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Liberalization of the Interurban Coach Market in Germany – Do Attitudes and Perceptions Drive the Choice between Rail and Coach?

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Abstract

In January 2013 the interurban passenger transport market in Germany was liberalized and several coach carriers emerged offering an alternative to the Deutsche Bahn, a state owned rail monopoly. The coach carriers have attempted to position themselves not just through lower prices but also through product differentiation, for example marketing their services as the most ecological way to travel. Hence, it is important to consider attitudes and perceptions when analyzing this market.

One year after liberalization we conducted a stated-choice experiment among students and employees at the Technical University of Berlin, where participants had to choose between different interurban public transport alternatives (regional and intercity trains or interurban coaches). Additionally, the experiment gathered perception and attitudinal indicators used to construct latent variables. Our results show that attitudes and perceptions indeed affect the way individuals choose between different transport modes and, therefore, they must be taken into account when analyzing the interurban passenger market in Germany.

Keywords: Liberalization, Coach Market, Latent Variables, Hybrid Discrete Choice Modelling, Attitudes and Perceptions

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1. INTRODUCTION

To protect the railway industry and to promote network development, the interurban passenger transport market in Germany was controlled by a state rail monopoly (now Deutsche Bahn AG) with scheduled long distance coach services practically forbidden (Maertens, 2012). In 2013 the market was liberalized, with several coach carriers emerging to offer various scheduled routes that connect major metropolitan areas within Germany (Gertsen *et al.*, 2013).

As of June 2014, the market for coach services is still expanding and it appears that the interurban transport market has not yet reached a steady state. Early analyses of the development of service supply show that in the first year following deregulation, the number of lines (city to city connections) doubled and the number of tours (frequency of services) offered more than tripled (IGES/bdo, 2013). As the statistical basis to monitor market development is not yet consolidated, it can only be estimated that the total demand for scheduled bus service has also about tripled in 2013 (ITP *et al.*, 2014).

An interesting aspect of the new services is that the coach carriers have not only attempted to position themselves in the market with lower prices but also through product differentiation. For example, coach services have been marketed as the most ecological way to travel, offering also the possibility of compensating for CO₂ emissions. In the same vein, several carriers provide on board Internet-services, while some offer free snacks or the possibility of taking breaks during long trips. Further some companies conduct satisfaction surveys after each trip. Deutsche Bahn (DB), in turn, can still count on offering a safer service (Statistisches Bundesamt, 2013), which can also be assumed to be more reliable, as busses are delayed by general traffic conditions. As a consequence, consumer choice is not only affected by the objective characteristic of each alternative, such as fares or travel times, but also by the attitudes and perceptions of the individuals toward each alternative (Vredin-Johansson *et al.*, 2006; van Acker *et al.*, 2011; Alvarez-Daziano and Bolduc, 2013, among others).

To the best of our knowledge, there has been no research on the competition between coach and rail service as it develops after liberalization of the coach market. Several European countries have deregulated the market for long-distance coach services in the last decades. After first steps were taken in the United Kingdom in the early eighties by now

Sweden, Norway, Poland, the Czech Republic and Spain amongst others have a deregulated coach market (Van de Velde, 2013). In most countries, the dominant regulatory regimes of the reformed markets include requirements for quality standards of the operators and authorization of services on request of operators. This regime, termed ‘market initiative’ by van de Velde, may be combined with further obligations, e.g. to prevent parallel services (van de Velde, 2009).

Following deregulation, the transitional development of markets was heterogeneous and eventually the markets may feature a dominant position of a major operator (UK), oligopolistic competition or the competition of numerous providers (White and Robbins, 2012; van de Velde, 2009). However, on the level of the operators, cooperation between providers (especially for marketing) and the activities of small local firms via subcontracting remain important characteristics of many markets.

The major customers of long-distance coaches are elderly, students and people prepared to accept longer travel times and they are more likely attracted from the car than from rail (van de Velde, 2009). There is very little information on trends of the market volume for coach services. As an example, for Norway high customer satisfaction for express coach service is reported in a growing market (Leiren and Fearnley, 2008).

Next we provide the theoretical framework for the Hybrid Discrete Choice modelling and we describe the experimental design of our data collection. In the fourth part of the paper we present the two stages of model estimation and we finally derive some conclusions based on the results of the models.

2. THEORETICAL BACKGROUND

Under the assumption that individuals are rational decision makers, it can be postulated that individuals q facing a set of available alternatives $A(q)$, will choose the alternative i that maximizes their perceived utility. In accordance with Random Utility Theory (Thurstone, 1927; McFadden, 1974), it is possible to depict this utility as the sum of a representative component (V_{iq}) and an error term (ε_{iq}), which leads to the following expression (Ortúzar and Willumsen, 2011):

$$U_{iq} = V_{iq} + \varepsilon_{iq} \quad (2.1)$$

The representative utility (V_{iq}), considering all attributes that can be quantified by an observer, is usually characterized through concrete and measurable properties of the alternatives and the individuals; the error term, in turn, represents all unknown or abstract elements affecting the decision.

When considering a Hybrid Discrete Choice (HDC) modelling framework (Ben-Akiva *et al.*, 2002), the modeler attempts to depict abstract attributes as measurable variables in order to include them as part of the systematic utility. Hereby, immaterial constructs, known as latent variables (η_{liq}), are also included into the modelling. These variables are supposed to represent attitudes and/or perceptions of the individuals and, as they cannot be directly observed, they must be constructed as a function of positively observed variables. The usual approach to construct these latent variables relies on a Multiple Indicators Multiple Causes (MIMIC) structure (Zellner, 1970; Bollen, 1989). Here, the latent variables are explained by a set of characteristics of the individuals and the alternatives (s_{iqr}), through so called *structural equations*, while explaining, at the same time, a set of attitudinal and/or perception indicators (y_{ziq}), previously gathered from the individuals, through so called *measurement equations*. This framework can be represented through the following equations:

$$\eta_{liq} = \sum_r \alpha_{lri} \cdot s_{riq} + v_{liq} \quad (2.2)$$

$$y_{ziq} = \sum_l \gamma_{lzi} \cdot \eta_{liq} + \zeta_{ziq} \quad (2.3)$$

where the indices i , q , r , l and z refer to alternatives, individuals, exogenous variables, latent variables and indicators, respectively. The error terms v_{liq} and ζ_{ziq} can follow any distribution, but they are typically considered to be normally distributed with mean zero and a certain covariance matrix. Finally, α_{lri} and γ_{lzi} are parameters to be jointly estimated.

If we assume a linear specification in V_{iq} , the utility function can be expressed as (2.4). This specification can be understood as a first-order Taylor expansion of any multi-variable complex function (and therefore it is always valid in the neighborhood of the estimation point); further, if the attributes are also assumed to be linear, the estimated parameters θ_{ik} and β_{il} (related to the tangible attributes and latent variables, respectively) can be directly interpreted as marginal utilities:

$$U_{iq} = \sum_k \theta_{ki} \cdot X_{kiq} + \sum_l \beta_{li} \cdot \eta_{liq} + \varepsilon_{iq} \quad (2.4)$$

Under the assumption that the error terms ε_{iq} in (2.1) are independent and identically distributed Extreme Value Type 1 (EV1) with the same variance σ^2 , the differences between the utilities associated with the alternatives follow a Logistic distribution with mean zero and scale factor λ , leading to the well-known Multinomial Logit (MNL) model (Domencich and McFadden, 1975); in this case, the probability of choosing alternative i is given by:

$$P_{iq} = \frac{e^{\lambda V_{iq}}}{\sum_j e^{\lambda V_{jq}}} \quad (2.5)$$

and λ is inversely related to the standard deviation of the error terms:

$$\lambda = \frac{\pi}{\sigma \sqrt{6}} \quad (2.6)$$

However, as the scale factor cannot be estimated (assuming a linear function as usual), it is customary to *normalize* it to one (Walker, 2002).

The estimation of both parts of the model should be performed simultaneously, as a sequential estimation considering first the MIMIC part as an isolated system and evaluating then the expected values for the latent variables cannot guarantee unbiased estimators (Train *et al.*, 1987; Ben-Akiva *et al.*, 2002). However, empirical evidence sustains the thesis that the sequential estimation produces no major discrepancies regarding the ratios between the estimated parameters and, therefore, the marginal rates of substitution (Raveau *et al.*, 2010; Bahamonde-Birke *et al.*, 2010). Nevertheless Bahamonde-Birke and Ortúzar (2014a) prove that the estimators may indeed be affected by a significant deflation bias (affecting all estimated parameters), while Bahamonde-Birke and Ortúzar (2014b) propose the following expression to correct this deflation:

$$\lambda_{HDC} = \frac{\lambda_{DC}}{\sqrt{1 + \frac{6 \cdot \lambda_{DC}^2 \cdot \sum_i \beta_i^2 \cdot \sigma_i^2}{\pi^2}}} \quad (2.7)$$

where $\sum_i \beta_i^2 \cdot \sigma_i^2$ stands for the variability induced into the model through the latent variables. This correction term performs in an acceptable manner as long as the ratio between the induced variability and the model's own variability is sufficiently small. If that is not the case, the sequential estimation must be disregarded.

3. EXPERIMENTAL DESIGN

We conducted a stated choice experiment (Ortúzar and Willumsen, 2011) among students and employees of Technical University of Berlin. The experiment was carried out one year after the liberalization and respondents were asked to choose between different interurban public transport alternatives (regional trains,¹ intercity trains, interurban coaches). Berlin was not chosen at random: it was the only major city in Germany (as an artifact of the Cold War) with some intra-Germany coach service prior to liberalization. Furthermore, Berlin is one of three German cities with a well-equipped interurban bus station (the others are Hamburg and Munich; Maertens, 2012). Thus, it was expected that the population would be more familiar with the services provided by the interurban carriers one year after the liberalization of the market.

The experiment was conducted online in January 2014. Altogether around 28,000 students and 2,500 employees were contacted. After data cleaning, the survey yielded a total of 1,425 responses (1,170 from university students). The questionnaire had four parts. In the first, respondents were asked to describe the main characteristics (fare, travel time, number of transfers, etc.) of their last trips with the regional and intercity trains of Deutsche Bahn. At the end of this module participants were required, based on their experiences traveling with Deutsche Bahn (considering the same kind of trains and the same number of transfers), to state their level of agreement with the following statements:

¹ Regional trains should not be confused with commuter rail. Regional trains operate over long interurban distances, stopping more and over shorter distances than high-speed trains. It is possible to travel across the country using only regional trains.

| | |
|--|---------------------|
| <i>I was able to relax during the trip (y₁₁)</i> | Relax |
| <i>I felt secure from thefts and losses (y₁₂)</i> | Security |
| <i>Traveling with heavy luggage was (would have been) uncomplicated (y₁₃)</i> | Luggage |
| <i>The departure time was reliable (y₁₄)</i> | Departure |
| <i>The arrival time was reliable (y₁₅)</i> | Arrival |
| <i>It was possible to use the travel time productively (y₁₆)</i> | Productivity |
| <i>The station was easily accessible (y₁₇)</i> | Station |
| <i>Purchasing the ticket was uncomplicated (y₁₈)</i> | Tickets |

In the same line, respondents were also asked to state their level of agreement with these statements under the assumption that a bus carrier with no transfers would offer the service. The level of agreement was stated on a scale which ranged from strongly disagree (1) to strongly agree (10).

The second part of the survey gathered travel behavior data as well as indicators related to the travelers' attitudes toward current political issues discussed in Germany. Hereby, the respondents had to state the level of agreement with the following sentences:

| | |
|---|--------------------------|
| <i>I agree with the nuclear power phase-out (y₂₁)</i> | NuclearPhaseOut |
| <i>Environment protection is more important than economic growth (y₂₂)</i> | Environment |
| <i>I am willing to pay a 25% surcharge on my electric bill to reduce CO₂ emissions from coal power plants (y₂₃)</i> | ElectricSurcharge |
| <i>Highway tolls should be introduced to compensate CO₂ emissions (y₂₄)</i> | HighwayTolls |
| <i>Automobiles with higher engine power should pay more taxes (y₂₅)</i> | CarTax |
| <i>Investing on the development of high-speed trains should be encouraged (y₂₆)</i> | HSTrains |
| <i>New highways or additional lanes to the existing ones should be built (y₂₇)</i> | Highways |
| <i>New high-speed rail lines should be built (y₂₈)</i> | RailLines |
| <i>I agree with the introduction of speed limits on highways (y₂₉)</i> | SpeedLimits |

The third part of the questionnaire was the stated-choice experiment itself. Here, respondents were required to choose between a first pivotal alternative, representing the trip previously described, and a new travel alternative. Altogether, respondents were confronted with 12 choice situations, where the first six used a pivotal alternative based on the trip with Deutsche Bahn regional trains and the last six considered a trip with Deutsche Bahn intercity trains as the base situation. The alternatives were described in terms of their travel time, fare, number of transfers, mode of transport - regional trains (RE), intercity trains (FVZ) and coaches (LB) - and safety level (represented through the number of

severally injured passengers and the number of fatalities in the overall network over a year).

The attribute levels of the alternatives presented to respondents were optimized maximizing the D-efficiency of the experimental design as proposed by Rose et al. (2008). As it was not possible to personalize the attribute levels during the survey, they were fixed *a priori* based on the average levels of the attributes. These average levels, as well as the priors used for computing the D-error, were established in accordance with models previously estimated, based on the answers gathered during the pre-test of the survey (48 individuals). Finally the fourth part of questionnaire gathered socioeconomic information about the respondents.

4. MODEL ESTIMATION

4.1 Model Structure

Before starting with the estimation of HDC models, it was necessary to establish the structure of the MIMIC-model considered. For this, the collected indicators were analyzed using factor analysis to guarantee a correct specification of the latent variables (LV). This way it was possible to identify three components explaining 68.5% of the variance of the perceptions indicators (y_{11} to y_{18}). In the same way, it was possible to establish that two variables captured 53.7% of the variability associated with the attitudinal indicators (y_{21} to y_{29}). Table 1 presents the rotated component matrices for both types of indicators. On the basis of these results, we constructed five latent variables, as highlighted in Table 1. The first was identified as “Comfort”, as it was exclusively related to comfort indicators. The second component was called “Stress-free”, as it was associated with situations causing tension during the trip. Finally, the third component was identified as “Reliability”.

Regarding the attitudinal indicators, the first component is associated with a “Green” attitude, including a negative predisposition toward automobiles (y_{24} , y_{25} , y_{27} and y_{29}). The second component is related to individuals who have great appreciation to development of trains and rail lanes; for that reason, this LV was called “TrainFan”.

Table 1 – Rotated Component Matrix of Perception and Attitudinal Indicators

| Indicator | Comfort | StressFree | Reliability | Indicator | Green | TrainFan |
|---------------------|---------|------------|-------------|--------------------------|--------|----------|
| <i>Relax</i> | 0.538 | 0.568 | 0.206 | <i>NuclearPhaseOut</i> | 0.676 | -0.024 |
| <i>Security</i> | 0.124 | 0.787 | 0.086 | <i>Environment</i> | 0.735 | -0.086 |
| <i>Luggage</i> | 0.057 | 0.805 | 0.174 | <i>ElectricSurcharge</i> | 0.702 | 0.045 |
| <i>Departure</i> | 0.103 | 0.217 | 0.894 | <i>HighwayTolls</i> | 0.653 | 0.238 |
| <i>Arrival</i> | 0.270 | 0.111 | 0.870 | <i>CarTax</i> | 0.677 | 0.189 |
| <i>Productivity</i> | 0.640 | 0.422 | 0.133 | <i>HSTrains</i> | 0.113 | 0.856 |
| <i>Station</i> | 0.804 | 0.056 | 0.153 | <i>Highways</i> | -0.558 | 0.362 |
| <i>Tickets</i> | 0.712 | 0.045 | 0.119 | <i>RailLines</i> | 0.053 | 0.891 |
| | | | | <i>SpeedLimits</i> | 0.604 | 0.107 |

4.2 MIMIC models

Given the complex structure of the data base it was not possible to perform a simultaneous estimation of the HDC model as, for certain individuals (who did not provide information related to their perceptions), it was necessary to impute the latent variable values based on the estimated MIMIC model. In addition, individuals were faced with more than one choice situation, thus making it imperative to rely on panel data estimation. Therefore, a sequential estimation was attempted and it was possible to establish that the bias caused by this second-best estimation technique was manageable. So, the MIMIC model was estimated first and the latent variables considered in the discrete choice model (DCM) component were built in accordance with these estimates.

It was necessary to estimate two different MIMIC models. First, a model for attitudes, which only considered individual characteristics as explanatory variables. Figure 1 presents the final structure of the selected model, after several specifications were considered: In the two systems of structural equations, the latent variable (e.g. Green) is explained by several (e.g. eight) socio-demographic variables, while the latent variable explains several (e.g. seven) attitudinal indicators.

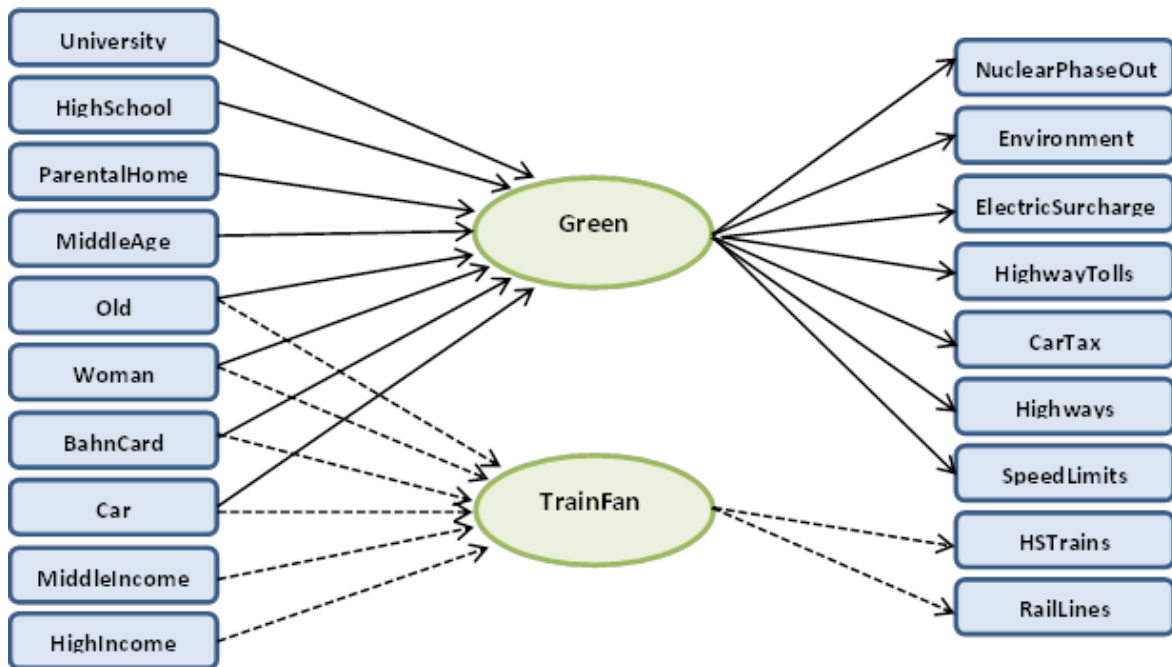


Figure 1 – Structure of the Attitudinal MIMIC model

In this case, “University” and “High School” are associated with working individuals holding the respective educational degree (in contrast to the base case representing university students). “Parental Home” only applies to students and it indicates that the individual still lives at their parental home. “BahnCard” indicates that the individual holds a Deutsche Bahn yearly discount card (which is common in Germany due to the price discrimination policies adopted by the state rail monopoly), while “Car” indicates automobile ownership. A detailed explanation of the remaining socio-economic variables is presented in the appendix 1. Table 2 presents the estimated parameters.

As expected, individuals more concerned about the environment tend to support initiatives, such as environmental taxes or the nuclear phase-out, while, at the same time, they disapprove of policies that encourage car usage, such as the absence of highway tolls or speed-limits. Further, people who favor public transport, represented through BahnCard possession, appear to have a more positive attitude toward the natural environment, than do car owners. Working people are more concerned about the environment than students; older people care more about the environment. The last results may be surprising, but we have to take into consideration that we are working with students and young people at a technical university, who may have a different attitude toward the environment than other people their age. Finally, women care more about the environment than men.

Table 2 – Estimated Parameters for the Attitudinal MIMIC model

| Explanatory Variable | Estimate | t-test | Attitudinal Indicator | Estimate | t-test |
|-----------------------------|-----------------|---------------------|------------------------------|-----------------|---------------|
| <i>Green Attitude</i> | | | <i>Green Attitude</i> | | |
| <i>University</i> | 0.222 | 2.741 | <i>NuclearPhaseOut</i> | 1.457 | 39.378 |
| <i>HighSchool</i> | 0.323 | 2.084 | <i>Environment</i> | 1.221 | 35.912 |
| <i>ParentalHome</i> | -0.183 | -2.691 | <i>ElectricSurcharge</i> | 1.672 | 41.800 |
| <i>MiddleAge</i> | 0.254 | 4.536 | <i>HighwayTolls</i> | 2.147 | 44.729 |
| <i>Old</i> | 0.582 | 2.328 | <i>CarTax</i> | 1.653 | 41.325 |
| <i>Woman</i> | 0.332 | 5.825 | <i>Highways</i> | -1.047 | -32.719 |
| <i>BahnCard</i> | 0.306 | 5.186 | <i>SpeedLimits</i> | 2.256 | 46.041 |
| <i>Car</i> | -0.547 | -8.967 | | | |
| <i>TrainFan</i> | | | <i>TrainFan</i> | | |
| <i>Old</i> | 0.427 | 1.655 ² | <i>HSTrains</i> | 2.116 | 44.083 |
| <i>Woman</i> | -0.3 | -5.172 | <i>RailLines</i> | 2.097 | 43.688 |
| <i>BahnCard</i> | 0.346 | 5.672 | | | |
| <i>Car</i> | -0.107 | -1.726 ² | | | |
| <i>MiddleIncome</i> | 0.099 | 1.737 ² | | | |
| <i>HighIncome</i> | 0.166 | 1.711 ² | | | |

Regarding the “TrainFan” variable, it appears that both older people and high-income individuals favor rail transport. This result is in line with our expectations as, given the history of public transport in Germany, older people are less familiar with the other alternatives, while high-income individuals are willing to allocate greater state resources toward improving faster ground transportation. Individuals holding a BahnCard have a more favorable attitude toward rail transport than individuals driving a car; finally, men have a more positive attitude toward rail transport than women.

As stated above, a MIMIC model was also estimated for the perception indicators. In this case, not only the characteristics of the individuals but also the attributes of the transport modes were considered as explanatory variables. It is also important to consider interactions between these two kinds of variables, as the attributes of the alternatives are perceived differently by different population groups (i.e. systematic taste variations, Ortúzar and Willumsen, 2011). The structure of the estimated model is shown in Figure 2.

² As the signs of the estimators were known *a priori*, a one-tailed test was performed ($\alpha_{5\%}=1.645$).

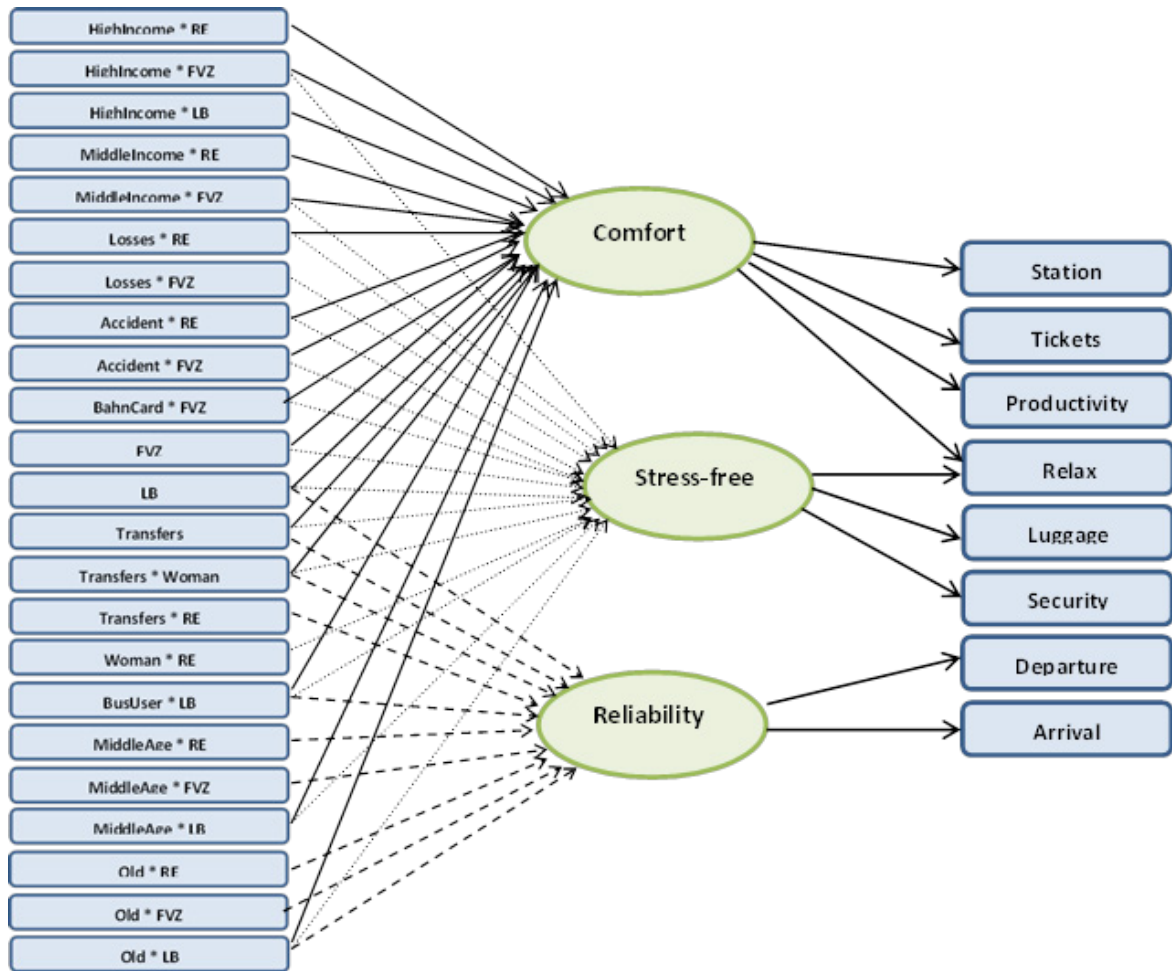


Figure 2 – Structure of the Perception MIMIC model

Here, “Losses” and “Accidents” indicate that in the past the individual had suffered losses during a trip or been involved in a train accident, respectively. The number of transfers is represented through a discrete variable ranging between zero and four, while “BusUser” indicates whether the individual had undertaken at least one trip with coach services during the last three years. The estimation results are presented in Table 3.

In line with our hypotheses, all explanatory variables affecting perceptions are directly related with the specific alternatives for which they were calculated, whether considering the attributes directly or through systematic taste variations (it is important to note that not considering the latter works as well, but provides a poorer goodness-of-fit).

Table 3 – Estimated Parameters for the Perception MIMIC model

| Explanatory Variable | Estimate | t-test | Attitudinal Indicator | Estimate | t-test |
|-----------------------------|-----------------|---------------------|------------------------------|-----------------|---------------|
| Comfort | | | Comfort | | |
| <i>HighIncome * RE</i> | 0.197 | 1.841 ³ | <i>Station</i> | 1.339 | 51.500 |
| <i>HighIncome * FVZ</i> | 0.297 | 2.517 | <i>Ticket</i> | 1.112 | 46.333 |
| <i>HighIncome * LB</i> | -0.29 | -2.458 | <i>Productivity</i> | 1.901 | 59.406 |
| <i>MiddleIncome * RE</i> | 0.121 | 2.123 | <i>Relax</i> | 1.333 | 51.269 |
| <i>MiddleIncome * FVZ</i> | 0.107 | 1.726 ³ | | | |
| <i>Losses * RE</i> | -0.225 | -2.419 | | | |
| <i>Accident * RE</i> | -0.279 | -3.402 | | | |
| <i>Accident * FVZ</i> | -0.209 | -2.155 | | | |
| <i>BahnCard * FVZ</i> | 0.239 | 4.193 | | | |
| <i>FVZ</i> | 0.481 | 10.689 | | | |
| <i>LB</i> | -0.857 | -18.234 | | | |
| <i>Transfers</i> | -0.11 | -4.400 | | | |
| <i>Transfers * Woman</i> | -0.056 | -1.612 ³ | | | |
| <i>BusUser * LB</i> | 0.288 | 5.647 | | | |
| <i>MiddleAge * LB</i> | -0.254 | -4.164 | | | |
| <i>Old * LB</i> | -1.113 | -4.184 | | | |
| Stress-free | | | Stress-free | | |
| <i>HighIncome * FVZ</i> | 0.408 | 3.400 | <i>Relax</i> | 0.69 | 28.750 |
| <i>MiddleIncome * FVZ</i> | 0.137 | 2.210 | <i>Luggage</i> | 2.089 | 59.686 |
| <i>Losses * RE</i> | -0.541 | -5.755 | <i>Security</i> | 1.459 | 52.107 |
| <i>Losses * FVZ</i> | -0.368 | -3.439 | | | |
| <i>Accident * RE</i> | -0.154 | -1.855 ³ | | | |
| <i>Accident * FVZ</i> | -0.221 | -2.255 | | | |
| <i>BahnCard * FVZ</i> | 0.241 | 4.155 | | | |
| <i>FVZ</i> | 0.222 | 4.933 | | | |
| <i>LB</i> | 0.378 | 8.217 | | | |
| <i>Transfers</i> | -0.067 | -2.680 | | | |
| <i>Transfers * Woman</i> | -0.145 | -4.143 | | | |
| <i>Woman * RE</i> | -0.232 | -4.000 | | | |
| <i>BusUser * LB</i> | 0.185 | 3.558 | | | |
| <i>MiddleAge * LB</i> | -0.13 | -2.097 | | | |
| <i>Old * LB</i> | -0.879 | -3.268 | | | |
| Reliability | | | Reliability | | |
| <i>LB</i> | -0.447 | -9.933 | <i>Departure</i> | 2.091 | 59.743 |
| <i>Transfers</i> | -0.07 | -2.917 | <i>Arrival</i> | 2.271 | 61.378 |
| <i>Transfers * Woman</i> | -0.076 | -2.235 | | | |
| <i>Transfers * RE</i> | -0.05 | -2.632 | | | |
| <i>BusUser * LB</i> | 0.22 | 4.314 | | | |
| <i>MiddleAge * RE</i> | 0.15 | 2.679 | | | |
| <i>MiddleAge * FVZ</i> | 0.117 | 1.918 ³ | | | |
| <i>Old * RE</i> | 0.442 | 1.674 ³ | | | |
| <i>Old * FVZ</i> | 0.637 | 2.413 | | | |
| <i>Old * LB</i> | -0.853 | -3.231 | | | |

In general terms, older and richer people have a worse perception of the coach services and a better one of the high-speed train. As previously stated, these valuations may be

³ As the signs of the estimators were known *a priori*, a one-tailed test was performed ($\alpha_{5\%}=1.645$).

explained by firmly established prejudices against newer alternatives as well as by an overvaluation of the alternative with which the individuals are accustomed to use. In this way, coach service users exhibit a better valuation of their characteristics. It is noteworthy that holders of BahnCards are only biased toward high-speed trains, suggesting that these individuals do not necessarily favor regional trains.

As can be expected, having been involved in an accident or having experienced a loss on the trains affects negatively an individual's perception.⁴ Additionally, a trip with more transfers is perceived as less comfortable, stress-free and reliable. Regarding transfers, it is important to note that women perceive them as a larger nuisance than do men. Coach services are considered to be the least comfortable and reliable way of travelling, but, at the same time, they are considered less stressful than trains. High-speed trains are perceived as more comfortable and stress-free than regional trains (which was expected, as the former have more modern and comfortable wagons), but are otherwise considered to be equally reliable.

4.3 Discrete Choice

This section reports the results of the estimation of the discrete choice component of the model. In addition to the previously described latent variables, socioeconomic characteristics of the individuals and attributes of the alternatives (price, travel time, number of transfers, transport mode and safety level) were considered. In addition, an inertia variable taking the value of one when individuals chose their revealed preference option in spite of the advantages of new alternatives was introduced. Altogether, there were 9,712 observations from 1,073 individuals (not every individual took part in the discrete choice experiment) available for estimation and the correlation (panel effect) between the responses of a given individual was taken into account.

The estimation was performed sequentially using BIOGEME (Bierlaire, 2003), so it was necessary to perform a correction of the estimates accounting for the bias described by Bahamonde-Birke and Ortúzar (2014b). It was possible to establish that the average ratio between the variability induced through the latent variables and the model's own variability was nearly 30%. Thus, we calculated that the ratio between the recovered

⁴ In the survey respondents are asked whether they themselves or relatives have experienced such incident.

estimates and the real parameters was around 90%. Table 4 presents the corrected parameters for the estimated model.

Table 4 – Estimated Parameters for the Discrete Choice model

| Variable | Estimated Value | Standard Deviation | t-test |
|------------------------------------|-----------------|--------------------|--------------------|
| <i>Inertia</i> | 0.371 | 0.0358 | 10.373 |
| <i>LB</i> | -1.377 | 0.243 | -5.662 |
| <i>RE</i> | -0.333 | 0.100 | -3.341 |
| <i>Travel Time</i> | -0.0178 | 0.000844 | -21.053 |
| <i>Travel Time * LV Green</i> | 0.00264 | 0.00139 | 1.904 ⁵ |
| <i>Ln(Price) * Very Low Income</i> | -5.819 | 0.209 | -27.872 |
| <i>Ln(Price) * Low Income</i> | -5.453 | 0.234 | -23.270 |
| <i>Ln(Price) * Middle Income</i> | -4.842 | 0.385 | -12.565 |
| <i>Ln(Price) * High Income</i> | -2.743 | 0.534 | -5.135 |
| <i>Safety Level</i> | -0.00298 | 0.00109 | -2.743 |
| <i>Transfers</i> | -0.438 | 0.033 | -13.221 |
| <i>LV Comfort</i> | 0.224 | 0.123 | 1.820 ⁴ |
| <i>FVZ * LV TrainFan</i> | 0.937 | 0.164 | 5.703 |

Analyzing this table, it can be seen that the signs of all parameters are in accordance with the theory. This way, the travel time, the number of transfers and the possibility of being involved in an accident affect negatively the utility of an alternative. The inertia value reveals a tendency of the individuals to stick with their former choices. The negative effect of price is greater for individuals with lower income, and decreases as income increases. It is important to mention that price is perceived logarithmically (the linearity of price and travel time was tested with help of a Box-Cox transformation), meaning that equal changes have larger importance when the price is lower.

Regarding the latent variables, it is noteworthy that two (“Reliability” and “Stressfree”) do not evidence of a statistically significant effect over the utility function. A possible explanation is that individuals internalize these two effects as a part of the intrinsic characteristics of the alternatives and, therefore, they are accounted for through the modal parameter. In fact, when modelling without modal parameters these variables become statistically significant, but the adjustment worsens. As expected, the perception of the remaining latent variable, “Comfort”, positively affects the utility of the alternative.

⁵ As the signs of the estimators were known *a priori*, a one-tailed test was performed ($\alpha_{5\%}=1.645$).

Both attitudinal latent variables are statistically significant but affect the utility ascribed to the alternatives in different manners. The “Green” attitude interacts with travel time in a fashion that resembles a systematic taste variation. Thus, ecologically oriented individuals appear more willing to accept a longer travel time than the rest of the population. This finding is in line with the perception that shorter travel times imply higher speeds and, therefore, greater CO₂ emissions and greater environmental damage. Interestingly, “Green” individuals have no positive predisposition toward coach services whatsoever, despite their marketing campaign seeking to position the mode as an ecological alternative. Finally, as expected, “TrainFans” tend to favor the high-speed trains, but there is no evidence suggesting that they prefer regional trains to coaches.

5. CONCLUSIONS

Our analysis reveals that, in accordance with our expectations, attitudes and perceptions affect the choices people make for intercity travel. Therefore these aspects must be taken into account when analyzing the German coach market. As a consequence, marketing campaigns for coach services (aiming for product differentiation) can be considered adequate, as some of these aspects play an important role in the choice of mode. Nevertheless, in our sample coach providers have not successfully positioned coaches as an environmentally friendly alternative.

Coach service providers face a population that, in general terms, is not just unfamiliar with their services, but is also reluctant to change their habits. Young people represent an interesting market opportunity for coach services as they are more open to try this new alternative and are not as negatively predisposed against coaches as the older population. Another aspect that must be taken into account is that the flexibility of smaller coaches that allow for travel without transferring, which negatively affects both the subjective perception of comfort, reliability and ease of travelling, and the direct utility ascribed to the alternatives.

One important finding of this study is that individuals with greater environmental concerns are not affected to the same extent as the rest of the population by larger travel times. This can be related to the fact that faster transport modes, typically, pollute more and, therefore, eco-friendly individuals are prepared to take longer in traveling in order to reduce environmental damage.

It was not possible to establish an undeniable link between the perceptions of reliability and stress-free travelling associated with a certain alternative and its utility, and it is possible that these perceptions are being captured by the general characterization of each transport mode. Further research is needed to confirm this hypothesis. On the contrary, it was indeed possible to describe a social group of train enthusiasts that are willing to favor the railways despite the apparent advantages of other alternatives. However, this favoritism does not extend to regional trains. Finally, it was possible to establish that fares are perceived logarithmically by the population and that equal changes are not perceived similarly depending on the base price.

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APPENDIX 1

| Variable | Description | Frequency |
|------------------------|--|------------------|
| <i>Young</i> | 18-25 years | 847 |
| <i>MiddleAge</i> | 26-50 years | 561 |
| <i>Old</i> | Older than 51 years | 17 |
| <i>Total</i> | | 1,425 |
| <i>Very Low Income</i> | < 700 € p.m. (N.I) | 881 |
| <i>Low Income</i> | 700€ - 1.500€ p.m. | 395 |
| <i>Middle Income</i> | 1.500 – 2.500 p.m. | 107 |
| <i>High Income</i> | > 2.500 € p.m. (N.I) | 42 |
| <i>Total</i> | | 1,425 |
| <i>Male</i> | | 897 |
| <i>Female</i> | | 528 |
| <i>Total</i> | | 1,425 |
| <i>HighSchool</i> | Working Individuals holding the respective degree | 45 |
| <i>University</i> | | 186 |
| <i>Students</i> | Students | 1,171 |
| <i>Other</i> | Others | 23 |
| <i>Total</i> | | 1,425 |
| <i>BahnCard</i> | BahnCard ownership | 435 |
| <i>Car</i> | Car ownership | 413 |
| <i>BusUser</i> | Previous exp. traveling by coach | 1,014 |
| <i>ParentalHome</i> | Living at the parental home | 281 |

It is noteworthy that irregular distributions in the SE characteristics of the individuals do not implied a bias, as long it is controlled for the respective source of variability. The size of all considered categorizations allows identifying statistical significate parameters in our models.