested free priced lanes and cordon-based charging

Contrasts between the eight initiatives: what are the policy suggestions to carry forward and change action initiatives?

The main focus of this paper is on establishing the extent to which any particular road pricing reform might garner greater support than another pricing regime, as informed by statistically significant drivers that we have identified, be they windows of change (WoC) or other contextual influences. The evidence suggests a number of key drivers that work to provide greater support for specific pricing reforms, and which may be used in a policy setting to promote buy-in for road pricing reforms or which are barriers to achieving a likely future buy-in agenda.

The dominating influences are many, but free parking provided by an employer has an interesting strong positive support. We find that individuals with such free parking tend to be associated with a higher probability of supporting a road user charging regime by kilometre (i.e., distance-based charge, DBC) with a higher probability as the cost per kilometre increases. What this suggests is that since such individuals have free parking, *ceteris paribus*, they are far less sensitive to the DBC, and we conjecture this is because they see improved travel times for them, given that they are committed to car use. This presents an interesting policy dilemma since free parking at work is a strong inducement to travel by car and a disincentive to switch to more environmentally friendly modes. Households that have more cars have negative elasticities which suggests, *ceteris paribus*, that they have a higher probability of not supporting a DBC. Individuals with more consciousness now of the environmental impact of their travel choices tend to support a DBC with a slightly greater support probability as the charge increases per kilometre.

It is important to recognise that a DBC charge applies in peak periods throughout a geographical jurisdiction, whereas a cordon-based charge focuses on a smaller area and applies throughout the day, and a congestion-free lane charge is limited to a specific road or corridor. Overall, we see a greater elasticity response (i.e., sensitivity) to a DBC charge compared to the other pricing regimes (Figure 5) when specific windows of change influences come into play.

The most important actionable change initiatives that can garner positive support for one or more of the eight re-pricing regimes is one that involves promoting environmental consciousness through the many media and other channels available and given the evidence of elasticities influences as an individual ages, the need to especially focus on the younger generation comes through very clearly[7].[ii] We can see that most WoC influences result in a 1%-3% change in the probability of positive support for a road pricing regime, and while this is statistically significant, the impact on overall traveller behaviour is negligible. What we can observe, however, is that for

[7] A referee offered a very interesting qualifying comment that environmental awareness can obviously be correlated with enthusiasm for innovative RUC like DBC, but it is important to recognise that this is usually an ancillary matter. Price, convenience, accessibility, etc., are going to be more salient values than caring about the environment. If your transport choices also happen to be good for the environment, that's a happy coincidence for the most part, and it's also an easy thing to say in a stated preference research context. I tend to think of sustainability as a "soft" value in the face of "hard" values like the aforementioned. How we make it a "harder" value remains an ongoing challenge.

the presence of ICE (i.e., petrol/diesel) cars in a household, for each one-car increase, we see a 11.77% to 22.8% reduction in the positive probability of support for the re-pricing regime proposals. In contrast, as public transport trips increase by 10%, the opposite occurs with a smaller but significant increase in the probability of positive support of 0.26% to 0.51%. Clearly, owning cars will always garner much lower support, and the challenge remains to establish if we have enough evidence to suggest that a majority of car owners do have some positive support for road pricing reform.

Finally, we see that a move to flexible working hours and days which is a strong feature of the last three years, results in a 2.8% to 5.13% increase in the probability of positive support for the road pricing regimes, which aligns well with the evidence from other studies (see Hensher et al. 2026 for a summary) that working from home (WFH) reduces the sensitivity to cost and time in using the car for travel, especially commuting. Hence, we can expect that we get some significant change in support for road pricing reform given the implied assumption that it benefits existing car users through improved travel times and with increased WFH, one is outlaying less money on car trips even under a proposed re-pricing model.

Overall, the evidence suggests that we have some *actionable change initiatives* that can potentially be effective in securing effective buy-in from the public, but they are few in number. Hensher et al. (2025) identified a number of WoC influences that have resulted in a statistically significant change in the number of trips by car, public transport and active modes, but very few of these WoC influences align with positive support for re-pricing of car use. Where they do align, they tend to go against the objective of encouraging a switch to more sustainable transport modes, namely free parking at work ('the gorilla in the room'), replacing an ICE car with an electric car, and charging facilities at the office for electric cars.

Conclusions

This paper has investigated the role that various past windows of change and current context variables play in determining degrees of support for eight road pricing reforms. While the real test of the impact of such reforms on traffic in the network can only truly be known through an implementation plan, we can, nevertheless, seek out some of the key drivers that support buy-in or are barriers to buy-in. The set of generalised ordered logit models has revealed candidate influences on the probability of supporting to varying degrees each of the eight pricing reforms investigated. This is important given the acknowledged crucial role of public acceptability in determining the success of road pricing reform which was highlighted in the literature review

Although all of the elasticities are numerically small in the relative elastic range, the percentage change responses associated with specific window of change contexts defined by lifestyle and household influences, work and commuter influences transport and mobility influences, and social and environmental influences and a number of socioeconomic effects can potentially - in combination - make a difference to the support or otherwise for specific road pricing reforms. Whether this translates into changing travel behaviour in scalable and sustainable ways remains to be tested, but we have some strong clues as to what will garner support and hence be attractive to the political agenda. What we have established in this paper (and have been supported in other literature, such as in Hensher et al., 2025) is that employer incentives that encourage car use do not align with sustainability objectives, but they most likely will garner buy-in support for road pricing reform. This is a real dilemma when we want actionable change initiatives to support a switch to sustainable modes, when in fact we are likely to see a greater reinforcement of the attractiveness of the preservation of car use even under a more efficient road pricing regime.

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