# Abstract

This article is based on a study that investigated social cognitive psychological factors associated with economic thresholds related to using public or other sustainable transport modes. A survey was conducted using a random sample of the Norwegian population living in the six largest urban regions (n = 1039). The respondents were asked to indicate the monthly increase in car taxes and fees that they would perceive necessary to make them use sustainable transport modes instead of their private car. The findings revealed that those who perceived themselves as definitive car users (strongly reluctant to change transport mode) reported low tolerance of push measures, low awareness of and ascription of responsibility for the consequences of car use, and weak environmental norms. Environmental norms, attitudes towards transport and push measure tolerance were the strongest predictors of the respondents belonging to either the lowest or the highest threshold groups. The authors conclude that measures aimed at increasing the costs of car use and improving the accessibility of public transport in urban areas could be supplemented by social cognitive factors.



Keywords: car cost, psychology, environment, norm, attitude

# 1. Introduction

Efforts to promote the use of sustainable transport modes are important in order to avoid increased pollution and decline in the quality of urban life. In Norway, around 70% of the population currently live in urban or peri-urban areas.: The population in the five largest Norwegian municipalities is expected to increase by 24% by 2030 (Eurostat, 2009). This in turn will create increased pressure on the transport systems in urban areas. We have therefore investigated the role of social cognitive psychological factors in urban residents' perceived economic thresholds with respect to mode change from private car to public transport modes and other sustainable transport modes such as walking and cycling.

In this article, 'perceived economic thresholds' are defined as the subjective lower limit increase of monthly car expenses and/or the push disincentives that discourage individuals from travelling by car. Financial resources may not be the sole determinant of whether individuals belong to an economic threshold group. Nobel Prize winner Richard H. Thaler has stressed that economic theory needs to be complemented with knowledge from the social sciences (Thaler, 2018). One such way could be to address the knowledge gap in social cognitive psychological factors associated with 'membership' in different economic threshold groups with respect to mode change.

Social cognitive psychological factors, such as how much emphasis individuals place on the benefits of using cars (e.g. travel flexibility), on environmental factors and on tolerance of environmental taxes, may influence their perceived economic thresholds for inducing a transport mode change. Such factors may either motivate or hamper their willingness to pay more for using their car, depending upon whether they are aware of the negative environmental consequences of car use and the impact of their own behaviour. This process

has been supported by studies that found that psychological factors were important for private car users' acceptance of push measures when the statistical influence of income was controlled for (Jacobsson et al., 2000; Schade & Schlag, 2003). From a psychological perspective, social cognitive factors may be particularly important in the study context because, unlike many European countries, Norway has not been strongly affected by the current economic crisis. Norway has a stable economy with growing individual purchasing power. Moreover, the standard of living is among the highest in the world and the country ranks high for most Human Development Index indicators (UNDP, 2013). Therefore, marginal increases in economic push factors such as parking fees and petroleum-based fuel costs may not be sufficient to reduce car use in urban Norway.

One of the more influential social cognitive models in the transport research field is the Norm Activation Model (NAM) (Schwartz, 1977). According to the NAM model, altruistic behaviour related to giving up personal preferences for the benefit of others may be relevant to car use (Nordlund & Garvill, 2003). Furthermore, individuals are more inclined to change for sustainable transport modes when they feel a strong obligation (personal norms) and when they accept that car use has negative consequences for the environment (awareness of consequences) and feel personal responsibility for the consequences (ascription of responsibility) (Abrahamse et al., 2009). The NAM is well established as a significant prediction model of transport mode choice (Klöckner & Blöbaum, 2010; Matthies et al., 2006). However, according to our knowledge, no studies have yet examined the model in relation to thresholds for transport mode change.

According to the theory of planned behaviour (Ajzen, 1991), positive attitudes towards a particular behaviour will increase the probability of that behaviour. The theory has been

extensively tested in empirical studies of traffic risk behaviour (Iversen & Rundmo, 2004; Parker et al., 1995) and transport mode choice (Bamberg et al., 2003; Heath & Gifford, 2002). However, studies examining the link between attitudes towards transport mode and thresholds for mode change are scant. Negative attitudes towards the use of public transport and tendencies to justify car use by personal needs and demand for a high level of personal welfare may increase the economic thresholds for mode change from private car to sustainable transport.

One of the more significant psychological barriers to the effectiveness of push measures is the target groups' tolerance level of these measures (Gärling & Loukopoulos, 2007; Viera et al., 2007). For example, measures aimed at limiting car use in urban centres and increasing the costs of using it are often challenging in their implementation because they are frequently perceived as unpopular, unfair and unjustified (Eriksson et al., 2008). Few studies to date have examined individuals' tolerance level of push measures, such as increased costs of petroleum-based fuels and reduced parking places in relation to thresholds for mode change. Tolerance of push measures may be influenced by psychological reactance that occurs when individuals perceive that countermeasures restrict their freedom. This could in turn cause individuals to attribute higher value to car use and to increase their perceived thresholds for mode change (Tertoolen et al., 1998).

Although attitudes and norms regarding sustainable transport could be important for threshold group belongingness, it can be argued that previous research has focused too much on pro-social motivations. Additionally, instrumental priorities such as mobility demand, focus on travel flexibility (e.g. possibility to choose departure times), travel safety and security (e.g. accidents and incidents such as theft and terrorism), and travel comfort (e.g. time spent

waiting for public transport and availability of seating) may be relevant for individual behaviour and cognition with respect to transport mode choice (Steg, 2005). The results of a previous study showed that frequent public transport users had strong priorities regarding travel mode convenience as well as health and environmental issues, whereas frequent car users considered travel flexibility and comfort as most important (Rundmo et al., 2011). Similar results may be expected for thresholds for transport mode change, as those who prioritize flexibility may be willing to pay more to continue to use their car.

Demographic characteristics such as income levels, gender, age, and education have been found to influence transport mode choice (De Groot & Steg, 2006; Poortinga et al., 2003). This also applies to the availability of transport such as having a car at disposal, the distance between home and workplace and the nearest public transport point.. Such variables were accommodated as covariates in the current study.

### 1.3. Aims and hypotheses

The main objective of the study was to investigate social cognitive psychological factors associated with perceived thresholds among a sample of an urban population for mode change from private car to public and/or other sustainable modes.

The specific aims of the study were:

1. To investigate differences in transport mode choice and tolerance of transport push measures in different economic threshold groups.
2. To investigate whether environmental norms, attitudes regarding transport mode,transport priorities and tolerance of push measures influenced threshold group belongingness.

In line with other studies, we hypothesized that pro-environmental transport norms and attitudes would be associated with lower perceived thresholds for transport mode change. We also expected that individuals who belong to the group with lower threshold for mode change would be more likely to have higher tolerance of push measures. Additionally, we hypothesized that individuals who belong to the group with higher threshold for mode change would be more likely to prioritize flexibility.

# 2. Methods

## 2.1. Sampling

In June and August 2013, we conducted a self-completion questionnaire survey[1] with a randomly selected representative sample (n = 6200) of the Norwegian population from the six largest urban regions. The sample was obtained from the National Population Registry with a random selection of individuals. The study protocol was compliant with the General Data Protection Regulation (GDPR) and approved by the Norwegian Social Science Data Services (NSD). The sample was restricted to urban regions and persons aged 18 years or above. Urban regions with relative few inhabitants and urban regions with high population figures were oversampled. The urban areas were selected on the basis that they had more than 100,000 inhabitants and included a city that was a regional capital. The six urban regions were: (1) the central Oslo region in south-east Norway (n = 2000); (2) the Skien and Porsgrunn region (n = 600); (3) the central Trondheim region in Central Norway (n = 1000); (4)the central Stavanger region in south-west Norway (n = 1000); (5) the central Bergen region on the west coast (n = 1000); and (6) the Tromsø region (n = 600) in Northern Norway. Combined, these urban regions contain around 23% of the total Norwegian population. As a response incentive, a

[1] The methodology has well-known limitations related to social desirability and other response biases (Donaldson & Grant-Vallone, 2002).

lottery ticket with the possibility of winning EUR 1900 was offered. 1039 individuals responded, resulting in a response rate of 18%.

The population characteristics obtained from Statistics Norway (2012) for the six city regions and the study sample are listed in Table 1. In terms of gender and age, the sample was relatively representative of the population in the six urban regions as a whole. There was a slight underrepresentation of males in the age ranges 20–29 years and 60–69 years, and there were more females in the age range 50–59 years and fewer females in the age range 60–69 years in the sample compared with the target population in the six urban areas. The gender, age and education characteristics of the sample were similar to those reported in previous urban transport studies conducted in Norway (Backer-Grøndahl et al., 2009) including those of studies that achieved response rates around 50% (Roche-Cerasi et al., 2013).

The sample included 44% males and 56% females, with 0.39%preferring not to report their gender. The respondents' age was in the range 18–74 years old (M = 41.43, SD = 12.06), 36% reported basic education (primary and secondary school levels), whereas 64% had high education with a college or university degree (0.39% missing). A large share of the respondents (85%) reported having access to a car (0.39% missing).

Table 1. Target population and study sample characteristics by gender and age

| Gender | Age group (years) | Number of individuals in population (% of total population) | Number of individuals in sample (% of total sample) |
|---|---|---|---|
| Male | 18–19 | * | 7 (0.68) |
| | 20–29 | 134,384 (11.70) | 84 (8.16) |
| | 30–39 | 141,662 (12.40) | 105 (10.20) |
| | 40–49 | 126,669 (11.10) | 121 (11.75) |

| | | | |
|---|---|---|---|
| | 50–59 | 101,111 (8.80) | 107 (10.39) |
| | 60–69** | 78,771 (6.90) | 32 (3.10) |
| Female | 18–19 | * | 12 (1.16) |
| | 20–29 | 134,691 (11.80) | 105 (10.20) |
| | 30–39 | 130,374 (11.40) | 138 (13.41) |
| | 40–49 | 118,717 (10.40) | 138 (13.41) |
| | 50–59 | 97,632 (8.50) | 155 (15.12) |
| | 60–69** | 80,349 (7.00) | 25 (2.42) |
| | Total males + females | 1,144,360 (100) | 1029 (100) |

* No information available in population statistics

** 60–69 years in target population and 60–74 years in sample

## 2.2. Measures

A pilot test of the questionnaire was run with relevant user groups before data collection commenced. The test results showed that completion of the questionnaire took around .20 minutes.

Threshold groups were defined by a stated preference measure with respect to the question: 'How large an increase in car use taxes and fees (e.g. parking fees, road tolls, fuel taxes) could you withstand before you would decide to buy an electric car, use public transport or walk or cycle instead of using an ordinary private car?' The respondents were asked to choose an answer between eight statements from 'remained unchanged', 'EUR 30-60 to EUR 384 or higher per month than the current taxes and fees', to 'I will use a private car no matter the costs' (the statements are presented in Table 5).

The response options were based on our knowledge about the Norwegian pricing structure, monthly income levels and individual purchasing power. All these items were originally

presented in Norwegian currency (NOK)[2] and covered all types of travel (e.g. for work, for leisure). The values in the second, third and fourth options (from EUR 30 to 191) were assumed to reflect rather low thresholds, while the fifth, sixth, and seventh options reflected moderate (from EUR 192 to 383) to high (EUR 384 and above) increases in taxation. The eighth option can partly be considered as a protest category (referred to as 'perceived definitive car use') as respondents in this group could not be expected to continue using a car entirely independent of how much the authorities increase the costs. Respondents in this group are strongly reluctant to accept mode change. The inclusion of this option allows for an examination of social cognitive factors associated with threshold membership including individuals who regarded themselves as the most cost-resistant (Carlsson & Johansson-Stenman, 2000).

Tolerance of transport push measures was recorded by an eight-item instrument covering measures commonly implemented to encourage use of sustainable modes, such as increased petroleum-based fuel costs, environmental fees and restrictions on car use in the city centres. The items were scored on a scale ranging from (1) 'very unacceptable' to (7) 'very acceptable'.

Transport priorities were recorded by using a 19-item revised version of an instrument developed by Rundmo et al. (2011). The respondents were asked to evaluate the relative importance of transport punctuality and departure frequency, travel time, costs, comfort, flexibility, and availability of transport when travelling for work or leisure. The measure also covered the relative importance of safety (e.g. safety related to accidents) and security factors

[2] NOK 1 = EUR 8.13, 24 October 2013

(e.g. security regarding theft and terrorism). A seven-point evaluation scale ranging from ‘not at all important’ to ‘very important’ was used for the measure.

The norm activation model was measured by a validated instrument related to transport mode (Steg & De Groot, 2010). The instrument contains 22 items covering the awareness of car use consequences for the environment, and items addressing whether respondents consider global warming and pollution factors when using transport. Responses were given on a seven-point scale ranging from (1) ‘strongly disagree’ to (7) ‘strongly agree’. Steg and De Groot (2010) reported three dimensions of the instrument: (1) Awareness of consequences (whether respondents acknowledge that car use contributes to pollution and environmental harm), (2) Ascription of responsibility (whether they take personal responsibility for such harm), and (3) Personal norms (moral obligations to take action). Measures regarding environmental awareness, responsibility and norms may be susceptible to socially desirable responses. However, previous studies have shown a weak correlation between the social desirability scale and environmental awareness, attitudes, values, and ecological behaviour (Kaiser et al., 1999; Zhao et al., 2018).

The respondents’ attitudes towards transport mode were evaluated by using a 12-item instrument, which included items such as ''People should use the mode of transport that suits their needs’, ‘Time pressure and economic issues make it impossible for business leaders and management to use public transport, and ‘It is impossible to deliver and pick up children from kindergarten without using a private car’. The respondents scored their level of agreement on a seven-point scale ranging from (1) ‘strongly agree’ to (7) ‘strongly disagree’.

228 Urban transport mode was measured by nine items asking how often the respondents used
229 public transport (bus, train, tram and metro) and private transport (car, walk, cycle,
230 moped/scooter, and motorcycle) (Rundmo et al., 2011). A six-point scale ranging from 'less
231 than one day per week' to 'five days or more per week' was used to record the responses.
232
233 The demographic variables included in the study were gender, age, education (basic =
234 secondary school and below, higher level = university/college education), and gross annual
235 income reported for the last 12 months (low/modest = EUR 50,000 or below, high = EUR
236 51,000 or above). Transport availability measured whether or not the respondents had access
237 to a car , the approximate number of minutes required to walk from their home to the closest
238 access point for public transport. In addition, we considered it important to record information
239 about transport availability on frequently repeated trips (e.g. from/to the workplace).
240 Information was therefore obtained about the approximate required number of minutes to
241 walk from the workplace to the closest public transport point, and the approximate distance in
242 kilometres between home and workplace.
243
244 2.3. Statistical procedures
245 Descriptive statistics were used to describe the proportion of the sample belonging to the
246 mode change threshold groups, and to show differences in transport mode use and tolerance
247 of specific transport push measures across the groups. Chi-square ($\chi^2$) analyses were
248 performed to investigate differences in gross annual income across the different threshold
249 groups. The dimensionality of the psychological constructs was examined with Principal
250 Component Analyses (PCA)[3] with iteration and Varimax rotation. A scree plot, Kaizer
251 criterion and the interpretability of the dimensions were used to determine the number of

[3] As an explorative analysis, PCA is somewhat susceptible to the researchers' interpretations.

252 factors to be extracted. Cronbach's alpha and average corrected inter-item total correlations
253 were calculated to estimate the reliability of the scales and indexes. Conventional criteria for
254 reliability were used (i.e. alpha values above .70 and average corrected inter-item total
255 correlations above .30) (Hair et al., 1998).
256
257 A multivariate analysis of covariance (MANCOVA) was carried out to examine differences
258 between the threshold groups with respect to transport priorities, norms and attitudes towards
259 transport mode, and their tolerance of push measures. The threshold group variable was used
260 as the fixed factor, while the psychological factors were used as dependent variables. The
261 following covariates were used: gender, age, education, gross annual income, number of
262 minutes to walk from home and workplace to the closest access point for public transport,
263 distance in kilometres between home and workplace, and access to a car. Planned post-hoc
264 Bonferroni tests were used to determine significant group means in the MANCOVA.
265
266 Multivariate discriminant analysis (MDA) was performed to establish a prediction model of
267 threshold group membership based on differences in psychological variables and covariates
268 detected in the MANCOVA ($p < .001$ criterion). An MDA was chosen because this usually
269 performs better than multinomial logistic regression analysis when the outcome categorical
270 variable contains more than two groups with an unequal number of respondents (Hossain et
271 al., 2002).
272
273 2.4. Dimensionality of the instruments
274 The dimensional structure of the 19-item transport priorities instrument is presented in Table
275 2. The instrument was segmented into three dimensions that explained around 70% of the
276 variance: 'Priorities concerning safety and security' ($\alpha = .932$, average corrected inter-item

277 total correlation = .82) included five items and explained 43.73% of the variance; 'Priorities
278 concerning convenience' ($\alpha$ = .877, average corrected inter-item total correlation = .69)
279 included six items and explained 15.82% of the variance; 'Priorities concerning flexibility'
280 included three items ($\alpha$ = .782, average corrected inter-item total correlation = .63) and
281 explained 9.91% of the variance. Five items were excluded because they did not load
282 consistently.
283
284
285 Table 2. Dimensional structure of transport priorities

| | Dimension | | |
|---|---|---|---|
| Items | Priorities concerning safety and security | Priorities concerning convenience | Priorities concerning flexibility |
| Safety regarding major accidents | **.89** | | |
| Security regarding terrorist attacks | **.88** | | |
| Safety regarding personal accidents and injuries | **.86** | | |
| Security regarding harassment and uncomfortable episodes | **.86** | | |
| Security regarding theft | **.83** | | |
| Frequency of departures | | **.87** | |
| Punctuality | | **.82** | |
| Travel time | | **.81** | |
| Transit time between different public transport types | | **.74** | |
| Possibility to walk to the nearest access point for public transport | | **.72** | |
| Travel costs | | **.53** | |
| Flexible travel route | | | **.86** |
| Flexible time of departure | | | **.81** |
| Accessible car parking space close to the access point for public transport | | | **.52** |
| **Variance explained (%)** | **43.73** | **15.82** | **9.91** |

286 *Notes:* Norwegian items were used. High scores reflect strong transport priorities. Factor loading of < .30 was
287 not reported. Bold values reflect the main factor of loading.
288

289 The dimensional structure of the 22-item instrument measuring the norm activation model
290 regarding transport mode is presented in Table 3. In line with the dimensional structure
291 reported by De Groot et al. (2007), the instrument was divided into three dimensions that
292 explained around .51% of the variance: 'Awareness of consequences' ($\alpha$ = .795, average
293 corrected inter-item total correlation = .58) contained five items and explained 35.03% of the
294 variance; 'Ascription of responsibility' ($\alpha$ = 820, average corrected inter-item total correlation
295 = .55), included seven items and explained 8.70% of the variance; 'Personal norms'
296 ($\alpha$ = 721, average corrected inter-item total correlation = .48) contained eight items and
297 explained 7.23% of the variance. Two items were excluded because they failed to load
298 consistently.
299
300 Table 3. Dimensionality of norms regarding transport mode

| Items | Dimension | | |
|---|---|---|---|
| | Awareness of consequences | Ascription of responsibility | Personal norms |
| Car use is an important cause of traffic-related accidents | **.77** | | |
| Car use reduces urban quality of life due to traffic noise and externalities | **.74** | | |
| By reducing car use, the level of air pollution will decrease | **.71** | | |
| Car use takes up a lot of space, resulting in less space for cyclists, pedestrians and children | **.68** | .36 | |
| Car use causes exhaustion of scarce resources, such as oil | **.57** | | |
| I feel morally obliged to choose a mode of transport that does not increase the load on the road networks | | **.73** | |
| I use my own car because I want to, regardless of what others think about it | .31 | **.71** | |

| | | | | |
|---|---|---|---|---|
| I feel personal responsibility for using transport that does not cause environmental harm | .31 | **.65** | | |
| I don't feel guilty when I use the car, even though there are other feasible transport alternatives available | | **.65** | | |
| The threat of climate change is unimportant for my use of transport | | **.61** | | |
| I would be a better person if I used other transport modes more often instead of the car | | **.59** | | |
| People like me should do whatever they can to minimize their car use | .32 | **.52** | | |
| My use of transport does not influence climate change | | | | **.73** |
| My behaviour is not important in the broad picture | | | | **.72** |
| To safeguard the environment is not my responsibility | | | | **.67** |
| My transport mode choice has no influence on the physical environment | | | | **.65** |
| My contribution to local pollution is minimal | | | | **.59** |
| Only politicians can stop global warming | | | | **.57** |
| By choosing sustainable transport, one contributes to reduce global warming | | | | **.48** |
| I am jointly responsible for choosing sustainable transport | | | | **.43** |
| **Variance explained (%)** | **35.03** | **8.70** | **7.23** | |

*Notes:* Norwegian items were used. High scores reflect more awareness of consequences, more ascription of responsibility, and stronger personal norms. Factor loading of < .30 was not reported. Bold values reflect the main factor of loading.

The dimensionality of the 12-item measure of attitudes towards transport mode is presented in Table 4. The instrument was divided into two dimensions that explained around 50% of the variance: 'Self-determination' ($\alpha$ = 770, average corrected inter-item total correlation = .54) included five items and explained 33.81% of the variance; 'Social status' ($\alpha$ = 739, average

309 corrected inter-item total correlation = .50) included five items and explained 14.95% of the
310 variance. Two items were excluded because they failed to load consistently on the two
311 dimensions.

312

313 Table 4. Dimensionality of attitudes towards transport mode

| Items | Dimension | |
|---|---|---|
| | Self-determination | Social status |
| I dislike that the authorities try to exclude cars from traffic | **.84** | |
| If I had political power, I would really address those who sanction the hostile car regulations | **.80** | |
| People should use the mode of transport that suits their needs | **.67** | |
| It is the politicians who create queues in road traffic | **.65** | |
| It is impossible to deliver and pick up children from the kindergarten without using a private car | **.51** | |
| It is obvious that business leaders and management drive their own car to work | | **.82** |
| Public transport is solely for people with a low income | | **.77** |
| Time pressure and economic issues make it impossible for business leaders and management to use public transport | | **.73** |
| The busy meeting schedules of business leaders and management make it impossible for them to use public transport | .34 | **.55** |
| Today's leaders neither have to nor should take the bus | | **.52** |
| **Variance explained (%)** | **33.81** | **14.95** |

314 *Notes:* Norwegian items were used. High scores reflect fewer self-determinant explanations for use of a car and a
315 lower tendency to report social status as important for transport mode. Factor loading of < .30 was not reported.
316 Bold values reflect the main factor of loading.

317

318 A PCA yielded a unidimensional structure of the eight-item measure 'Tolerance of push
319 measures for mode change' ($\alpha$ = .841, average corrected inter-item total correlation = .57).

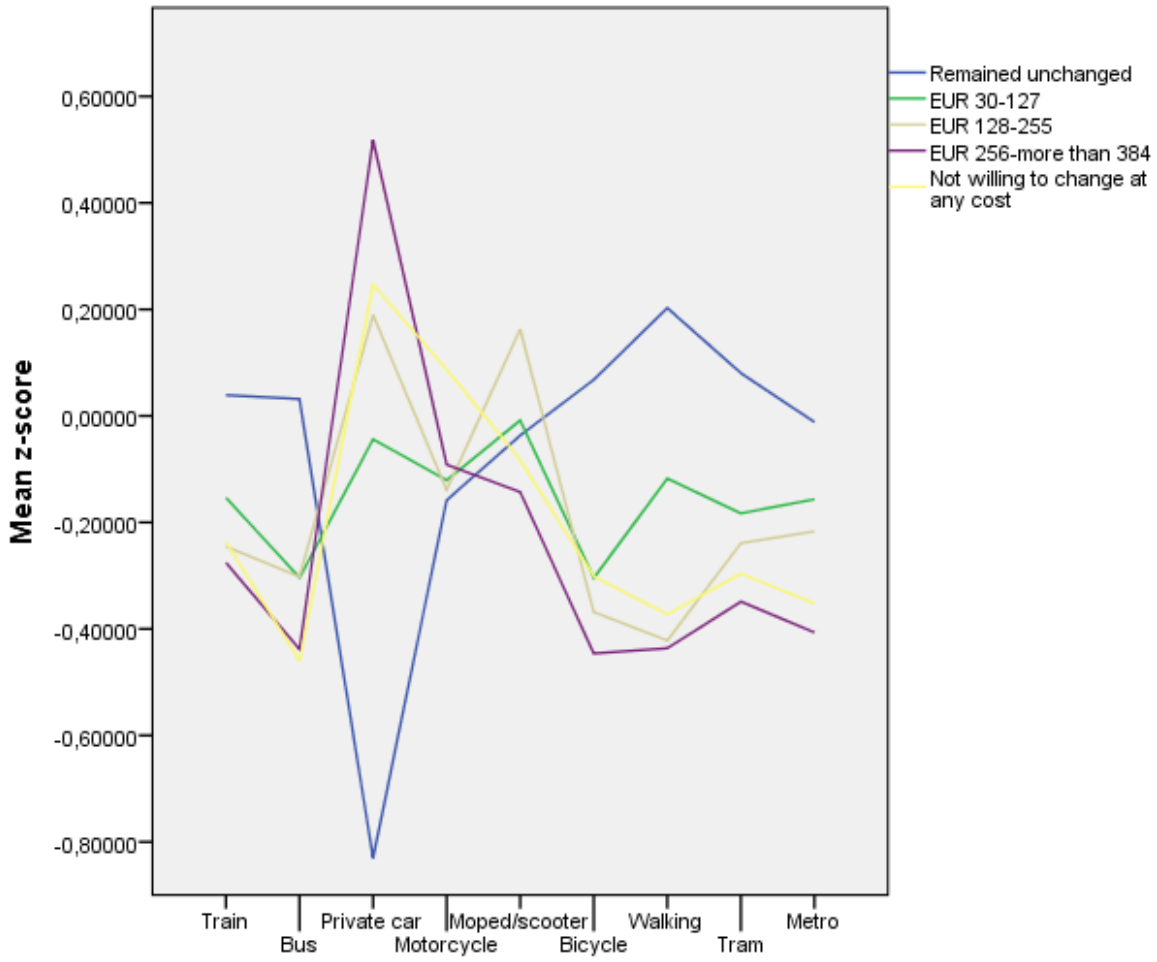
320 The factor loadings ranged from .52 to .86, and the dimension explained 57.59% of the
321 variance.
322
323 # 3. Results
324 ## 3.1. Economic change threshold groups
325 The results showed that 34% of the respondents reported that they would change to
326 sustainable transport given the current monthly private car tax levels, whereas 19% reported
327 that they would not be willing to change at any cost (Table 5). 47% reported a potential for
328 changing their mode of transport if monthly private car taxes and fees increased. Additionally,
329 the results showed that a monthly increase in car taxes and fees of about EUR 128–191 would
330 contribute to a mode change among 54% of respondents who mainly travelled by car (n =
331 685).
332
333 Table 5. Proportion of respondents in the threshold groups

| Thresholds | Number of respondents | % of total sample (n = 1039) | % of car users (n = 685) |
|---|---|---|---|
| Remained unchanged | 354 | 34 | |
| EUR 30–60 higher per month than the current taxes and fees | 130 | 12 | 19 |
| EUR 61–127 higher per month than the current taxes and fees | 130 | 12 | 19 |
| EUR 128–191 higher per month than the current taxes and fees | 112 | 11 | 16 |
| EUR 192–255 higher per month than the current taxes and fees | 61 | 6 | 9 |
| EUR 256–383 higher per month than the current taxes and fees | 27 | 3 | 4 |
| EUR 384 or higher per month than the current taxes and fees | 28 | 3 | 4 |
| I will use a private car no matter the costs | 197 | 19 | 29 |
| Total | 1039 | 100 | 100 |

334
335 ## 3.2. Transport mode use and push measure tolerance in the groups
336 Respondents who considered that the current taxes and fees were sufficiently high for them to
337 change their transport mode (n = 354) already used sustainable transport more often than

private motorized modes of transport (Figure 1) and were excluded from further analyses. To establish adequate statistical power in the analyses, the respondents were divided into four threshold groups: those who reported that they would change mode given the following monthly car tax increases: (1) EUR 30–127 (n = 260), (2) EUR 128–255 (n = 112), (3) EUR 256–384 or higher (n = 116), and (4) individuals who reported that they would not change transport mode at any costs (n = 197). The latter group was included in further analyses in anticipation that it might serve as an important reference group in terms of factors that promote or reduce the threshold for mode change from private car to sustainable modes. It is a relevant target group for transport policy aimed at increasing the use of public transport and healthy modes - of transport (walking and bicycling). Respondents in all the threshold groups used cars substantially more often than they used health-promoting transport modes or public transport (Figure 1). There was a tendency for individuals in the group 'EUR 256–384 or higher' to report more use of private cars than those in group 4 who reported not being willing to change at any cost. In general, the greater use of private car, the higher is the reported economic threshold.

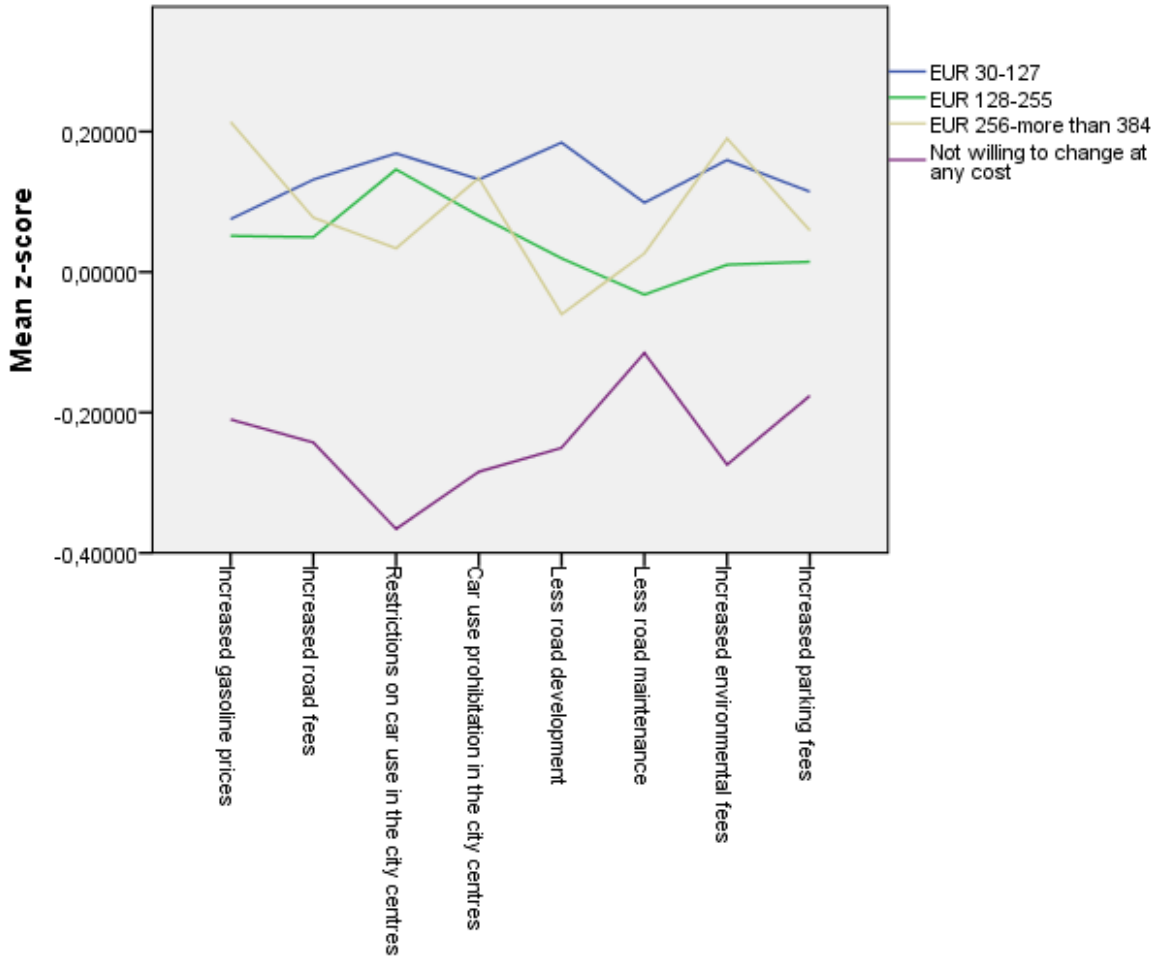
Moreover, the results of chi-square analyses showed that there were more individuals in the 'EUR 30–127' threshold group, who had a gross annual income of EUR 50,000 or below, whereas the opposite was the case in the remaining groups. Individuals with the two highest mode change thresholds 'EUR 256–384 or higher' and individuals who reported that they would not change mode at any costs had a high gross annual income above EUR 50,000 ($\chi^2 = 16.14$, $p < .001$). This suggests feasible validity of the perceived threshold group measure as it correlated with both transport mode use and gross annual income in the expected directions.




Mean z-score = the average number of standard deviations from the mean in the respective groups

Figure 1. Transport mode use in the threshold groups

Respondents who reported that they were unwilling to change transport mode at any costs reported an overall lower push measure tolerance than respondents in the other threshold groups (Figure 2). Those who were unwilling to change regardless of the costs also reported the lowest tolerance of restrictions and prohibition of car use in city centres. The three remaining groups were quite similar in terms of push measure tolerance, but the group with the lowest perceived economic threshold for change reported the highest tolerance of such measures, as could be expected.




Mean z-score = the average number of standard deviations from the mean in the respective groups

Figure 2. Tolerance of transport push factors in the threshold groups

### 3.3. Psychological factors and mode change thresholds

A MANCOVA was performed to test differences between the four threshold groups with regard to transport priorities, norm activation components and attitudes towards transport mode use, and tolerance of push measures. Statistical significance was achieved for the following variables: threshold group, gender, age education, access to a car, and gross annual income.

Respondents who reported that they would not change behaviour also reported an overall lower push measure tolerance than those in the remaining groups, when other psychological factors and covariates were considered (Table 6). The same respondents also reported a lower awareness of the consequences of car use, a lower ascription of responsibility for such consequences, and weaker environmental personal norms. Additionally, they also had stronger self-determined attitudes towards car use.

Table 6. Transport priorities, mode norms and push measure tolerance in the threshold groups

| Dimension | EUR 30–127 | EUR 128–255 | EUR 256–384 or higher | Not willing to change at any cost | *F*-value |
|---|---|---|---|---|---|
| Priorities concerning safety and security | 5.16 | 4.98 | 4.86 | 5.10 | 1.32 |
| Priorities concerning flexibility | 4.77 | 4.70 | 4.91 | 5.11 | 1.22 |
| Priorities concerning convenience | 6.06 | 5.99 | 6.03 | 5.91 | .77 |
| Tolerance of push measures for transport mode change | 2.92$^{d}$ | 2.65$^{d}$ | 2.79$^{d}$ | 2.23$^{abc}$ | 9.17*** |
| Norm – awareness of consequences of transport mode choice | 4.92$^{d}$ | 4.88$^{d}$ | 4.65$^{d}$ | 4.20$^{abc}$ | 12.13*** |
| Norm – ascription of responsibility for transport mode choice | 4.39$^{d}$ | 4.11$^{d}$ | 4.05$^{d}$ | 3.48$^{abc}$ | 15.22*** |
| Norm – personal norms for transport mode choice | 5.40$^{d}$ | 5.24$^{d}$ | 5.18$^{d}$ | 4.84$^{abc}$ | 6.59*** |
| Attitudes – social status | 5.44 | 5.28 | 5.14 | 5.37 | .87 |
| Attitudes – self-determination | 4.01$^{d}$ | 3.75$^{d}$ | 3.80$^{d}$ | 3.21$^{abc}$ | 16.46*** |

*Notes:* *** p < .001, ** p < .005, * p < .05. Wilks' $\lambda$ = .86, $F$ = 3.19, $p$ < .001. Mean values with different subscripts are statistically different at p < .05 or below. a = EUR 30–127, b = EUR 128–255, c = EUR 256–384 or higher, d = Not willing to change at any cost. High scores reflect strong transport mode priorities, high tolerance of push measures, stronger pro-environmental norms, and attitudes towards transport mode use. The covariates were gender, age, education, gross annual income, number of minutes to walk from home and from the workplace to the closest access point for public transport, distance in kilometres between home and workplace, and whether the respondents had access to a car.

404 The MDA identified one significant discriminant function (function 1: Wilks' $\lambda = .84$, $\chi^2 =$
405 113.77, df = 27, $p < .001$), which described core differences between the group with the
406 lowest change threshold (EUR 30–127) and the group that would not change at any cost
407 (group centroid values of .35 and -.60 respectively). Six predictors were important for
408 discriminating between the two groups (function 1) (Table 7). Those who belonged to the
409 group with the lowest change threshold were more likely to report strong ascription of
410 responsibility regarding car use, strong awareness of the consequences of car use and strong
411 personal norms and obligations regarding taking action regarding their car use. Respondents
412 in the same group also reported less self-determined attitudes towards car use and were more
413 likely to report strong tolerance of push measures. High gross annual income was negatively
414 related to belongingness in the group with the lowest change threshold.
415
416 Table 7. Results from the structure matrix in the multivariate discriminant analysis

| Dimension | Function | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Norm – ascription of responsibility for transport mode choice | .83* | -.10 | -.25 |
| Attitude – self-determination | .79* | .09 | .21 |
| Norm – awareness of consequences of transport mode choice | .75* | .22 | .15 |
| Norm – personal norms for transport mode choice | .59* | -.01 | -.16 |
| Tolerance of push measures for mode change | .57* | .11 | .36 |
| Gross annual income (high) | -.43* | .08 | .29 |
| Gender (male) | -.22 | .73* | .04 |
| Access to a car (yes) | .25 | -.55* | .31 |
| Education (high) | .16 | .24 | .71* |
| Age | -.13 | -.09 | .13* |

* Largest absolute correlation between each variable and any discriminant function

# 4. Discussion

The core objective of the study was to investigate social cognitive psychological factors associated with perceived thresholds for mode change from private car to public transport and/or other sustainable transport modes in urban populations.

Numerous previous studies have examined the Norm Activation Model in relation to transport mode use (Klöckner & Blöbaum, 2010; Matthies et al., 2002; Matthies et al., 2006). The results of our study suggest that the NAM is useful for improving our understanding of economic thresholds for mode change. In line with the research hypotheses, respondents who realized that their car use had a negative impact on the environment reported lower thresholds for mode change. This was also the case for those who reported a strong sense of personal responsibility for such negative impacts and strong personal norms for taking action aimed at reducing the negative impacts on the environment of transport mode choice.

As hypothesized and in line with social cognitive theory (Ajzen, 1991), attitudes towards transport mode use were associated with thresholds for transport mode change. Weaker self-determination of car use was rather substantially related to a low threshold for mode change. Strong self-determination regarding car use may arise from a social dilemma whereby car users have to weigh personal goals and aspirations against the needs of society (e.g. need for sustainable urban environments). Individuals who have a strong self-determinant attitude towards car use may experience a reduction in and threat to their personal freedom due economic push disincentives. This in turn could intensify their perceptions of having a personal right to use cars for personal purposes (Jakobsson et al., 2000). This suggestion fits

with the self-determination theory (Deci & Ryan, 1987), which argues that measures that encourage the initiation of specific behaviour and that promote psychological freedom are more likely to generate flexibility, interest and motivation. Policy measures that promote tension and pressure may have the opposite effect as they are more likely to cause low intrinsic motivation, negative emotions and increased resistance. As such, licensed drivers may become even more persistent in their car use when faced with increased costs and other authority-initiated economic push efforts. Policy interventions could therefore stress the underlying motivation for introducing push measures, namely that they are not aimed at 'punishing' car users through increased expenses related to car use but rather represent a systematic strategy to improve the urban environment.

Contrary to our initial hypothesis, the overall differences in transport priorities between the threshold groups were marginal. It seemed that transport priorities were more important for transport mode choice (Rundmo et al., 2011) than for perceived mode change thresholds. One reason may be that the priority dimensions measured in our study (e.g. flexibility and safety factors) are important and relevant for most individuals and do not discriminate between individuals with diverging thresholds for transport mode change.

Since the late 1990s the dominating Norwegian transport policy has been to increase costs related to car use. However, the cost increase has been relatively small, in line with the tendency in most other OECD countries, where car use costs constitute a quite low proportion of the overall taxes and fees (Ekins, 1999). In our study, around 20% of the respondents who mainly used a car reported that they would change mode given an increase of EUR 30–60 in monthly car-related costs and more than 50% given an increase of EUR 128–191. These results could call into question the findings from previous research (Button & Verhoef, 1998),

which have indicated that increased costs of car use are ineffective in promoting a change from car use to sustainable modes of transport.

However, a substantial increase (EUR 128–191) may represent what has been referred to as a 'policy shock' (Gallego et al., 2013). Increases of this size could cause a socio-economic redistribution of those who could afford to drive on a regular basis and might contribute to a reduction in car use mainly among individuals with fewer socio-economic resources (e.g. students, young individuals in general, and the elderly). This suggestion is in line with the results of research showing that car users with low incomes are more likely to increase their intention of reducing car use when faced with increased car costs (Jakobsson et al., 2000). Substantial increases in car-related taxes and fees could therefore exclude certain demographic groups from the roads. It should also be mentioned that we adjusted for economic resources (i.e. gross annual income) in our multivariate analyses, and the psychological social cognitive factors were found more relevant for mode change thresholds than were economic resources. This suggests that additional factors to economic resources (e.g. environmental campaigns, attitude and norm formation efforts) need to be considered when promoting a change from car use to sustainable transport modes.

In accordance with our hypothesis, the results showed that tolerance of push measures discriminated strongly between the lowest and highest transport mode change threshold groups. Item analyses showed that this was particularly true for tolerance of car use restrictions in city centres. However, car use restrictions are also a push measure, which could be argued to have high social legitimacy in the urban public. One advantage is that car use restrictions do not reinforce social differences to the same extent as increased car costs and might influence more car users who are resistant to changing their transport mode.

Although the above-mentioned push measure may to some extent inhibit the mobility of individuals who live far from city centres, it results in reduced noise and pollution. Given that slightly increased costs of car use may not influence those in the more change-resistant groups, increasing the tolerance of car-use restrictions in urban centres could be more efficient in promoting sustainable transport modes (Rundmo et al., 2011). Combined with pull measures, such as increased availability of transport and cheaper tickets on metro services, trams and other public transport modes, this could be a more feasible alternative or contribution to sustainable urban growth than slowly increasing the costs related to car use. Restrictions on car use could be coupled with policy efforts aimed at improving public transport. However, restrictions coupled with failed attempts to improve the public transport system may contribute to more cars on the roads than before the restrictions were introduced, partly due to psychological reactance (Gallego et al., 2013).

The findings showed that neither access to public transport close to home and workplace nor the distance between the two places were associated with mode change threshold groups. This suggests that the barriers to promoting mode change are not necessarily addressed by introducing pull measures, such as decreasing the distances to the closest metro station, tram stop or bus stop in urban settings. In Norway, urban regions are relatively well covered by public transport (Aarhaug et al., 2017) and walking distances to the closest access point for public transport are usually not far. Having access to a car appears to be a stronger predictor of mode change thresholds than access to public transport.

### 4.1. Limitations

Some limitations of the study merit discussion. The low response rate raises questions about the ecological validity of the results. There has been a general decrease in participation rates for surveys conducted in Western Europe and the USA (Galea & Tracy, 2007), but we would argue that participation rates alone cannot determine the extent of non-response bias. Rather, differences between respondents in a study sample and individuals in the sample population are more important. In our study there were few deviations in demographic characteristics between the sample population and target population. Further, the distribution of demographics was relatively similar to that found in other transport studies with higher response rates. The limitations regarding self-reported data and a correlational research design that are common in transport surveys occurred also in our study.

The results obtained by using a single-item scenario-based instrument to establish the perceived threshold groups warrant cautious interpretation. It has been argued that the public's tolerance of a push measure could increase after the measure has become established (Eliasson, 2010). The reason for such increased tolerance is that the positive effects on, for example, the urban environment could be greater than expected and that the consequences for public economy and travel patterns are often less negative than initially feared by the public. Consequently, stated thresholds for mode change may not correspond with actual thresholds. However, our analyses showed that higher thresholds for mode change were systematically associated with higher frequency of car use. This result aligns with psychological theory arguing that when a specific behaviour is conducted on a frequent basis the perceived cognitive value of the behaviour will increase (Bem, 1972) and thus the thresholds for changes to the behaviour may increase accordingly. The social cognitive psychological constructs used in our study as well as gross annual income related to the perceived threshold variable in a manner that corresponded well with theory and our initial hypotheses. An

interesting expansion of the current measure of thresholds would be to investigate the specific modes of transport that individuals would change to given a rise in conventional car use costs.

## Acknowledgement

The study was funded by the Research Council of Norway (Grant no. 224754) as part of the Safety and Security in Transport (TRANSIKK) Programme. The authors are grateful towards the two anonymous reviewers who provided critical input that substantially improved the article.

## References

Aarhaug, J., Fearnley, N., Rødseth, K.L., Svendsen, H.J., Hoff, K.L., Müller, F., Norseng, R.B., & Tveter, E. *Cost developments in Norwegian public transport – key observations*. TØI Report 1582b/2017.

Abrahamse, W., Steg, L., Gifford, R., & Vlek, C. (2009). Factors influencing car use for commuting and the intention to reduce it: A question of self-interest and morality? *Transportation Research Part F: Traffic Psychology and Behaviour, 12,* 317–324.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179–211.

Backer-Grøndahl, A., Fyhri, A., Ulleberg, P., Amundsen, A. H. (2009). Accidents and unpleasant incidents: worry in transport and prediction of travel behavior. *Risk Analysis, 29,* 1217–1226.

Bamberg, S., Ajzen, I., & Schmidt, P. (2003). Choice of travel mode in the theory of planned behavior: The roles of past behavior, habit, and reasoned action. *Basic and Applied Social Psychology, 25,* 175–187.

Bem, D.J. (1972). Self-Perception Theory. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 6, pp. 1–62). New York: Academic Press.

Button, K.J., & Verhoef, E.T. (1998). *Road pricing, traffic congestion and the environment – issues of efficiency and social feasibility.* Cheltenham, UK: Edward Elgar.

Carlsson, F., & Johansson-Stenman, O. (2000). Willingness to pay for improved air quality in Sweden. *Applied Economics, 32,* 661-669.

Deci, E.L. & Ryan, R.M. (1987). The support of autonomy and the control of behavior. *Journal of Personality & Social Psychology, 53,* 1024–1037.

De Groot, J. & Steg, L. (2006). Impact of transport pricing on quality of life, acceptability, and intentions to reduce car use: An exploratory study in five European countries. *Journal of Transport Geography, 14,* 463–470.

De Groot, J. & Steg, L. (2007). General beliefs and the theory of planned behavior: The role of environmental concerns in the TPB. *Journal of Applied Psychology, 37,* 1817–1836.

Donaldson, S.I., & Grant-Vallone, E.J. (2002). Understanding self-report bias in organizational behavior research. *Journal of Business and Psychology, 17,* 245–260.

Ekins, P. (1999). European environmental taxes and charges: recent experience, issues and trends. *Ecological Economics, 31,* 39–62.

Eliasson, J. (2010). So you're considering congestion charging? Here's what you need to know. FAQ based on Stockholm's experiences. In OECD/ITF (2010) Implementing Congestion Charging, Roundtable 147.

Eriksson, L., Garvill, J., & Nordlund, A. M. (2008). Acceptability of single and combined transport policy measures: The importance of environmental and policy specific beliefs. *Transportation Research Part A: Policy and Practice, 42,* 1117–1128.

Eurostat. (2009). Regional population projections. Accessed 7 November 2013: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Regional_population_projections

Galea, S., & Tracy, M. (2007). Participation rates in epidemiological studies. *Annals of Epidemiology, 17,* 643-653.

Gallego, F., Montero, J.-P., & Salas, C. (2013). The effect of transport policies on car use: evidence from Latin American cities. *Journal of Public Economics, 107,* 47–62.

Gärling, T., & Loukopoulos, P. (2007). Effectiveness, public acceptance, and political feasibility of coercive measures for reducing car traffic. (pp. 313–324). In T. Gärling., L. Steg. (Eds.). *Threats from car traffic to the quality of urban life: Problems, causes, and solution.* Oxford, UK: Elsevier.

Hair, J.F., Anderson, R.E., Tatham, R.L., & Black, W.C. (1998). *Multivariate Data Analysis*. Upper Saddle River, NJ: Prentice-Hall.

Heath, Y., & Gifford, R. (2002). Extending the theory of planned behavior: Predicting the use of public transportation. *Journal of Applied Social Psychology, 32,* 2154–2189.

Hossain, M., Wright, S., & Petersen, L. A. (2002). Comparing performance of multinomial logistic regression and discriminant analysis for monitoring access to acute myocardial infarction. *Journal of Clinical Epidemiology, 55,* 400–406.

Iversen, H.H., & Rundmo, T. (2004). Attitudes towards traffic safety, driving behaviour and accident involvement among the Norwegian public. *Ergonomics 47,* 555–572.

Jakobsson, C., Fujii, S., & Gärling, T. (2000). Determinants of private car users' acceptance of road pricing. *Transport Policy, 7,* 153–158.

Kaiser, F.G., Ranney, M., Hartig, T., & Bowler, P.A. (1999). Ecological behavior, environmental attitude, and feelings of responsibility for the environment. *European Psychologist, 4,* 59–74.

Klöckner, C.A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology, 30,* 574–586.

Matthies, E., Kuhn, S., & Klöckner, C.A. (2002). Travel mode choice of women: The result of limitation, ecological norm, or weak habit? *Environment and Behavior, 34,* 163–177.

Matthies, E., Klöckner, C.A., & Preissner, C.L. (2006). Applying a Modified Moral Decision Making Model to Change Habitual Car Use: How Can Commitment be Effective? *Applied Psychology: An International Review, 55,* 91–106.

Nordlund, A.M., & Garvill, J. (2003). Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. *Journal of Environmental Psychology, 23,* 339–347.

Oreg, S. (2003). Resistance to change: Developing an individual differences measure. *Journal of Applied Psychology, 88,* 680–693.

Parker, D., Reason, J.T., Manstead, A.S.R., & Stradling, S. G. (1995). Driving errors, driving violations and accident involvement. *Ergonomics, 38,* 1036–1048.

Poortinga, W., Steg, L., Vlek, C., & Wiersma, G. (2003). Household preferences for energy-saving measures: A conjoint analysis. *Journal of Economic Psychology, 24,* 49–64.

Roche-Cerasi, I., Rundmo, T., Sigurdson, J.F., & Moe, D. (2013). Transport mode preferences, risk perception and worry in a Norwegian urban population. *Accident Analysis & Prevention, 50,* 698–704.

Rundmo, T., Sigurdson, J.F., & Cerasi-Roche, I. (2011). Travel mode use, transportation priorities, and risk perception (pp. 9–29). In: T. Rundmo (Ed.). Perception of transport risk and urban travel mode use. Trondheim: Rotunde publ. no. 92.

Schade, J., & Schlag, B. (2003). Acceptability of urban transport pricing strategies. *Transportation Research Part F: Traffic Psychology and Behaviour, 6,* 45–61.

Schwartz, S.H. (1977). Normative influence on altruism. (pp. 221 - 279). In L. Berkowitz. (Ed.). *Advances in experimental social psychology.* New York, US: Academic Press.

Gärling, T., & Loukopoulos, P. (2007). Effectiveness, public acceptance, and political feasibility of coercive measures for reducing car traffic. (pp. 313–324). In T. Gärling., L. Steg. (Eds.). *Threats from car traffic to the quality of urban life: Problems, causes, and solution.* Oxford, UK: Elsevier.

Statistics Norway. (2012). Population's level of education, 1 October 2012. Accessed 07 November2013: http://www.ssb.no/en/utdanning/statistikker/utniv/aar/2013-06-18?fane=tabell&sort=nummer&tabell=116239

Steg, L. (2005). Car use: lust and must. Instrumental, symbolic and affective motives for car use. *Transportation Research Part A: Policy and Practice*, *39*, 147–162.

Steg, L., & De Groot, J. (2010). Explaining prosocial intentions: Testing causal relationships in the norm activation model. *British Journal of Social Psychology, 49,* 725–743.

Tertoolen, G., van Kreveld, D., & Verstraten, B. (1998). Psychological resistance against attempts to reduce private car use. *Transportation Research Part A: Policy and Practice, 32,* 171–181.

Thaler, R.H. (2018). From cashews to nudges: The evolution of behavioral economics. *American Economic Review, 108,* 1265–1287.

UNDP. (2013). Human Development Report 2013. The rise of the south: Human progress in a diverse world. Accessed 07 November2013: http://issuu.com/undp/docs/hdr_2013_en?e=3183072/1754153

Viera, J.F., Moura, F., & Viegas, J.M. (2007). Transport policy and environmental impacts: the importance of multi-instrumentality in policy integration. *Transport Policy, 14,* 421–432.

Zhao, H., Zhang, H., Xu, Y., Lu, J., & He, W. (2018). Relation between awe and environmentalism: The role of social dominance orientation. *Frontiers in Psychology, 9,* 2367.