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Free public transport: a socio-cognitive analysis

Mario Cools^{a,b,c}, Yannick Fabbro^d, Tom Bellemans^d

^a*University of Liège, ARGENCO, LEMA, Quartier Polytech 1, Allée de la Découverte 9, Bât 52/3, 4000 Liège, Belgium*

^b*KULeuven Campus Brussels, Department of Informatics, Simulation and Modeling, Warmoesberg 26, 1000 Brussels, Belgium*

^c*Hasselt University, Faculty of Business Economics, Agoralaan Gebouw D, 3590 Diepenbeek, Belgium*

^d*Hasselt University, Transportation Research Institute (IMOB), Wetenschapspark 5, bus 6, 3590 Diepenbeek, Belgium*

Abstract

In this study, the modal shift potential of introducing a free alternative (free public transportation) and of changing the relative prices of transportation is examined. The influence of a cognitive analysis on the zero-price effect is also analyzed. The data used for the analysis stem from a stated preference survey with a sample of approximately 670 respondents that was conducted in Flanders, Belgium. The data are analyzed using a mixed logit model. The modeling results yield findings that confirm the existence of a zero-price effect in transport, which is in line with the literature. This zero-price effect is increased by the forced cognitive analysis for shopping trips, although not for work/school or recreational trips. The results also demonstrate the importance of the current mode choice in hypothetical mode choices and the importance of car availability. The influence of changing relative prices on the modal shift is found to be insignificant. This might be partially because the price differences were too small to matter. Hence, an increase in public transport use can be facilitated by the introduction of free public transport, particularly when individuals evaluate the different alternatives in a more cognitive manner. These findings should be useful to policy makers evaluating free public transport and considering how best to target and promote relevant policy.

Keywords: free public transport, socio-cognitive analysis, mixed logit model

1. Introduction

Transportation has become extremely important in modern life. Everybody is, in some way, either directly or indirectly affected by transport. Its availability and accessibility delineate how, where and when we travel. Transport modal choice impacts many aspects of our lives, including our work, leisure and health (Kingham et al., 2001). The dependence on the car in everyday travel has increased enormously in recent decades, resulting in serious and growing consequences for the environment (e.g., greenhouse emissions) and health (e.g., casualties). Simultaneously, these consequences are very expensive for business (e.g., time lost due to congestion) and society (Brög et al., 2004). Growing 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., 2009; Cools et al., 2012). The problems concerning car use might be reduced in different ways. First, the negative impact of car use may be reduced via technological innovations that, e.g., increase the energy efficiency of cars or reduce the emissions per car kilometer. However, this type of policy tends to be overtaken by the continuing growth of motorized traffic worldwide. A second type of policy that has previously been very popular is the creation of new road infrastructure. This reduces congestion problems; however, environmental and health problems are likely to be exacerbated (Steg, 2003). A third type of policy is encouraging people to drive at other times or to other places. The fourth type of policy aims at reducing the level of car use by encouraging people to use other modes of transport, to combine trips, or to travel less. The fifth type of intervention aims at making people drive safer or in a more environmentally friendly manner (Steg, 2003).

This paper attempts to identify factors that influence an individual's mode choice by anticipating people's motivation to use other modes of transport and therefore can be framed in the fourth type of policy as described above. In this view, public transport (especially electric trains, trams and buses) appears to be a promising means of providing passenger transportation because it performs perhaps five or ten times better than cars in terms of energy per passenger-km (MacKay, 2009). Regardless, the car is more attractive than public transport because of its convenience, independence, flexibility, comfort, speed, and reliability and because driving is perceived to be more pleasurable (Steg, 2003). Another reason that it is so difficult

38 to persuade people to use other travel modes instead of the car is the ha-
39 bitual character of the modal choices. Habits are formed when a behavior
40 is repeated frequently in a stable context and leads to rewarding outcomes
41 (Thøgersen, 2009). Nonetheless, there exists the potential to persuade peo-
42 ple to switch to public transport when a set of circumstances are met. These
43 circumstances include travel cost savings, frequency of service, time savings,
44 accessibility to jobs, a variety of payment types, and the opportunity to do
45 other things while traveling (Majumdar and Lentz, 2012). Other studies
46 have indicated that travel choice is governed by a number of factors, most
47 notably travel time and the availability of a car and of discounted long-term
48 tickets and fares (Borndörfer et al., 2012). When one of these factors can
49 be so powerful that it disrupts the context wherein habitual behavior is per-
50 formed, progress can be made in influencing the modal split. In this context,
51 the savings on travel cost, or travel fares, represents a factor in the modal
52 choice worth investigating. Various studies (Kingham et al., 2001; Steg, 2003)
53 have shown that the transportation price is one of the few evaluation factors
54 where public transport can beat car transport. Fares are a direct and flexi-
55 ble instrument for influencing passenger behavior (Borndörfer et al., 2012).
56 Therefore, to motivate people to use public transport, fares would need be
57 lowered to a level whereby the traveler is enticed to choose public transport.
58 This can be achieved by offering public transport at a reduced price or as
59 free public transport. Nevertheless, free public transport to the user implies
60 that a third party pays for the cost of provisioning (van der Vliet, 2010).

61 This paper examines the effect of transport at a reduced price and at a
62 zero price. To investigate this effect, a respondent’s actual (revealed) mode
63 choice is compared (*i*) with the mode choice knowing the genuine prices
64 of transport, (*ii*) with the mode choice of the respondent when faced with
65 reduced transport prices and (*iii*) with the mode choice of the respondent
66 when the transport prices are further reduced such that public transport
67 becomes free to the transport user.

68 **2. Literature Review**

69 *2.1. Zero-Price effect*

70 In this section, an explanation of the zero-price effect and some factors
71 influencing the zero-price effect are provided. The word “free” has several
72 meanings but essentially denotes that a product or service is made available
73 at a zero price (Anderson, 2009). A free product used to be nothing more

74 than an attention-grabbing marketing trick; however, under certain condi-
75 tions, businesses can now obtain greater profits by giving products away than
76 by charging for them. Smith (2008) indicated that when there is a voluntary
77 exchange between two parties, both parties will benefit. Free is becoming a
78 strategy that is essential for any company to survive. The success of a free
79 product lies in the zero-price effect. The zero-price effect is an overreaction
80 to a free product when people are faced with a choice between two products,
81 of which one is free. This overreaction is to such an extent that the zero
82 price means not only a low cost of buying the product but also an increased
83 valuation of the product (Shampanier et al., 2007). People see zero as more
84 than simply another price. The power of “free” also suggests that once a
85 free item is priced above zero, the demand for that item could decrease sig-
86 nificantly, namely by more than what conventional economics would predict
87 (Leong and Lew, 2011). An explanation of this zero-price effect can be found
88 in the mental transaction costs (Szabo, 1999). The mental transaction cost
89 is a process that appears with every purchase of a priced product. The cus-
90 tomer will ask himself whether this product is worth its price. In case of a
91 free product, the lacking of this mental transaction cost makes it easier to
92 convince people. The disadvantage of lacking a mental transaction cost is
93 that there is no commitment and that people attach more value to products
94 that they paid for (Szabo, 1999).

95 In prospect theory (Kahneman and Tversky, 1979), an explanation for the
96 individual consumer choice behavior is examined. Prospect theory assumes
97 that the choice process consists of two stages. In the preparation stage,
98 the individual sets a reference point for a certain choice. In the evaluation
99 stage, the outcome is compared to the reference point. The zero-price effect
100 makes the reference point for relative thinking disappear (Nicolau, 2012).
101 This disappearance creates a positive feeling within the consumer, who is
102 used to making the decision concerning the purchase of a product. It has
103 been suggested that this positive feeling is derived from the fact that the
104 purchase implies only benefits, not costs. When this feeling is eliminated,
105 the zero-price effect disappears.

106 The zero-price effect was examined for several products, including choco-
107 lates (Shampanier et al., 2007; Baumbach, 2011), telecommunication (Dri-
108 ouchi et al., 2011) and stereo systems (Baumbach, 2011). These studies
109 generally confirm the zero-price effect. Especially in regard to simple de-
110 cisions, the zero-price effect is found to be significant. In more complex
111 decisions concerning more expensive products, a unilateral conclusion about

112 the significance of the zero-price effect could not be found. Of all the pos-
113 sible explanations for the zero-price effect, the psychological mechanism af-
114 fect was found to be the only significant such effect. This psychological
115 mechanism ensures that options with no downside (no cost) invoke a more
116 positive affective response, to the extent that consumers use this affective
117 reaction as a decision-making cue to opt for the free option (Finucane et al.,
118 2000; Gourville and Soman, 2005). Other psychological mechanisms, such
119 as mapping difficulty, i.e., the difficulty consumers have with mapping the
120 utility they expect to receive from hedonic consumption into monetary terms
121 (Ariely et al., 2006), and social norm, i.e., the norm that consumers use when
122 deciding over a free product, were not found to influence the zero-price effect
123 significantly (Shampanier et al., 2007).

124 There is much controversy concerning the role of the affect mechanism
125 in the decision-making process. Peine et al. (2009) proposed the Appraisal
126 Theory of Lazarus. In this theory, cognition comes first in the decision-
127 making process before the affect mechanism. This theory was confirmed
128 in the study of Shampanier et al. (2007). This means that the positive
129 feelings about the free product lead to an increased demand for the free
130 product. This theory is in contrast to the theory of Zajonc (1980, 1984), in
131 which it is stated that affect can be generated without the participation of
132 cognition, which proves that affect should not precede cognition. This theory
133 is supported by several studies (Baumbach, 2011; Driouchi et al., 2011). The
134 strength of the influence of the affective and cognitive evaluation depends on
135 the situation in which they occur, the focus during the decision, processing
136 resources available in the decision-making process and the involvement of the
137 decision maker (Baumbach, 2011).

138 *2.2. Zero-price effect in public transport*

139 Public transport fares are subject to a number of contradictory needs and
140 requirements. On the one hand, the fares should be increased in response
141 to, e.g., budgetary requirements and dividends to owners. On the other
142 hand, there are strong pressures to keep fares low and subsidies high because
143 people strongly value public transport; however, they consider it to be too
144 expensive or infrequent to effectively replace private transport (Link and
145 Polak, 2003). Objectives such as social inclusion, fairness, internalization of
146 external benefits and corrections for underpriced private transport pull in
147 the direction of lower fares (Fearnley, 2003). Fares can also have an impact
148 on traffic safety. Although reductions in fares for public transport provide

149 smaller direct safety benefits, they can have substantially larger impacts if
150 they help create more transit-oriented communities, where residents tend to
151 own fewer cars and drive less than they would otherwise (Litman, 2012).

152 Weis et al. (2010) computed price elasticities, therein suggesting that re-
153 spondents are more sensitive to increases in public transport ticket prices
154 than to rising fuel prices. Thus, it may be expected that an increase in the
155 prices of public transport will result in a decrease in the demand for public
156 transport (Witbreuk and De Jong, 2001). Therefore, fares are an important
157 variable in terms of both the increase in usage as well as the improvement of
158 the cost-benefit ratio. Several studies have been conducted on how certain
159 determinants, such as price, affect modal choice. Thøgersen (2006) illustrated
160 that motivation, past behavior and habits, opportunities or constraints re-
161 garding the use of public transport and car ownership determine the mode
162 choice. A modification in fares can influence some of these determinants.
163 A decrease in fares to zero may positively influence motivation because the
164 zero-price effect will elicit positive feelings toward public transport (Sham-
165 panier et al., 2007). This will influence attitude, which powers the behavioral
166 intention to use public transport (Ajzen, 1991).

167 In addition to the motivation, free public transport could increase the
168 opportunities regarding the use of public transport. The study of Thøgersen
169 (2006) indicated the importance of habits as a determinant of mode choice.
170 Habits are a form of automaticity in responding that develops as people
171 repeat actions under stable circumstances (Verplanken and Aarts, 1999; Ver-
172 planken and Wood, 2006). To change these habits, interventions can be
173 applied upstream and downstream of the behavior (Verplanken and Wood,
174 2006). Downstream interventions aim at the avoidance of existing negative
175 outcomes, whereas upstream interventions intent to avoid the outcome in the
176 first place. Free public transport is an example of a downstream interven-
177 tion; however, the study of Verplanken and Wood (2006) demonstrated that
178 an economic incentive was only effective in the case of weakly habitual or
179 non-habitual behavior, whereas mode choice typically is strongly habitual.
180 These results contradict the study of Fujii and Kitamura (2003), where the
181 effect of a temporary change in the level of service on habitual drivers was
182 measured. The results showed that a structural change in the level of ser-
183 vice (e.g., free bus ticket or temporary road capacity reduction) led to an
184 increased usage of the public transport, which was sustained after the pe-
185 riod of temporary, structural change. Moreover, the attitude toward public
186 transport use was improved over that before the structural change, and the

187 habitual behavior of car usage was reduced. De Witte et al. (2008) found a
188 certain margin of growth in the usage of public transport when it becomes
189 free; however, it should be combined with investments in the quality of pub-
190 lic transportation (e.g., frequency, capacity, and connections). In the study
191 of Boyd et al. (2003), the modal shift on the campus of the University of
192 California at Los Angeles was examined after making bus transport free of
193 charge. Transit ridership increased by more than 50%, and more than 1000
194 fewer automobile trips were taken to the campus each day. De Witte et al.
195 (2006) investigated the effects of free public transport for students in Brussels
196 and found that public transport ridership increased when it was made free
197 of charge, although they could not draw significant conclusions due to the
198 lack of a control group. De Witte et al. (2006) also conducted a cost-benefit
199 analysis, in which they illustrated that the introduction of free public trans-
200 port can increase the social surplus as long as no more than 86% of the space
201 made available on the road is filled up by new car users. Verheyen (2010)
202 investigated the effect of free public transport on the modal split and made a
203 distinction according to trip motives, i.e., trip purposes such as commuting,
204 shopping and recreation. The results indicated that fares were significantly
205 influential only in the case of shopping trips.

206 **3. Data and Methodology**

207 A stated preference survey was conducted to examine whether a price
208 effect and/or a zero-price effect occurs among respondents in Flanders (the
209 northern part of Belgium). The total population in 2010 amounted to 6.2
210 million inhabitants. An average Flemish respondent makes 2.8 trips a day.
211 A total of 68% of these trips are made by car, followed by 12.28% by foot,
212 11.91% by bike, 2.71% by bus and 1.78% by train (Declercq et al., 2012).

213 Stated preference methods are widely accepted in travel behavior research
214 and in particular for the identification of behavioral responses to choice situ-
215 ations that are not revealed in the market (Hensher, 1994). There has been
216 some disagreement as to whether individuals' stated preferences closely cor-
217 respond to their actual preferences (Kroes, 1986). Despite this disagreement,
218 Wardman (1988) found evidence that individuals' stated preferences among
219 hypothetical travel scenarios are a reasonably accurate guide to true under-
220 lying preferences. The SP-survey was conducted on a individual level from
221 mid-November 2012 to late January 2013 and was completed by random in-
222 dividuals who are assumed to make their own transport decisions (over 17

223 years of age). The survey was distributed over the Internet, thereby allowing
 224 flexible question ordering to be included in the survey. This flexible question
 225 ordering counters question order effects. Typically, question order effects re-
 226 sult in differences in means and correlations for specific and general questions
 227 and are caused by changes in the placement of specific (general) questions
 228 relative to general (specific) questions in the survey (DeMoranville and Bi-
 229 enstock, 2003). In total, the survey collected valuable information from 670
 230 respondents.

231 The stated preference questionnaire consisted of four parts: (i) socio-
 232 economic questions about the respondent, (ii) questions about the respon-
 233 dent’s transport situation, (iii) hypothetical modal choices and (iv) ques-
 234 tions about fare evasion. The first part of the survey consisted of some
 235 socio-economic variables (e.g., gender, age, household situation, and income).
 236 In addition to the socio-economic variables, information about the respon-
 237 dent’s transport situation was obtained (e.g., car availability and current
 238 used modes). In part three, the respondents have to indicate their modal
 239 preferences among a set of three alternatives with certain prices or tariffs.
 240 Each respondent was confronted with nine modal choices (3 price scenarios
 241 x 3 trip motives), as displayed in Table 1.

Table 1: Overview of the 9 price scenarios (prices expressed in Euros)

	Scenario A			Scenario B			Scenario C		
	Car	PT	Bike	Car	PT	Bike	Car	PT	Bike
<i>Work/school trip</i>									
Distance: 0-2.5 km	1.00	0.50	0.60	0.75	0.25	0.35	0.50	0.00	0.10
Distance: 2.6-5.0 km	2.00	0.50	0.60	1.75	0.25	0.35	1.50	0.00	0.10
Distance: 5.1-7.5 km	3.00	0.50	0.60	2.75	0.25	0.35	2.50	0.00	0.10
Distance: 7.6-10.0 km	4.25	0.50	0.60	4.00	0.25	0.35	3.75	0.00	0.10
Distance: 10.1-15.0 km	6.00	0.50	0.60	5.75	0.25	0.35	5.50	0.00	0.10
Distance: 15.1-20.0 km	8.50	0.50	0.60	8.25	0.25	0.35	8.00	0.00	0.10
Distance: 20.1-30.0 km	12.00	0.50	0.60	11.75	0.25	0.35	11.50	0.00	0.10
Distance: 30.1-50.0 km	19.50	0.50	0.60	19.25	0.25	0.35	19.00	0.00	0.10
Distance: >50.0 km	24.25	0.50	0.60	24.00	0.25	0.35	23.75	0.00	0.10
<i>Shopping trip</i>									
Distance: 5 km	2.40	0.50	0.60	2.15	0.25	0.35	1.90	0.00	0.10
<i>Leisure trip</i>									
Distance: 15 km	7.00	0.50	0.60	6.75	0.25	0.35	6.50	0.00	0.10

242 In price scenario A, the respondents were confronted with the actual
 243 transport prices. Actual prices for the car were determined using a study
 244 of De Ceuster (2004), who estimated a complete cost per kilometer (based

245 on, e.g., fuel, net purchase vehicle, maintenance, insurance, and fuel tax).
246 For a bike, a fixed cost was calculated based on the net purchase cost and
247 the maintenance cost. The actual cost for the bus was estimated based on
248 the subscription fee charged by the Flemish transport company. Because the
249 subscription fee, as is the case for the costs for a bike, are fixed costs, the
250 assumption was made that this mode was used on a (work) daily base. In
251 price scenario B, the tariff for the public transport was halved. The tariffs
252 for the other modes were decreased by the same amount (i.e., 0.25 Euros).
253 In price scenario C, the prices and tariffs were again decreased by the same
254 amount, thereby making the public transport option free. This enables a
255 measurement of the reaction to a price reduction toward a positive price as
256 well as the reaction to the same price reduction toward a zero price. Each
257 of these three price scenarios was investigated for three trip motives, i.e.,
258 work/school, shopping and recreation. For the work/school trip, a distance-
259 related cost is calculated for the car option based on the distance to work
260 or school that the participants indicated. For the shopping trips, the cost
261 for the car was based on a distance of approximately 5 kilometers to a shop.
262 For the recreational trip, the cost for the car was based on a trip length of
263 approximately 15 kilometers to the nearest cinema.

264 Table 2 gives an overview of the data types and the corresponding coding
265 of the variables that were collected in the survey. Due to the large number
266 of variables, only the variables that are included in the final models are
267 presented here. Note that the relative cost is defined as the ratio of the
268 cost of a given transport mode compared to the car cost as a function of
269 the price scenarios (Table 1). For instance, for leisure trips under scenario
270 A, the relative cost for car, public transport and bike are respectively 1
271 ($= 7.00/7.00$), 0.0714 ($= 0.50/7.00$), and 0.0857 ($= 0.60/7.00$).

272 Approximately half of the respondents (i.e., 348 of the 670 respondents)
273 were subjected to a cognitive analysis. This cognitive analysis was assigned
274 on a random basis (based on the month of birth) and was invoked imme-
275 diately after the questions concerning the respondent's transport situation.
276 Through this cognitive analysis, the participants were forced to engage in a
277 cognitive and deliberate evaluation of the alternatives before making a deci-
278 sion, thereby making non-affective, more cognitive evaluations available and
279 accessible. In particular, the participants were first asked to which degree
280 they prefer to spend less for a random purchase. Consequently, the respon-
281 dents were forced to make an internal comparison of the different modes. We
282 assume that participants are more likely to base their evaluations on cog-

Table 2: Overview of the variables collected in the survey with regard to modal choices

Variable	Data type	Remarks (Coding)
<i>Socio-economic variables</i>		
Man_D2	Categorical	1 if man, 0 if woman
Man_D3	Categorical	1 if man, 0 if woman
Age_D2	Numeric	Age of the respondent
Age_D3	Numeric	Age of the respondent
Alone_D2	Categorical	1 if respondent lives alone, 0 otherwise
Alone_D3	Categorical	1 if respondent lives alone, 0 otherwise
Inc_D2	Categorical	1 if net monthly income of the respondent between €0 and €1500, 0 otherwise
Inc_D3	Categorical	1 if net monthly income of the respondent between €0 and €1500, 0 otherwise
IncNS_D2	Categorical	1 if net monthly income not specified, 0 otherwise
IncNS_D3	Categorical	1 if net monthly income not specified, 0 otherwise
Edu_D3	Categorical	1 if higher education (university/university college), 0 otherwise
Urb_D2	Categorical	Bike dummy: 1 if respondent lives in urban area, 0 otherwise
<i>Transport-related variables</i>		
DistHomeWS_D2	Numeric	Distance between home and work
DistHomeWS_D3	Numeric	Distance between home and work
CarAvail_D2	Categorical	1 if car is usually or always available, 0 otherwise
CarAvail_D3	Categorical	1 if car is usually or always available, 0 otherwise
CUWS_D1	Categorical	1 if respondent uses car for work/school trips currently, 0 otherwise
CUWS_D2	Categorical	1 if respondent uses bike for work/school trips currently, 0 otherwise
CUWS_D3	Categorical	1 if respondent uses public transport for work/school trips currently, 0 otherwise
CUShop_D1	Categorical	1 if respondent uses car for shop trips currently, 0 otherwise
CUShop_D2	Categorical	1 if respondent uses bike for shop trips currently, 0 otherwise
CUShop_D3	Categorical	1 if respondent uses public transport for work/school trips currently, 0 otherwise
CUREcr_D1	Categorical	1 if respondent uses car for recreational trips currently, 0 otherwise
CUREcr_D2	Categorical	1 if respondent uses bike for recreational trips currently, 0 otherwise
CUREcr_D3	Categorical	1 if respondent uses public transport for recreational trips currently, 0 otherwise
ExpPT_D3	Categorical	1 if respondent has experience with free public transport, 0 otherwise
<i>Modal choice variables</i>		
Bike_D2	Categorical	1 if mode is bike, 0 otherwise
PT_D3	Categorical	1 if mode is public transport, 0 otherwise
RelCostWS	Numeric	Prices and tariffs for the work/school motive relative to the car
RelCostShop	Numeric	Prices and tariffs for the shopping motive relative to the car
RelCostRecr	Numeric	Prices and tariffs for the recreational motive relative to the car
Free	Categorical	1 if mode is free, 0 otherwise

_D1, _D2, _D3 indicate application to the car, bike and public transport alternative, respectively

283 nitively available inputs under these conditions and therefore place a lower
 284 weight on the affective evaluations. Reliance on cognitive inputs should re-
 285 duce the zero-price effect. Note that the cognitive analysis only marginally
 286 increased the average duration of the survey: respondents who undertook the
 287 cognitive analysis spent on average 10.9 minutes on the survey, in compari-
 288 son to 10.2 min for those respondents who were not assigned to the cognitive
 289 analysis.

290 The descriptive statistics of the variables that are used in the models
 291 are displayed in Table 3. First, the dependent variables are displayed. The
 292 market shares for the different motives and the different price scenarios are
 293 displayed below, thereby demonstrating an explicit difference between the
 294 shares of the respondents who were subjected to the cognitive analysis and

295 those who were not. The following socio-demographic variables were con-
 296 sidered: gender, age, living situation, income, education and urbanization.
 297 In addition, the following transport-related variables were considered: dis-
 298 tance from home to work or school, car availability, the current use of modes
 299 for work or school trips, for shopping trips and for recreational trips and
 300 experience with free public transport.

Table 3: Descriptive statistics

Variable name	Description
<i>Dependent variables</i>	
Work/School mode choice	Scenario A ¹ : Car: 36.00%, Bike: 27.00%, Public Transport: 37.00%
	Scenario A ² : Car: 40.43%, Bike: 26.85%, Public Transport: 32.72%
	Scenario B ¹ : Car: 33.33%, Bike: 28.00%, Public Transport: 38.67%
	Scenario B ² : Car: 40.74%, Bike: 27.78%, Public Transport: 31.48%
	Scenario C ¹ : Car: 32.67%, Bike: 24.00%, Public Transport: 43.33%
Shopping mode choice	Scenario C ² : Car: 37.96%, Bike: 25.62%, Public Transport: 36.42%
	Scenario A ¹ : Car: 66.15%, Bike: 28.57%, Public Transport: 5.28%
	Scenario A ² : Car: 66.67%, Bike: 28.16%, Public Transport: 5.17%
	Scenario B ¹ : Car: 64.91%, Bike: 27.95%, Public Transport: 7.14%
	Scenario B ² : Car: 67.53%, Bike: 27.59%, Public Transport: 4.89%
Recreational mode choice	Scenario C ¹ : Car: 62.42%, Bike: 26.71%, Public Transport: 10.87%
	Scenario C ² : Car: 64.08%, Bike: 24.43%, Public Transport: 11.49%
	Scenario A ¹ : Car: 61.18%, Bike: 5.28%, Public Transport: 33.54%
	Scenario A ² : Car: 66.95%, Bike: 5.75%, Public Transport: 27.30%
	Scenario B ¹ : Car: 61.18%, Bike: 5.90%, Public Transport: 32.92%
	Scenario B ² : Car: 65.52%, Bike: 6.61%, Public Transport: 27.87%
	Scenario C ¹ : Car: 57.76%, Bike: 4.35%, Public Transport: 37.89%
	Scenario C ² : Car: 62.07%, Bike: 5.17%, Public Transport: 32.76%
<i>Independent variables: Socio-demographic characteristics</i>	
Gender	Female: 47.76%, Male: 52.24%
Age	Mean: 31, Standard Deviation: 15.41
Living situation	Alone: 12.09%, Other: 87.91%
Net monthly income	Low (No Income and < €1500): 57.91%, High (> €1500): 31.79%, Unspecified: 10.30%
Education	University/University college: 41.64%, Other: 58.36%
Urbanization	No: 44.78%, Yes (Urban): 55.22%
<i>Independent variables: Transport-related characteristics</i>	
Distance home-work/school	0-10 km: 41.35%, 10-20 km: 21.96%, 20-30 km: 17.95%, 30-50 km: 13.14%, >50 km: 5.61%
Car Availability	Always: 43.43%, Usually: 19.85%, Sometimes: 17.01%, Rarely: 7.76%, Never: 11.94%
Current Use Work/school	Car: 43.43%, Bike: 22.92%, Public Transport: 29.33%, Other: 4.32%
Current Use Shopping	Car: 60.00%, Bike: 24.48%, Public Transport: 1.79%, Other: 13.73%
Current Use Recreational	Car: 57.76%, Bike: 26.27%, Public Transport: 5.67%, Other: 10.30%
Experience Free Public Transport	No: 1.94%, Yes: 98.06%

¹: Respondents not subjected to cognitive analysis

²: Respondents subjected to cognitive analysis

301 In terms of sample representativeness, the basic descriptive statistics pre-
 302 sented in Table 3 correspond well to those reported in official travel behavior

303 statistics (see, e.g., Declercq et al. (2012)). Nonetheless, the high share of
 304 respondents that experienced free public transport is noticeable but can be
 305 accounted for by the fact that the survey was conducted in a province (Lim-
 306 burg) where the largest city had adopted free public transport at the time of
 307 the survey.

308 The focus in this study lies on the assessment of whether the zero-price
 309 effect and price effect play a role in the transport decision process and of
 310 what other factors affect this decision. Each respondent had to indicate the
 311 preferred mode for a number of hypothetical situations. Therefore, a model-
 312 ing approach that considers correlated responses for the choice among three
 313 or more categories is needed. The multinomial discrete choice procedure an-
 314 alyzes models wherein the choice set consists of multiple alternatives. This
 315 procedure supports conditional logit, mixed logit, heteroscedastic extreme
 316 value, nested logit, and multinomial probit models. The MDC procedure uses
 317 the maximum likelihood (ML) or simulated maximum likelihood method for
 318 model estimation. In this case, a mixed logit model is developed to estimate
 319 these relationships. As indicated by Hoffman and Duncan (1988), the mixed
 320 logit model is a combination of a multinomial logit and a conditional logit
 321 model. The multinomial logit focuses on the individual as the unit of anal-
 322 ysis and uses the individual’s characteristics as explanatory variables. The
 323 conditional logit focuses on the set of alternatives for each individual, and the
 324 explanatory variables are characteristics of those alternatives. A mixed logit
 325 model includes both characteristics of the alternatives and the individual.
 326 The corresponding choice probability can be written as

$$\pi_{ij} = \frac{\exp \{ \mathbf{x}'_i \beta_j + \mathbf{z}'_{ij} \gamma \}}{\sum_k \exp \{ \mathbf{x}'_i \beta_k + \mathbf{z}'_{ik} \gamma \}},$$

327 where \mathbf{x}_i represents characteristics of the individuals that are constant across
 328 choices and \mathbf{z}_{ij} represents characteristics that vary across choices (whether
 329 they vary by individual).

330 For each trip motive, three models were estimated to assess whether the
 331 price level and in particular the zero-price play a significant role in the modal
 332 decisions of the respondents: a model for all the respondents together (overall
 333 model) and a separate model for respondents who were subjected to the
 334 cognitive analysis and for those who were not subjected to the analysis.
 335 In addition to examining the effects of the zero-price and the prices, other
 336 personal and transport-related variables are included in the model to further

337 explain the modal choices. Backward selection was used to find the most
338 significant variables in the model. Backward selection removes variables from
339 the model one at a time. Each variable included in the model is tested for
340 removal at every step. The most insignificant variable is then removed from
341 the model as long as its P-value remains above the significance level of 0.05.
342 Note that the key variables of interest were included in the final models,
343 irrespective of their significance level. To evaluate the goodness-of-fit of the
344 models, three commonly used pseudo R^2 -values, i.e., McFadden's likelihood
345 ratio index R_M^2 , Estrella's alternative measure $R_{E_2}^2$, and Veall-Zimmermann's
346 R_{VZ}^2 , for which higher values indicate better model fit, were calculated.

347 4. Results

348 4.1. Overall Results

349 From Table 4, it can be concluded that the relative cost does not sig-
350 nificantly affect the modal choice of the respondents. This is true for all
351 trip motives considered in the study, is evidenced by the overall models as
352 well as the group-specific models, and might be partially because the price
353 differences were insignificant. On the other hand, the presence of a free alter-
354 native does affect the modal choice significantly for work/school (overall and
355 non-cognitive model) and shopping trips (all three models). In addition, this
356 effect is only borderline non-significant for the recreational motive (p-value
357 between 0.05 and 0.10 for the overall model).

358 Concerning socio-economic variables, the different considered variables all
359 play a role in the mode choice models; however, their respective impact is
360 strongly dependent on the considered trip motive and group of respondents
361 (overall, cognitive or non-cognitive). Education and the urban environment,
362 in which the respondents live, have only a marginal role in the different
363 models.

364 Regarding the transport-related variables, the longer the distance to work/school,
365 the smaller the likelihood to bike, and the higher the likelihood to use public
366 transport. Furthermore, car availability affects the choice for a bike sig-
367 nificantly in the context of work/school and recreational trips and affects
368 the choice for public transport significantly in all three trip motives. More-
369 over, the current (revealed) mode choice for the different trip motives has
370 a significant impact on the stated mode choice. Finally, an experience with
371 free public transport does affect the choice for public transport significantly

372 for work/school trips (overall and non-cognitive model) and recreation trips
 373 (overall model).

Table 4: Direction and significance of the parameter estimates for the different modal choice models

Parameter	Work/school			Shopping			Recreation		
	All	Cog.	Non-Cog.	All	Cog.	Non-Cog.	All	Cog.	Non-Cog.
Bike_D2	+	+++	0	0	0	0	0	0	0
PT_D3	0	0	--	--	0	0	0	0	0
RelCostWS	0	0	0						
RelCostShop				0	0	0			
RelCostRecr							0	0	0
Free	++	0	+	+++	+++	++	+	0	0
Age_D2	++		+++			---	++		
Age_D3	++		+++		+++	--			
Man_D2				+++	++	+++	+++	+++	
Man_D3						+++		---	
Alone_D2			---						
Alone_D3				+++	+++	+++	+++		++
DistHomeWS_D2	---	---	---						
DistHomeWS_D3	+++	+++	++						
Inc_D2	---	---	--	+++			++		
Inc_D3							+++		+++
IncNS_D2	---	---			--				
IncNS_D3	+++		+++						
Edu_D3								--	++
Urb_D2							--	--	
CarAvail_D2	---	---					---	---	---
CarAvail_D3	---	---		---	---	---	---	---	---
CUWS_D1	+++	+++	+++						
CUWS_D2	+++	+++	+++						
CUWS_D3	+++	+++	+++						
CUShop_D1				+++	+++	+++			
CUShop_D2				+++	+++	+++			
CUShop_D3				+++	++	0			
CUREcr_D1							+++	+++	+++
CUREcr_D2							+++	+++	+++
CUREcr_D3							++	0	+
ExpPT_D3	+++		+++				++		
R^2_{E2}	0.763	0.757	0.783	0.630	0.635	0.623	0.566	0.588	0.542
R^2_M	0.489	0.487	0.516	0.369	0.378	0.371	0.323	0.343	0.310
R^2_{VZ}	0.754	0.752	0.773	0.651	0.661	0.653	0.604	0.626	0.590

.D1, .D2, .D3 indicate application to respectively the car, bike and public transport alternative
Positive effects: +++: p-value < 0.01; ++: 0.01 ≤ p-value < 0.05; +: 0.05 ≤ p-value < 0.10
Negative effects: ---: p-value < 0.01; --: 0.01 ≤ p-value < 0.05; -: 0.05 ≤ p-value < 0.10
0: No effect (p-value ≥ 0.10); blank value: the parameter was not included in the final model

374 4.2. Parameter estimates

375 The parameter estimates for the mixed (multinomial conditional) logit
 376 mode choice models are shown in Tables 5, 6 and 7. The most used way to
 377 interpret the parameter is by the sign and the magnitude of the parameters.

378 *4.2.1. Work/school model*

379 In the overall work/school model (Table 5), the parameter that represents
380 the zero-price effect has a positive sign. This implies an increased modal
381 share for public transport when it is available for free. Parameter estimates
382 from the cognitive and non-cognitive model show that the effect is larger
383 for respondents that were not subjected to the cognitive analysis, albeit it
384 should be noted that these estimates are only significant at the 0.10 level
385 of significance. The distance between the home location and the work or
386 school location has a negative sign for a bike and a positive sign for public
387 transport. Thus, an increase in distance between the home location and the
388 work or school location decreases the modal share of a bike and increases the
389 modal share of public transport.

390 The income parameter of a bike has a negative sign. This implies that
391 an increase in income significantly lowers the likelihood of using a bike when
392 traveling to work or school. The car availability parameters of a bike and
393 public transport also have a negative sign. This indicates a lower probability
394 of choosing a bike and public transport when a car is usually or always avail-
395 able. The current use parameters show all three positive signs, which is quite
396 logical. When a respondent uses a specific mode in daily life, the likelihood
397 of choosing this specific mode increases in the hypothetical situations. This
398 means that the respondent's choice in hypothetical situations depends partly
399 on the current modal choice in daily life for a specific motive.

400 *4.2.2. Shopping model*

401 In the shopping models (Table 6), the parameters representing the zero-
402 price effect are positive, which suggests an increased probability of choosing
403 public transport when it is made available for free. The magnitude of the
404 parameter shows that the zero-price effect is more powerful for the shopping
405 motive than for the work/school motive. Moreover, there is a difference in
406 the zero-price effect for people who were subjected to a cognitive analysis
407 and those who were not. The parameter estimate of the zero-price effect for
408 the group that was subjected to the cognitive analyses was 1.133, whereas
409 the parameter estimate of the zero-price effect for the group that was not
410 subjected to the cognitive analyses was 0.634. Thus, we can conclude that
411 the zero-price effect is greater when people are forced to engage in a cognitive
412 and deliberate evaluation of the alternatives before they make a decision and
413 thereby make a less affective and more cognitive decision.

414 The gender parameters have a positive sign for the bike mode. This

Table 5: Parameter estimates for the work/school modal choice models

Parameter	All			Cognitive			Non-cognitive		
	Est.	S.E.	p-value	Est.	S.E.	p-value	Est.	S.E.	p-value
Bike_D2	1.198	0.716	0.094	2.373	0.821	0.004	-1.020	1.063	0.337
PT_D3	-1.084	0.677	0.110	-0.178	0.922	0.847	-2.066	0.934	0.027
RelCostWS	-0.630	0.787	0.424	-0.519	1.107	0.639	-0.983	1.127	0.383
Free	0.365	0.147	0.013	0.337	0.205	0.100	0.401	0.219	0.068
Age_D2	0.023	0.010	0.018				0.058	0.015	<0.001
Age_D3	0.015	0.006	0.016				0.026	0.009	0.004
Alone_D2							-1.152	0.369	0.002
DistHomeWS_D2	-0.308	0.057	<0.001	-0.368	0.079	<0.001	-0.269	0.085	0.002
DistHomeWS_D3	0.132	0.038	0.001	0.160	0.053	0.003	0.134	0.056	0.017
Inc_D2	-1.284	0.297	<0.001	-1.184	0.314	<0.001	-1.068	0.444	0.016
IncNS_D2	-1.378	0.419	0.001	-1.892	0.661	0.004			
IncNS_D3	0.582	0.212	0.006				1.125	0.291	<0.001
CarAvail_D2	-0.851	0.264	0.001	-1.012	0.361	0.005			
CarAvail_D3	-0.744	0.203	<0.001	-1.133	0.271	<0.001			
CUWS_D1	2.112	0.234	<0.001	1.773	0.303	<0.001	2.940	0.363	<0.001
CUWS_D2	2.968	0.221	<0.001	2.842	0.317	<0.001	3.930	0.395	<0.001
CUWS_D3	1.302	0.215	<0.001	1.269	0.292	<0.001	1.242	0.334	<0.001
ExpPT_D3	0.570	0.165	0.001				0.963	0.245	<0.001

_D1, _D2, _D3 indicate application to respectively the car, bike and public transport alternative

Table 6: Parameter estimates for the shopping modal choice models

Parameter	All			Cognitive			Non-cognitive		
	Est.	S.E.	p-value	Est.	S.E.	p-value	Est.	S.E.	p-value
Bike_D2	-0.965	0.609	0.113	0.206	0.835	0.805	-0.620	0.888	0.485
PT_D3	-1.231	0.619	0.047	-1.441	0.899	0.109	-1.261	0.944	0.182
RelCostShop	0.126	0.699	0.857	0.951	0.972	0.328	-0.239	1.012	0.814
Free	0.841	0.194	<0.001	1.133	0.281	<0.001	0.634	0.275	0.021
Age_D2							-0.017	0.006	0.002
Age_D3				0.032	0.009	0.001	-0.028	0.012	0.023
Man_D2	0.387	0.115	0.001	0.326	0.154	0.035	0.485	0.171	0.005
Man_D3							0.864	0.278	0.002
Alone_D3	0.917	0.212	<0.001	1.049	0.315	0.001	0.809	0.301	0.007
Inc_D2	0.499	0.121	<0.001						
IncNS_D2				-0.636	0.303	0.036			
CarAvail_D3	-1.427	0.202	<0.001	-1.762	0.329	<0.001	-1.298	0.329	<0.001
CUShop_D1	1.072	0.139	<0.001	1.107	0.197	<0.001	1.028	0.201	<0.001
CUShop_D2	1.092	0.151	<0.001	1.112	0.220	<0.001	1.206	0.212	<0.001
CUShop_D3	1.102	0.383	0.004	1.503	0.665	0.024	0.471	0.522	0.367

_D1, _D2, _D3 indicate application to respectively the car, bike and public transport alternative

415 means that men have a significantly higher probability of choosing a bike for
416 the shopping motive compared to women. The living situation parameters
417 have a positive sign for the public transport option. This indicates a higher
418 probability of choosing public transport for the shopping motive when people

419 live alone compared to people who do not live alone. The car availability
420 parameters associated with the public transport choice have a negative sign.
421 This indicates a lower probability of choosing public transport when a car
422 is usually or always available. The three current use parameters all show
423 positive signs, which is logical. When a respondent uses a specific mode in
424 daily life for shopping trips, the probability of choosing this specific mode
425 increases. This indicates that the likelihood of choosing a specific mode is
426 enhanced when this mode is used in daily life for these motives. When we
427 compare these parameters with the daily use parameters of the work/school
428 motive, we see that these parameters are lower. This means that the modal
429 choices depend to a lesser extent on the current use of modes for the shopping
430 motive compared to the work/school motive.

431 *4.2.3. Recreation model*

432 The parameter representing the zero-price effect in the overall model (Ta-
433 ble 7) has a positive sign but is only significant at the 0.10 level of significance.
434 In contrast, in the cognitive and non-cognitive model, the zero-price effect
435 was not significant.

436 The age parameter concerning a bike has a positive sign in the overall
437 model, which implies that the probability of choosing a bike as the mode
438 of transport for recreational trips increases with increasing age. The gender
439 parameter has a positive sign for the bike mode (in the overall and cognitive
440 model). This means that men exhibit a significantly higher probability for
441 choosing a bike for the recreational motive compared to women. The living
442 situation parameter shows a positive sign for public transport (in the overall
443 and non-cognitive model). This means that people who are living alone are
444 more inclined to use public transport for recreational trips than are people
445 who do not live alone. This parameter is smaller than for the shopping
446 motive; therefore, the effect of living situation is less distinct than for the
447 shopping model.

448 The parameter that includes whether the respondent lives in a urban
449 environment shows a negative sign for the use of a bike (in the overall and
450 cognitive model). This implies that people are less inclined to use a bike for
451 recreational trips when they live in urban environments. The car availability
452 parameters of a bike and public transport show a negative sign. This means
453 that there is a lower probability of choosing a bike and public transport
454 when a car is usually or always available. Car availability has the greatest
455 influence on bike use for shopping trips, followed by recreational trips, and

Table 7: Parameter estimates for the recreational modal choice models

Parameter	All			Cognitive			Non-cognitive		
	Est.	S.E.	p-value	Est.	S.E.	p-value	Est.	S.E.	p-value
Bike_D2	-1.884	2.612	0.471	-2.763	3.577	0.440	-1.005	3.696	0.786
PT_D3	0.945	2.567	0.713	0.033	3.558	0.993	0.553	3.689	0.881
RelCostRecr	1.538	2.703	0.570	-0.331	3.752	0.930	1.162	3.888	0.765
Free	0.317	0.169	0.060	0.251	0.236	0.287	0.280	0.242	0.247
Age_D2	0.018	0.009	0.048						
Man_D2	0.712	0.221	0.001	1.159	0.337	0.001			
Man_D3				-0.435	0.148	0.003			
Alone_D3	0.402	0.147	0.006				0.419	0.202	0.038
Inc_D2	0.807	0.317	0.011						
Inc_D3	0.339	0.115	0.003				0.612	0.174	<0.001
Edu_D3				-0.401	0.156	0.010	0.382	0.161	0.018
Urb_D2	-0.405	0.204	0.047	-0.673	0.287	0.019			
CarAvail_D2	-0.949	0.256	<0.001	-0.908	0.297	0.002	-0.973	0.325	0.003
CarAvail_D3	-0.611	0.120	<0.001	-0.625	0.166	<0.001	-0.633	0.169	<0.001
CURecr_D1	0.614	0.112	<0.001	0.749	0.161	<0.001	0.573	0.159	<0.001
CURecr_D2	1.149	0.220	<0.001	1.333	0.306	<0.001	1.066	0.324	0.001
CURecr_D3	0.503	0.215	0.019	0.334	0.307	0.277	0.527	0.305	0.084
ExpPT_D3	0.293	0.124	0.018						

_D1, _D2, _D3 indicate application to respectively the car, bike and public transport alternative

456 has the smallest influence on work/school trips. In addition, car availability
 457 has greater influence on public transport use for work/school trips than for
 458 recreational trips. The current use parameters of the car, bike and public
 459 transport modes show positive signs. This indicates that the likelihood of
 460 choosing a specific mode is enhanced when this mode is used in daily life for
 461 these motives. The parameter that represents the experience with free public
 462 transport shows a positive sign (in the overall model). This indicates that
 463 the probability of choosing public transport is enhanced after experiencing
 464 free public transport.

465 5. Discussion

466 In the previous sections, it was shown that the relationship between the
 467 relative prices and the modal choices were not significant at a 0.05 level. The
 468 absence of this relationship between prices of transport and modal choices
 469 is in contrast to the studies of De Witte et al. (2008) and Paulley et al.
 470 (2006). A possible reason for the absence of this relationship could be that
 471 the absolute differences in prices of the different scenarios were insignificant,
 472 i.e., a €0.25 difference between scenarios; thus, the difference might not have
 473 been clear to the respondents.

474 In contrast to the study of Verheyen (2010), where only a zero-price ef-
475 fect for the shopping motive was found, a zero-price effect is found for the
476 work/school motive and the shopping motive. The zero-price effect for the
477 recreational motive was found to be insignificant at the 0.05 level but signif-
478 icant at the 0.10 level. These findings are in accordance with the revealed
479 preference study for students conducted by De Witte et al. (2006), which
480 indicated the modal shift potential of free public transport. The cognitive
481 analysis, which was presented to 51.9% of the participants, had an unex-
482 pected effect on the zero-price effect for the shopping motive. The study
483 of Shampanier et al. (2007) demonstrated that reliance on cognitive inputs
484 should reduce the zero-price effect. Thus, the group that was subjected to
485 a forced cognitive analysis was expected to show a reduced zero-price effect.
486 This study shows a larger zero-price effect in the group that was subjected
487 to a forced cognitive analysis. Therefore, we can conclude that the zero-price
488 effect is not driven by the psychological construct affect in this modal choice
489 study.

490 With respect to the socio-economic variables, different factors influence
491 the modal choices depending on the trip motive that is considered and de-
492 pending on which group of respondents is analyzed. Regarding the transport-
493 related parameters, one can observe that the transport-related parameters ex-
494 hibit a larger influential nature compared to the socio-economic variables ac-
495 cording to the magnitude of these parameters. The variable with the largest
496 explanatory power is the current (revealed) use of modes. This variable repre-
497 sents the transport modes that the participants currently use for the different
498 types of trips. The biggest influence of the current use variable is exerted
499 on the work/school motive, followed by the shopping motive and then the
500 recreational motive. This indicates that habitual behavior plays a role in this
501 decision-making process. There is evidence that individuals at least have a
502 strong tendency to "recycle" a decision made in the past when making travel-
503 mode choices (Thøgersen, 2006). When a decision is repeated several times
504 per week in a stable context while obtaining the same outcome every time,
505 it is unlikely that much reasoning is involved, and it seems highly likely that
506 habitual processes are active in that decision-making process (Wood et al.,
507 2002). This explains the strength of the explanatory power of the current use
508 variable in the different scenarios. The greater number of times the decision
509 is repeated in a stable context, the larger the influence of habitual behavior,
510 and the larger the parameter estimates of the current use variable. For this
511 reason, the parameter estimate of the current use variable is higher for the

512 work/school motive than for the shopping motive and the recreational mo-
513 tive. A strong habit to use a particular travel mode is, in comparison with a
514 weak habit, characterized by seeking less information and by a less elaborate
515 choice of travel mode (Aarts et al., 1997; Verplanken et al., 1997). According
516 to this view of habit, a strong habit is perceived to block the more deliberate,
517 cognitive processing prior to behavior (Eriksson et al., 2008). This could be
518 an explanation for the larger zero-price effect with participants subjected to
519 a cognitive analysis for the shopping motive. This is because this cognitive
520 evaluation makes a more deliberate, cognitive processing available for the
521 participants, which in turn causes the decision making to be more based on
522 cognitive reasoning instead of habitual behavior. This theory was also con-
523 firmed by Eriksson et al. (2008). This cognitive evaluation, wherein the car
524 user evaluates the different features of his/her trip, will not automatically
525 lead to a change in behavior. This evaluation can lead to a continuation of
526 current behavior;h however the choice will be more influenced by personal
527 norms and less by habitual behavior.

528 Another important transport-related parameter is car availability. In this
529 model, the availability of a car significantly decreases the probability of using
530 a bike or public transport in almost all models. This is because the availabil-
531 ity of a private car in the household facilitates the choice of car transport and
532 thereby reduces the likelihood of choosing other modes (Thøgersen, 2006).
533 This is because car owners have more alternatives than does someone with-
534 out a car and because habitual processes are more important than attitudes
535 for car owners (Thøgersen, 2006). The variable including experience with
536 free public transport has a positive influence on public transport use, which
537 is in accordance with the literature. In a study of Fujii and Kitamura (2003),
538 an experiment in which a one-month-free bus ticket was given to an experi-
539 mental group was performed. The results showed that attitudes toward bus
540 transport were more positive and that the frequency of bus use increased,
541 whereas the habits of using automobiles decreased after the intervention, even
542 one month after the intervention period. The implications of the variables
543 including the distance between home and work or school and the urban en-
544 vironment are quite logical because the probability of using a bike decreases
545 when travel distance increases. This produces a modal shift toward other
546 modes such as public transport. Living in an urban environment reduces the
547 likelihood of choosing a bike because there are numerous public transport
548 options in an urban environment and because the safety of biking is lower in
549 urban environments.

550 **6. Policy recommendations**

551 The findings in this paper provide insight into the success and application
552 of a measure concerning travel demand that aims at changing travel behav-
553 ior. The modal split potential of the introduction of public transport at a
554 reduced and at zero price was examined. A zero-price effect was found for
555 the work/school motive and the shopping motive at a 5% significance level
556 and for the recreational motive at a 10% significance level. This implies that
557 the use of public transport will increase significantly when it is provided for
558 free, and a change in relative prices does not provoke significant changes in
559 the modal split because of the insignificance of the price effect. Thus, the
560 subsidizing of public transport with the aim of making it free seems to be an
561 effective measure to increase the use of public transport. Subsidizing public
562 transport with the aim of making it less expensive or to change the relative
563 prices with regard to car usage does not seem to be an appropriate measure
564 for policy makers. Important obstacles to the success of such a policy mea-
565 sure are the current use of modes for different motives and car availability.
566 The magnitude of the explanatory power of the current use variable in ex-
567 plaining the modal choices indicates that individuals have a strong tendency
568 to recycle a decision made in the past. A policy measure that can counteract
569 this recycling of decisions is the creation of a deliberate, cognitive process
570 prior to the specific behavior. This can be accomplished by informational
571 campaigns that raise awareness of the different characteristics of a trip, in-
572 cluding price or tariffs. Additionally, car availability plays an important role
573 in modal choices and may counteract the zero-price effect. To overcome this
574 obstacle, policy makers must convince car owners to exchange car usage for
575 public transport. Actions by the Flemish government, where a license plate
576 can be exchanged for a free bus pass, have been demonstrated to be suc-
577 cessful. Thus, combinations of policies with free public transport can further
578 reduce car availability and increase the market share of public transport.

579 **7. Conclusions and further research**

580 This study investigated the impact of public transport at a reduced and
581 zero price on the modal shares for individuals in Flanders, Belgium. The
582 results from a mixed logit model indicate that people are not influenced by
583 changing relative prices; however, the results show a significantly different
584 modal split when free public transport is added to the range of alternatives.

585 This zero-price effect was found to be more significant when individuals are
586 first subject to a cognitive analysis, wherein participants are forced to engage
587 in a cognitive and deliberate evaluation of the alternatives. This research
588 finding can be considered by policy makers to increase the success of the
589 implementation of free public transport. The key variables influencing mode
590 choice appear to be the current use of modes and car availability. Both vari-
591 ables indicate the importance of habitual behavior and large commitments
592 such as residential location choice, which should be considered by policy
593 makers when they want to change choice behavior. However, for further re-
594 search, the absolute value differences and budget changes can be increased to
595 measure whether a price effect can be observed. This is because it is plausi-
596 ble that price does affect modal choices. Furthermore, developing a revealed
597 preference experiment testing the zero-price effect using a sample in which
598 all sections of the population are represented represents an intriguing study.
599 To our knowledge, revealed preference experiments have only been performed
600 for specific sections of the population in Flanders (such as students).

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604 **References**

- 605 Aarts, H., Verplanken, B., van Knippenberg, A., 1997. Habit and information
606 use in travel mode choices. *Acta Psychologica* 96, 1–14.
- 607 Ajzen, I., 1991. The theory of planned behavior. *Organizational Behavior*
608 and Human Decision Processes 50, 179–211.
- 609 Anderson, C., 2009. *Free: The Future of a Radical Price*. Hyperion, London.
- 610 Ariely, D., Gneezy, U., Haruvy, E., 2006. Social norms and the price of zero.
611 Working Paper. MIT. Boston, MA.
- 612 Baumbach, 2011. *The Zero-Price Effect - Its Relation to Price Affect and*
613 *Price-Quality Inferences Regarding Low- and High-Priced Products*. Mas-
614 *ter's thesis. Universitt Wien. Vienna, Austria.*

- 615 Borndörfer, R., Karbstein, M., Pfetsch, M.E., 2012. Models for fare planning
616 in public transport. *Discrete Applied Mathematics* 160, 2591–2605.
- 617 Boyd, B., Chow, M., Johnson, R., Smith, A., 2003. Analysis of effects of
618 fare-free transit program on student commuting mode shares: Bruingo at
619 university of california at los angeles. *Transportation Research Record:*
620 *Journal of the Transportation Research Board* 1835, 101–110.
- 621 Brög, W., Erl, E., Mense, N., 2004. Individualised marketing changing travel
622 behaviour for a better environment, in: *Communicating Environmentally*
623 *Sustainable Transport The Role of Soft Measures: The Role of Soft Mea-*
624 *asures*, OECD, Paris, France. pp. 83–97.
- 625 Cools, M., Brijs, K., Tormans, H., De Laender, J., Wets, G., 2012. Opti-
626 mizing the implementation of policy measures through social acceptance
627 segmentation. *Transport Policy* 22, 80–87.
- 628 De Ceuster, G., 2004. Internalisation of external costs of road traffic in
629 Flanders. Technical Report MIRA/2004/04. Vlaamse Milieumaatschap-
630 pij MIRA. Mechelen, Belgium. Original dutch title: “Internalisering van
631 externe kosten van wegverkeer in Vlaanderen”.
- 632 De Witte, A., Macharis, C., Lannoy, P., Polain, C., Steenberghen, T., Van de
633 Walle, S., 2006. The impact of “free” public transport: The case of brussels.
634 *Transportation Research Part A: Policy and Practice* 40, 671–689.
- 635 De Witte, A., Macharis, C., Mairesse, O., 2008. How persuasive is “free” pub-
636 lic transport?: A survey among commuters in the brussels capital region.
637 *Transport Policy* 15, 216–224.
- 638 Declercq, K., Janssens, D., Wets, G., 2012. Travel Behavior Research Flan-
639 ders 4.3 (2010-2011): Table Report. Technical Report. Hasselt University.
640 Diepenbeek, Belgium.
- 641 DeMoranville, C.W., Bienstock, C.C., 2003. Question order effects in mea-
642 suring service quality. *International Journal of Research in Marketing* 20,
643 217–231.
- 644 Driouchi, A., Chetioui, Y., Baddou, M., 2011. How Zero price Affects De-
645 mand? Experimental Evidence from the Moroccan Telecommunication
646 Market. MPRA Paper 32352.

- 647 Eriksson, L., Garvill, J., Nordlund, A.M., 2008. Interrupting habitual car use:
648 The importance of car habit strength and moral motivation for personal
649 car use reduction. *Transportation Research Part F: Traffic Psychology and*
650 *Behaviour* 11, 10–23.
- 651 Fearnley, N., 2003. *Inventive Pricing of Urban Public Transport*. TØI report
652 655/2003. Institute of Transport Economic. Oslo, Norway.
- 653 Finucane, M.L., Alhakami, A., Slovic, P., Johnson, S.M., 2000. The affect
654 heuristic in judgments of risks and benefits. *Journal of Behavioral Decision*
655 *Making* 13, 1–17.
- 656 Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to
657 habitual drivers? an experimental analysis of habit and attitude change.
658 *Transportation* 30, 81–95.
- 659 Gourville, J.T., Soman, D., 2005. Overchoice and assortment type: When
660 and why variety backfires. *Marketing Science* 24, 382–395.
- 661 Hensher, D.A., 1994. Stated preference analysis of travel choices: the state
662 of practice. *Transportation* 21, 107–133.
- 663 Hoffman, S.D., Duncan, G.J., 1988. Multinomial and conditional logit
664 discrete-choice models in demography. *Demography* 25, 415–427.
- 665 Janssens, D., Cools, M., Moons, E., Wets, G., Arentze, T., Timmermans, H.,
666 2009. Road pricing as an impetus for environment-friendly travel behavior.
667 *Transportation Research Record: Journal of the Transportation Research*
668 *Board* 2115, 50–59.
- 669 Kahneman, D., Tversky, A., 1979. Prospect theory: An analysis of decision
670 under risk. *Econometrica* 47, 263–292.
- 671 Kingham, S., Dickinson, J., Copsey, S., 2001. Travelling to work: will people
672 move out of their cars. *Transport Policy* 8, 151–160.
- 673 Kroes, E., 1986. The use of attitude models and stated preference models
674 in practical transport analysis, in: *Behavioural Research for Transport*
675 *Policy*. VNU Science Press, Utrecht, Netherlands, pp. 307–326.

- 676 Leong, W.Y., Lew, Y.D., 2011. A behavioural perspective to managing traffic
677 congestion in singapore, in: Low, D. (Ed.), *Behavioural Economics And*
678 *Policy Design*. World Scientific Publishing, Singapore, pp. 53–67.
- 679 Link, H., Polak, J., 2003. Acceptability of transport pricing measures among
680 public and professionals in europe. *Transportation Research Record: Journal*
681 *of the Transportation Research Board* 1839, 34–44.
- 682 Litman, T., 2012. Pricing for traffic safety: How efficient transport pricing
683 can reduce roadway crash risk. *Transportation Research Record: Journal*
684 *of the Transportation Research Board* 2318, 16–22.
- 685 MacKay, D.J.C., 2009. *Sustainable Energy Without the Hot Air*. IUT,
686 Cambridge.
- 687 Majumdar, S.R., Lentz, C., 2012. Individuals' attitudes toward public transit
688 in a rural transit district. *Public Works Management & Policy* 17, 83–102.
- 689 Nicolau, J.L., 2012. Battle royal: Zero-price effect vs relative vs referent
690 thinking. *Marketing Letters* 23, 661–669.
- 691 Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Ward-
692 man, M., Shires, J., White, P., 2006. The demand for public transport:
693 The effects of fares, quality of service, income and car ownership. *Transport*
694 *Policy* 13, 295–306.
- 695 Peine, K., Heitmann, M., Herrmann, A., 2009. Getting a feel for price af-
696 fect: A conceptual framework and empirical investigation of consumers'
697 emotional responses to price information. *Psychology and Marketing* 26,
698 39–66.
- 699 Shampanier, K., Mazar, N., Ariely, D., 2007. Zero as a special price: The
700 true value of free products. *Marketing Science* 26, 742–757.
- 701 Smith, A., 2008. *An Inquiry into the Nature and Causes of the Wealth of*
702 *Nations: A Selected Edition*. Oxford Paperbacks, Oxford, UK.
- 703 Steg, L., 2003. Can public transport compete with the private car? *IATSS*
704 *Research* 27, 27–35.
- 705 Szabo, N., 1999. Micropayments and mental transaction costs, in: 2nd Berlin
706 *Internet Economics Workshop*, Berlin, Germany.

- 707 Thøgersen, J., 2006. Understanding repetitive travel mode choices in a stable
708 context: A panel study approach. *Transportation Research Part A: Policy*
709 *and Practice* 40, 621–638.
- 710 Thøgersen, J., 2009. Promoting public transport as a subscription service:
711 Effects of a free month travel card. *Transport Policy* 16, 335–343.
- 712 Verheyen, G., 2010. Irrationality in modal choices: Free public transport.
713 Master’s thesis. Hasselt University. Diepenbeek, Belgium. Original dutch
714 title: “Irrationaliteit in Vervoerswijzekeuze: Gratis”.
- 715 Verplanken, B., Aarts, H., 1999. Habit, attitude, and planned behaviour:
716 Is habit an empty construct or an interesting case of goal-directed auto-
717 maticity? *European Review of Social Psychology* 10, 101–134.
- 718 Verplanken, B., Aarts, H., Van Knippenberg, A., 1997. Habit, information
719 acquisition, and the process of making travel mode choices. *European*
720 *Journal of Social Psychology* 27, 539–560.
- 721 Verplanken, B., Wood, W., 2006. Interventions to break and create consumer
722 habits. *Journal of Public Policy & Marketing* 25, 90–103.
- 723 van der Vliet, S., 2010. “Free” public transport: Social costs and benefits of
724 “free” public transport in Dutch cities. Lambert Academic Publishing.
- 725 Wardman, M., 1988. A comparison of revealed preference and stated pref-
726 erence models of travel behaviour. *Journal of Transport Economics and*
727 *Policy* 22, 71–91.
- 728 Weis, C., Axhausen, K.W., Schlich, R., Zbinden, R., 2010. Models of mode
729 choice and mobility tool ownership beyond 2008 fuel prices. *Transportation*
730 *Research Record: Journal of the Transportation Research Board* 2157, 86–
731 94.
- 732 Witbreuk, M., De Jong, L., 2001. *The Use and Efficiency of Public Transport*
733 *: The Effects of Price and Service Measures*. Thredbo 7. Institute of
734 *Transport and Logistics Studies*. Sydney.
- 735 Wood, W., Quinn, J.M., Kashy, D.A., 2002. Habits in everyday life: thought,
736 emotion, and action. *Journal of personality and social psychology* 83, 1281–
737 1297.

- 738 Zajonc, R., 1980. Feeling and thinking: Preferences need no inferences.
739 American Psychologist 35, 151–175.
- 740 Zajonc, R.B., 1984. On the primacy of affect. American Psychologist 39,
741 117–123.