LIFESTYLES AS LATENT HETEROGENEITY TO MODAL CHOICE

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ABSTRACT

The objective of this study is to identify and understand the different lifestyles of the Brazilian population and their influence in the modal choice through the latent class analysis (LCA). There have been identified three classes of latent lifestyle through data from the survey 'System of Indices for Social Perception of Urban Mobility' (IPEA – Institute for Applied Economic Research, 2011). The three latent classes presented likelihood probability of choosing a predominant transportation mode, which suggests the existence of a non-observed heterogeneity of population's lifestyle that influences decisions, as far as the transportation mode.

Keywords: lifestyle, latent class analysis, modal choice, travel behavior

INTRODUCTION

Despite an overall understanding that public transportation appears as a viable and rational solution for even more congested urban areas, it is noticeable that an individual is subject to other choices related to her/his mobility right, which can be different from public transportation. It is worth noting that public policies towards promoting urban mobility are focused on how to implement accessibility improvements through solutions based on infrastructure, which, in most cases, do not take into consideration the individuals' preferences and interests (Vasconcellos, 2002).

Even considering the individual's desire, in general, s/he is seen as someone who makes choices through predetermined criteria of demand prediction models. For instance, what is pointed out in this case is that those who conceive or apply a model have no control over what type of information is available to the individual at the moment s/he chooses the transportation mode, which can create mistakes or problems within the predictions (Bhat et al., 2004). It is understood that an individual has a behavioral component that guides her/his

decisions, and that these decisions are based on symbolic elements, not yet fully perceived by proponents of forecast models, which end up lacking these important features that have an even greater role than the one that is concerned with travel attainments necessary for the accomplishment of any type of activity.

In an attempt to capture the subjective factors related to mobility decision of individuals, Walker (2001) argues that a major theoretical contribution to current models, especially to the discrete choice model, which, in a more simple way, comprises a set of observable and explanatory variables related to preferences, whereby the maximization of utility to arrive to an option is applied is still faulty. Walker's study aimed to identify other elements that interfere with one's preferences, and have a meaningful value when processed within a group of possible choices. Therefore, it is possible to observe that some elements related to an individual's choosing process cannot be directly measured. For example, in order to obtain any result in relation to transportation services, it is necessary the definition of a set of indexes concerned to mobility and accessibility derived from observable variables in the environment.

Based on the above, it is understood that one of inherent fundamental elements in the choosing process for travel methods is the lifestyle, which consists of an individual's attitudes vis-à-vis the environment and the social group to whom s/he belongs. These attitudes have a symbolic character, as far as the individual tries to differentiate her/himself in relation to others from the group s/he belongs, and, this differentiation, can be observed through the way s/he chooses (Silva, 2012).

This study aims to identify and understand the different lifestyles and their influence in the modal choice through the latent class analysis (LCA). This study departs from the premise that, within a supposedly homogenous group, there is heterogeneity according to latent classes of lifestyle related to the choosing of transportation modes. This study is divided in 5 sections. Following this introduction, the 2nd section brings the theoretical subsidies about lifestyle and its influence over the modal option; in the 3rd section, data, the methodology of analysis, and its application are presented; the 4th section deals with the analysis of results; and the final considerations are presented in the 5th section.

LIFESTYLE AND MOBILITY

One of the most important inherent characteristics of individuals living in urban centers is their participation in social groups, from families to the most diverse and ample groups, such as, for instance, those where individuals identify themselves through ethnic, ideological, or merely through recreational/sports characteristics. Regardless the group an individual belongs, s/he will always try to differentiate her/himself from others through a set of attitudes whereby the individual makes choices through things that have for her/him symbolic meanings (Bourdieu, 1996).

This form of differentiation is understood as the individual's lifestyle trait in which a series of decisions that seek something the put her/his individuality in evidence will make the

individual have a differentiated position within the group s/he belongs. The lifestyle can be identifiable, for example, through the way we purchase goods and services, such as products with a specific feature, or considered "premium," that, in general, are acquired by individuals with higher purchasing power or by those who seek status symbol among their social peers.

In the human behavior field, Adler (1956) suggests that the term lifestyle reflects a basic character of a human being, as something that has been established during an individual's childhood, and ends up guiding her/his reactions and behavior. Under this perspective, anyone has a lifestyle that is developed through her/his creative power and endogenous style throughout the first year of infancy (mainly in between 0 and 5 years old). The lifestyle creates a behavioral unit that is in charge of thoughts, emotions, and actions, either conscious or unconscious, and reflects the individual's chosen direction to her/his daily affairs.

In sociology studies, one of the first theorists to identify the lifestyle was Weber (1948) who argues that the individuals' lifestyles are revealed by means of social interactions, and the social groups are formed by individuals with similar lifestyles. According to Weber, the lifestyle is one of the boundaries of the social status, acquired through formal education and closely linked to the individual's profession. Different from Adler (1956), Weber argues that certain lifestyles apply to all people in a group instead of an individual solely, and it is not the guiding principle for life structure but the structure itself.

Linking features from the psychological and sociological approaches, Valette-Florence and Jolibert (1999) provide a systemic vision of lifestyle related to marketing, which is built in three different levels, as per Figure #1: i) the most stable and safe level where the individual values can be found, i.e. where the closed and lasting impressions about a specific behavioral mode or the end of the existence is better than the other; ii) the intermediate level, where there are activities, interests, and the individual's self-opinion that reveals her/his values system; and iii) the peripheral level, where there are a set of products and services acquired and consumed, which are ephemeral reflexes of the preceding levels.

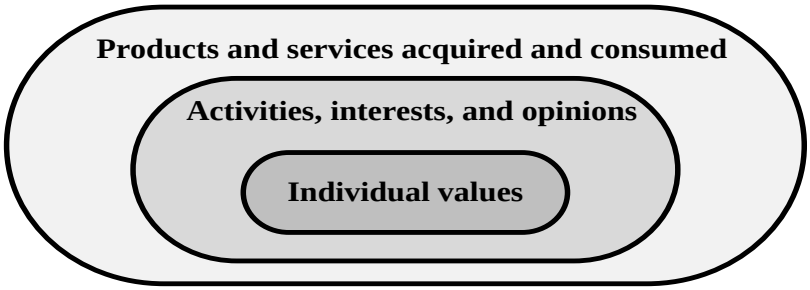

Figure 1: The lifestyle for Marketing. Source: Valette-Florence and Jolibert (1999).

Thus, specifically in the field of transportation study, the act of travelling can be understood as a social act that incorporates the social differentiation dimension. Travelling satisfies the needs of individuals of being in specific places to perform specific activities, and, depending on how the trip is taken, it fulfills the symbolic and social functions. This symbolic character

tends to differentiate in relation to the inherent changes concerned to the individual, such as the social class s/he belongs and the stage in the life cycle, among others. Considering that the act of travelling can be conceived as a vital need (especially because it allows one's participation in mandatory activities), travel attributes such as, "when," "to where," "with whom," "how," and "for how long," are some of the aspects that comprise a system that implies the attribution of meanings to the act of travelling (Uth, 1996).

Based on this scenario, when it is analyzed "the way" the act of travelling is performed within determined social groups, the ownership of an automobile, for example, can be understood as an attribute directly related to the desire of differentiation (the self-assertion) of an individual in relation to her/his social group. The choosing of air transportation over road transportation, for instance can be understood, in some cases, as "differentiation" or "assertion" sought by an individual in relation to society.

The influence of lifestyle in the transportation mode option

The differences in lifestyle can be found in the variations of how each individual perceives the world, and those variations influence how an individual makes choices, as far as her/his mobility (Bourdieu, 1989). This is understood that in social groups where observable attributes such as income and others are utilized to determine their homogeneity, there are, however, other attributes linked to lifestyle that determine a non-observable heterogeneity in the group in relation to variations in the options.

The transportation mode can be considered as the fundamental element in the choosing, limited by the lifestyle, considering that there is a symbolic character in it. This suggests which behavioral elements related to lifestyle act upon potential modal choices.

Concepts related to behavioral predisposition, such as social attitude and personality trait, play an important role in the attempts to predict and explain human behavior. Due to its complexity, human behavior is something hard to be predicted, and, therefore, its inclusion in travel modeling processes constitutes a challenge.

Crucial to the understanding of the behavioral process that makes an individual choose, as well as influence her/his lifestyle and may offer support to travel modeling, is the theory of planning behavior proposed by Ajzen (1991). This theory is grounded in the principle of aggregation in which unique or ample behavior reflects the influence of a general disposition related to and and that influence that makes individuals to an individual or group, and also the influence of various exclusive factors for the moment of observation, or the situation whereby the action is being observed. Therefore, when different behaviors are aggregated, observed in events and in different situations, the other behavioral sources of influence tend to cancel each other out. The result is an aggregation that represents a valuable measure for underlying behavior of any individual's behavior (Ajzen, 1991).

The central point of the theory of planning behavior is the individual's intention to adopt a specific behavior. The intentions are incorporated in order to capture the motivational factors

that influence behavior; for they are the indication of how individuals make an effort to attain that behavior, and how much of the effort they are planning to make with the purpose of attain that specific behavior. As a general rule, the stronger the intention to engage in a behavior, the higher the chances of concretization. It is noteworthy, however, that the behavioral intention can only be meaningful if the behavior at hand is under volitional control, i.e. if the person can decide according to her/his will of having or not a type of behavior (Ajzen, 1991).

Ajzen's model suggests the utilization of a structural model, whereby latent or theoretical variables are incorporated, and they covariate among themselves and contribute for the result directly or indirectly. However, when observing the structure of the model, there are only latent variables that with a prediction class for behavior, suggesting a homogenous response. Based on the assumption that there is heterogeneity in behavior and in its consequent choices, it is important that, while modeling, to apply a structure that incorporates latent class analysis, where a latent variable that links to the result can be subdivided in classes, according to the heterogeneity present in the group.

DATA AND METHOD OF ANALYSIS

Sections 3.1 and 3.2 describe the development of the analysis for this study. The objective of this section is to present the data and the method of analysis through Latent Class Analysis – LCA and the Chi-Squared Automatic Interaction Detection – hybrid CHAID, whose algorithm was developed by Vermut and Magidson (2004).

Description of the database

Data from the '2010 System of Indices for Social Perception of Urban Mobility (SIPS)' survey conducted by the Institute for Applied Economic Research (IPEA) have been utilized in this study. The survey consisted of household interviews, with 2,786 valid questionnaires (a 30-question questionnaire), administered to people 18 years and older from 146 Brazilian cities during August 4-20, 2010. The survey's scope encompassed the country's major regions and quotas, utilizing as its parameter the '2008 National Household Sample (PNAD)' survey, conducted by the Brazilian Institute of Geography and Statistics (IBGE). The 2010 SIPS´s sample size was adjusted to assure a domestic error margin of 1.86%, 95% of confidence level, and p = 0.5. Within the region, keeping the same confidence level, this approximation of the error margin is of 5% and p = 0.7. The data detail the social and economic characteristics of the individual, the transportation mode more often utilized, and, especially, the individuals' perceptions on the characteristics of the transportation mode utilized.

Method of analysis

In order to achieve the objective of this study, the Latent Class Analysis – LCA technique has been utilized, according to the following application steps: i) LCA formulation; ii) identification

of income brackets; iii) definition of dependent and covariant variables per segment; iv) analysis of results and identification of lifestyle classes.

Formulation of Latent class analysis (LCA)

The latent class analysis (aka finite mixture modeling) encompasses the identification of relationships among variables utilizing both observable indices, as in traditional regression models, and non-observable indices or latent variables, frequently utilized in analysis of structural equations (Magidson and Vermunt, 2002). The idea behind the latent class analysis is to analyze the variation patherns of the dependent variable and to identify groups of individuals with a relatively homogenous behavior.

Thus, the classification of each person in a class is based on likelihood of class membership. The process is conducted through the assumption of the existence of a latent variable (non-observable), which can be deducted from the data collected in the field, and this latent variable is utilized to explain the data variation. Therefore, one can distinguish, for example, a group of people who leave their home earlier and make a longer trip by car from another group of people who leave their homes later and make a shorter trip by bus. These two groups are considered two different categories of an assumed latent variable. When someone takes this latent variable and specifies a series of models with different categories, s/he ends up estimating different models and determining the model that creates balance, rationality, and goodness of fit in the best way possible.

Equation #1 was utilized for latent class analysis for this study.

$$f(y_i = m|z_{ij}^{cov}) = \sum_{x=1}^{K} P(x|z_{ij}^{cov}) \prod_{m=1}^{M} P(y_i = m|x) \quad (1)$$

Where: y_i is a dependent variable that represents the choice of the transportation mode; m is the nominal choice, in which m assumes values, such as 1, 2, …, m (according to each transportation mode); z_{ij}^{cov} represent the covariant variables that assume values from 1 to j, as specified in the model; x is a latent nominal variable in the model; and K is the number of latent classes.

Equation #2 was applied for y_i variable of transportation mode choice, in which the logistic model is utilized.

$$P(y_i = m|x) = \frac{\exp(\eta_{m|x}^{t})}{\sum_{m'=1} \exp(\eta_{m'|x}^{t})} \quad (2)$$

Where: $\eta_{m|x}^{t}$ is a linear term; t represents the number of nominal choices (modes); and m is the specific choice among the t set of choices (modes).

The model of latent classes is expressed by equations #3 and #4.

$$P(x|Z_i^{cov}) = \frac{\exp(\eta_{x|z_i^{cov}})}{\sum_{x'=1}^{K} \exp(\eta_{x'|z_i^{cov}})} \quad (3)$$

$$\eta_{x|Z_i} = \gamma_{x0} + \sum_{r=1}^{R} \gamma_{xr} z_{ir}^{cov} \quad (4)$$

Where: γ_{x0}, and γ_{xr} are the coefficients to be estimated; and R is the number of covariances utilized to explain the association in each latent class.

Identification of Income Segments

One of the fundamental hypothesis for the development of the method of analysis, and that justifies the utilization of LCA, is the assumption of heterogeneity of choices within a group that is understood as homogenous. In order to mitigate issues related to it, we decide to utilize the continuous variable, Income, from the database of 2010 SIPS, which was recoded into categories according to the Brazilian minimum wage value (SM – salário mínimo brasileiro) as determinant for groups where statistical techniques have been applied.

Therefore, the income variable was subdivided in four segments whereby the individuals from the sample were distributed as follows:

- Segment 1 – Income up to 2 minimum-wages – 981 individuals
- Segment 2 – Income higher than two minimum wages up to five minimum wages – 1046 individuals
- Segment 3 – Income higher than five minimum wages up to ten minimum wages – 480 individuals
- Segment 4 – Income higher than ten minimum wages – 279 individuals

Definition of the dependent variables and covariances

The transportation mode was chosen as a dependent variable, being classified as a categorical variable based on “MUB01” index of the 2010 SIPS database. The transportation mode options under this variable are: “public transportation,” “car,” “motorcycle,” “walking,” and “bicycle.”

Seven independent covariant variables have been chosen for the analysis, which are based on data from the 2010 SIPS. The covariant variables are:

AGE (IDADE) – continuous variable, varying from 18 to 90 years old, where the recoding was done in categories subdivided in decadic format for the BRACKET-AGE (FAIXAS-IDAD) categorical variable, in which seven age groups were defined as follows: “between 18 - 27 YO,” “28 – 37 YO,” “38 – 47 YO,” “48 – 57 YO,” “58 – 67 YO,” “68 – 77 YO,” “over 77 YO.”

ETHNIC (ETIN) – categorical variable for ethnic with six groups: “White,” “Black,” “Yellow,” “Brown,” “Indigenous heritage,” and “NS (NR- não respondeu) not stated.”

EDUCATION ATTAINMENT (ESCO) – categorical variable for education attainment with four categories: "Illiterate up to Elementary School," "Middle School," "Complete or Incomplete High School," "Complete or Incomplete College and Higher Education (graduate degree)."

MARITAL STATUS (CIVI) – categorical variable for marital status with five categories: "Single," "Married / Cohabitating," "Separated / Divorced," "Widowed," and "NS (NR – não respondeu) not stated."

GENDER (SEXO) – categorical variable for gender with two categories: "Male" and "Female."

MUB18A – categorical variable for the main individual preference. In the case of this preference, there have been considered the 5 response with higher frequency, and the other responses were aggregated under "other characteristic." Thus, the five responses with higher frequency were: "Mobility through more than one mode," "The chosen mode is fast enough," "The chosen mode suits one needs," "The chosen mode is economical," "The chosen mode is comfortable."

MUB18B – categorical variable for the secondary individual preference. In the case of this secondary preference, four responses with higher frequency have been considered, and the remainder responses were aggregated under "other characteristic." Therefore, the four responses with higher frequency were: "The chosen mode is fast enough," "The chosen mode's schedule suits one needs," "The chosen mode is economical," and "The chosen mode is comfortable."

INCOME (RENDA) – categorical variable recoded in four categories: "Up to two minimum wages," "Over two and up to five minimum wages," "Over five and up to ten minimum wages," "Over ten minimum wages."

With the dependent variables and covariances, it is possible to build a diagram of simplified routes, identifying the relationships among covariances and the categorical latent variable of Lifestyle (EV) and Lifestyle Classes (CEV), and the latter with the dependent variable "Transportation Modes (MUB01)," as per Figure 2.

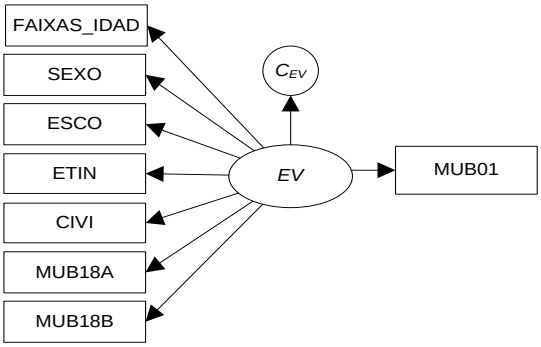

Figure 2: Relationships among covariant and latent variable of Lifestyle – EV and their classes - C_{EV}.

As explained previously in this study, and according to what has been observed in the obtained data, the variables chosen for this study are the ones that, as per theoretical conformity, have higher proximity to lifestyle, in which the individual preferences #1 and #2 are revealed and they relate to the perception of the transportation mode choice (our dependent variable). This variable represents the individual's desire linked to her/his lifestyle and loaded with an attitudinal (behavioral) characteristic.

Analysis of the Results

During the modeling, an iterative process took place whereby eight models have been tested utilizing the relationships presented in Figure 2, for each income segment, with a vast amount of latent classes that totalized the processing of 32 distinct models for all income segments.

For each segment ideal models were found with the following amount of classes:

- Segment of Income 1 – Model with five latent classes
- Segment of Income 2 – Model with five latent classes
- Segment of Income 3 – Model with four latent classes
- Segment of Income 4 – Model with four latent classes

The models found presented the best values for the indices of quality adjustment, Bayesian Information Criterion (BIC, calculated through the log-likelihood, LL, in convergence), Akaike Information Criterion (AIC), among the eight tested model for each income segment. Goulias and Henson (2006) utilized this method of model specification and identification of latent classes in another analysis of travel behavior.

The result of the models will be presented according to income segments, as can be seen in the following Tables 1, 2, 3, and 4. For all situations, the latent class sizes indicates the proportion of the total population of the sample for each income segment within each class. With the identification of four and five latent classes, the models present a significant improvement in relation to models with a smaller number of classes.

Segment of Income 1

In the case of this income segment, through an iterative process of tests, a model with five latent classes of lifestyle was determined and thus considered ideal for the purposes of this study. This model presented the best values for the indices of quality adjustments, the Bayesian Information Criterion (BIC, calculated through the log-likelihood, LL, in convergence) and the Akaike Information Criterion (AIC), as per Table 1.

With the identification of five latent classes (EV1, EV2, EV3, EV4, and EV5), the model presents a significant improvement in relation to models with a smaller number of classes. With a log-likelihood (LL) of -1,034 and 2.3% of classification error, this represents a significant improvement in relation, for example, to a model of one class with log-likelihood (LL) of -1,290.

Table 1: Results of a 5-latent-class model for segment of income 1 in relation to a dependent variable

	EV 1	EV 2	EV 3	EV 4	EV 5
Class Size	0.3136	0.2525	0.2424	0.1507	0.0408
Dependent Variable					
Mode (MUB01)	EV 1	EV 2	EV 3	EV 4	EV 5
Public Transportation	0.7986	0.4412	0.3329	0.5795	0.0050
Automobile	0.0001	0.0553	0.0354	0.1692	0.5961
Motorcycle	0.1868	0.2920	0.0548	0.2511	0.0012
Walking	0.0109	0.0724	0.2767	0.0001	0.3971
Bicycle	0.0036	0.1391	0.3003	0.0001	0.0005
Indices					
Log-likelihood (LL)	-1,034.4374				
BIC	3,005.7206				
AIC	2,340.8748				
Chi-squared	1,765.8204				
Classification Error	0.0234				

Generally speaking, the results presented by Segment of Income 1 indicate the predominance of the likelihood of choice toward the public transportation mode, as can be seen in the four first lifestyle classes of Table 1. However, in EV5 class, with a likelihood of fewer individuals in this income segment, it is noticeable a tendency toward the use of automobile mode and also walking. This indicates a slight diversity in lifestyle within this segment, which can be explained through the likelihood of covariances.

It can be observed through the chart in Figure 3 that for each one of the Lifestyles – EV, the main covariances that present the best P values had variations. Female individuals in between 28 – 57 YO predominate with an education attainment that is still lower (individuals with up to High School).

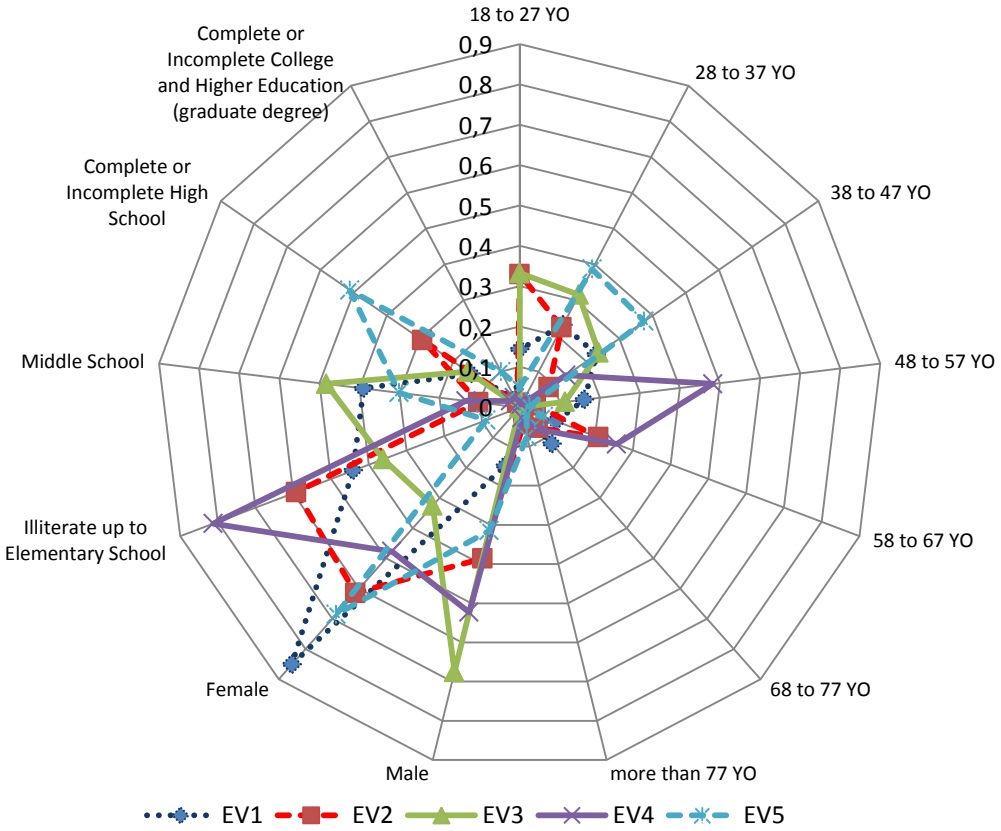

Figure 3: Chart type *Spider* with the distribution of the main covariances per segment of income 1.

Segment of Income 2

Regarding Segment of Income 2, after an iterative process of tests, it was obtained a model of five latent classes, considered for the purposes of this study as the idea model. This model presented the best values for the indices of quality adjustments, the Bayesian Information Criterion (BIC, calculated through the log-likelihood, LL, in convergence) and the Akaike Information Criterion (AIC), as can be seen in Table 2.

Table 2: Results of a 5-latent-class model for segment of income 2 in relation to a dependent variable

	EV 1	EV 2	EV 3	EV 4	EV 5
Class Size	0.3288	0,2845	0.1869	0.1091	0.0907
Dependent Variable					
Mode (MUB01)	EV 1	EV 2	EV 3	EV 4	EV 5
Public Transportation	0.4322	0.4026	0.9112	0.3335	0.0036
Automobile	0.1196	0.2051	0.0005	0.3347	0.9020
Motorcycle	0.0834	0.2650	0.0651	0.0002	0.0179
Walking	0.2673	0.0167	0.0003	0.3315	0.0762
Bicycle	0.0976	0.1106	0.0229	0.0001	0.0002
Indices					
Log-likelihood (LL)	-1,214.3509				
BIC	3,374.2729				
AIC	2,700.7018				
Chi-squared	1,966.4607				
Classification Error	0.0272				

With the identification of five latent classes (EV1, EV2, EV3, EV4, and EV5), the model presents a significant improvement in comparison to models with a smaller number of classes. With a log-likelihood (LL) of -1,214 and 2.7% of classification error, this represents a considerable improvement in relation to, for example, the model of one class with log-likelihood (LL) of -1,455.

Overall, the results obtained in Segment of Income 2 indicate the predominance of the likelihood of choice toward the public transportation mode, as can be seen in the first three classes of lifestyle of Table 2. However, in other classes, which have the likelihood of containing fewer individuals within this income segment, it is noticeable a tendency toward the use of automobile, something that indicates a diversity in lifestyles within the segment that can be explained by the likelihood of covariances.

Through the chart in Figure 4, one can notice that, for each one of the Lifestyles – EV, the main covariances, that presented the best P values, had variations. It can be seen that single individuals within the age group 18 – 37 YO are predominant in this segment, and there is a balance in the distribution of male and female individuals.

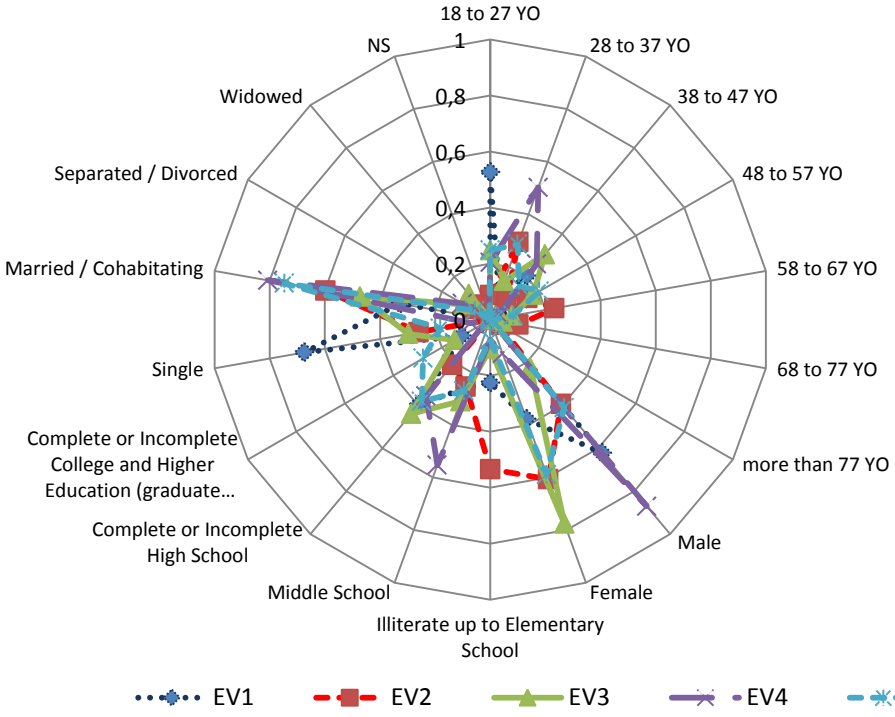

Figure 4: Chart type *Spider* with distribution of the main covariances per segment of income 2.

Segment of Income 3

In the case of Segment of Income 3, after an iterative process of tests, a 4-latent-class model was obtained and considered, for purposes of this study, as an ideal model. This model presented the best values for the indices of quality adjustments, the Bayesian Information Criterion (BIC, calculated through the log-likelihood, LL, in convergence) and the Akaike Information Criterion (AIC), as can be seen in Table 3.

Table 3: Results of a 4-latent-class model for segment of income 3 in relation to a dependent variable

	EV 1	EV 2	EV 3	EV 4
Class Size	0.3661	0.2907	0.1747	0.1685
Dependent Variable				
Mode (MUB01)	EV 1	EV 2	EV 3	EV 4
Public Transportation	0.1545	0.4036	0.1523	0.8380
Automobile	0.7528	0.2375	0.3274	0.0013
Motorcycle	0.0464	0.0994	0.0360	0.1602
Walking	0.0463	0.2594	0.3295	0.0005
Bicycle	0.0000	0.0001	0.1548	0.0001
Indices				
Log-likelihood (LL)	-485.513			
BIC	1,588.4045			
AIC	1,171.0259			
Chi-squared	837.2079			
Classification Error	0.0273			

With the identification of four latent classes (EV1, EV2, EV3, and EV4), the model presents a significant improvement in comparison to models with a smaller number of classes. With a log-likelihood (LL) of -485 and 2.73% of classification error, this represents a considerable improvement in relation to, for example, the model of one class with log-likelihood (LL) of -1,155.

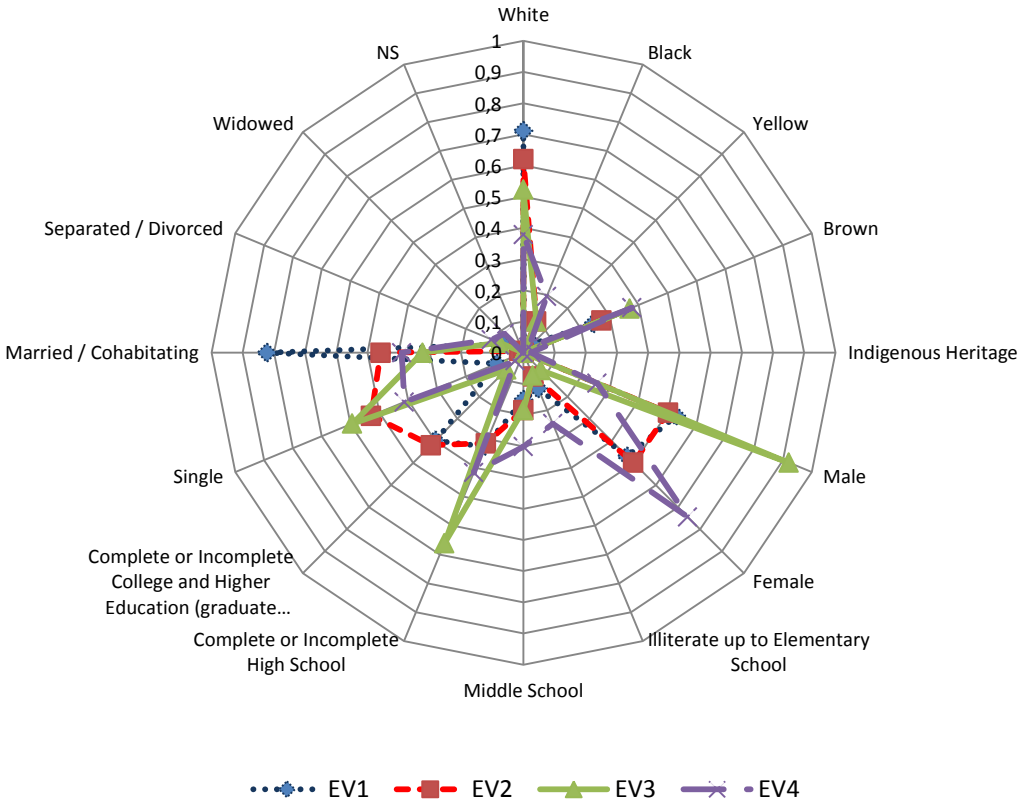

Figure 5: Chart type *Spider* with distribution of the main covariances per segment of income 3.

In general terms, the results presented in Segment of Income 3 indicate the predominance of the likelihood of choices toward the automobile mode, as can be seen in the first three classes of lifestyle of Table 3. However, in the last class, which has the likelihood of

containing fewer individuals within this income segment, it is noticeable a tendency toward the use of public transportation, something that indicates a slight diversity in lifestyles within the segment that could be explained through the likelihood of covariances.

Through the chart in Figure 5, one can notice that, for each one of the Lifestyles – EV, the main covariances, that presented the best P values, had variations. It can be observed that married or male individuals in a cohabitating relationship and of white ethnic are, in their vast majority, those with education attainment of up to complete High School.

Segment of Income 4

As far as Segment of Income 4, after an iterative process of tests, a 4-latent-class model was identified and considered ideal for the purposes of this study. This model presented the best values for the indices of quality adjustments, the Bayesian Information Criterion (BIC, calculated through the log-likelihood, LL, in convergence) and the Akaike Information Criterion (AIC), as can be seen in Table 4.

With the identification of four latent classes (EV1, EV2, EV3, and EV4), the model presents a significant improvement in comparison to models with a smaller number of classes. With a log-likelihood (LL) of -168 and 2.94% of classification error, this represents a considerable improvement in relation to, for example, the model of one class with log-likelihood (LL) of -435.

Table 4: Results of a 4-latent-class model for segment of income 4 in relation to a dependent variable

	EV 1	EV 2	EV 3	EV 4
Class size	0.3687	0.2778	0.1802	0.1734
Dependent Variable				
Mode (MUB01)	EV 1	EV 2	EV 3	EV 4
Public Transportation	0.0016	0.0010	0.8368	0.4893
Automobile	0.9979	0.8314	0.0057	0.0963
Motorcycle	0.0001	0.1158	0.0597	0.0002
Walking	0.0003	0.0004	0.0977	0.4140
Bicycle	0.0000	0.0514	0.0001	0.0001
Indices				
Log-likelihood (LL)	-168.7505			
BIC	866.835			
AIC	525.501			
Chi-squared	298.3179			
Classification Error	0.0294			

The results presented in Segment of Income 4, generally speaking, indicate the predominance of the likelihood of choice toward the automobile mode, as indicated in the two first classes of lifestyle, and public transportation in the two remainder classes, as seen in Table 4. However, these two last classes have the likelihood of having fewer individuals within this income segment. Even so, this indicates a visible diversity in lifestyles within the

segment, something that may be better explained through the likelihood of covariances, as per the chart in Figure 6.

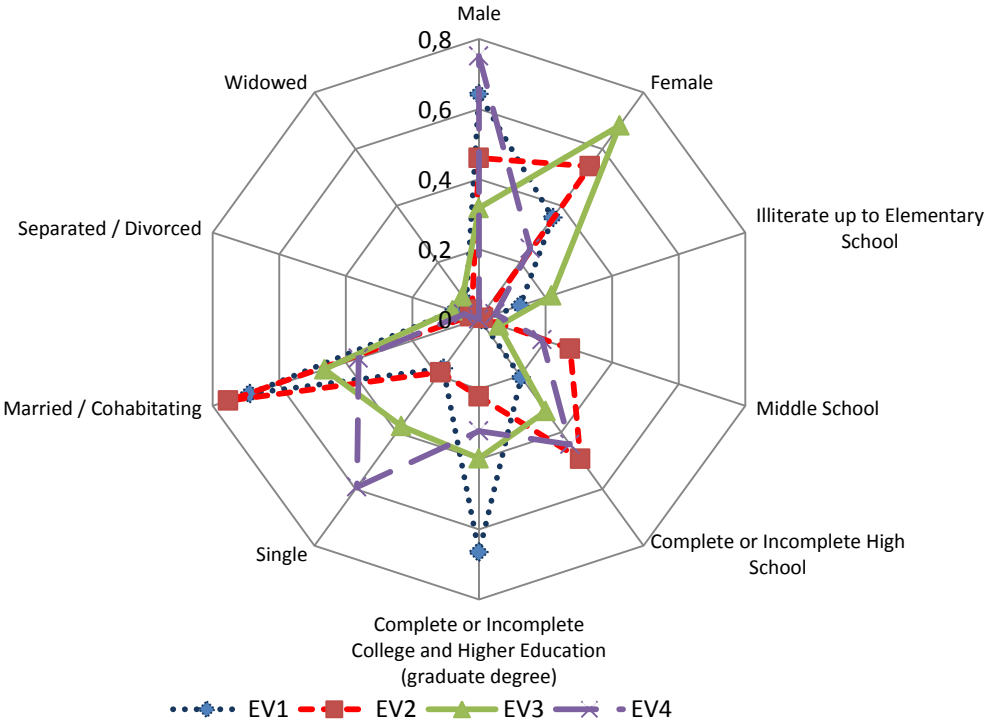

Figure 6: Chart type *Spider* with distribution of main covariances per segment of income 4.

Identification of latent classes

In order to better define the identification of latent classes, the relationship between the covariances with each latent class is analyzed. For Figures 3, 4, 5, and 6, the values represent the average likelihood of each covariant with greater significance through the Wald test with each latent class (Magidson and Vermunt, 2002). Thus, with the results of specific likelihoods it is possible to observe that there are important differences between latent classes of individuals found in this analysis for each one of the income segments.

In the Segment of Income 1 the following classes were identified:

- EV1– "*Dynamic Motorized Women*:*"* with a predominance of likelihood of choice toward public transportation mode, approximately 80%, and motorcycle, with 18%. The preferences are related to a fast and economical type of transportation. In its composition, the majority of the individuals within this segment if female individuals, and this lifestyle represents 31.36% of the total of individuals within the segment of income 1.
- EV2 – *"Hasty Youth on Wheels*:*"* in this class predominates likelihood of choices toward public transportation, motorcycle, and bicycle, with approximate values respectively of 44%, 29%, and 14%. It is noticed that the preferences gravitate around a faster transportation mode.

- EV3 –*"Sustainable and Low* Cost:*"* in this class the predominant likelihood of choices go toward more sustainable transportation modes, such as public transportation, bicycle, and walking, with each mode holding, respectively, 33%, 30%, and 38% of the likelihood choices. It is noteworthy that the preferences are for an economical and convenient transportation, i.e. something that suits the needs and schedule of individuals.
- EV4 –*"Hasty Motorized*:*"* formed by individuals that would have the likelihood of choosing public transportation, the motorcycle, and the automobile that present respectively 58%, 25%, and 17% in this class. The preference of individuals in this class is of transportation modes that are fast and present also other characteristics.
- EV5 – "*Hasty Well-to-do*:" formed by individuals for whom the automobile mode is the main likelihood of choice, with approximately 60% in the class, and the walking mode is the secondary choice with approximately 40%. The individuals in this class prefer transportation modes fast and comfortable.

In the Segment of Income 2 the following classes were identified:

- EV1– "*Single Youth Well-to*-do:*"* with the predominance of likelihood of choices toward public transportation mode with approximately 43% and walking mode with 27%. The preferences are related to a type of transportation that suits the individuals' schedule, being fast, comfortable, and economical. The composition of this class comprehends individuals in the age group 18 – 27YO who are, predominantly, single.
- EV2 – *"Motorized Multimodal*:*"* in this class the predominant likelihood of choices fall upon the automobile and the public transportation modes, with approximate values of, respectively, 47% and 40%. One would be able to notice that the preferences are for a faster transportation and, at the same time, the individuals in this class appreciate more than one type of mobility.
- EV3 –*"Women Captivated by Public Transportation*:*"* in this class the likelihood of choice falls upon public transportation with approximately 91%, which is predominant. It is worth noting that the preferences aim at other characteristics of the transportation mode. This class has in its majority female individuals, i.e 77%, and with education attainment of complete high school or higher education level of 44%.
- EV4 – *"Hasty Multimodal*:*"* formed by individuals that would have as modal choices public transportation, automobile and walking, with a balanced division among the modes, i.e. approximately 33% for each in this class. The individuals in this class prefer a faster and economical transportation mode.
- EV5 – *"Hasty and Married Captivated by* Automobilies:*"* the automobile mode predominates in this class with 90% of the likelihood choice. The individuals prefer agility and other characteristics of the transportation mode. In the composition of this class, the marital status of the individuals deserves attention with approximate likelihood that 75% of individuals to be married or live in a cohabitating relationship.

In the Segment of Income 3 the following classes were identified:

- EV1– "Married Motorized and with Higher Education Attainment:*"* with approximately 75% of likelihood of choosing the automobile mode and 15% of choosing public transportation, in this class, the preferences fall upon transportation modes that are faster. In the composition of this class, there is an approximate likelihood that 82% of individuals are married or live in a cohabitating relationship. As far as education attainment, odds are that approximately 40% of individuals are in between non-complete college studies and complete graduate degrees.
- EV2 – *"Economical Youth*:*"* in this class the two predominant likelihood of transportation mode choices are public transportation and walking, with values of approximately 40% and 26%, respectively. It is noticeable that the preferences of individuals in this class are for transportation modes that are fast. Predominantly, this class presents in its composition the likelihood that up to 46% of its individuals are in between 18 – 27 YO.
- EV3 –*"Multimodal Sustainable* Men:*"* in this class predominates the likelihood of choices toward automobile and walking modes, with these two modes sharing an approximate likelihood of 33%, and, the public transportation and walking modes come second, with an approximate likelihood of 15% each. It is worth mentioning that the preferences of individuals of this class are related to other characteristics of the transportation mode, which was not so frequent among other lifestyles. The class composition, in its majority, is formed by 92% of males.
- EV4 – *"Women Captivated by Public* Transportation:*"* formed by individuals with the likelihood of choice of 84% toward public transportation mode. The preferences of individuals in this class are for transportation modes that present more than one mobility option. In its composition, this class has an approximate likelihood that 74% of the individuals are females.

In the Segment of Income 4 the following segments were identified:

- EV1– *"Higher Education Attainment – My Automobile, My Life*:*"* in this class the automobile is part of the higher likelihood of choice found among the classes and segments, with an approximate value of 99%. With regards to preferences, agility and other characteristics predominate among individuals in this class. Moreover, the education attainment of individuals in this class varies from non-complete college to complete graduate degrees, with approximately 66%. The marital status of individuals in this class corresponds to approximately 69%.
- EV2 – *"Married Captivated by the Automobile*:*"* in this class the predominance of likelihood of choices of transportation modes falls upon the automobile mode with approximately 82%. One would be able to notice that the preferences of individuals in this class are for transportation modes that are faster and that offer more than one mode of mobility. In the class composition, the likelihood that approximately 75% of individuals in its class are married or live in a cohabitating relationship deserves attention.
- EV3 – *"Brown Women Aiming at Public Transportation*:*"* in this class, odds are that the predominant choice is the public transportation mode, with approximately 83%. One would notice that the preferences of individuals in this class are for a faster

transportation and that offer other characteristics. The composition of this class is made of an approximate likelihood that 68% of its individuals are females that have an education attainment that encompasses non-complete college to complete graduate degrees of 40%. Another important feature in this class is that is predominately formed by brown individuals, i.e. 57% of them.

- EV4 – *"Mindful Youth*:*"* formed by individuals who are more likely to choose public transportation and walking as transportation modes, with approximate values of the aforementioned modes of 49% and 41%, respectively. The preferences of individuals in this class are for transportation modes that are faster and that have other characteristics. It is worth noting that young individuals are the majority in this class, i.e. with a likelihood that 64% of the totals are in between 18 – 37YO, and 75% within this age group are males.

FINAL COMMENTS

The data utilized in this study, which were consolidated by IPEA – Institute of Applied Economic Research (2011), offer us the scenario of the Brazilian citizens' behavior in relation to their daily choices of mobility. Because IPEA's survey was conducted nationwide, it provides us the opportunity to identify the individuals' tendency, as far as their decisions of urban mobility, which do not only take into consideration variables related to socioeconomic characteristics, but also aspects linked to their attitudes and opinions on the Brazilian mobility system that they are able to perceive. According to the data and the method chosen for this study, it is possible to provide subsidies to public policies that aim at urban mobility by having as their focal points the groups of individuals identified in each one of the obtained classes, which represent the diverse lifestyles of the Brazilian citizen, and that guide the transportation mode choices. Also, it is expected that this study can offer its contribution to the scientific development in the field of Travel Behavior applied to the Brazilian situation.

The attainment of different types of classes of lifestyle in the four income segments proposed, and determined by the "latent class analysis" (LCA), suggests that the predominant population profile in Brazil can be found in the segments of income 1 and 2, characterized by low-income individuals, females, single in their majority, and that utilize, primarily, public transportation and motorcycle. In the segments of income 3 and 4, where there are individuals with income varying from medium to high, males prevail, they are married, with higher education attainment, and with preferences for agility and comfort, as far as their transportation choices, therefore, they tend to utilize more the automobile mode. However, there are young individuals, single, either with low and high incomes, whose lifestyles are guided by their preferences for economical and sustainable transportation modes, such as bicycles and walking mobility.

Thus, the results demonstrate the influence of lifestyle on the choices for transportation modes, as well as they demonstrate how diverse is the Brazilian population, whereby, for instance, specific age groups, marital status, and income have specific likelihood of choices. Based on this findings, the possibilities for implementation of actions that improve mobility

within Brazilian urban areas should take in consideration the diverse lifestyles of the country's inhabitants. Besides, the obtained classes can facilitate a better enforcement of the current Legislation related to Urban Mobility, especially considering the population's lifestyle heterogeneity. For example, due to its low cost, the motorcycle has become a concrete likelihood of transportation choice for low-income individuals. However, there are no sound policies toward the consequences derived from the choosing of this transportation mode. What has been seen, in fact, is the increasing number of accidents involving motorcycle drivers. Moreover, this study reveals that married individuals present higher likelihood of choosing the automobile mode, which should warn the Brazilian society about stimulus packages offered to automakers through governmental policies, which are likely to impact mobility negatively through the augment of drivers lured by the possibility of buying their own vehicles.

Corroborating what is found in the transportation literature, as in Vasconcellos's (2002), the use of individual motorized transportation modes is greater in higher-income population layers. It may be inferred that the choice related to transportation modes are not only given by the available options to individuals, but also when individuals weigh each one of the options according to their possibilities. It is inferred empirically in this study that low-income individuals are subject to greater restrictions of transportation mode choices. On the other hand, it is also observed that there is a "latent" preference to individual motorized transportation modes, as observed in the low-income segments, for some lifestyles, with the predominance of likelihood of choice of the automobile and the considerable participation of the motorcycle.

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