MODELLING TRAVEL WELL-BEING AND MODE CHOICE BEHAVIOUR

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ABSTRACT

The present paper attempts to incorporate the concept of happiness or subjective well-being (SWB) in travel decisions. It aims at understanding the travel well-being of individuals and modelling the relationship between satisfaction/happiness and travel decision making.

The research is based on an on-line survey launched between November 30, 2008 and April 20, 2009. The survey incorporated innovative Stated Preferences experiments capturing two different aspects of subjective well-being:

(1) The notion of level of comfort regarding two modes of transport, namely car and metro, is represented via the presentation of cartoons. This level of comfort may also reflect part of the trip-specific well-being as it is perceived by travellers.

(2) Indicators of the expected level of happiness with the chosen mode are recorded after each mode choice experiment.

The paper presents, on the one hand, the estimation of a transport mode choice model taking into account just the trip specific well-being, along with other explanatory variables. On the other hand, a hybrid choice model is developed, which incorporates the indicators of happiness as indicators of the overall utility of the mode, together with the stated choice indicator. This model structure significantly improves the goodness of fit in comparison with the first estimated model.

The conclusions to be drawn may contribute to an enhanced understanding of the transport market demand and thus to the improvement of strategic decisions to be made by policy makers.

Keywords: Transport Surveys, Travel Well-being, Subjective Well-being, Mode Choice Models, Trip-specific Happiness, Hybrid Choice Model.

INTRODUCTION

The quest for happiness is a key factor of human behaviour: ‘‘How to gain, how to keep, how to recover happiness is in fact for most men at all times the secret motive for all they do’’ (James 1902, p. 76 upon Bruno S. Frey *et al.*, 2005).

The construct of happiness has been empirically pursued by psychologists and scientists of other fields, since the beginning of the 20th century. The aim to answer questions such as ”*What is happiness? Can it be measured? What causes happiness?*” has long been on the social sciences research agenda (Diener *et al.*, 2003).

Up to the present, the study of subjective well-being (SWB), human strengths and positive psychology has considerably increased, contributing for the development of strong theoretical frameworks and rigorous methodology, and also for the proliferation of new measures and clear definitions (Kashdan, 2004). The Experience Sampling Method (ESM), also known by the names of time sampling, beeper studies and Ecological Momentary Assessment (EMA) (Diener, 2000) and the Day Reconstruction Method (DRM), which seems to be a more practical method to measure SWB (Kahneman *et al.*, 2004), are part of a set of recent methods that attempt to measure happiness.

Reported data on subjective well-being allows researchers to address elementary questions such as, for e.g., ‘Do people consciously maximize their utility?’ or ‘Can people predict their future utility/preferences?’

“Happiness is a very good thing” (Koszegi *et al.*, 2008) and has also been an emerging research topic over the last decades, foreseen as potential trend within the broader behavioural movement in economics.

As we perceive, Happiness data can be used to further inform the behavioural models based on random utility theory. By this way, not only it is possible to test the basic assumptions of the economic approach but also to evolve in the construct of utility. Therefore, the relationship between happiness and utility is foremost important to make use of improved model frameworks that include the concept of happiness.

Even though rationality has been seriously questioned through research (Kahneman *et al.*, 2006), the transportation field is yet largely grounded in the construct of human rationality. As it happens, large evidence supports that people are irrational, and behavioural economists have succeeded in suggesting what principles might be responsible for this lapses (Gaker *et al.*, 2010). Knowledge of behavioural techniques and the principles that drive irrational behaviour might enable researchers to capture other significant factors of transport behaviour that the traditional ones. Furthermore, happiness research offers the possibility for separate/distinguish models that predict the same patterns in behaviour but estimate different experienced utilities.

This paper proceeds as follows: the present section brings an introduction about the paper. Section two presents a brief state of the art in the Happiness research field, in particular the motivations that have been raised to study this topic in the transportation field. Following, section three outlines the methodological approach. Section four focuses on the case study development and presents the descriptive statistics. Section five presents the modelling

framework of travel well-being and the estimation and discussion of its main results, based upon the data collected from a web-based experiment. The final chapter draws the most important conclusions and recommendations for further research.

STATE OF THE ART

When the behavioural approach was introduced in transport models a path was cleared for the subsequent introduction of the thematic of Subjective Well-Being (SWB) into the transportation field, - which was so far prominent in the fields of Hedonic Psychology and Behavioural Economics (Diener, 2000; Kahneman *et al.*, 2006; Kahneman *et al.*, 2004). This innovative field of research involving transportation and happiness hall borrow and encompass several methodologies and findings from the fields of psychology and economics, adapting and extending them in the transport domain.

Earlier transport studies have focused on the impact of individual's choices on their level of satisfaction. Mokhtarian and Salomon (Mokhtarian *et al.*, 2001) and Steg (Steg, 2005) recognised that travellers may value travel in itself. They found that choices, such as car ownership and usage, can be the outcome of psychological factors related to emotions such as feelings (freedom) and moods (pleasure-to-use). Ory and Mokhtarian (Ory *et al.*, 2005) measured how much individuals like to travel. Travelling satisfaction was studied according to the transport mode, trip purpose, and travelling distance. They found that travellers' attitudes and personality are more important determinants of travel liking than objective travel attributes (such as travel cost).

Only recently, research in transportation has focused on identifying the interrelationship between transportation choices and SWB.

Duarte *et al.* (Duarte *et al.*, 2009a; Duarte *et al.*, 2009b) attempted to understand and model the impact of happiness in a transportation context. Specifically, they quantified the impact of different indicators related to the happiness on the decision choice between a private transport mode (car), and a public transport mode (metro). To achieve this goal, an internet survey was developed and data were collected worldwide, but essentially from European countries. The concept of happiness as examined in this context was broken down to Experienced and Expected Happiness (Duarte *et al.*, 2009b). The former is conditioned by similar experiences acquired by the individual in the past and by their reminiscence. The latter involves the individual's predicting skills, his expectations, motives and beliefs underlying the decision making process. A Mixed Multinomial Logit (MMNL) model using panel data was estimated. Findings related: (1) the importance of the role played by both the concepts of Experienced and Expected Happiness in the transport mode decision process; and (2) the degree to which both concepts are identified with the choice of a private owned vehicle rather than with that of a public means of transportation (metro).

Abou-Zeid and Ben-Akiva (Abou Zeid *et al.*, 2010), studied the interrelationship between transportation and happiness by means of a cross-sectional travel and activity well-being survey. They conducted experiments in Switzerland and in Massachusetts (USA) involving a temporary change of mode for habitual car drivers, who were asked to commute by public transport for a few days and were given a free public transportation pass as an incentive.

According to the findings, commute satisfaction is related to commute stress, social comparison, commuter's personality and overall well-being; whereas happiness derived from performing a certain activity is tied to the individual's propensity for activity participation. Ratings of perceptions and attitudes towards car and public transportation also changed for several participants, which indicate that people often hold misperceptions of public transportation that may be corrected through direct experience. Furthermore, a number of participants continued to commute by public transport after the trial, which suggests that a temporary change in behaviour might be effective in inducing behavioural modification. In terms of model estimation, the measures of happiness or satisfaction with the chosen alternatives were used as additional indicators of their utility (the assumption being that the higher the utility of a certain alternative, the happier or more satisfied an individual will be with that alternative).

Ettema *et al.* (Ettema, 2010), argued that: (a) participation in goal-directed activities, facilitated or hindered by travel, contribute to SWB; (b) the degree of travel-related stress in participating in these activities reduces SWB; and (c) that positive affect associated with travel in itself has an impact on SWB. Ettema *et al.* (Ettema *et al.*, 2009) proposed a new measure of domain specific SWB in the context of travel. Changes in the travel conditions can influence global SWB (the cognitive and affective evaluation of life as a whole), but also domain-specific satisfaction with the travel conditions per se. The proposed Satisfaction with Travel Scale (STS) consists of six affective and three cognitive items, which are evaluated on a -4 to 4 scale. The STS was tested along with existing mood and (daily) SWB scales, in a survey in which respondents evaluated three hypothetical agendas, differing in terms of travel mode, travel time, walking distance and activity participation. The outcomes suggest that STS shows a high reliability, resulting in intuitively plausible responses to changes in travel conditions. In addition, results suggest that travel satisfaction is primarily affected by travel mode, walking distance and time pressure of the agenda, and not by travel time solely; as well as the existence of a correlation between travel satisfaction and global SWB.

From a general point of view, the last decade developments on the study of subjective well-being in various domains of life and its applications have interested us, as many other researchers, in exploring this topic within the transport domain. Moreover, our previous work (Duarte *et al.*, 2009a; Duarte *et al.*, 2009b) on this innovative field of transport research, along with other colleagues (Abou-Zeid, 2008; Abou-Zeid *et al.*, 2009; Abou Zeid, 2009; Abou Zeid *et al.*, 2010; Ben-Akiva; Ben-Akiva, 2007a; Ben-Akiva, 2007b; McFadden, 2007) has encouraged us to systematically explore other dimensions of decision-making processes related to the choice of a mode of transport rather then the classic time and cost factors that presently determine travel behaviour models and project evaluation methodologies.

In this sense, the work presented further contributes to our aim in developing advanced demand models that reflect the impacts of happiness in mode choice travel behaviour.

RESEARCH METHODOLOGY

Exploring subjective well-being in the transportation domain requires, first of all, an approach to the concepts of 'happiness' and 'well-being'. However, their construction is largely attached to a personal individual and emotional evaluation, which makes it unrealistic to assert a global and unique definition for both concepts.

The work we have been developing so far in this topic (Duarte et al., 2009a; Duarte et al., 2009b), has explored the concept of happiness as the individual positive reaction to a particular environment, or system, in a particular moment of time. The perceived happiness will depend upon both the considered context of the situation and the different opinions among individuals. Alternatively, well-being is understood as the individual perceived evaluation of the overall environment or system. Moreover, the behavioural framework that supports our work (Abou-Zeid, 2008; Abou Zeid, 2009; Bechara, 2004; Duarte et al., 2009b) suggests that memory of previous experience, choice or environment, plays an important role in the decision making process in favour of a similar future experience or choice process, which has been stated as Experienced Happiness (Duarte et al., 2009b).

In the present work, through the display of a cartoon aiming to mirror the expected environment when performing the suggested trip, and afterwards, measuring the stated happiness with the chosen mode, we intended to capture a latent part of the overall utility associated with the choice made.

CASE STUDY

The research for this study comprised three major phases as follows: (1) on-line survey development; (2) data collection and descriptive analysis; (3) development and estimation of hybrid discrete-choice models combined with stated happiness indicators.

The main objectives for the development of the case study included, on the one hand, to measure the happiness / level of satisfaction respondents stated concerning four general life aspects and current transport mode used to work and leisure trips, and on the other hand the importance of transport proposed attributes on their mode choice process and respondents' level of agreement with transport suggested situations and / or attitudes. Furthermore, we aimed to measure the respondents' level of happiness / satisfaction with the chosen transport mode, through eight discrete choice experiments targeting 2 transport modes: private car and metro.

The case study was developed recurring to the data collected through a web based survey, which was launched between November 30, 2008 and April 20, 2009.

The results following presented are extracted from a convenient sample, derived from the web based survey aforementioned, as one of the targets of the survey held was to capture the socio-economic influences on the transport mode decision choice and not having a country representative sample analysis.

Survey Design

The web-based survey, developed in PhP language and MySql, was derived from a previous survey carried out in 2007 (see (Duarte et al., 2009a; Duarte et al., 2009b)

It consisted of three sections. The first was intended to capture the behaviour of different social groups through the respondents' social and demographic characteristics. Secondly, a set of questions was proposed aiming to: (a) record the respondents' perception of happiness in different life domains; (b) obtain information on the respondents' level of happiness with current transport mode used to work and leisure trips; (c) perceive how much suggested transport attributes influence respondents transport mode choice decision-making; and (d) determine what was the level of agreement of respondents with proposed transport related situations / attitudes. Finally, the last section focused on individuals' travel-related choices, where each respondent was asked to make eight different transport mode choices, from a set of metro and car alternatives, for a specific trip length (long and short trip). The choice between private car and metro was detailed into two separate scenarios, for each one of the considered trip purposes - work and leisure trips, in which mode choice attributes such as: travel costs, real travel time, waiting time, and parking search time for the car option or waiting time for the metro one were varying among experiments, according to previously developed experiment design (Duarte et al., 2009a).

In addition, for each designed scenario an extra choice experiment was added, which included not only the mode choice attributes, but also a cartoon intended to transmit a graphic illustration of the expected travel environment, which we relate to level of expected comfort with the target transport mode (private car and metro), as shown below in Figure 1.

Satisfaction Level	Low	Average	High
Private Car			
Metro			

Figure 1 – Cartoons' Design

One of the original advances of the developed survey consists in the inclusion of questions aiming to target the respondents' experienced happiness with regard to the transport mode chosen for the two trip purposes suggested on the case study, namely business and leisure (the actual questions were: *How happy do you feel by using your current mode of transport to make a work related trip? How happy do you feel by using your current mode of transport to make a leisure trip?*). In addition, the use of the cartoons as a suggestion of the notion of the comfort level regarding the two proposed transport modes, aimed to help the

respondents on their decision-making, was also an innovative aspect introduced by the developed survey.

Descriptive Statistics

The 2009 survey remained on line for nearly five months, from November 30, 2008 until April 20, 2009, and received a total of 2'004 entries. Of this total, around 70% or 1'431 of entries were used to analyse the social-demographic characteristics and the stated happiness of the individuals as several of them did not answer all questions. For the model approximately 70% of the total entries were considered, corresponding to complete answered questionnaires.

According to the social-demographic answers most of the respondents are from Switzerland, Portugal and Greece which together represent 50% of the total entries. Switzerland is the most represented country, with a total of 24% respondents of the overall entries, followed by Portugal with 16% of responses and Greece with 10% of the total entries. The majority of the respondents are aged between 20 and 34 years old, with an average monthly household income of 2'700€, and living in a household with an average size of 2.7 members. Approximately 2/3 of the respondents correspond to employed people and 1/3 are students. With respect to the transport modes used for both work and leisure trips, it was observed that private car and metro are the most used modes. Considering car ownership, 60% of the total respondents own a private vehicle and 40% do not have a private vehicle.

Stated Happiness Statistics

Table 1 presents the average rank of each one of the thirty-three questions that comprise the second part of the survey. As it is shown, the average rank on stated happiness in different life domains is around Level 7, with a lower value stated for question four, focused on the financial situation; and the higher value on ranking the importance of family life. The standard deviation of the set of stated happiness in different life domains query from the average answer to the respective question is around 1.81, with the lower deviation on the first question, focused on the overall happiness; and the higher on the fourth question, targeting the respondents' happiness level with the financial situation.

Table 1 – Stated Happiness Statistics

2009 Survey				
Stated Happiness Questions (Happy Survey – Part 2: available at *http://www.civil.ist.utl.pt/~aduarte/StatedHappy.php*)			*Average*	*Standard Deviation*
Stated Satisfaction with Life Contexts	1)	How happy would you consider yourself, in an overall perspective?	7.46	1.52
	2)	How happy do you feel with your family life?	7.63	1.94
	3)	How happy do you feel with your social life?	7.23	1.70
	4)	How happy do you feel with your financial situation?	6.77	2.06
		Overall: Stated Satisfaction with Life Contexts	7.27	1.81
Stated Transport Satisfaction	5)	How happy do you feel by using your current mode of transport to make a work related trip?	7.46	2.16
	6)	How happy do you feel by using your current mode of transport to make a leisure trip?	7.78	1.81
	7)	How important is for you to feel happy / satisfied during a work related trip?	7.38	1.94
	8)	How important is for you to feel happy / satisfied during a leisure trip?	8.46	1.64
		Overall: Stated Transport Satisfaction	7.77	1.89

2009 Survey			
Stated Happiness Questions (Happy Survey – Part 2: available at *http://www.civil.ist.utl.pt/~aduarte/StatedHappy.php*)		*Average*	*Standard Deviation*
Stated Importance of Transport Attributes	9) How much cost / price affects your transportation choices?	6.84	2.46
	10) How much safety affects your transportation choices?	6.68	2.63
	11) How much quality of transportation affects your transportation choices?	7.45	2.04
	12) How much interchange facilities affects your transportation choices?	6.89	2.53
	13) How much carrying Luggage affects your transportation choices?	6.12	2.63
	14) How much accessibility to public transport affects your transportation choices?	7.29	2.57
	15) How much escorting children and elderly people affect your transportation choices?	4.37	3.49
	16) How much environmental awareness affects your transportation choices?	6.88	2.55
	Overall: Stated Importance of Transport Attributes	6.57	2.61
Stated Level of Agreement with Transport Related Situations and / or Attitudes	17) I would suggest my current transport mode to other people.	7.06	2.66
	18) My current transport choice depends on the lack of other available transport alternatives/modes	5.24	3.62
	19) I usually encounter congestion when I am commuting to work.	4.23	3.19
	20) I need to get to work on time every day.	5.80	3.20
	21) If I am late to work I will suffer some kind of consequence.	3.65	3.05
	22) I like to have my favourite transport mode always available.	8.39	1.90
	23) I reconsider the transport mode I use on a daily base.	4.59	3.27
	24) I find difficult to understand the public transport available to my destination(s).	2.99	3.18
	25) My daily trip to work causes me stress.	2.95	2.83
	26) Sometimes I feel unsafe when travelling in my current transport mode.	3.32	3.01
	27) I like to drive.	6.30	3.33
	28) I like to be free to decide when and how I go to my next destination.	8.37	1.96
	29) I feel that I take too much time to arrive to work.	3.92	3.32
	30) I like my daily trips to work.	5.98	2.62
	31) My current transport mode suits well my mobility needs.	7.77	2.09
	32) There are no other available transport modes in my area which I could consider to go to work.	4.62	3.70
	33) I always use the same transport mode to make my daily trips.	7.29	2.84
	Overall: Stated Level of Agreement with Transport Related Situations and / or Attitudes	5.44	2.93

As for the stated happiness with current transport mode used to work and leisure trips the average rank is also around Level 7, with a lower value for the importance in feel satisfied during a work trip (Question 7), and the higher level on raking the importance of feeling satisfied during a leisure trip (Question 8). The standard deviation on the overall of these questions is of 1.89, with the lower deviation on the eighth question, focused on the importance of feeling satisfied during a leisure trip; and the higher deviation being observed on the fifth question, related to the satisfaction with the current mode used to make work trips.

The average rank observed for the questions related with the importance of transport attributes in transportation choices is around Level 6, with the lower value observed on ranking the impact of escorting children and elderly people (Question 15), and the higher level on raking the quality of transportation (Question 11). The standard deviation observed in this group of questions is around 2.6, in which Question 15 and Question 11 present the higher and the lower deviation, respectively.

With regard to the set of questions on the level of agreement of respondents with proposed transport related situations / attitudes, the average rank was, in fact, the lowest observed for the overall stated happiness query, around the Level 5. The lower ranking was observed for the statement about the stress caused by the daily trip to work (Question 25), and the higher

raking was observed, in average, for the statement about favouring the possibility of having the favourite transport mode always available (Question 22). The overall standard deviation for this set of questions is higher compared to the overall deviation observed in the other three set of questions, around 2.93. The statement referring to the availability of the favourite mode (Question 22) presented the lower standard deviation, and the statement focusing on the availability of other transport modes to be considered for work trips (Question 32) presented the higher value.

An interesting finding from the survey's stated happiness questions show that the overall level of happiness significantly varies by country, as shown by Figure 1-a . The Swiss are the most satisfied respondents, followed by the Greeks and the Portuguese. In general, other Europeans respondents stated to be less happy than the respondents from non-European countries.

Stated Happiness, Trip Purpose, Car Ownership and Transport Mode

Concerning the relation between the stated happiness, trip purpose, car ownership and transport mode used by respondents, the most important results are as follows, as shown in Figure 2:

- The Swiss are the happiest with the current transport mode used in work related trips, while the Portuguese are the least happy about it (Figure2-a);
- The Swiss are the happiest with the current transport mode used in leisure trips, followed by the Portuguese and the Greek (Figure 2-a);
- Disregarding nationality all respondents, from Switzerland, Portugal and Greece, stated to be happier with their leisure trips than with their work trips (Figure 2-a);
- Car ownership does not seems to be a determining factor of the level of happiness since there is no significant differences in the satisfaction either with work or leisure related trips (Figure 2-b);
- Car owners state to be happier with their leisure trips rather than with their work related trips, and by the contrary, respondents that do not have a car state that they are happier with their work related trips than with their leisure trips (Figure 2-b);
- The respondents that use non-motorized modes, such as cycling and walking, to travel to work are more satisfied than those who use motorized modes such as bus and car, despite the fact that private car is used to travel to work by 34% of the total respondents and cycling, walking and bus users account, all together, for 33% of the total respondents (Figure 2-c and 2-d);
- The motorbike users are the third more satisfied transport mode used to work trips group, but this mode is only used by 2% of the total respondents (Figure 2-c and 2-d);
- The metro users, the second most used transport mode, are more satisfied with their work related trips than car and train users (Figure 2-c and 2-d).

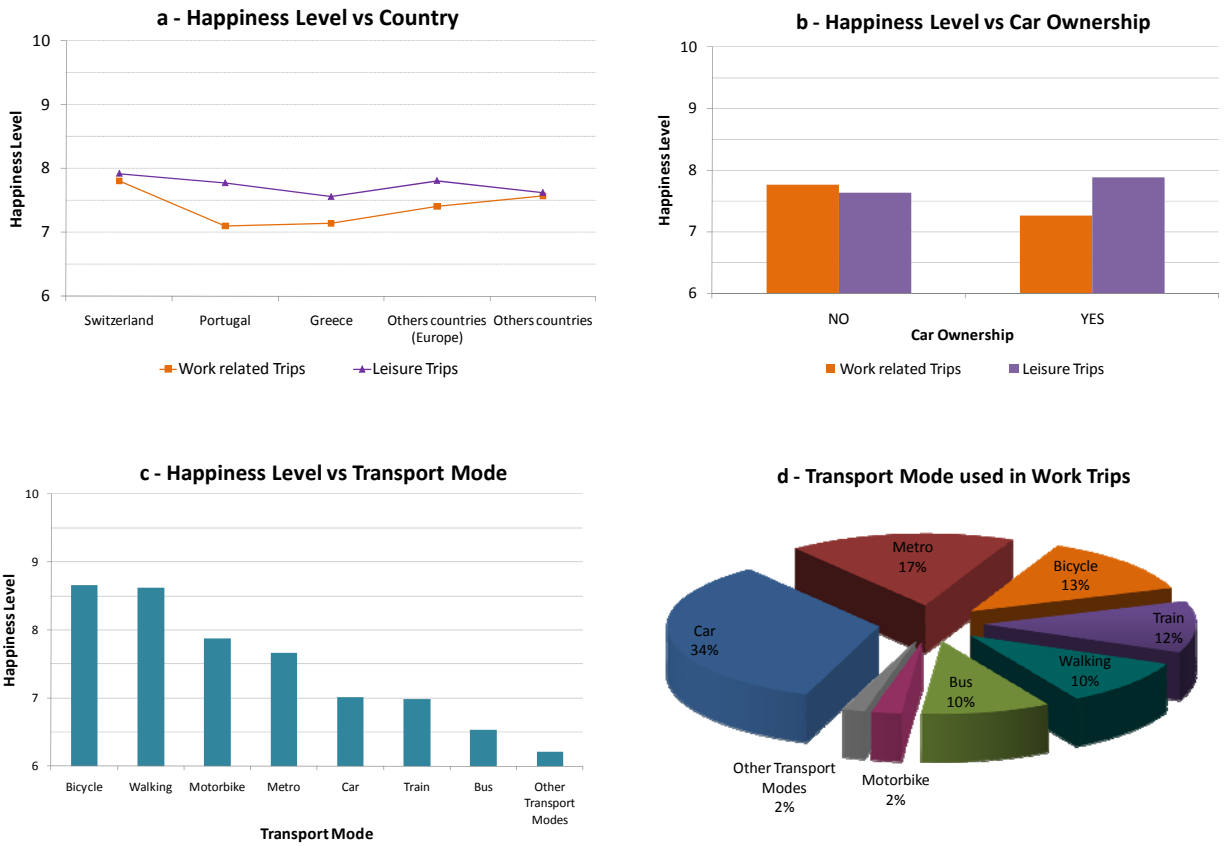

Figure 2 – Stated Happiness, Trip Purpose, Car Ownership and Transport Mode

MODELLING FRAMEWORK AND ESTIMATION RESULTS

This section presents the modelling framework developed representing traveller's mode choice behaviour and Travel Well-being. This framework follows the one described by Abou Zeid and Ben-Akiva (Abou Zeid, 2009; Abou Zeid *et al.*, 2010).

Behavioural Mode Choice Model

Figure 3, summarizes the general mode choice model structure which is developed in the present study. The model system consists of a discrete choice model enriched with expected stated happiness ratings that are being used as indicators of utility. Let *x* denotes observed variables, *U* denotes utility, *y* denotes choice indicators and *h* denotes happiness indicators.

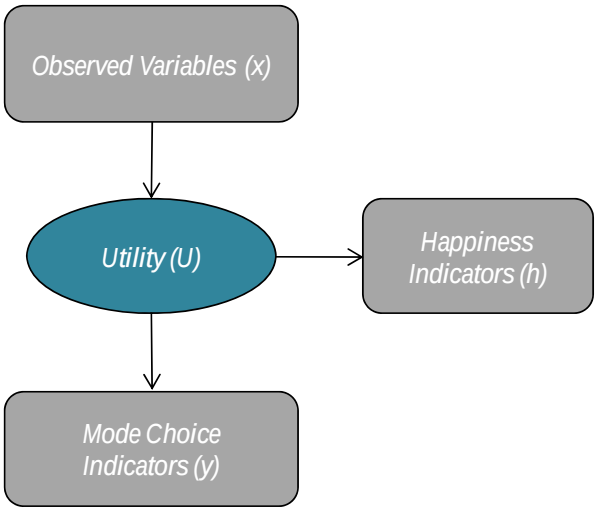

Figure 3 – Mode Choice Model Structure

Model Specification

The structural model is a specification of the utility equations of car and metro, as presented below:

$$U_{CAR} = V_{CAR} + \varepsilon_{CAR} = \beta_0 + \beta_1 * Traveltime_{CAR} + \beta_2 * Parkingtime_{CAR} + \beta_3 * Travel\cos t_{CAR} + \beta_4 * AGE25 + \beta_5 * AGE40 + \beta_6 * LONG + \beta_7 * Greece + \beta_8 * Portugal + \beta_9 * Switzerland + \beta_{10} * CartoonLow_{CAR} + \beta_{11} * CartoonMedium_{CAR} + \beta_{12} * LEISURE + \beta_{13} * LowIncome + \beta_{14} * HighIncome + \varepsilon_{CAR}$$

$$U_{METRO} = V_{METRO} + \varepsilon_{METRO} = \beta_{15} * Traveltime_{METRO} + \beta_{16} * Waitingtime_{METRO} + \beta_{17} * Travel\cos t_{METRO} + \beta_{18} * CartoonLow_{METRO} + \beta_{19} * CartoonMedium_{METRO} + \varepsilon_{METRO}$$

where U_{CAR} is the car utility, U_{METRO} is the metro utility, V_{CAR} and V_{METRO} are systematic utilities of car and metro respectively, which are specified as a function of a number of observed variables, such as travel time, travel cost, comfort level represented by cartoons, etc., and

$\varepsilon_{CAR}, \varepsilon_{METRO} \sim N(0,1)$ are normally distributed error terms for car and metro.

In this model, there exist two stated happiness measures (one for each mode: car and metro), which are treated as underlying continuous latent response variables indicating the corresponding utility.

Therefore, the **measurement model** is given by the following equations:

$$ModeChoice: y = \begin{cases} 1 & Car\ if \quad \Delta U + \eta \geq 0 \\ 0 & Metro, \quad otherwise \end{cases}, \ \eta \sim \text{Logistic}(0,1),$$

$$ExpectedStatedHappinessCar: h_{CAR} = a_1 + \lambda_1 \Delta U + \upsilon_1, \quad \upsilon_1 \sim \text{N}(0, \sigma^2_{\upsilon_1})$$

$$ExpectedStatedHappinessMetro: h_{METRO} = a_2 + \lambda_2 \Delta U + \upsilon_2, \quad \upsilon_2 \sim \text{N}(0, \sigma^2_{\upsilon_2})$$

where,

y	=	*the mode choice indicator*
ΔU	=	*difference of the utility of car and metro*
η	=	*logistic error term with a location of 0 and a scale parameter of 1*
λ_1, λ_2	=	*the loading factors*
υ_1, υ_2	=	*normally distributed error terms* $\sigma_{e\upsilon_1} = \sigma_{e\upsilon_2} = \sigma_{\upsilon_1\upsilon_2} = \sigma_{\varepsilon\eta} = \sigma_{\eta\upsilon_1} = \sigma_{\eta\upsilon_2} 0$
h_{CAR}, h_{METRO}	=	*indicators of happiness, for the latent stated expected happiness with car and metro respectively*

The likelihood function for one observation (n) is:

$$P_n = \int_{\varepsilon} f_1(y \mid \varepsilon) f_2(h_{CAR} \mid \varepsilon) f_3(h_{METRO} \mid \varepsilon) f_4(\varepsilon) d\varepsilon$$ where,

$$f_1(y \mid \varepsilon) = \left(\frac{1}{1+e^{\Delta U}}\right)^Y \left(\frac{e^{\Delta U}}{1+e^{\Delta U}}\right)^{1-y}$$

$$f_2(h_{CAR} \mid \varepsilon) = \frac{1}{\sigma_{\upsilon_1}} \phi\left(\frac{h_{CAR} - \alpha_1 - \lambda_1 \Delta U - \lambda_1 \varepsilon}{\sigma_{\upsilon_1}}\right)$$

$$f_3(h_{METRO} \mid \varepsilon) = \frac{1}{\sigma_{\upsilon 2}} \phi\left(\frac{h_{METRO} - \alpha_2 - \lambda_2 \Delta U - \lambda_2 \varepsilon}{\sigma_{\upsilon_2}}\right)$$

$$f_4(\varepsilon) = \phi(\varepsilon)$$

MODEL VARIABLES STATISTICS AND ESTIMATION RESULTS

Table 2 and Table 3 present the descriptive statistics of the variables used in Model Estimation. Each respondent was to respond to eight choice experiments based on the trip purpose (work and leisure trips), length of the trip (short and long trips) and the type of Trip Specific Happiness (TSH), represented by three types of cartoons (low, medium, and high), according to previous survey design (Duarte et al., 2009a), reflecting the comfort level as well as a suggestion of overall satisfaction with the trip.

Table 2 - Categorical Variables

Variables	*# of Observations*	*% in Total*
Choice_Car	11'448	34.8
Trip Purpose: Leisure	11'448	50
TSH_Low_Car	11'448	17.5
TSH_Medium_Car	11'448	15.8
TSH_Low_Metro	11'448	16.2
TSH_Medium_Metro	11'448	17.8
AGE25: Individual younger than 25 years old	11'448	24.6
AGE40: Individual older than 40 years old	11'448	56.3
Greece: Dummy for Greek	11'448	13.6
Portugal: Dummy for Portuguese	11'448	22.2
Switzerland: Dummy for Swiss	11'448	33.7
LowIncome: Income lower than 2'000€	11'448	39.2
HighIncome: Income greater than 5'000€	11'448	17.0

Table 3 - Continuous Variables

Variables	*Average*	*Standard Deviation*
Expected Happiness Car	7.42	1.97
Expected Happiness Metro	7.66	2.05

Following, Table 4, Table 5 and Table 6 present the estimation results of two models. **Model 1** is a simple MNL. **Model 2** was built based on the model structure presented in the previous section (see Figure 3 and Model Specifications). The models were estimated using the *GAUSS* software (*Aptech Systems*).

Model Estimation

Table 4 below presents the estimation results for the structural model corresponding to the above model framework. The model estimation / calibration was made using *GAUSS (Aptech Systems*).

Table 4 – Estimation Results for the Model 1 and Model 2: Structural Model

	Model 1: Simple MNL		Model 2: MNL with Happiness Indicators	
Coefficients	Coefficient Estimates	t-stat	Coefficient Estimates	t-stat
STRUCTURAL MODEL				
Car Constant	-1.064	-10.18	-1.049	-20.12
Mode Attributes				
Real Travel Time: Car trip	-0.0488	-24.82	-0.024	-29.60
Parking Time: Car trip	-0.056	-9.88	-0.028	-11.34
Travel Cost: Car trip	-0.102	-13.35	-0.0471	-14.47
Real Travel Time: Metro trip	-0.0503	-28.60	-0.026	-34.22
Waiting Time: Metro trip	-0.0552	-12.263	-0.033	-16.46
Travel Cost: Metro trip	-0.1532	-11.86	-0.078	-13.86

	Model 1: Simple MNL		Model 2: MNL with Happiness Indicators	
Coefficients	Coefficient Estimates	t-stat	Coefficient Estimates	t-stat
Trip Purpose: Leisure	0.716	15.579	0.373	18.59
Socioeconomic Characteristics				
AGE25: Individual younger then 25 years old	0.1605	2.14	0.0697	2.12
AGE40: Individual older then 40 years old	-0.0568	-0.91	-0.0460	-1.67
LowIncome: Income lower then 2'000€	-0.396	-7.55	-0.202	-8.78
HighIncome: Income greater then 5'000€	0.0852	1.25	0.0142	0.48
Country of Origin				
Greece: Dummy for Greek	0.254	4.03	0.108	3.86
Portugal: Dummy for Portuguese	0.616	8.39	0.326	9.87
Switzerland: Dummy for Swiss	-0.475	-7.76	-0.226	-8.54
Trip-specific Happiness - Level of Comfort				
TSH_Low_Car: Low Comfort in Car	-1.493	-20.011	-0.750	-25.37
TSH_Medium_Car: Normal Comfort in Car	-0.346	-4.993	-0.184	-6.016
TSH_Low_Metro: Low Comfort in Metro	-0.827	-12.06	-0.491	-16.30
TSH_Medium_Metro: Normal Comfort in Metro	-0.617	-9.23	-0.357	-12.12

Table 5 and Table 6 bellow present the estimation results concerning the measurement model and the statistics obtained for both **Model 1** and **Model 2**.

Table 5 – Estimation Results for the Model 1 and Model 2: Measurement Model

	Model 1: Simple MNL		Model 2: MNL with Happiness Indicators	
Coefficients	Coefficient Estimates	t-stat	Coefficient Estimates	t-stat
MEASUREMENT MODEL				
α_1			4.7336	73.282
Stated Happiness Car: λ_1			2.6347	123.694
α_2			2.6664	37.493
Stated Happiness Metro: λ_2			2.8504	128.107

Table 6 – Estimation Results for the Model 1 and Model 2: Statistics

	Model 1: Simple MNL	Model 2: MNL with Happiness Indicators
STATISTICS		
Number of Observations	11'448	11'448
Initial Log-Likelihood	-7935.1468	-84257.28
Final Log-Likelihood	-5843.1622	-56782.08
Rho-square	0.263	0.326

The model estimation results indicate that metro is generally preferred to car. The main mode attributes, such as travel costs, travel time, parking time and waiting time, are significant and with negative signs as expected. The coefficient sign of the trip purpose shows that travellers prefer to use their private car for leisure trips.

The socioeconomic variables that prove to significantly affect mode choice are age and level of income. More specifically, individuals younger than 25 years old prefer private car while

those who are more than 40 years old choose mainly the metro. Individuals with income lower than 2'000€ prefer metro.

All the dummy variables representing the country of origin of respondents are significant, and it can be advocated that Greek and Portuguese have a higher preference for choosing the private car when compared to Swiss respondents.

Furthermore, the Trip-specific Happiness (TSH) or levels of comfort, represented in the experiments by the use of the cartoons are highly significant both in car and metro alternatives. Their sign indicates that as the THS with a mode decreases the probability of choosing the alternative mode increases.

Concerning the measurement model, both loading factors λ_1 and λ_2 representing, respectively, car stated happiness and metro stated happiness measures are significant and along the hypothesized direction.

Finally, comparing the **Model 1** and **Model 2**, it can be observed that the goodness of fit of the models developed increase significantly from **Model 1** to **Model 2**.

CONCLUSIONS

The past few years have witnessed an increasing number of research focuses on Transport related Subjective Well-being (SWB) or happiness. As people spend an important amount of time travelling each day, it is important to provide a transport service that can meet travellers' needs and increase their travel happiness. Cleary, governments and policy makers should adopt measures in order to support transport solutions with which individuals' feel happier.

Following the economists' interest in perceiving what is beyond the classical formulation of the utility function, transport researchers have been recently motivated by the introduction of happiness attributes and indicators in their transportation models, in order to better predict the decision process of transport users (see for e.g. Abou Zeid *et al.*, 2010).

The analysis presented in this paper is based on an on-line survey launched between November 30, 2008 and April 20, 2009. The similarities and differences among travellers' behaviour for the three EU most represented countries, namely Switzerland, Portugal and Greece, are explored. Disregarding nationality, all respondents stated to be happier with their leisure trips than with their work trips. Swiss respondents state to feel happier with their work related trips when compared to Portuguese and Greek respondents, who stated, in average, lower levels of happiness with their work related trips.

Another interesting finding observed is that car ownership does not seems to be a determining factor of the level of happiness since there is no significant differences in the satisfaction either with work or leisure related trips, since no evidence was observed in the respondents' answers. However, car owner's state to be happier with their leisure trips rather than with their work related ones', and on the contrary, respondents who do not have a car state to be happier with work related trips rather then with leisure trips. Moreover, users of non-motorized modes, such as cycling and walking are happier with their work trips when compared with users of motorized modes such as car and bus.

Innovative Stated Preferences experiments were developed involving two different aspects of subjective well-being:

(1) The notion of level of comfort with regards of two modes of transport, namely car and metro, is represented via cartoons. This level of comfort may also reflect part of the trip-specific happiness (TSH) as it is perceived by travellers.

(2) Indicators of the expected level of happiness with the chosen mode are recorded after each mode choice experiment. These are then used as indicators of the utility function.

Model estimation results demonstrate the improvement of goodness of fit, when including the Expected Happiness as indicators of the mode utility functions. Furthermore, the TSH proved to be very significant, influencing mode choice behaviour.

The above mentioned conclusions contribute to an enhanced understanding of the mode choice models development and thus to reinforce the need to proceed in the exploration of other dimensions of decision-making processes, specifically the role of travel well-being, in order to ameliorate evaluation methodologies, providing the basis for a better use of them as instruments for policy and strategic decision making.

FURTHER RESEARCH

The results obtained were not fully explored, considering the various analyses that can yet be done.

One of the questions that we still aim to answer relates to question "*Which transport mode attributes has the most significant contribution to the level of happiness of the chosen transport alternative?*"

In what concerns the model development, model structure could be extended in order to: (a) include latent variables with regards to car addition, mode captivity and freedom of mode transport use, by exploring the collected data referring to the stated importance of transport attributes and the stated level of agreement with transport related situations and / or attitudes; (b) account for multiple observations from the same individual; and (c) account for unobserved differences of behaviour among years, when minor or major changes may occur in individuals life, such as change in the family size, change of place of residence, etc.

Moreover, provided that the model specification assumes that happiness is the same as the utility (as in the model developed), the model could be enriched with additional variables that can directly affect travel well-being. In addition, this research could be further extended so that different behavioural assumptions and travel situations be tested. Finally, a path for repeating data collection to model dynamic decision-making behaviour could also be assigned for our future work agenda.

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