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REVEALED PREFERENCE IN MODAL CHOICE: THE PASSENGER'S VALUE OF TIME

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ABSTRACT
This paper is part of a research that aims to estimate the real total cost of traveling in Brazil, both by air and by coaches. Considering the value of the time as a relevant factor for the passenger's decision when traveling by coach or by plane, this study calculates the trade-off income for which the passenger will choose when traveling by one of the modes of transportation.

It was considered the five most important Brazilian domestic routes, leaving from São Paulo. São Paulo is the biggest city of the South America and through these routes were transported aproximatelly 8,5 millions of passengers in 2006. A model developed by Gronau (1970) was applied considering the relation between the diference of the average fares and travel time for both means of transportation. The results show the trade-off income for which the passenger changes from the slowest to the fastest mode maximizing his utility. Nowadays this analysis is more relevant because the prices behavior of the low cost airlines makes this service closer to the low income consumers. In the same way, the gradual increase income process of the Brazilian population also leads the market to a new break-even point. The trade-off income is relevant since the passenger's choice by mode depends critically on relation value of time.

As it was expected, the cost of traveling by coach is lower than traveling by plane, but there is a break-even point that can be assumed as a trade-off income which allows the passenger to decide to travel by coach or by plane. Even though the results are still preliminary, they are comparable with another study that applied a different methodology. It is recommended to pursue this research mainly by comparing these results that was based on data from surplus with another data from the demand.

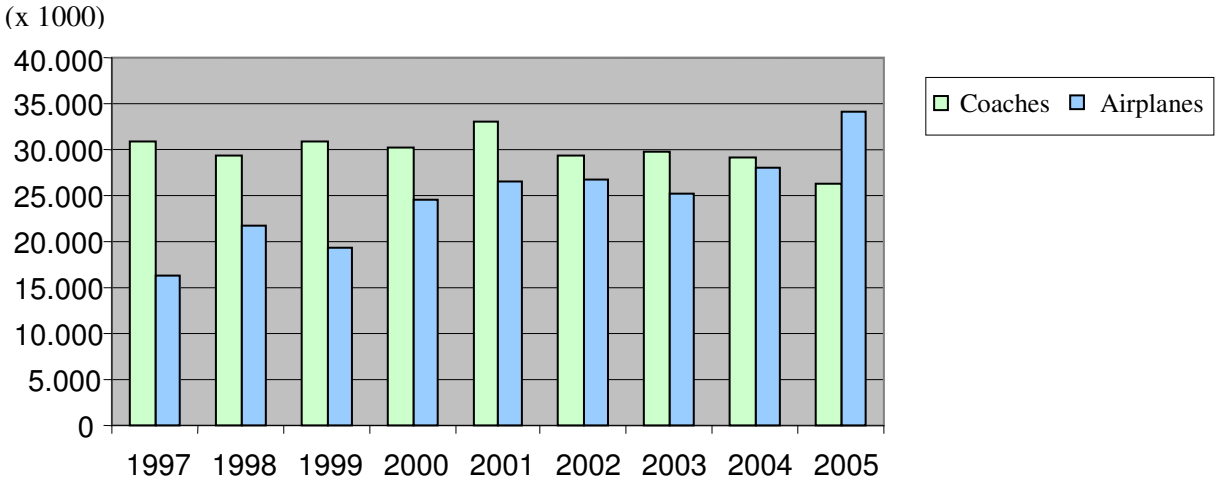
1. INTRODUCTION

The regulatory system for public transportation of passengers in Brazil is based on the legal concept of public service. This system establishes that the route operation can be delegated by the government to the private operators by means of concession (Brasileiro et al, 2001).

There is no restriction to operators from different modes exploring the same route and each mode of transportation is regulated by a specific Agency of Regulation. There is a potential competition between modes for the same route.

The public intercity passenger's transportation in Brazil has been strongly affected by the low cost airline's prices and by the increasing of people income. The air transportation became more accessible while traveling by coaches is still expensive. In this context, the potential competition between modes has increased and the market share of different modes has been changed.

Actually, in Brazil, during the recent years the air transportation of passengers has grown significantly, while the road transportation has kept more steady performance, as shown in the Figure 1. It was built with data from Abrati (Brazilian Association of Land Transportation of Passengers Enterprises) (2005), ANTT (National Agency of Land Transportation) (2006) and DAC (Department of Civil Aviation (2006):



Sources: Abrati (2005); ANTT (2006); DAC (2004)

Figure 1: Domestic Travel by mode in Passenger-kilometer traveled (pkt) in Brazil

These data present the evolution of passenger-kilometer traveled by both modes. Passengers' composition was changed in last years, with significant rise of pkt in the air transportation.

Wardman (1997) pointed out that "relatively little is known about the interaction between modes in the inter-urban travel market", so this paper aims to find out the trade-off income that shows the change of transportation mode when the consumer has to travel by plane or by coach. For in such a way, a model developed by Gronau (1970) is applied. It considers the relation between the diference of the average fares and travel time for both means of transportation for the five most important domestic routes in Brazil. The results show the trade-off income for which the passenger changes from the slowest to the fastest mode maximizing his utility. The analysis of this relevant variable in the competition between modes is important in this moment that low cost airlines prices makes this service closer to the low income consumers. In the same way, the gradual increase income process of the Brazilian population also leads the market to a new break-even point. These changes tend to modify the distribution of passengers in the country, by mode, with important consequences for the public transport politics decisions.

2. MICROECONOMIC THEORY

In the demand theory the consumers are assumed to make their choices so as to maximize their utility against a budget restriction. In accordance with Varian (2003) the optimal choice of the consumers depends on their income and on the prices of the economic goods, *ceteris paribus*.

2.1 Revealed Preference (RP)

The Revealed Preference is a discrete choice model applied to evaluate the real choices of the consumer. The consumers' behavior can be analyzed by observing how they make choices throughout a determined period (Bradley et al., 1994). The premise of Revealed Preference is that people's real choices are preferred than the choices they could have been done. This

approach was applied to this research by considering that consumers choose traveling by coaches or by planes, depending on their income and on the prices for both modes.

This model is classified as an indirect method and it is useful to analyze travel cost models (Adamowicz, Louviere and Williams, 1994). However, this way of getting information has some restrictions, since one assumes that consumers may not be able to choose the best option if they cannot have experienced this subject in the past (Senna, Toni and Lindau, 1994). Additionally, it can be difficult to get a large data range to examine the entire variable of interest (Kroes and Sheldon, 1988).

2.2 Normal goods and inferior goods

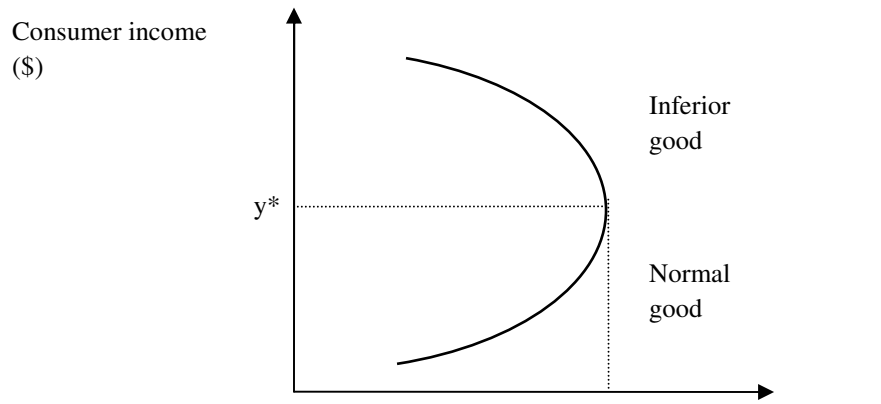
Assuming constant prices, changes in the consumer's income affect the demand in different ways. For some types of goods, the income changes produce changes in the quantity demanded in the same direction of this variation, defining a direct relation between income and demand. The income elasticity of demand is positive. Goods which demand presents this behavior are called *normal*. Assuming x_1 as a normal good, the variation of the quantity demanded (Δx_1) always happens in the same direction of the income variation (Δy):

$$\frac{\Delta x_1}{\Delta_y} > 0 \qquad (1)$$

On the other hand, when the demand is reduced in reply to an increase of the income, the goods are called *inferior*. It happens because consumer has more income to spend and he decides to buy better goods. The income elasticity of demand is negative. Considering (x_2) an inferior good and (y) the income:

$$\frac{\Delta x_2}{\Delta_y} < 0 \qquad (2)$$

These microeconomic concepts allow observing that the same economic good can present a normal good behavior for some income levels and inferior good behavior for another. It happens because the variation of income can change the consumers' preferences, and therefore their choices. This situation is demonstrated by mean of an Engel's Curve, which relates the behavior of the demand in relation to the consumer's income variation:



Source: Varian, 2003

Figure 2: Engel's Curve

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Applying the theory to passengers' transportation, it is possible to affirm that there is an income boundary for what the transport of passengers by coach can be considered a normal good, with increase in the demand from increases in the consumer's income. However, for persistent increases of the income, this economic good will assume the behavior of inferior good. This occurs in reason of the substitution in the road way for the aerial way, when the income of the consumer exceeds a certain limit. This limit can be called trade-off income and is strongly related, also, to the distance of the travel and to the passenger's value of time.

3. METHODOLOGY

According to Gronau (1970) the higher the travel time, the higher the passenger's preference of staying longer in some place. On the other hand, the higher the hotel prices and restaurants and the smaller access costs, the higher the passenger's tendency to come home.

In this way, one can be point out that the passenger, as any consumer, has the objective to optimize their relation choice both maximizing relation utility and diminishing the total cost of the economic good that: the trip.

How can the consumer optimize the choice if there are different costs for each mode, and obviously, different tickets prices that depend among other factors, on the distance traveled? The differences in fare and in time elapsed between air and land transportation increase with the distance. If the consumer has an income to afford these prices, it is expected that the value placed on time must increase with the passenger's income.

Faced with time scarcity, one must choose among available alternatives. Gronau (1970) proposed the value of time could be given by:

$$\pi = P + K\,T \tag{3}$$

where P is the total price that the passenger has to pay for traveling, including the fare and the cost of access to and from the terminals. K is the time value, that corresponds to the cost of the passenger's time and T is the value of the total time of the trip, including the specific travel time plus time of access to and from the terminals.

The total cost of the trip is strongly affected by factors that increase the travel time like delayed on boarding, climatic conditions or maintenance and conservation of the roads.

Assuming that the consumer always objectives to maximize the utility against to a budget constraint and considering that the mode of transportation A is faster than the mode B, but the mode B is cheaper than the mode A, the mode A would be preferable only if :

$$K > \frac{P_A - P_B}{T_B - T_A} = K^*_{A-B} \tag{4}$$

The price of time increases with the income, hence one would expect that high income and air transportation are strongly related. Thus, if people are on a business trip they can afford better

air transportation prices tickets. Moreover, if people are traveling on vacation, for example, they may prefer to travel by land transportation that is cheaper considering the same route. The time assumes a relative value depending on the travel purpose. It was found out by a research made in Brazil that shows "… 39% of the interviewed people that household income is upper than US$ 1.900 a month say to use planes to travel. For income between US$ 950 and US$ 1.800 the users of air transportation are 16% and for those which the income is lower than US$ 950 the percentage is 4%". (Instituto Data Folha, 2007).

The study made by Gronau (1970) shows the relation between costs and distance can be approximated by linear functions:

$$T_i = \alpha_{0i} + \alpha_{1i} M \tag{5}$$

$$P_i = \beta_{0i} + \beta_{1i} M \tag{6}$$

$$\pi_i = (\alpha_{0i} K + \beta_{0i}) + (\alpha_{1i} K + \beta_{1i}) M \tag{7}$$

where M is the distance traveled.

Considering this relation it is possible to find out the trade-off distance for which the passenger changes the mode of transportation. By taking into account the value of time (K), the air transportation would be the best choice when:

$$K > \frac{(\beta_{0A} - \beta_{0B}) + (\beta_{1A} - \beta_{1B}) M}{(\alpha_{0B} - \alpha_{0A}) + (\alpha_{1B} - \alpha_{1A}) M} = K^*_{A-B} \tag{8}$$

On the other hand, for a specific value of the time (K), the consumers would choose the fastest mode from the distance M, since:

$$M > \frac{(\beta_{0A} - \beta_{0B}) + (\alpha_{0A} - \alpha_{0B}) K}{(\beta_{1B} - \beta_{1A}) + (\alpha_{1B} - \alpha_{1A}) K} = M^*_{A-B} \tag{9}$$

where $M^*_{A\text{-}B}$ is the trade-off distance for which the passenger changes from the slowest mode to the fastest one.

3.1. Selecting the routes

This study started by selecting the routes. The research made by Melo and Mota (2003) with 1.047 interviewed people shows that 84,1% of the passengers traveling from Congonhas

Airport in São Paulo are on business while 15,9% are traveling by other reasons, including on vacation. Congonhas is a domestic airport and the sample reaches the condition of passenger's profile similarity, hence São Paulo was defined as the point of the departures by planes and by coaches for this study. To select the points of arrivals, it was studied the major routes departing from São Paulo in number of passengers. After that were estimated these relations:

a) the time and the distance of the trip;
b) the price tickets and the distance of the trip;
c) the trade-off income for which the passenger changes from the slowest mode to the fastest one.

3.1.1 Air Transportation routes

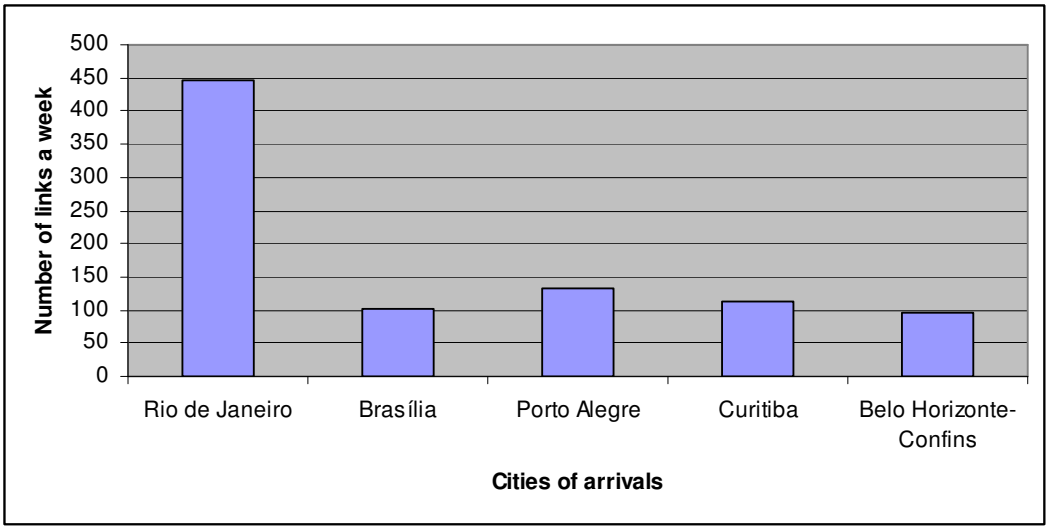
Initially, it was analyzed the twenty most important links considering the number of flights by year according to the National Agency of Civil Aviation (ANAC). It had been chosen the most relevant points of arrivals for trips starting in Sao Paulo as are shown in the Table 1:

Table 1: The most important domestic routes leaving from Congonhas Airport considering the number of passengers during 2005

Arrival	Links	Passengers
Rio de Janeiro	19.249	1.705.054
Brasília	8.444	711.225
Porto Alegre	7.095	582.317
Curitiba	5.888	612.619
Belo Horizonte-Confins	3.739	317.348

Source: ANAC, 2006

It is possible to verify the number of links a week leaving from São Paulo in 2006, as shown in the Figure 3:



Source: ANAC, 2006

Figure 3: Number of links a week for the most important routes leaving from São Paulo-Congonhas in 2006

Under a geographical approach these links are also important, especially from São Paulo to Rio de Janeiro, as it can be seen in the Figure 4:

Figure 4: Considered routes leaving from São Paulo

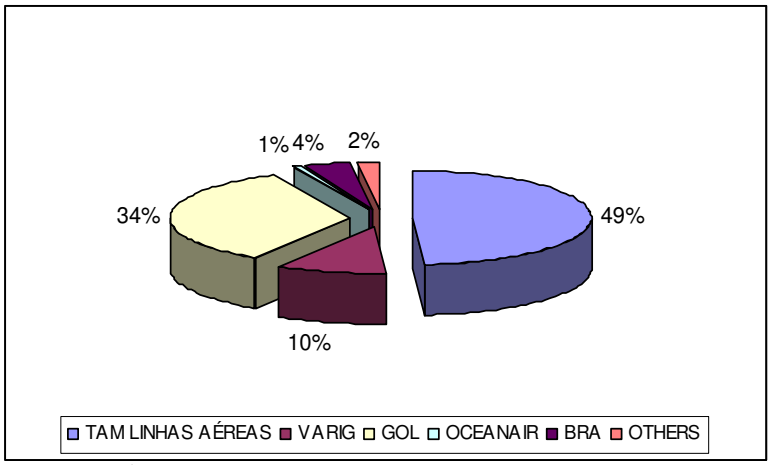
This route links the major industrial regions in Brazil and is characterized by passengers who travel on business

Another approach that explains the selection of these routes refers to their profit. For example, in the period 1997-98, the profit obtained in the route São Paulo-Rio de Janeiro was a third part of all the profit from regular brazilian domestic airlines. Besides, 20% of these airlines´ incomes came from São Paulo-Congonhas (Portal Exame, 2007).

In accordance with Melo and Mota (2003) it is possible to identify the consumer`s behavior that shows relation business profile:

- the trade-mark is no relevant for the consumer;
- there is a preference to buy the ticket in the web;
- price and flight time are important to choose the carrier.

In Brazil there are three airlines that are the most important players in the domestic market. The market share, considering passenger-kilometer transportaded is presented in the Figure 5:



Source: ANAC, 2006

Figure 5: Market-share for domestic air transportation market

The Figure 5 shows that the three biggest players have 93% of the market. In this study the research about the relation between the prices and the distance was focused on these airlines that were assumed representing the entire market.

3.1.2 Routes in the land mode

The part of this study that focuses the land transportation considered the same five routes that were shown on the air transportation to become possible comparing them. The performance of these links according to the data from the National Agency of Land Transportation (ANTT) is presented in the Table 2:

Table 2: Data for the land transportation in selected routes during 2006

Arrivals	Passengers	Passenger-kilometer
Rio de Janeiro	1.332.754	579.107.794
Brasília	105.177	106.392.585
Porto Alegre	46.732	56.610.810
Curitiba	674.356	290.778.563
Belo Horizonte	583.918	344.544.281

Source: ANTT, 2006

3.2 Tickets prices

In sense to obtain the price of the tickets it was used the tool Import Data from Excel that allows getting data from the internet. The period of the research was from September 25 to October first 2007.

Since in the air transportation mode there is a yield management that offer the same product for different prices, in this study it was analysed the most important players of the market. Then it was calculated the average price based on the frequency of the flights and on the market-share of each enterprise. For the land mode the methodology was repeated except for the yield management since all the prices are the same for the same route in the same enterprise. For passengers leaving from São Paulo to each arrival point, the results are shown in the Table 3:

Table 3: Average prices for tickets by land and air transportation for selected routes

Arrivals	Average Prices of the tickets (US$)*	
	Coaches	Planes
Rio de Janeiro	34.48	129.00
Brasília	67.47	178.68
Porto Alegre	70.72	189.20
Curitiba	31.73	119.62
Belo Horizonte	39.25	137.88

*The prices were converted by the exchange tax R$ 2 = US$ 1.

Source: Elaborated by the authors.

4. RESULTS

4.1. Value of the passenger's time

Once it was obtained the average price for the routes, the next step was to calculate the time value of the passenger for one hour during the trip. It was assumed that for each link there is a trade-off income for which the passenger changes from one mode to another one in sense to maximize his utility.

Table 4: Average price, duration of the trip and distance for each selected route

Arrivals	Coaches		Planes		Distance (km)
	Average Price	Duration of the trip/hour	Average Price	Duration of the trip/hour	
Rio de Janeiro	34.48	5h34	129.00	1h	500
Brasília	67.47	18h30	178.68	1h40	1.120
Porto Alegre	70.72	12h	189.20	1h32	1.030
Curitiba	31.73	6h	119.62	0h56	410
Belo Horizonte	39.25	8h30	137.88	1h08	590

The trade-off income can be calculated by:

$$Trade-off = \frac{Fare_{plane} - Fare_{coach}}{Time_{plane} - Time_{coach}} \qquad (10)$$

In this work it was not considered the access cost. The trade-off income for each route is as presented in the Table 5. These values correspond to an explicit cost of the time. The last column shows the trade-off income that passenger gets a month working 42 hours a week and 4 weeks a month.

Table 5: Trade-off income perceived by the passenger

Routes	Δ Fare	Δ Duration	Trade-off income/hour (US$)	Trade-off income/month (US$)
São Paulo - Rio de Janeiro	94.52	4h34	21.78	3.659
São Paulo - Brasília	111.21	16h50	6.74	1.132
São Paulo - Porto Alegre	118.48	10h28	11.53	1.937
São Paulo - Curitiba	87.89	5h04	17.44	2.930
São Paulo - Belo Horizonte	98.63	7h22	13.66	2.295

It can be observed that there is a negative relation between trade-off income and distance showing that longer trips are less attractive for the land mode. In this case the trade-off

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income is shorter than that one for the air transportation mode. The relation between distance and trade-off income is presented in the Figure 6.

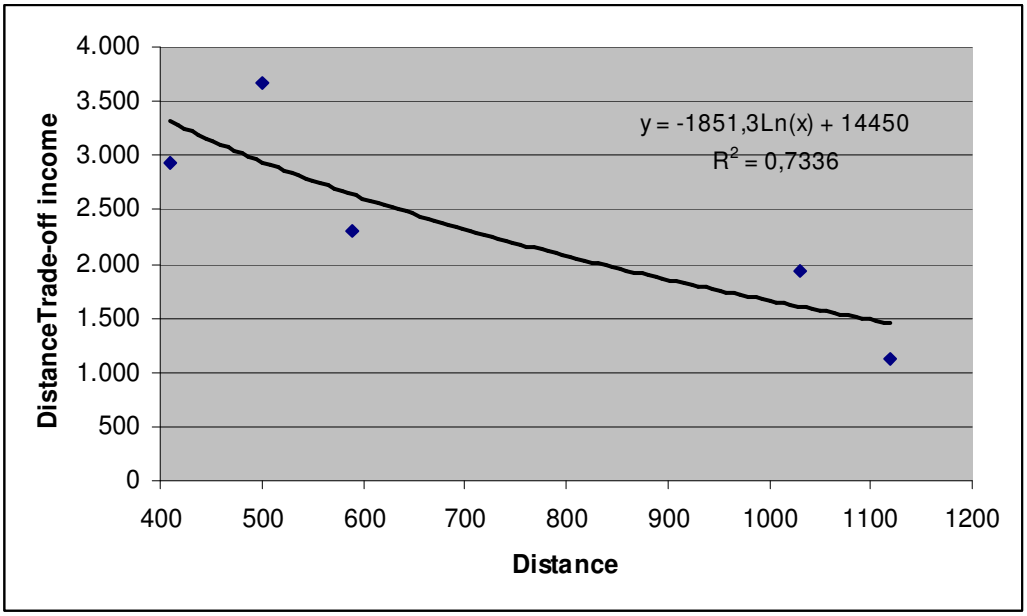

Figure 6: Trade-off income for distance of the trip

Applying the theoretical economics concepts to the route São Paulo – Rio de Janeiro for example, with a distance of 500 km, the trade-off income for modes is US$ 21.78 that means the economic good *trip by coach* behaves as a normal good for income lower than that. For upper income the same economic good starts to behave as an inferior good.

5. CONCLUSIONS

The paper shows the importance of the value of the consumers´ time when they have to decide to travel by planes or by coaches. The basic premise is that the consumer aims to maximize his utility, looking for the most efficient transportation mode. The results obtained by this study are still preliminary, but it is possible to find out that an increase in income increases the intrinsic price of time. Study developed by Eller (2007) with the methodology of loss of production estimated a value of US$ 15.78 for one hour spent in a 677 km trip. It took into account the average Brazilian per capita income, with no discrimination between travelers on business and on vacation. In the case of the routes analysed in this research there is a strong component of travelers on business that are suposed to have larger income. The results are consistent with it.

To fulfill the users need, it is expected that the transportation system be capable to offer a set of accessibility solutions among regions, answering different preferences and market segments. The model obtained helps to predict the demand for both modes. It should be observed that, the lower the region income level, the bigger will be the importance of passenger transportation by coaches. On the other hand, the increase income of Brazilians consumer and the low prices of air tickets make the demand of this mode of transportation to increase.

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