Quantifying the Perceived Safety of Cyclists in Dublin

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Abstract

In recent years, cycling has been recognized by policy makers and practitioners as a sustainable alternative to motorized travel. But a lack of perceived safety associated with cycling may have inhibited its growth as a popular mode of transportation in urban environments. A questionnaire based survey, conducted in Dublin city, found cyclists to perceive cycling as less safe than driving in the city. The survey responses were analysed in an Ordered Logistic Regression framework to identify the determinants of their perceived safety, in order to recommend possible policy interventions for improvement of these perceptions. A Cyclist Safety Index (CSI) is also proposed which allows the perceptions of cyclists relative to driving to be quantified for consideration in transport network design and adaptation for cyclists.

Keywords

Cycling, Health and Safety, Sustainability

$Y =$ perceived safety

$\pi_1 =$ probability of considering cycling to be less safe than driving

$\pi_2 =$ probability of considering cycling to be as safe as driving

$\pi_3 =$ probability of considering cycling to be safer than driving

$x_1 =$ prefer to cycle with no cycle lanes

$x_2 =$ average number of days cycled per week

$x_3 =$ rush hour traffic likely to cause an accident

$x_4 =$ bus likely to cause an accident

$x_5 =$ avoids roundabouts

$x_6 =$ prefer to cycle on cycle path

$x_7 =$ generally comply with the rules of the road

$x_8 =$ always comply with the rules of the road

$\phi_1 =$ weight applied to π_1

$\phi_2 =$ weight applied to π_2

$\phi_3 =$ weight applied to π_3

1. Introduction

An increasing dependency of society on motorized vehicles in Dublin city has raised concerns regarding growing traffic congestion, harmful vehicle emissions and public health problems. As a result, attention has returned to non-motorized means of transport to combat these issues. Walking and cycling are beginning to be promoted as sustainable alternatives to motorized vehicles. Increased use of these sustainable modes of travel would reduce vehicle numbers on the roads within the city thereby reducing traffic congestion, vehicle emissions and health problems associated with these vehicle emissions. In 2005, the cost of congestion to the Greater Dublin Area was €2.5billion (Dublin Chamber of Commerce, 2005). This is a threat to the competitiveness of Dublin as a city trying to attract companies to invest in its economy. Due to these concerns, the attention of policy makers has turned to encouraging sustainable modes of travel. In 2009, the Department of Transport published Ireland's first National Cycle Policy Framework (NCPF), which aims to increase the cycle mode share for commuter trips to 10% by 2020 (Department of Transport, 2009). In 2009, this mode share stood at 1.9%.

The perception of cycling as an unsafe mode of travel is a huge barrier to its popularity in Dublin City. Information on cycling accident rates is limited, as the majority of minor accidents go unreported to authorities. A study by Doherty et al. (2000) found that only 19.2% of cycling collisions in Toronto, and 11.7% in Ottawa had been reported to the police. A report from the Irish Road Safety Authority (RSA) (2010) states that between 1998 and 2008 there were 144 cyclists (43 in Co. Dublin) fatally injured and 335 (115 in Co. Dublin) seriously injured on Irish roads. Despite the percentage of fatalities among cyclists contributing only 3.5% of all road fatalities between these years in Ireland, cycling remains a low preference mode of transport due to a high number of minor incidents occurring which remain unreported. A recent survey carried out by one of the authors on the travel diary of cyclists in the city of Cork noted 42 incidents within a week of cycling of 20 volunteers, of which 38 were minor. In 2008, the RSA reported 192 cycling accidents resulting in minor injury.

To promote cycling it is important to establish the factors which influence the increase of the perceived risks of cycling compared to other modes. This paper aims at investigating these critical factors in a network and also provides a quantitative analysis of the perceived safety of cyclists. The study in this paper is based on the city of Dublin in Ireland where the perceived safety of cycling relative to driving has been estimated based on responses from a sample of cyclists.

Existing research has looked at the behaviour differences among cyclists according to location, age and gender. Harris et al. (2006) stated that female cyclists are more likely to perceive a negative outcome in many recreational, social and health related situations. Compared to male cyclists, female cyclists and non-cyclists perceive cycling to involve higher risk as they are more sensitive to poor driver attitudes, a lack of confidence, a lack of cycling facilities and having to share road space with other modes of transport (Bernhoft and Carstensen, 2008; Parkin et al., 2007, 2008; Siu et al., 2000; Wardman et al., 2000; Westerdijk, 1990). Male cyclists are willing to take more risks to avail of faster and direct routes. Older cyclists hold similar risk perceptions to female cyclists; preferring to make use of cycling facilities, signalized intersections and crossings, rather than faster, more direct routes (Bernhoft and Carstensen, 2008). Very little research attention has been focused in analysing the perceived safety of cyclists based on their access to other faster, more comfortable, but less sustainable modes such as car. In this paper, the perceived safety of cyclists are analysed in comparison to cars which essentially is the main travel mode from where a modal shift to cycling is preferred by environmentalists and policy makers.

The critical factors which influence the perceived safety of cyclists in a network have been investigated by analysing the survey responses using an Ordered Logistic Regression (OLR) model. A significant amount of work is present in the field of transportation engineering employing Logistic Regression (LR) models to relate to accidents (Dupont et al., 2010; Ma et al., 2009; Yannis et al., 2005; Yau, 2004) and route choice options (Ben-Elia and Ettema, 2011; Popuri et al., 2011). Logistic regression is a powerful tool in establishing probabilities related typically to binary choices. However there can be ordinal dependent variables for which an extension of the binary model, an ordered logistic model may be used successfully.

The remainder of the paper is divided into five sections. The next section gives a description of the survey data collected, the section following that describes the analysis of perceived safety of cyclists categorised by access to cars, the fourth section describes the Cyclist Safety Index, the penultimate section provides a discussion on the outcomes of the analysis in the previous section and the final section concludes the paper.

2. Description of Survey Data

Dublin City is the capital of Ireland and the largest city in terms of area, residing and working population of the country. The cycling mode share in Dublin city stood at 5% in 2011 (Central Statistics Office, 2011). This is higher than the average rate in Ireland, but remains far below the 2020 target set out in the NCPF. In comparison with cycling friendly countries and cities, this is also extremely low. Cycling mode shares in countries like Netherlands, Denmark and Germany are on an average between 10%-26% with some cities reaching 35%-40% (Ministerie van Verkeer en Waterstaat, 2009). The mode share for cycling in Amsterdam is 27%) while it is as high as 37% for Copenhagen (Pucher and Buehler, 2008). Additionally, it is important to note that through appropriate safety management, Copenhagen has been able to consistently reduce the number of seriously injured cyclists for the last three decades despite a significant upward trend of number of kilometres cycled.

The transport network in Dublin, however, is primarily designed for the use of private vehicles. Other main modes of motorized transport in Dublin City are Dublin Bus, Luas (tram), Dublin Area Rapid Transport (light rail) and Commuter trains (suburban railway networks). The network also contains approximately 120km of on-road cycle tracks, 50kms of shared bus-cycle lanes and 25kms of off-road cycle tracks. However, the cycling facilities cover only a small part of the network and multiple factors negatively influence the actual and perceived safety of cyclists. To identify and fully investigate the critical factors which affect the perceived safety of cyclists compared to the most subscribed travel mode, private cars, it is essential carry out a detailed analysis.

A questionnaire based survey was conducted in Dublin to analyse the perceived safety of cyclists in Dublin city. 1954 responses were collected from cyclists in Dublin, of which 1732 responses were eligible for use in the analysis. The questionnaire was published online so as it was freely available to anyone with the appropriate web-link. Irish and multi-national companies, universities and governmental departments based in Dublin city were contacted via e-mail with the web-link. The web-link was also posted on cycle club and group websites, cycling forums and on social networking websites. Hardcopies were also available from bicycle repairs stores and from the authors upon request.

It was decided to include only cyclists (and not non-cyclists) in the study as their perceptions of the network differ greatly from those of the cyclists. For a consistent increase in cycling mode share it is important to identify factors other than lack of cycling skills which can affect the perceived safety associated with the mode. Accordingly, it was decided to focus on the experiences and perceptions of existing skilled cyclists, as this is the population that has first-hand knowledge of the safety problems and concerns associated with cycling in Dublin.

In Table 1, the important information regarding the composition of survey respondents and their self-reported cycling behaviour is presented. 63.7% of the respondents were male. The majority of these cyclists were less than 45 years old. Above 45 years, the number of cyclists dramatically decreased. The most recent statistics available at the time of the survey state that the majority of the cycling population of Dublin consists of males under the age of 40 (Central Statistics Office, 2006), indicating that the survey is an unbiased representation of this population. Table 1 shows that most of the cyclists spend 46 to 60 minutes a day cycling on a week day, less at the weekend and cycle distances of between 2.1 and 5kms. Generally these cyclists travel at speeds of 10-20 km/hr, although a great number of those describing themselves as confident cyclists, travel at higher speeds.

Figure 1 shows the preference of cycling facilities among cyclists according to their level of confidence. Among each group there is a strong preference to avoid the use of shared bus-cycle lanes and to cycling on roads with no cycle facilities; however it can be seen that this tendency lessens with confidence.

3. Analysis of Perceived Safety

The section investigates the determinants which influence a cyclist's perception of safety in the shared multi-modal transport network of Dublin City. To investigate how having access to a vehicle on a day to day basis (i.e. having the option to drive instead of cycle) influences the safety perception of cyclists, two separate models were developed for those with access to a vehicle, and those without. The question in the survey related to this categorisation was "Do you have access to a vehicle on a day-to-day basis which you can drive?" associated with a binary fixed response.

The modelling is carried out employing an OLR analysis for each group of cyclists. For the models presented here, the dependent variable compares the safety of cycling with that of driving in Dublin city. It has three ordered values; 'cycling is less safe than driving', 'cycling is as safe as driving' and 'cycling is safer than driving'. The 23 independent variables included considered in the models are listed in Table 2. The parallel regression assumption was tested for both of these models using the Brant test. The non-significant test statistics for χ^2 of 32.0 (p=0.10) for the 'access' group and 21.57 (p=0.55) for the 'no access' group show that this assumption has not been violated for this data.

The results of the OLR analysis reveal both similarities and differences between the two groups; both feel safer for a greater number of days cycled per week and with a preference for cycling on urban roads and both feel less safe when they consider rush hour traffic likely to lead to an accident involving them. Elsewhere differences arise between the groups; those with access are more than twice as likely to feel safer when they show a preference for cycling where no cycle facilities are present, while their likelihood for feeling less safe increases if they consider themselves likely to be involved in an accident with a bus. These factors were not found to be significant to those without vehicle access.

For this group, the avoidance of roundabouts is associated with a decreased safety experience, while full and general compliance with the rules of the road considerably increases the likelihood of perceiving cycling as safer. Similarly, these factors were not found to be significant to cyclists with vehicle access. All other factors presented in Table 2 where found to be insignificant to the perceptions of safety of either group of cyclists. Figure 2 presents the probability of an individual (a) with access and (b) without access to a car finding cycling to be less safe than, as safe as or safer than driving in Dublin. The cyclists with the lowest probability of feel less safe are those with no access to a vehicle and who comply fully with the rules of the road.

4. Cyclist Safety Index

To quantify the perceived safety of cyclists in Dublin city, a Cyclist Safety Index (CSI) was formulated using an OLR model of all respondent cyclists. The formulation and the analysis of the CSI values of all survey respondents are described in this section.

An OLR model of all survey respondents has been developed using stepwise logistic regression methods, as described by Hosmer and Lemeshow (2000). For each of the variables in the model, Hosmer and Lemeshow (2000) recommend a probability of inclusion (p_E) of 0.2. The use of a smaller value of p_E (typically 0.05), as used with other methods is too stringent and may exclude important variables from the model. Following this approach 18 independent variables (including 1 variable with 3 categories which was transformed to 2 dummy variables, giving a total of 19 variables) where originally considered for inclusion in the model. Of these, 8 variables were found to be significant as described in the equations of the resulting OLR model,

$$\pi_1 = \frac{1}{1+\exp(Z-1.937)} \tag{1}$$

$$\pi_2 = \frac{1}{1+\exp(Z-3.293)} - \frac{1}{1+\exp(Z-1.937)} \tag{2}$$

$$\pi_3 = 1 - \frac{1}{1+\exp(Z-3.293)} \tag{3}$$

$$Z = 0.598x_1 + 0.182x_2 - 0.491x_3 - 0.434x_4 - 0.230x_5 - 0.170x_6 + 0.577x_7 + 0.552x_8 \tag{4}$$

where $Y =$ perceived safety

$\pi_1 =$ probability of considering cycling to be less safe than driving

$\pi_2 =$ probability of considering cycling to be as safe as driving

$\pi_3 =$ probability of considering cycling to be safer than driving

$x_1 =$ prefer to cycle with no cycle lanes

$x_2 =$ average number of days cycled per week

$x_3 =$ rush hour traffic likely to cause an accident

$x_4 =$ bus likely to cause an accident

$x_5 =$ avoids roundabouts

$x_6 =$ prefer to cycle on cycle path

$x_7 =$ generally comply with the rules of the road

$x_8 =$ always comply with the rules of the road

The CSI has been developed from this model by calculating the probabilities of an individual considering cycling to be safer than (π_3), as safe as (π_2) or less safe than driving (π_1).

$$\text{CSI}=\phi_1\pi_1+\phi_2\pi_2+\phi_3\pi_3 \tag{5}$$

where ϕ_1,ϕ_2,ϕ_3 are the weights applied to π_1,π_2,π_3 .The weights are chosen in this manner as this is representative of the way the categorical outcome variable of 'perceived safety' was coded in the stepwise logistic regression model. Accordingly, CSI value for an individual cyclist can range between 1 (lowest safety rating) and 3 (highest safety rating).

Figure 3 presents a histogram of the CSI values calculated for each respondent. The maximum CSI obtained for these respondents was 1.95 and the minimum was 1.06. Figure 4 presents the histogram of the unweighted probabilities (π_1,π_2,π_3) that form CSI. Figure 5 presents boxplots for the CSI values related to each variable included in the OLR model. It is observed that apart from the mean value, the skewedness of the distribution of CSI is also a good indicator of the tendency of the population in terms of perceived safety. Clearly, this is more on the unsafe side for Dublin. Also important to note is that the population with a feeling of perceived safety higher than car, represented by π_3, forms a distribution not only separate from the other two categories of lesser perceived safety, but is also skewed more on the safe side.

CSI is thus observed to be a beneficial, quantitative marker at an individual and at a population level. The effects of implementation of a policy may be measured by assessing the statistical properties of the distribution of CSI. Additionally, different mixed mode cycling networks may be benchmarked and compared through the statistical properties of the distribution of CSI.

Figure 5 presents the variation of CSI values for factors that have an effect on perceived safety for all of the respondent cyclists. All subfigures are presented as boxplots. The upper and the lower edge of each box represent the 75th and 25th percentile respectively, the horizontal line in the middle of the box is the median (50th percentile) and the whiskers represent the extreme points in the dataset that are not considered as outliers. The outliers are the plus signs at the extreme of each box. When the median is not at the middle of the box, it indicates skewedness present in the plotted dataset.

The relationship between the experience of a cyclist and the higher perception of safety is illustrated in Figure 5a where a consistent increase in CSI is observed for cyclists with the number of days cycled per week. Cyclists who preferred no cycle lane (Figure 5b) and or preferred cycle paths (Figure 5c) perceived cycling in Dublin to be safer than those who did not. Avoidance of cycle lane can be often related to poor maintenance and the lack of integration of the design requirements of cyclists as a mode of travel in a mixed mode network, within a shared space. The perception of safety increased consistently with a decreased likelihood of getting involved in a rush hour traffic accident (Figure 5d) or a bus accident (Figure 5e). Confident cyclists, who would not alter their routes due to the presence of roundabouts (Figure 5f) experience a higher level of safety than who would. However, confidence is not related to non-compliance with the rules of the road, since the compliant cyclists report a higher safety experience (Figure 5g). CSI values are essential to quantify these differences.

5. Discussion

This study on perceived safety of cyclists in Dublin city indicated that cycling is seen as a less safe mode of travel compared to driving by majority of existing cyclists in the city. Following existing research, it can be extrapolated that non-users of the mode would perceive cycling to involve even higher risk than that perceived by existing cyclists. The analyses completed in this paper aim to better understand why this is so in order that these safety perceptions may be improved. In this section the outcomes of the analyses are discussed in detail along with the relevant policy implications.

Analysis of perceived safety of cyclists categorised by access to a car illustrated that the determinants of perceived safety differ between the two groups. The group with access to a car on a day to day basis that they can drive are more familiar with the rules of the road as standardised by RSA and are also more experienced with the intermodal interactions in the transport network. By making the knowledge of the rules of the road mandatory for cyclists similar to car drivers, through campaigns and policy changes, it may be possible to improve the perceived safety of 'no access' cyclists.

The OLR analysis highlighted the importance of the regularity of cycling in improving the safety experience of cyclists. Campaigns and incentives to encourage and reward regular cycling activities may prove useful. Ireland has successfully implemented a 'Bike-to-Work' scheme which promotes commuting by cycling through provision of a tax-incentive. This has contributed to the increased popularity of cycling in Ireland. However, once an individual has purchased the bicycle through the scheme there is no requirement on the regularity of use and there is in fact no procedure to ensure the individual uses the bicycle for commuting purposes. Although the focus of this study is not restricted to bicycle commuting, this is an activity which can easily be incorporated into the daily routine of individuals to encourage regular cycling. Taking from a similar work place mobility management based concept, such as the 'Pedometer Challenge', which rewards and encourages positive competitiveness in the workplace may prove effective.

It was also shown that preferring to cycle in an urban setting is significant to improve safety perceptions. Other detrimental factors such as driver attitude and accident involvement may be linked to this. The transport network should not be a daunting place for cyclists. Increasing understanding between drivers and cyclists regarding positioning on the road, right-of-way in conflicting situations, awareness of each other's presence and cooperation between various mode users may improve how the network is perceived by cyclists. Reassurance to cyclists that they belong and are entitled to use the transport network is also necessary, both in document and visually, within the road environment through positive signage to the presence of cyclists.

As an example, roundabouts are a potential area of conflict between cyclists and vehicles. Avoidance of roundabouts was found by analysis to be significant to the perceived safety of cyclists. Roundabouts allow a better flow of vehicles through junctions, making them more environmentally friendly and they also incur lower maintenance costs, making them an attractive option for network design. The Irish rules of the road advise cyclists, through illustration, to indicate left before entering the roundabout, for a movement straight through the roundabout. This is not the same for vehicle users, who are advised to indicate after passing the exit before which they wish to leave the roundabout. This introduces ambiguity and issues such as this need to be clarified; with all road users being informed of such differences.

As Dublin is a city with a large amount of narrow streets the provision of cycling facilities is not always possible. This may prove to be a deterrent factor for the attractiveness of cycling as a viable travel mode for cyclists who prefer to use cycle paths because they do not feel safe cycling in traffic. Providing training which informs cyclists about cycling in traffic with little or no cycling infrastructure may increase cyclists' confidence and comfort while cycling on such roads. This training should be provided at school level and also as a part of workplace mobility management schemes at organisations which support sustainable travel.

As previously mentioned respondents have been shown to associate the chances of being involved in an accident during rush hour traffic or with a bus with a lower safety experience. Research into reporting of cycling accidents has shown that as the severity of an accident involving a cyclist decreases, so does the likelihood of the incident being reported (Stutts and Hunter, 1998). The Irish RSA reported 376 minor accidents involving cyclists in 2011 (Road Safety Authority, 2013). It is possible, that these accidents are only a fraction of the total number of such cases and hence, the importance of improving the safety of cyclists in the network may appear as a less critical consideration. Appropriate reporting of such accidents may improve the situation. Creation of concepts which incentivize public participation in the reporting of minor incidents would create a more reliable database. More accurate identification of the types, and situations which lead to an accident may allow design, or redesign of the network to minimize the risk of such an incidence occurring again.

The need to adapt network design to accommodate for cyclists and to improve their perceived safety has started to get acknowledgement from governments and policy makers, including those in Ireland, Northern Ireland and England (Department of Transport, 2009; Northern Ireland Greenways, 2013; Transport for London, 2010). The study formulated an index, CSI to quantify the safety experience of cyclists in the transport network. An index such as CSI is required to be designed for every country/transport network to understand the improvement of the network attractiveness as perceived by cyclists. The index would provide a basis for integrating perceived safety in the design of transport networks. It also provides specific benchmarks which trigger policy changes by specifying quantitative change.

The following limitations should be considered when considering the findings of this study. The study is based on a fixed-response survey and with it there are associated limitations. Although the available statistics show males to be in the majority in the cycling population, there may still exist residual bias within the study. The study is based on the self-reporting of cyclists; responses may therefore not correspond to actual behaviour or perceptions. In order to reduce the effects of this, all responses collected were anonymous and respondents were informed about this.

6. Conclusions

Cycling network design and policy documentation has begun to acknowledge the need to consider the perceived safety of cyclists in the promotion of cycling as a mode of transport. This study aims to broaden the current limited knowledge base on cyclists' safety perceptions through analysis of a questionnaire based survey of 1954 cyclists in the city of Dublin Ireland.

The responses were analysed within an OLR modelling framework by dividing cyclists into two groups; those who have access to a car on a day-to-day basis and those without, in order to evaluate the differences in their safety preferences. This is the first such study to analyse cyclists in this way. The study found the perceived safety of either group to be quite different. Also, a Cyclist Safety Index was developed to provide a safety rating of each individual cyclist to quantify their perception of safety within the network. The Cyclist Safety Index can be used to assess the perception of safety of populations, for creating benchmarks for different transportation networks, for comparing different transportation networks and for creating quantifiable objectives or targets for policy changes.

Considering the perceived safety of cyclists in network design and adaptation and through the implementation of policy changes to improve these currently poor perceptions could have a positive influence on the overall mode shares of the bicycle.

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Table 1 Description of survey respondents.

	Cautious 536	Balanced 575	Confident 638
Access to a car on a daily basis			
Yes	15.9%	16.6%	18.9%
No	14.7%	16.4%	17.5%
Average number of days cycled per week			
2 or less	6.9%	4.7%	2.5%
3 to 5	17.6%	18.6%	19.0%
6 to 7	6.2%	9.5%	15.0%
Time spent cycling on an average weekday			
15 - 30mins	10.5%	9.0%	8.2%
46mins - 1hr	16.1%	19.1%	22.9%
More than 1hr	4.1%	4.5%	5.7%
Time spent cycling on an average at the weekend			
15 - 30mins	17.9%	19.4%	17.9%
46mins - 1hr	5.4%	6.8%	7.8%
More than 1hr	6.5%	7.0%	11.5%
Distance cycled on an average weekday			
2.1 - 5kms	13.1%	11.9%	9.9%
5.1 - 10kms	7.3%	7.9%	10.5%
10.1 - 15kms	3.6%	6.1%	5.9%
More than 15kms	6.6%	6.8%	10.3%
Distance cycled on an average day at the weekend			
2.1 - 5kms	19.5%	18.9%	17.3%
5.1 - 10kms	3.3%	3.8%	5.1%
10.1 - 15kms	1.5%	2.4%	2.7%
More than 15kms	5.7%	7.4%	12.5%
Average travel speed			
Less than 10km/hr	2.5%	1.3%	0.8%
10 - 20km/hr	19.4%	20.4%	17.9%
More than 25km/hr	7.4%	9.4%	20.8%
Helmet use			
Usually	18.5%	18.0%	17.4%
About half the time	1.2%	1.7%	2.1%
Seldom	11.0%	13.3%	17.0%
Bright/Hi-visibility clothing use			
Usually	22.0%	22.0%	19.6%
About half the time	1.9%	2.7%	3.2%
Seldom	6.7%	8.1%	13.7%
Light and reflective clothing use			
Usually	28.1%	29.1%	30.8%
About half the time	0.6%	1.3%	2.2%
Seldom	1.9%	2.5%	3.5%
Gender			
Male	14.7%	19.5%	29.9%
Female	15.8%	13.6%	6.5%
Age			
Less than 25	9.6%	12.7%	16.2%
25 to 44	15.8%	16.3%	17.8%
45 to 64	4.0%	3.8%	3.2%
65 and over	0.2%	0.1%	0.1%

Table 2 Odds Ratios and Coefficients for the OLR of respondent cyclists with and without access to a vehicle on a day-to-day basis.

Is cycling safer than driving?	Access		No Access	
	Odds Ratio	Coef.	Odds Ratio	Coef.
Average number of days cycled per week	1.245 **	0.219	1.136 *	0.128
Prefer to cycle on urban roads	1.830 *	0.605	1.826 *	0.602
Prefer to cycle on cycle path	0.760	-0.274	0.785	-0.242
Prefer to cycle on off road trails	1.021	0.021	1.053	0.052
Prefer to cycle on kerb-side lanes	0.852	-0.160	0.989	-0.011
Prefer to cycle on shared bus lanes	0.828	-0.189	1.438	0.363
Prefer to cycle with no cycle lane	2.029 **	0.708	1.330	0.286
Avoids stop signs	1.112	0.106	0.618	-0.481
Avoids traffic lights	0.455	-0.788	1.333	0.287
Avoids poor quality road surfaces	1.123	0.116	0.688	-0.373
Avoids right turns	0.941	-0.061	1.137	0.129
Avoids traffic congestion	0.930	-0.073	1.470	0.385
Avoids roads with higher speed limits	1.273	0.242	1.101	0.096
Avoids roads with parked vehicles	1.091	0.087	1.313	0.272
Avoids roundabouts	0.875	-0.133	0.552 *	-0.594
Fully compliant with the rules of the road	0.886	-0.122	2.750 *	1.012
Generally compliant with the rules of the road	1.224	0.202	2.116 *	0.749
Rush hour traffic likely to cause an accident	0.646 *	-0.437	0.574 **	-0.555
Bus likely to cause an accident	0.551 *	-0.596	0.781	-0.247
Taxi likely to cause an accident	1.188	0.172	0.732	-0.313
Poor road surface likely to cause an accident	0.975	-0.025	1.209	0.190
Parked cars likely to cause an accident	1.214	0.194	1.245	0.219
Pedestrians likely to cause an accident	1.163	0.151	0.763	-0.271

** 99% * 95% CI

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Table 1 Description of survey respondents

	Cautious 536	Balanced 575	Confident 638
Access to a car on a daily basis			
Yes	15.9%	16.6%	18.9%
No	14.7%	16.4%	17.5%
Average number of days cycled per week			
2 or less	6.9%	4.7%	2.5%
3 to 5	17.6%	18.6%	19.0%
6 to 7	6.2%	9.5%	15.0%
Time spent cycling on an average weekday			
15 - 30mins	10.5%	9.0%	8.2%
46mins - 1hr	16.1%	19.1%	22.9%
More than 1hr	4.1%	4.5%	5.7%
Time spent cycling on an average at the weekend			
15 - 30mins	17.9%	19.4%	17.9%
46mins - 1hr	5.4%	6.8%	7.8%
More than 1hr	6.5%	7.0%	11.5%
Distance cycled on an average weekday			
2.1 - 5kms	13.1%	11.9%	9.9%
5.1 - 10kms	7.3%	7.9%	10.5%
10.1 - 15kms	3.6%	6.1%	5.9%
More than 15kms	6.6%	6.8%	10.3%
Distance cycled on an average day at the weekend			
2.1 - 5kms	19.5%	18.9%	17.3%
5.1 - 10kms	3.3%	3.8%	5.1%
10.1 - 15kms	1.5%	2.4%	2.7%
More than 15kms	5.7%	7.4%	12.5%
Average travel speed			
Less than 10km/hr	2.5%	1.3%	0.8%
10 - 20km/hr	19.4%	20.4%	17.9%
More than 25km/hr	7.4%	9.4%	20.8%
Helmet use			
Usually	18.5%	18.0%	17.4%
About half the time	1.2%	1.7%	2.1%
Seldom	11.0%	13.3%	17.0%
Bright/Hi-visibility clothing use			
Usually	22.0%	22.0%	19.6%
About half the time	1.9%	2.7%	3.2%
Seldom	6.7%	8.1%	13.7%
Light and reflective clothing use			
Usually	28.1%	29.1%	30.8%
About half the time	0.6%	1.3%	2.2%
Seldom	1.9%	2.5%	3.5%
Gender			
Male	14.7%	19.5%	29.9%
Female	15.8%	13.6%	6.5%
Age			
Less than 25	9.6%	12.7%	16.2%
25 to 44	15.8%	16.3%	17.8%
45 to 64	4.0%	3.8%	3.2%
65 and over	0.2%	0.1%	0.1%

Table 2
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TABLE 2

Is cycling safer than driving?	Access Odds Ratio	Access Coef.	No Access Odds Ratio	No Access Coef.
Average number of days cycled per week	1.245 **	0.219	1.136 *	0.128
Prefer to cycle on urban roads	1.830 *	0.605	1.826 *	0.602
Prefer to cycle on cycle path	0.760	-0.274	0.785	-0.242
Prefer to cycle on off road trails	1.021	0.021	1.053	0.052
Prefer to cycle on kerb-side lanes	0.852	-0.160	0.989	-0.011
Prefer to cycle on shared bus lanes	0.828	-0.189	1.438	0.363
Prefer to cycle with no cycle lane	2.029 **	0.708	1.330	0.286
Avoids stop signs	1.112	0.106	0.618	-0.481
Avoids traffic lights	0.455	-0.788	1.333	0.287
Avoids poor quality road surfaces	1.123	0.116	0.688	-0.373
Avoids right turns	0.941	-0.061	1.137	0.129
Avoids traffic congestion	0.930	-0.073	1.470	0.385
Avoids roads with higher speed limits	1.273	0.242	1.101	0.096
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Figure 1
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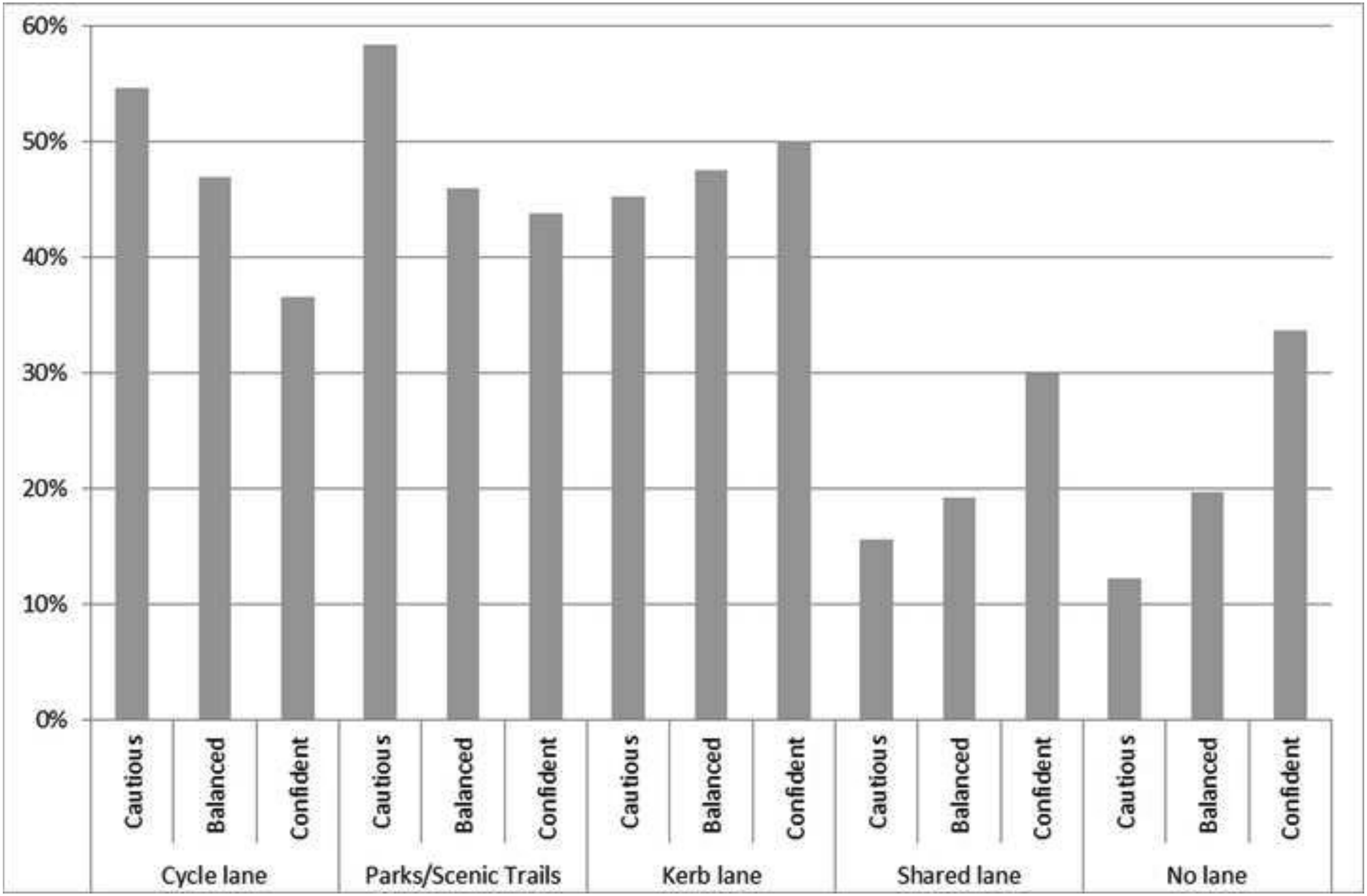

Figure 2
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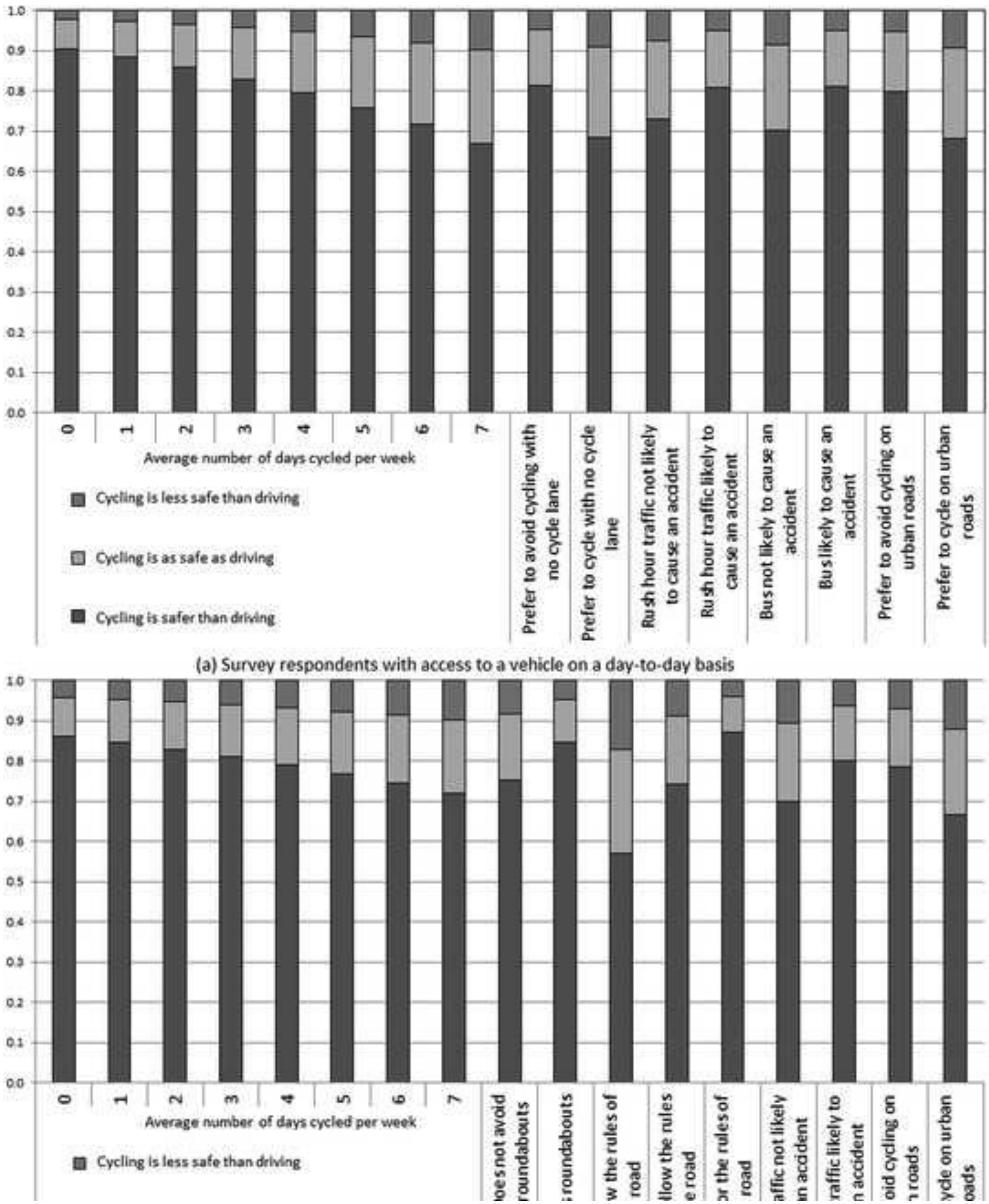

Figure 3

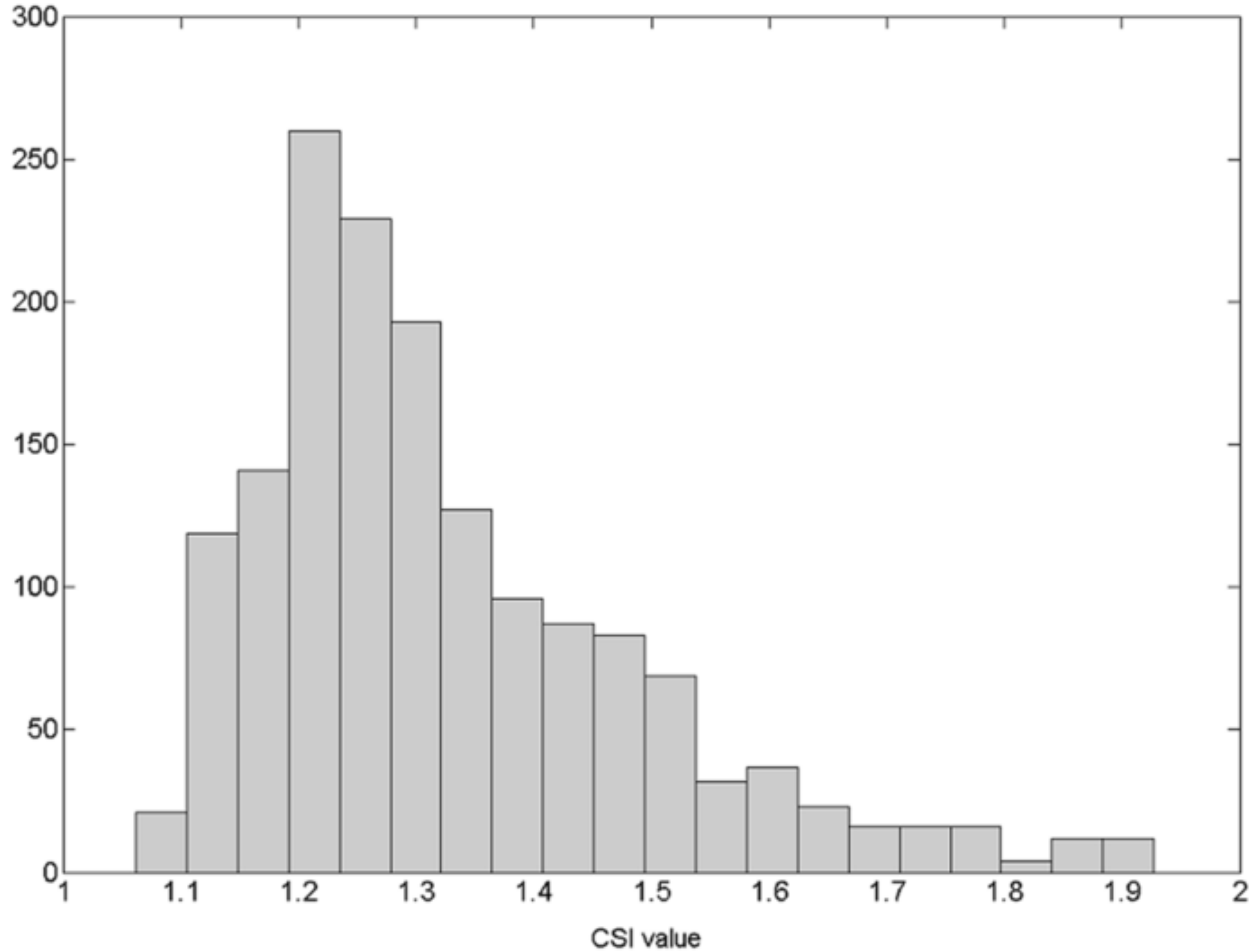

Figure 4
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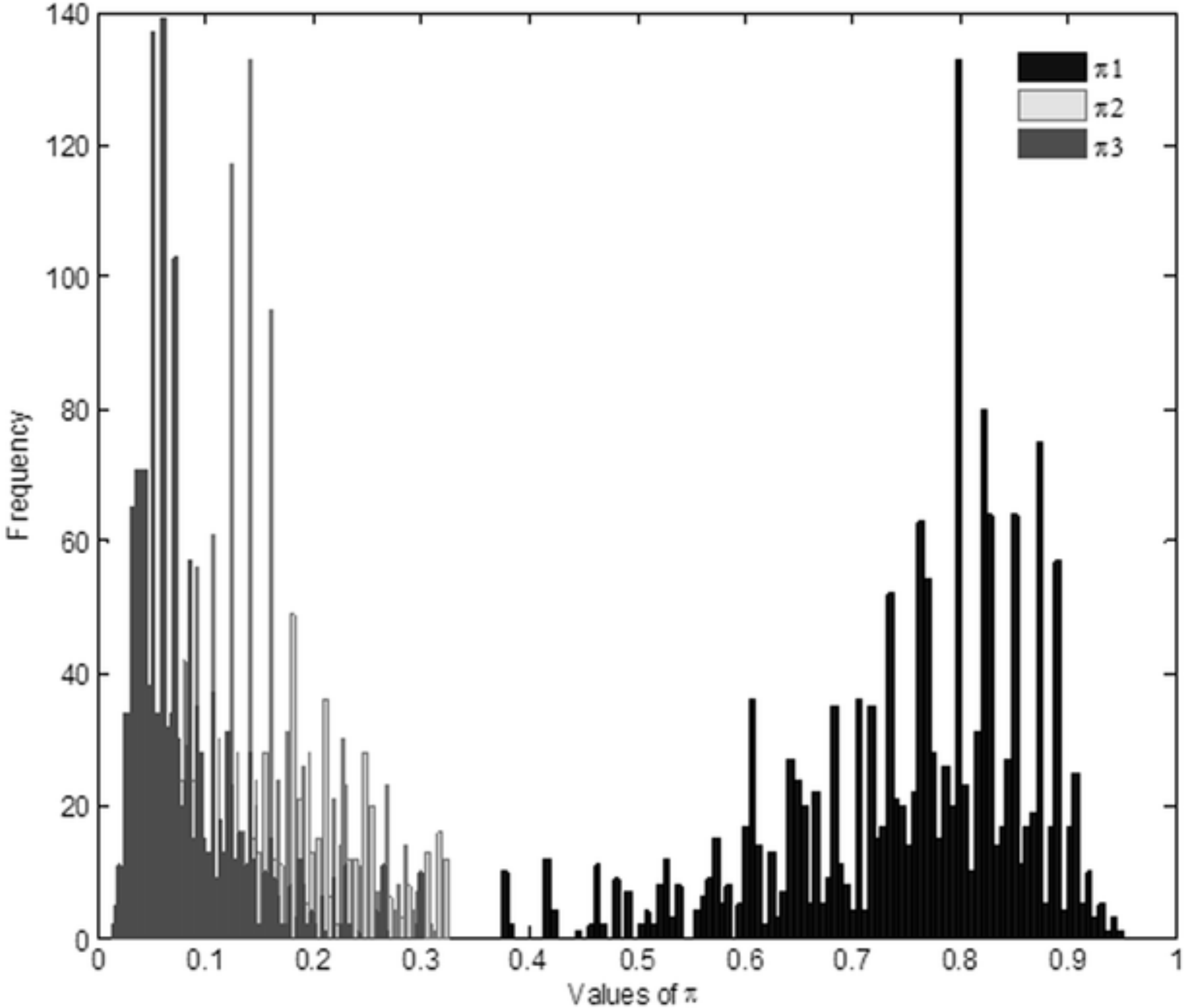

Figure 5
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