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# The Socio-Cognitive Links between Road Pricing Acceptability and Changes in Travel-Behavior

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## Abstract

The objective of this study is to examine the effect of road pricing on people's tendency to adapt their current travel behavior. To this end, the relationship between changes in activity-travel behavior on the one hand and public acceptability and its most important determinants on the other are investigated by means of a stated adaptation experiment. Using a two-stage hierarchical model, it was found that behavioral changes themselves are not dependent on the perceived acceptability of road pricing itself, and that only a small amount of the variability in the behavioral changes were explained by socio-cognitive factors. The lesson for policy makers is that road pricing charges must surpass a minimum threshold in order to entice changes in activity-travel behavior and that the benefits of road pricing should be clearly communicated, taking into account the needs and abilities of different types of travelers. Secondly, earlier findings concerning the acceptability of push measures were validated, supporting transferability of results. In line with other studies, effectiveness, fairness and personal norm all had a significant direct impact on perceived acceptability. Finally, the relevance of using latent factors rather than aggregate indicators was underlined.

*Keywords:* road pricing, socio-cognitive factors, acceptability, activity-travel behavior, stated adaptation experiment

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## 1. Introduction

The previous century is characterized by an extraordinary growth in car use that has continued in the current century (Blythe, 2005). Passenger car use in the European Union grew by 18% between 1995 and 2004 and was responsible for 74% of all passenger transport in 2004 (European Environment Agency, 2008). As a result, in today's society, various car-related problems are manifested, including serious environmental, economic and societal repercussions (Schuitema et al., 2010). It is estimated that urban transport in the European Union accounts for 80% of congestion costs, 15% of all greenhouse gas emissions and annually 20,000 road fatalities (May et al., 2008). Rising concerns over these increasingly intolerable externalities have generated particular interest in how transport-planning policies might moderate the pressures resulting from growth in personal mobility and support the principles of sustainable development (Janssens et al., 2009a).

Although no standard definition of sustainable transport is available (Beatley, 1995), most delineations imply that sustainable transport balances environmental, social and economic qualities (Steg and Gifford, 2005). Generally speaking, sustainable transport could be seen as the outcome of different policy measures that aim at lowering the ecological footprint of activity-travel patterns in an economically feasible manner (Wittneben et al., 2009). These policy measures are commonly referred to as Travel Demand Management (TDM) measures. As indicated by Eriksson et al. (2006, pg. 15), Travel Demand Management measures can be defined as 'strategies aiming to change travel behavior'.

An important policy measure for governments in modifying activity-travel behavior is the introduction of road pricing (Xie and Olszewski, 2011). The term road pricing, also referred to as congestion charging and congestion pricing, can be defined as any form of charging of the use of roads during periods of peak demand (Janssens et al., 2009a). A key issue in making road pricing systems operational is building support for the policy measure.

The objective of this study is to investigate the effect of road pricing on people's tendency to adapt their current travel behavior. In order to reach this goal, we will make use of a two-stage hierarchical model (see Figure 1) concentrated around the concept of public acceptability. By means of this model, three specific research targets will be set. Firstly, we will explore the relationship between adapted travel behavior itself on the one hand and public acceptability as well as its most important first- (i.e., effectiveness

38 and fairness) and second-order determinants (i.e., general environmental be-  
39 liefs and values, problem awareness, personal norm, and willingness to act  
40 pro-environmentally) on the other. Secondly, we verify whether earlier find-  
41 ings concerning the acceptability of push measures replicate for road pric-  
42 ing. In line with previous research (Eriksson et al., 2006, 2008), we expect  
43 for instance that public acceptability in case of road pricing, besides being  
44 determined by perceived effectiveness and fairness, is rather a function of  
45 personal norm than problem awareness. In addition, we expect road pricing  
46 to be perceived as a rather unfair policy measure. Thirdly, while estimating  
47 the model, latent constructs measured by means of multiple items will not  
48 be replaced by the aggregate of their indicators.

49 In the next Section, a literature review will be provided discussing the  
50 concept of public acceptability and the use of two-stage models. Special  
51 emphasis will be put on the delineation of the socio-cognitive factors. Con-  
52 sequently, in Section 3 the methodology will be elucidated and the actual  
53 interpretation of the various socio-cognitive factors will be highlighted. Af-  
54 terwards, in Sections 4 and 5, the results will be presented and discussed more  
55 in detail. Finally, Section 6 will recapitulate the most important findings and  
56 pin-point some worthwhile avenues for policy makers.

## 57 2. Literature Review

58 Together with Schade (2003), Eriksson et al. (2006, pg. 16) define public  
59 acceptability as ‘the degree of positive or negative evaluation of a TDM-  
60 measure that may be implemented in the future.’ In line with its basic  
61 definition, public acceptability is traditionally operationalized as a single-  
62 dimensional concept, captured by means of one (or more) item(s) probing  
63 for some kind of overall evaluative assessment such as the degree to which  
64 individuals consider a certain TDM-measure is likeable, acceptable, admissi-  
65 ble, agreeable or favorable.

66 In general, studies on public acceptability of TDM-measures concentrate  
67 around one main issue which is how to model the concept’s origination. Ac-  
68 cording to Eriksson et al. (2006, 2008), two basic approaches can be distin-  
69 guished within the extant literature.

70 A first approach is to treat a TDM-measure’s public acceptability ex-  
71 clusively in function of TDM-measure-specific aspects with the two most  
72 important ones being perceived *effectiveness* and *fairness*. A measure’s per-  
73 ceived effectiveness stands for the extent to which a person believes it will

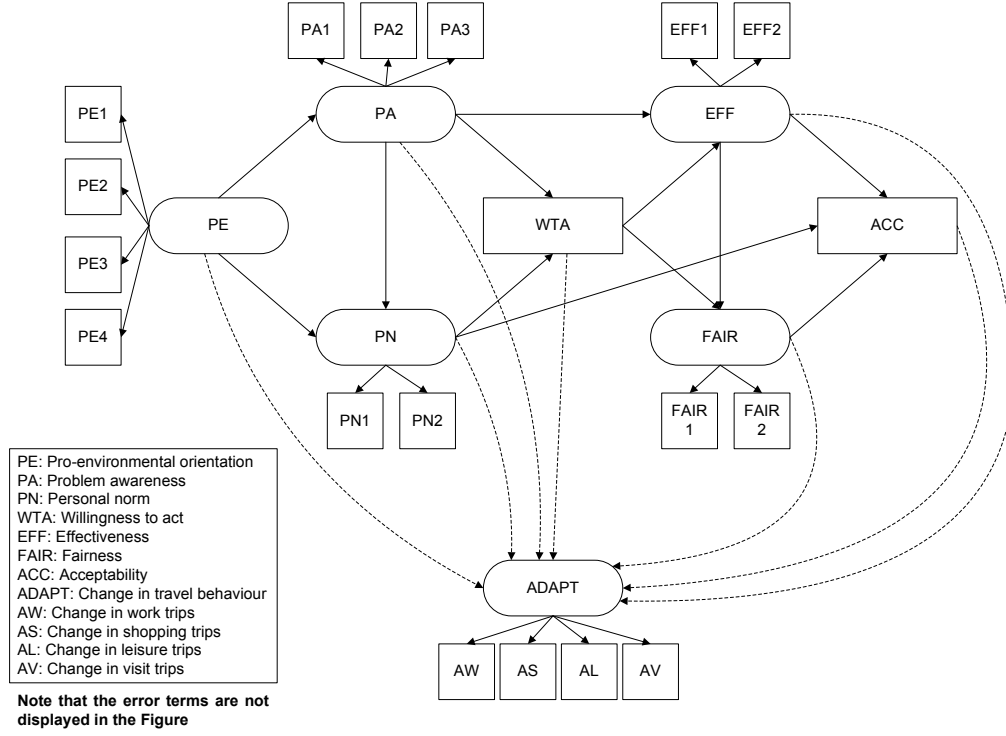


Figure 1: Conceptual model

reach the purpose for which it has been developed (in case of road pricing, the final objective is to reduce car use and thereby diminish human pressure on the ecological environment). Perceived fairness is more a matter of moral legitimacy, i.e., the degree to which a policy measure is seen as ethically just. On the one hand, fairness is seen as a function of the degree to which a measure infringes on personal freedom with the underlying reasoning being that, the more a measure threatens individual freedom, the less fair it is perceived to be (Bamberg and Rölle, 2003). On the other hand, a measure's fairness is considered as dependent upon its perceived effectiveness as well. That is, given a measure is not believed to reach its goal, its implementation is perceived as unfair (Eriksson et al., 2006). In terms of how both perceived effectiveness and fairness structurally relate to a measure's overall acceptability, it is assumed the effect of effectiveness can be direct as well as indirect,

87 i.e., mediated through fairness.

88 An alternative approach is to treat public acceptability of a TDM-measure  
89 as a two-stage hierarchical model, that is, with the inclusion of deeper-lying  
90 environmental-related beliefs, norms and values. As indicated by Eriksson  
91 et al. (2006, 2008), the primary reason for doing so is drawn from the work of  
92 Schwartz (1977) on Norm Activation Theory where he explains pro-social be-  
93 havior in function of altruistic norms and motives. With pro-environmental  
94 actions (such as recycling or reducing car use) seen as typical examples of  
95 pro-social behavior, the idea of explaining pro-environmental behavior in  
96 function of more deeply ingrained environment-related beliefs, norms and  
97 values is perfectly arguable. One of the most popular theoretical frameworks  
98 to this respect is the Value-Belief-Norm (VBN) Theory of Environmentalism  
99 (Stern, 2000; Stern et al., 1999). One of its basic hypotheses is that *gen-*  
100 *eral environmental beliefs and values* determine both the extent to which the  
101 individual is cognizant of the environmental problem (i.e., *problem aware-*  
102 *ness*) and whether s/he feels a personal obligation to contribute to the solu-  
103 tion and thus behave in a (more) pro-environmental manner (i.e., *personal*  
104 *norm*). Personal norm and problem awareness in turn, are believed to affect  
105 the individual's *willingness to act pro-environmentally*.

### 106 3. Methodology

#### 107 3.1. Two-Stage Model

108 This paper adopts the two-stage hierarchical model approach, explain-  
109 ing public acceptability by measure-specific aspects (i.e., effectiveness and  
110 fairness) as first-stage constructs and variables appearing within the VBN  
111 framework (i.e., general environmental beliefs and values, problem awareness,  
112 personal norm and willingness to act pro-environmentally) as second-stage  
113 constructs (see Figure 1). The starting point is the two-stage hierarchical  
114 model proposed by Eriksson et al. (2006, 2008), but addresses the following  
115 concerns and issues.

- 116 1. *Relationship between public acceptability and changes in travel behav-*  
117 *ior*. Although lack of public acceptability is widely acknowledged as the  
118 single greatest barrier to the implementation of road pricing (see e.g.  
119 Gaunt et al., 2007), to the best of our knowledge, no studies focusing  
120 on the psychological underpinnings of road pricing, have investigated  
121 whether or how public acceptability itself, as well as its most impor-  
122 tant determinants, relate to people's actual changes in travel behavior.

Put differently, prior research investigating the socio-cognitive underpinnings of road pricing has systematically taken public acceptability instead of behavior as the final outcome variable. This is somewhat surprising since, strictly taken, the key-question when it comes to examining the effectiveness of TDM-measures is not so much to understand what makes such measures more or less acceptable, but *whether* and (even more importantly) *how* acceptability relates to the induction of a behavioral change. Indeed, as for the ‘whether’ question, although it seems an agreed upon idea that acceptability is an important condition for TDM-measures to make people adapt their behavior, without this assumption being empirically verified, it remains a speculative assertion. As for the ‘how’ question, we do not know for instance whether it is overall acceptability itself or (one of) its underlying determinants that leads to the desired behavioral change.

2. *The use of latent factors rather than aggregate indicators.* A second issue is related to the way in which two-stage models for public acceptability of TDM-measures have been statistically analyzed. Given the fact that (1) two-stage models are structural by definition with multiple equations to be estimated simultaneously and, (2) variables appearing in such two-stage models are typical latent (i.e., not directly observable) constructs, *Structural Equation Modeling* (SEM) is the preferred approach in terms of model estimation. Interestingly, a closer look at how latent constructs are treated in the literature reveals that, in strict sense, these are not operationalized as full worthy latent constructs. Instead, a typical practice is to have the *unobservable* construct itself being replaced by the aggregation of values obtained for that construct’s *observable* indicators (see e.g. Eriksson et al., 2006, 2008). Nonetheless, this practice is to be avoided. First, from theoretical point of view, SEM should be used as a confirmatory approach. As most of the socio-cognitive factors have their operationalization rooted in the theories on the explanation and prediction of behavior, the reflective structure of the latent constructs should be kept. Second, dropping an indicator from the aggregate construct might alter the meaning of the construct and measurement errors are capitalized in this one construct. Third, as the different indicators are likely to be correlated and the direction of the causality is from the construct to the indicators, only a reflective model structure will yield valid results. For a more elaborate methodological discussion concerning the need for a reflective model structure

161 in this type of analysis, the reader is referred to Bollen (1984) and  
162 Jarvis et al. (2003).

### 163 3.2. Stated Adaptation Experiment

164 The research represented in this paper was conducted in Flanders, the  
165 Dutch-speaking region of Belgium, by means of an interactive stated adap-  
166 tation survey, administered on the internet, involving 300 respondents. Al-  
167 though it could be argued that sample bias is introduced when solely con-  
168 ducting an internet-based data collection, internet-based surveys allow for  
169 automatic randomization of the ordering of the questions and can be com-  
170 pleted at the respondent's discretion. Furthermore, it is simpler to prompt  
171 additional questions within the situational context entered in the question-  
172 naire (Janssens et al., 2009a). On the basis of these arguments, it was decided  
173 to choose for an internet-based survey rather than a traditional paper-and-  
174 pencil survey as the advantages outweighed the disadvantages.

175 Given that private car use is derived from needs, desires and obligations  
176 to participate in out-of-home activities, it is argued that changes in activity-  
177 travel behavior in response to road pricing are not one-dimensional and need  
178 to be conceptualized in function of the engagement of out-of-home activities  
179 (Loukopoulos et al., 2006). Therefore in this paper, changes in activity-  
180 travel behavior in response to road pricing for the four most frequent out-  
181 of-home activities (commuting (work/school), shopping, leisure and visits),  
182 most frequent according to the Flemish travel behavior survey 2007-2008  
183 (Janssens et al., 2009b), are surveyed.

#### 184 3.2.1. Behavioral Adaptations

185 For each activity a congestion pricing scenario was formulated of the  
186 following general form:

187 *Assume that the fixed vehicle taxation is replaced by a variable road price*  
188 *which is to be paid for each kilometer traveled by car. The charge will be 7*  
189 *eurocents on roads at un-congested periods, and 27 eurocents at congested*  
190 *periods.*

191 After the introduction of the congestion price measure, the respondents  
192 could indicate multiple long-term and short-term adaptations. For each trip  
193 for a particular activity, the following long-term changes were considered: (i)  
194 a change of residential location of the household (e.g. moving to a location  
195 closer to the workplace), (ii) a change of work location of the individual

196 (closer to the residential location), and (iii) no change. Concerning short-  
 197 term changes the following alternatives were defined: (i) eliminating the trip  
 198 by conducting the activity at home, (ii) eliminating the trip by skipping the  
 199 activity, (iii) reduce the distance of the trip by conducting the activity more  
 200 close to home, (iv) change the transport mode of the trip, (v) change the  
 201 departure time of the trip, (vi) change the route of the trip, and (vii) no  
 202 change.

203 For each activity, these behavioral alterations have been recoded on six  
 204 point scales (1 representing the smallest impact on the activity-travel be-  
 205 havior, 6 the largest impact): 6 representing structural changes, 5 corre-  
 206 sponding to changes in activity situation, 4 indicating a model shift towards  
 207 environment-friendly transport modes, 3 representing time-of-day changes, 2  
 208 indicating route changes, and 1 corresponding to the no change alternative.  
 209 Thus, four indicators to represent the changes in activity-travel behavior have  
 210 been obtained: changes in work trips [AW], changes in shopping trips [AS],  
 211 changes in leisure trips [AL] and changes in visit trips [AV].

### 212 3.2.2. Socio-Cognitive Factors

213 Next to indicating changes in travel behavior, the respondents were asked  
 214 to answer questions concerning general environmental and policy-specific be-  
 215 liefs. Beliefs are defined as the subjective probability that an object has a  
 216 certain outcome. The outcome of an object can be judged to be favorable,  
 217 neutral or unfavorable, referring to the valance of a belief (Schuitema et al.,  
 218 2010). It was decided to adopt the questionnaire implemented by Eriksson  
 219 et al. (2008) to assess whether earlier findings concerning the acceptability  
 220 of road pricing are transferrable across notations.

223 Concerning *general environmental beliefs*, first, the respondents' *pro-envi-*  
 224 *ronmental orientation* [PE] was assessed by four items (see Table 1) included  
 225 in the NEP scale (Dunlap et al., 2000). The respondents had to indicate to  
 226 what extent they agreed to the statements on a five point scale (1 = strongly  
 227 disagree, 2 = mildly disagree, 3 = unsure, 4 = mildly agree, 5 = strongly  
 228 agree). The internal consistency of the latent construct pro-environmental  
 229 orientation was reassured by a Cronbach's alpha of 0.67. Note that Moss  
 230 et al. (1998) suggest that an alpha score of 0.60 is generally acceptable.  
 231 Next, *problem awareness* [PA] and *personal norm* [PN] were assessed by  
 232 respectively three and two statements. Similar to the pro-environmental

orientation, respondents had to evaluate the statements on a five point scale. Alpha scores of 0.91 for the indicators of problem awareness, and 0.79 for the indicators of personal norm, underlined the high internal reliability of the latent constructs. Finally, *willingness to act* [WTA] was directly measured with one item, again measured on the same five point scale.

Table 1: Statements for the indicators of the socio-cognitive factors

Indicator <sup>1</sup>	Statements
<i>General environmental beliefs</i>	
PE1	When humans interfere with nature it often produces disastrous consequences.
PE2	Humans are severely abusing the environment.
PE3	If things continue on their present course, we will soon experience a major ecological catastrophe.
PE4	The balance of nature is very delicate and easily upset.
PA1	Air pollution from private car use is a threat to humans and the environment in the whole world.
PA2	Air pollution from private car use is a threat to humans and the environment in Belgium.
PA3	Air pollution from private car use is a threat to the health and well-being of me and my family.
PN1	I feel morally responsible to reduce the negative environmental effects of my car use.
PN2	I get a guilty conscience if I don't try to reduce the negative environmental effects of my car use.
WTA	I am willing to reduce the negative environmental effects of my car use.
<i>Policy specific beliefs</i>	
EFF1	To what extent do you perceive road pricing to be effective?
EFF2	To what extent do you perceive road pricing will lead to an improved environment?
FAIR1	To what extent do you perceive road pricing to be fair for you?
FAIR2	To what extent do you perceive road pricing to be fair for others?
ACC	To what extent are you in favor or against the implementation of this policy measure?

<sup>1</sup> Abbreviations are indicated in the text between square brackets.

With respect to *policy specific beliefs*, road pricing was evaluated to the extent road pricing was perceived to be effective, fair and acceptable. First, *perceived effectiveness* [EFF] was evaluated by two questions rated on a five point scale (1 = not all effective, 3 = neither effective nor ineffective, 5 = very effective). Second, respondents evaluated *perceived fairness* [FAIR] for both themselves and others using also a five point scale (1 = very unfair, 3 = neither fair nor unfair, 5 = very fair). The internal reliability of both latent constructs was reassured by alpha values of respectively 0.87 and 0.89. Finally, *perceived acceptability* [ACC] was directly measured with one item, again measured on a five point scale (1 = completely against, 3 = neither in favor nor against, 5 = completely in favor).

## 249 4. Results

### 250 4.1. Descriptive Analysis

251 Before providing an in-depth interpretation of the results of the proposed  
252 conceptual model, first the relationships between adapted travel behavior  
253 itself on the one hand and public acceptability as well as its most important  
254 first- and second-order determinants on the other, are investigated by means  
255 of Pearson correlations between the observable variables.

256 From Table 2 one could notice that the direct relationship between ac-  
257 ceptability [ACC] and changes in travel behavior are not significant, except  
258 for visit trips [AV]. Moreover, most of the indicators of the first- and second-  
259 order determinants of acceptability neither have a significant relationship  
260 with the changes in travel behavior. In contrast, all these indicators, with  
261 exception of the first indicator of pro-environmental orientation, do have a  
262 statistically significant correlation with perceived acceptability. Next to the  
263 relationships between the various indicators on the one hand and accept-  
264 ability on the other, most of these indicators are highly correlated among  
265 themselves.

### 266 4.2. Two-Stage Model Results

267 The estimated model predicting both acceptability of road pricing and  
268 behavioral adaptations in response to road pricing, is displayed in Figure  
269 2. Recall that both general environmental and policy specific beliefs were  
270 included in the model. One could observe that the final obtained model  
271 deviates from the proposed model displayed in Figure 1 as only the significant  
272 paths (at the 5% level) were kept in the final model to ensure the parsimony  
273 of the model. The whole sample ( $N = 300$ ) was used in the analysis. Note  
274 that the proposed model was tested using AMOS 4.0 (Arbuckle and Wothke,  
275 1999).

276 To assess the appropriateness of the proposed model, different goodness-  
277 of-fit measures were tabulated, for the proposed model, as well as for the  
278 independence model and the saturated model. All the tabulated goodness-of-  
279 fit and model evaluation criteria (see Table 3) are indicating a good model fit,  
280 providing evidence that the proposed model can explain well the relationships  
281 between adapted travel behavior on the one hand and public acceptability  
282 and its most important determinants on the other hand.

283 Investigation of the causal relationships between adapted travel behavior  
284 on the one hand and public acceptability and its most important determi-

Table 2: Correlation matrix of observed variables included in the model

	AW	AS	AL	AV	ACC	PE1	PE2	PE3	PE4	
AW	1									
AS	.259**	1								
AL	.251**	.439**	1							
AV	.268**	.356**	.456**	1						
ACC	.014	.024	.016	.134*	1					
PE1	-.110	-.016	-.024	.004	.092	1				
PE2	.051	.033	.005	.115*	.234**	.398**	1			
PE3	-.040	.027	-.012	.035	.193**	.293**	.433**	1		
PE4	.044	.112	-.010	.105	.144*	.180**	.347**	.353**	1	
PA1	.086	.146*	.110	.016	.331**	.239**	.305**	.324**	.283**	
PA2	-.002	.106	.049	.057	.306**	.249**	.291**	.361**	.286**	
PA3	.013	.105	.055	.043	.299**	.265**	.286**	.388**	.297**	
PN1	.111	.136*	.078	.097	.309**	.047	.286**	.256**	.222**	
PN2	.060	.120*	.032	.080	.289**	.076	.323**	.274**	.188**	
EFF1	.129*	.026	.066	.127*	.690**	.002	.139*	.146*	.162**	
EFF2	.042	.095	.014	.095	.694**	.073	.151**	.233**	.165**	
FAIR1	-.046	-.041	-.061	.022	.773**	.060	.184**	.140*	.162**	
FAIR2	.029	-.019	-.061	.058	.756**	.069	.206**	.170**	.183**	
WTA	.037	.033	.078	.129*	.164**	.059	.139*	.160**	.136*	
	PA1	PA2	PA3	PN1	PN2	EFF1	EFF2	FAIR1	FAIR2	WTA
PA1	1									
PA2	.740**	1								
PA3	.719**	.882**	1							
PN1	.416**	.375**	.419**	1						
PN2	.370**	.405**	.450**	.651**	1					
EFF1	.366**	.344**	.312**	.254**	.218**	1				
EFF2	.318**	.308**	.284**	.232**	.266**	.774**	1			
FAIR1	.257**	.267**	.266**	.239**	.268**	.651**	.648**	1		
FAIR2	.255**	.245**	.224**	.204**	.274**	.684**	.681**	.812**	1	
WTA	.271**	.304**	.325**	.505**	.412**	.119*	.094	.132*	.072	1

\*\* Pearson correlation is significant at the 0.01 level (2-tailed)

\* Pearson correlation is significant at the 0.05 level (2-tailed)

Table 3: Goodness-of-fit-statistics

Model	$\chi^2/df$	CFI	GFI	AFGI	NFI	TLI
Two-stage model	1.41	0.98	0.94	0.91	0.93	0.97
Independence model	16.99	0.00	0.39	0.32	0.00	0.00
Saturated model		1.00	1.00		1.00	
Model	RMSEA	PCLOSE	AIC	BIC	ECVI	
Two-stage model	0.037	0.97	297	616	0.99	
Independence model	0.231	0.00	2944	3070	9.85	
Saturated model	380	1643	1.27			

285 nants on the other (Table 4), reveals that the behavioral changes themselves  
286 are not dependent on the perceived acceptability of road pricing. Moreover,  
287 only a relative small amount of the variability in the behavioral changes  
288 (10.7%) is explained by the socio-cognitive factors. Nonetheless, personal  
289 norm and in particular, perceived effectiveness, have an inducing effect on  
290 changes in activity-travel behavior. In contrast, perceived fairness has a

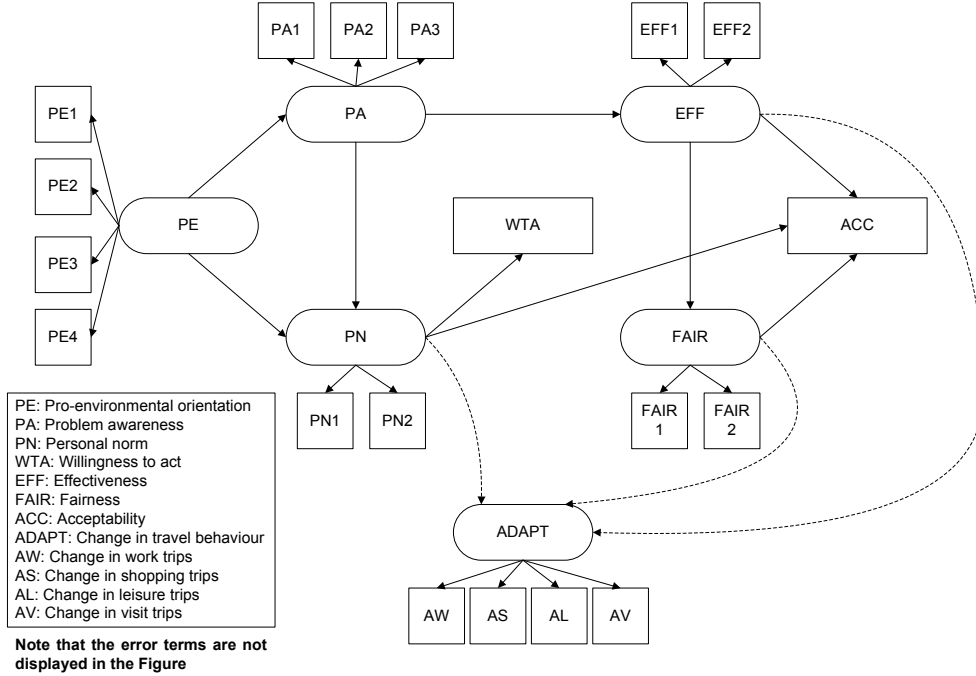


Figure 2: Estimated model

negative effect on the behavioral changes.

An assessment of the total standardized effects (i.e. the sum of direct and indirect effects) displayed in Table 5, yields the insight that next to personal norm, perceived effectiveness, and perceived fairness, also pro-environmental orientation and problem awareness have an impact on behavioral changes, albeit it a small impact.

Evaluation of the regression weights (Table 4) illustrates that acceptability of road pricing is directly influenced by effectiveness, fairness and personal norm: all three socio-cognitive factors have an increasing effect on acceptability.

## 5. Discussion

Earlier findings concerning the acceptability of push measures could be validated. The fact that effectiveness, fairness and personal norm have an

Table 4: Regression weights, standard errors and standardized regression weights

Path	Est.	S.E.	S. Est	Path	Est.	S.E.	S. Est
EFF → ACC	0.324	0.107	0.246	ADAPT → AW	1.000		0.402
EFF → ADAPT	0.404	0.156	0.477	EFF → EFF1	1.093	0.057	0.885
EFF → FAIR	0.959	0.062	0.838	EFF → EFF2	1.000		0.875
FAIR → ACC	0.711	0.093	0.618	FAIR → FAIR1	1.000		0.901
FAIR → ADAPT	-0.349	0.134	-0.470	FAIR → FAIR2	0.917	0.041	0.903
PA → EFF	0.432	0.067	0.390	PA → PA1	0.899	0.048	0.784
PA → PN	0.440	0.080	0.425	PA → PA2	1.001	0.037	0.941
PE → PA	1.044	0.181	0.552	PA → PA3	1.000		0.934
PE → PN	0.436	0.177	0.223	PE → PE1	1.000		0.473
PN → ACC	0.141	0.052	0.100	PE → PE2	1.389	0.217	0.680
PN → ADAPT	0.153	0.073	0.168	PE → PE3	1.391	0.218	0.662
PN → WTA	0.525	0.056	0.577	PE → PE4	1.042	0.183	0.514
ADAPT → AL	1.624	0.298	0.706	PN → PN1	1.000		0.846
ADAPT → AS	1.459	0.274	0.611	PN → PN2	0.969	0.082	0.768
ADAPT → AV	1.283	0.240	0.625				

Note: Est. = Estimate, S.E. = Standard Error, S. Est = Standardized Estimate  
Explained variance: ADAPT 10.7%, ACCEPT 74.1%, FAIR 70.2%, EFF 15.2%,  
WTA 33.3%, PN 33.5%, PA 30.5%

Table 5: Total standardized effects for road pricing

	PE	PA	EFF	FAIR	PN
ADAPT	0.095	0.104	0.083	-0.470	0.168
ACC	0.211	0.341	0.764	0.618	0.100

increasing effect on acceptability is in line with the model predicting the acceptability of raised tax on fossil fuel (which could be seen as an operationalization of road pricing) presented by Eriksson et al. (2008). The transferability of the results across nations is even further supported by the mutual relationships between the most important first- (i.e. effectiveness and fairness) and second-order determinants (i.e. pro-environmental orientation, problem awareness and personal norm).

Despite the large amount of similarities, the relationships concerning the willingness to act differ between the two studies. Whereas willingness to act was significantly influenced by both problem awareness and personal norm, and had on its own a positive effect on effectiveness and fairness in the study reported by Eriksson et al. (2008), in the study reported in this paper willingness to act was only directly influenced by personal norm, and had on its own no significant impact on effectiveness and fairness. This could be an indication that the concept of willingness to act might be better grasped by a latent factor using multiple indicators.

An important difference between the present study and the study reported by Eriksson et al. (2008) is that the latent constructs measured by means

322 of multiple items in this study are not replaced by the aggregate of their  
 323 indicators. The appropriateness of using latent constructs is supported by  
 324 the proportion of the variance that is explained by the model presented in  
 325 this paper, when compared to the percentage of the variance that is explained  
 326 by the TAX-model presented by Eriksson et al. (2008). When focussing on  
 327 the final outcome variable of their model (i.e. perceived acceptability) in  
 328 the present study, 74% of the variance is explained, while the TAX-model  
 329 reported by Eriksson et al. (2008) accounts for 58%. Also for all underlying  
 330 determinants a larger portion of the variance is explained by the model that  
 331 uses the latent constructs. The largest difference in variance explained could  
 332 be noticed for perceived fairness: 70% of the variance was explained by the  
 333 latent construct model, while only 22% of the variance was accounted for  
 334 by the model using aggregate indicators. Especially for this socio-cognitive  
 335 factor the reflective structure of the construct contributed significantly.

336 A controversial finding in this paper is the negative effect caused by per-  
 337 ceived fairness on changes in activity-travel behavior. This finding can be  
 338 partially accounted for by the fact that the monetary value of the road pric-  
 339 ing charges must surpass a minimum threshold before people will actually  
 340 change their activity-travel behavior. This is especially true for the structural  
 341 changes, such as residential relocations and changes of job location. This is  
 342 in line with the findings reported by Tillemans et al. (2010) who reported that  
 343 travel costs (i.e. toll and fuel) are a crucial factor in the actual residential  
 344 location choice in the case of road pricing. Notwithstanding, this finding  
 345 does not imply that the level of congestion charging has no boundaries. Af-  
 346 ter all, when congestion charges are too high, and no reasonable alternatives  
 347 are available, people might oppose to the congestion charges and accessibil-  
 348 ity (see e.g. Condeço-Melhorado et al. (2011)) and equity problems (see e.g.  
 349 Eliasson and Mattsson (2006)) can arise.

## 350 **6. Conclusions**

351 In this paper, changes in activity-travel behavior in response to road pric-  
 352 ing are treated as a complex psychological phenomenon. The most important  
 353 finding is that acceptability of road pricing as a single dimensional overall  
 354 evaluative construct itself does not directly entice changes in activity-travel  
 355 behavior. As Goodwin and Lyons (2010) reported, there are strong argu-  
 356 ments that socio-cognitive factors and actual choices may be ill-matched.  
 357 The lack of a direct impact of acceptability on behavioral changes supports

358 this hypothesis of mismatching. From policy point of view however, it was  
359 argued that road pricing charges must surpass a minimum threshold in or-  
360 der to change a person’s mind set in such way that he/she alters his/her  
361 activity-travel behavior. This however, does not mean that acceptability  
362 can be neglected. A very delicate issue of importance in every (mobility)  
363 policymaking program lays in the challenge to shift people away from the  
364 self-interest that commonly drives them. Therefore, creating a sound basis  
365 of policy support first is essential, especially when push measures such as  
366 road pricing are to be introduced (Cools et al., 2009).

367 How much effort is required to convincing someone to move over to the  
368 societal side of the spectrum and thus to create policy support for the policy  
369 initiatives is heavily dependent on the individual’s values, i.e. the individu-  
370 als’ orientation with respect to how inclusive the measures’ impact on their  
371 environment is perceived to be (Stern et al., 1999). Homocentric and ecocen-  
372 tric personalities can fairly easily be convinced by focusing the attention on  
373 the pressure daily congestion lays on society and the ecosystem. To convince  
374 the most radical egocentric members of society to adapt to the new initia-  
375 tive, the before-mentioned negative impact of perceived fairness on changes  
376 in activity-travel behavior is of interest here: because of their self-centered  
377 mind-set, they will continue to strive for the optimization of their own ben-  
378 efits. Driving more in off-peak hours will therefore become more interesting,  
379 since the egocentric human being will experience it as more beneficial when  
380 compared to driving during rush hour. As Bonsall et al. (2007) suggest, op-  
381 portunities for getting these people on board may lay in presenting the road  
382 pricing tariff as an off-peak discount rather than as a peak surcharge.

383 Thus, a main focus point in the strategy of creating broad policy support  
384 for road pricing lays in clearly communicating and even providing education  
385 on the benefits thereof. It is a matter of convincing rather than seducing the  
386 public. In addition, these benefits should be clearly visible for the road users  
387 (Schuitema et al., 2010). The rationale “*may need to be communicated in a*  
388 *variety of ways, in both summary and detailed formats, in order to meet the*  
389 *needs and abilities of different types of driver. Significant effort would be re-*  
390 *quired, prior to launch, to explain the reasons for the scheme and the logic of*  
391 *the charging structure, and the system should be trialed with no actual charg-*  
392 *ing to help people become familiar with the charge structure. The development*  
393 *of information services [...] could play an enormous role in helping people to*  
394 *understand, predict and react to variable charges. Government has a role in*  
395 *facilitating this development while staying alert to the equity.*” (Bonsall et al.,

2007, pg. 680). Additional issues that have to be taken into account when introducing a road pricing policy on order to enhance the measure's acceptance are matters of technical simplicity and minimized hindrance (Blythe, 2005) and uniformity, clarity and stability in the diversity of tariffs (Bonsall et al., 2007).

Note that an increase in generalized transport costs (e.g. induced by road pricing), may cause accessibility disparities at a regional level (Condeço-Melhorado et al., 2011) and within the population. Certain areas may become economically unattractive and people may be cut off from opportunities because of the increased transport costs. The introduction of congestion charging policies will remain a controversial issue, making it politically risky. Urban planners, policy makers and politicians are forced to consider how they can legitimately introduce a policy that the public may not want. Especially for the latter group of actors, this is an unnatural given. Politicians have a difficult task: to continuously find a good balance between acceptability and efficiency (Eriksson et al., 2008; Isaksson and Richardson, 2009; Rotaris et al., 2010). For a combination of the before mentioned arguments, it is suggested that the responsibility of introducing a road pricing policy is assigned to a higher (national or regional) level of policymaking. In general, a decent preparation and a strong leadership with a clear and well-underpinned vision in mind are essential when bringing a road pricing initiative into practice (Isaksson and Richardson, 2009).

In the attempt of achieving a more sustainable transport, road pricing alone will not counterbalance the growth in car use. As discussed by Jakobsson et al. (2002), even substantial economic disincentives are unlikely to lead to any large reduction in private car use. Therefore, it is important to implement a wider range of policy packages at a higher intensity in application (Hickman et al., 2010). Combined improvements to public transport services and fares, road pricing and integration of land use and transport planning can be instrumental in achieving a more sustainable transport (May et al., 2008). A single policy response is unlikely to encourage changed behavior in all users. The travel market is thus probably best simplified and understood by segmentation into coherent groups that share similar characteristics (Hickman et al., 2010). The key challenge will be to induce the most car-dependent travelers to shift towards more sustainable activity-travel behavior. Even focusing on small changes in behavior might yield significantly larger benefits on the long term, as people who are already inclined to show ecological activity-travel behavior are more likely to express similar behavior.

434 Once a first step toward an increased environmental awareness is achieved,  
435 more significant changes can be obtained more easily (Janssens et al., 2009a).

## 436 **Appendix A. Model Evaluation**

437 As was indicated before, the appropriateness of the proposed model has  
438 been assessed by tabulating different goodness-of-fit and model evaluation  
439 criteria. The first criterion that is displayed in Table 3 is the chi-square  
440 value divided by the degrees of freedom of the model. Values lower than 2  
441 are generally considered to represent a minimally plausible model (Byrne,  
442 1991). Second, the comparative fit index (CFI) is displayed, which should be  
443 greater than 0.95 to represent a good fit (Hu and Bentler, 1999). Next, the  
444 goodness-of-fit index (GFI), adjusted GFI (AFGI), normed fit index (NFI)  
445 and Tucker-Lewis index are computed. A good fit is indicated by values  
446 greater than 0.90 (Hu and Bentler, 1999; Sanders et al., 2005). In addition,  
447 the root mean square error of approximation (RMSEA) and PCLOSE  
448 are presented. RMSEA values lower than 0.05 indicate a good fit (Browne  
449 and Cudeck, 1993). PCLOSE tests the null hypothesis that RMSEA is not  
450 greater than 0.05. If PCLOSE is greater than 0.05, the null hypothesis is  
451 not rejected, indicating a good fit. Finally, the Akaike information criterion  
452 (AIC), Bayesian information criterion (BIC) and expected cross-validation  
453 index (ECVI) are displayed. The model with the lowest value is considered  
454 to be the best model according to these criteria.

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