HETEROSCEDASTIC EXTREME VALUE MODEL APPLICATION TO THE CRUISING PRICING STRATEGY MANAGEMENT

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ABSTRACT

Main objective of the paper is to evaluate the pricing strategy of a cruise shipping company by passenger demand elasticity application. The approach focuses on passengers behavior choosing between different classes on board a cruise ship. It is important to specify that we are in presence on board of different level of service and pricing configuration as class (category). Infact the cruise ships can have many different pricing class subdivided as regard the cabin deck location and ship accommodation (inside–ouside or foreword–aft). In this sector, we assist also to a great market development of demand in the main world areas as Caribbean, Mediterranean , North Europe, Alaska, Asia etc . In the paper the methodology will be based on a RP survey on board a cruise ship leader operating in Northern Mediterranean (Catalani M. and Wild 2000). This will consent to analyze the passenger behavior with different nationality, employment, qualification, income, age, choosing classes. The survey will be integrated by an analysis based on passenger comment form on board of a post panamax cruise ships as regard entertainment, quality of food and beverage, embarkation procedure, itinerary etc . From the RP survey and the comment form kindly given by the crusing ship will be tested two econometric model based on multinomial logit model and heteroscedastic extreme value approaches to explain the passenger behaviour (McFadden D. 2000, Bhat C. 1995 , Ben Akiva M. and Walters J. 2002). The parameters estimates will consent us to determine a probabilistic criterion across passengers of choice between different classes on board and direct and cross price elasticity demand computation in front of changing pricing.

Keywords: cruise, shipping, competition, HEV

1. INTRODUCTION

The main object of the paper is to explain a criteria of passenger choosing between different pricing class on board a cruise ship. Cruising industry developed in the mid-seventies thanks

to the shipping company Carnival, RCL, MSC, always leaders in the sector. The last few years have seen also a process of concentration and consolidation of holiday packages in the hands of a few large tour-operators (Airtour). This phenomenon, common to both the European and North-American markets, has also witnessed a growing interest in the cruise market by these operators (Ward D. (2002). Of particular interest in this field are studies of the growth in demand and the behaviour of passengers in a market which can be said to be in expansion, though unstable (Catalani M. 2007). Tastes vary inside passengers nationality on board with the general satisfaction feel concerning from different cabin pricing and the relative willingness to pay for a better level of service offered (Catalani M. and Ferrara G. 2006 , Vogel M.P. 2007, Gunlu E. Cerit G., Pirnar I. 2007). At last it needs to say that there are not great variations, in offered pricing, by operators present in the same market, inside the same type of cruise ship (e.g. standard or deluxe ranking). The market is essentially an oligopoly with main leader shipping cruise company is Carnival. The paper focused on the passenger choice on board a cruising ship among different classes (categories). The application based on RP analysis will consider as main passenger variables influencing the choice such as pricing, age of passengers, employment, income etc (Catalani M. and Scamardella A. 2005, Seymur J. 2007). The methodology has based on consists in evaluating the degree of passenger class (category) satisfaction on board modeled from two econometric models : MultiNomial Logit (MNL) and Heteroscedastic Extreme Value (HEV) models (Greene W.H. 2003, McFadden D. 2000, Ben Akiva M. and Walters J 2002, Ben Akiva M. 2004). The probabilistic choice evaluation will allow us to optimise pricing strategy of the shipping cruise company by elasticity demand calculation.

2.CRUISE INDUSTRY CHALLENGES: A MED OVERVIEW

CLIA official data reports the passenger transported on 2006 are about 12 millions with an increasing as regard 2007. Interesting is the trend to the 2015 with a point of 16 million passengers transported. The long term market segmentation evidences an optimistic evaluation with a most relevant percentage increasing from 1965. It is evident in this contest to be afraid of the American and European reduction spending power due negative international conjunction (Dawson P (2000)). The cruise ship order book number in the 2007 must reach 36 with a deployed capacity of 91.000 lower berths, with a contribution of Europe and rest of the world of about 2 million passengers to the global market (G.P.Wild 2006). As regard passengers taste recent market survey evidencing important modifies as regards behavioural passengers preference. Generally passengers are changing their life style with a longer life as in the past and the board entertainment must be remodelled on this new generation life sensation (Dickinson B. Vladimir A. (2000). Clearly, post-panamax tonnage dominates current construction, exceeding panamax tonnage by more than two-fold against every measure except the actual number of ships being built. With nearly 20,000 more lower berths than last year and an increasing number of mega-cruise ships visiting the Mediterranean area, including offerings from Carnival and Royal Caribbean, Costa and MSC. Table 1 lists the fleet deployed in Mediterranean cruising during 2006, including a small number of vessels . The table includes an analysis of the fleet by cruise category, based on the ratings given in the current 2006 edition of the Berlitz guide (G.Wild International 2007).

Table 1. Mediterranean Cruise Fleet List 2006

Name	Operator	Q	SDx	Dlx+	Dlx	Std	Econ	Total
Total: 138 vessels		138	5,330	14,959	68,530	30,537	12,354	131,710
2005 126 vessels			6,422	13,107	59,296	23,801	11,034	113,660
Change 2005/6			-17.0	+14.1	+15.6	+28.3	+12.0	+15.9%

① Vessels believed to be cruising the Mediterranean in 2006, for which no information has been obtained, or for which the operator has indicated that itineraries have yet to be announced.

Source: G. P. Wild (International) Limited.

It will be noted that overall capacity is set to grow by nearly 16 per cent with growth in all five classes except Superdelux. It is significant that all these are either panamax-max or post-panamax ships. Although the ships in the medium and large/ medium size ranges (chiefly with a capacity of 500 to 1,500 passengers) represent the largest categories, ships of panamax and post-panamax size, taken together, account the great majority of lower berths deployed in the region (Dikos G, and Papapostulou L,.(2002)). Table 2 shows the passenger numbers in the Mediterranean in 2006, assuming 100 per cent occupancy of lower berths. This is analyzed by market and operator. As can be seen the main operator is Costa with about 420.000 passengers transported followed by MSC with about 243.000 passengers RCI of about 165.000 passengers. It need to specify that the main component derived by USA and UK. Although the Western Mediterranean remains the leading cruise ground the Adriatic is set to achieve 29 per cent growth and the Eastern Mediterranean 21 per cent. The Black Sea sector is set to increase by 50 per cent (G.P. Wild 2006). The largest cruise shipping companies in terms of passenger capacity deployed are in 2006 as follows :

Table 2. Main operators present in the Med area in 2006

Main Operator	Pax
Costa	**419,520**
MSC	**242,128**
RCI	**164,334**
Celebrity	**73,780**
Princess	**64,524**
P&O	**50,418**

Source: G. P. Wild (International) Limited and others.

As regards base port utilization in 2006 Venice maintains the premier position with a modest increase in potential throughput but the second and third place go to Barcelona and Palma Majorca, compared with Savona and Piraeus last year. Civitavecchia has improved its position from seventh to fourth place (with Roma as excursion destination) displacing Genoa from the top six. The ingress of mega-ships has played a key role in these movements with *Carnival Liberty* and *Costa Concordia* home porting from Civitavecchia and *Voyager of the Seas* from Barcelona.

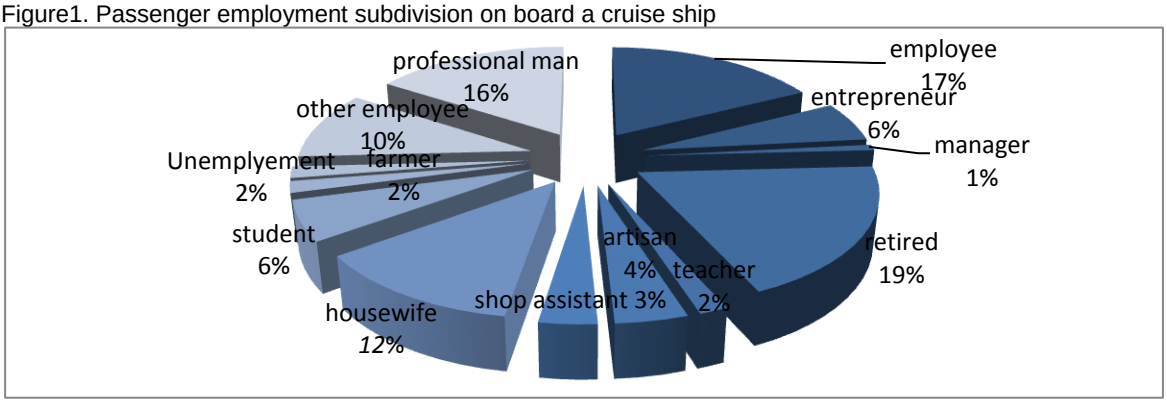
3. CRUISE PASSENGER DATA

A RP survey on board of a shipping cruise has been conducted with a wide collaboration of a leader cruising shipping company operates in MED area. Thanks to the shipping company, consented the use of passenger comment form about level of service on board, it has been

possible to know a general picture of the passenger behaviour. The objective is to develop a demand model able to represent the passenger behaviour to a changing price of cabins of a cruise ship of standard category (corresponding of a three stars on ashore hotel). The data included in RP survey consist of different variables as income, age, employment, family composition to elaborate the utility function of passenger. The paper focuses on the strategy analysis of ship owner knowing passengers willingness to pay for a pricing variation. The econometric models approach will be based on direct and cross elasticity computation. The sample data have been aggregated in five classes averaging the actual pricing system consistent of 11 classes. This simplification consent to operate with a wide pricing differentiation simplifying the calculation of probability of choosing inside the classes an to capture the willingness to pay. The sample used in the paper is of 1352 passengers travelled on a cruise ship in the Mediterranean area in a cruise of seven days.

The design phase of the survey required a few strategies regarding the choice of questions to put to the passengers and their order of appearance in the questionnaire. In fact all that limited the total number of questions that could be included in the questionnaire. In order to avoid the so-called "tiredness effect" or errors such as spelling mistakes, and so to preserve the same meaningfulness of the data, we adopted a compact model with not only the essential information, but also subjective opinions on a few indicators considered able to express the latent aspects of *ship preference attitude*. A lot of care was taken also in the graphics of the questionnaire. The design of a section of ship helps to understand the organization of the passengers on board, while the tables repeated in alternating ways on the last sheet, causing the respondent to concentrate. The questionnaire was applied to a series of interviews administered to passengers of diverse age, economic conditions and status. The respondents were chosen at random from among the passengers on board. The investigation was carried out over one working day in the month of May 2006. They were interviewed *face-to-face* at the entrance/exits at the ship border relevant to the area under consideration and the different parts of the questionnaire were explained, and support was given as to how to answer, without this influencing their choices. In the figure 1 you see the subdivision of the passenger as regard the employment. As regard the passenger employment in front of 19% retired we have a 16% of professional men and 17 % of employee in that cruise.

Figure1. Passenger employment subdivision on board a cruise ship

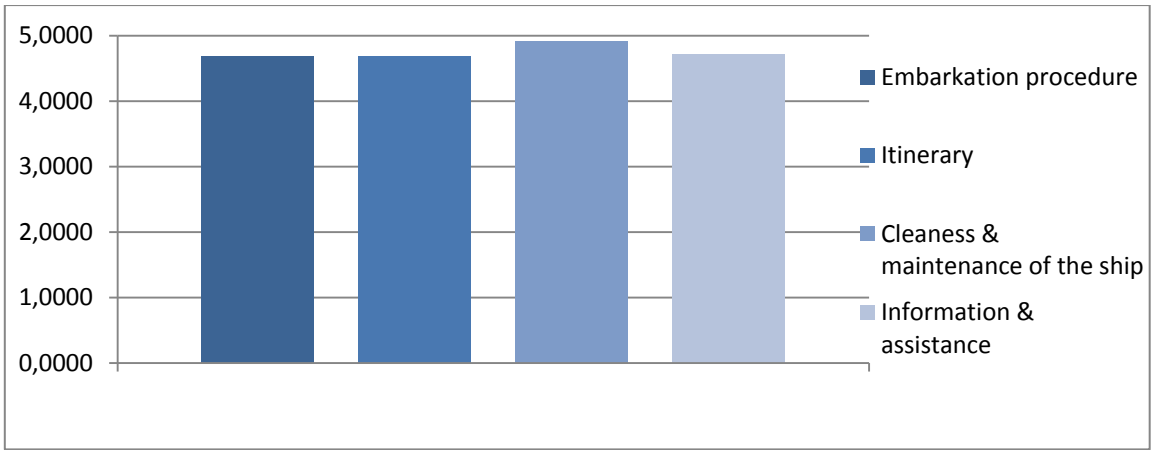


The survey has been integrated by data availability from the cruise company passenger comment forms compiled by the passengers on board. It has been possible elaborated a series of information based on judgment of passengers about the level of service present on board . The main questions concerning:

general information: embarkation procedure, itinerary, cleanliness & maintenance of ship information and assistance
personnel: information office, dining room staff, bar and public room staff, cabin staff
cabin: cabin cleanliness, cabin service
entertainment: show, entertainment activities, children activities, the bands
excursion: tour programmers, organization and assistance on board, quality of the guides
food and beverage: menu selection, quality of food, quality of drinks
buffet: lunch buffet, midnight buffet
other services on board: gift shops, beauty salon, photo, casino
general opinion: impression of cruise

It is possible to confirm an excellent judgment of the shipping companies service from the passenger as regard main services offered. Interesting is the excellent judgment as regard cleanness & and maintenance of the ship, embarkation procedure, itinerary and information, and assistance (at low level is the judgment as regard children activity) (Figure 2).

Figure 2. General evaluation as regard level of service on board



4. MNL VERSUS HEV CRUISING MODEL

The Multinomial Logit model (MNL) is based on the hypothesis that the uncertain residues εj relating to the different alternatives are independently and identically distributed (i.i.d.) according to an uncertain Gumbel variable (v.a.) with average zero and parameter *θ*. It will thus have a marginal probability function distribution given from (McFadden D .1973 , McFadden D. 1975) :

$$F_{\varepsilon_j}(x) = \Pr\left[\varepsilon_j \le x\right] = \exp\left[-\exp(-x/\theta - \Phi\right] \quad (1)$$

where Φ is the constant of Eulero (Φ ≈ 0,577). Average and variance of the Gumbel variable expressed by (5) are respectively worth:

$$E\left[\varepsilon_j\right] = 0 \qquad \forall j \;\; Var\left[\varepsilon_j\right] = \sigma_\varepsilon^2 = \frac{\pi^2}{6}\theta^2 \qquad \forall j \qquad (2)$$

The independence of the uncertain residue implies that the covariance between any couple of residuals is nothing:

$$Cov(\varepsilon_j, \varepsilon_h) = 0 \qquad \forall j, h \in I \qquad (3)$$

From this it results that the perceived usefulness U_j, sum of a constant $V_{.j}$ and the v.a. ε_j, are also uncertain Gumbel variables with the probability distribution function , average and variance supplied by

$$F_{U_j}(U) = \Pr\left[V_j + \varepsilon_j \le U\right] = \Pr\left[\varepsilon_j \le U - V_j\right] = \exp\left[-\exp(-(U - V_j)/\theta - \Phi\right] \qquad (4)$$

$$E\left[U_j\right] = V_j \qquad Var\left[U_j\right] = \frac{\pi^2}{6}\theta^2 \qquad (5)$$

On the basis of the hypothesis made on the uncertain residues ε_j and thus on the utility perceived U_j, The variance-covariance matrix of the residual $\sum_\varepsilon$ for the *m* alternatives available is a diagonal matrix proportional to the identity matrix according to σ^2_ε. .The Gumbel variable enjoys an important property called stability *compared with maximisation*, or the maximum of independent Gumbel variables with the same parameter θ is still a Gumbel variable with parameter θ (Cascetta E. 2001*)*.

The average V_M of the maximum $U_M = max_j \{U_j\}$ is supplied from:

$$V_M = E\left[U_M\right] = \theta \ln \sum_j \exp(V_j/\theta) \qquad (6)$$

The variable V_M is also called *inclusive utility* and the variable *Y* proportional to this is called the "logsum" variable, because of its analytical structure,:

$$Y = \ln \sum_j \exp(V_j/\theta) \qquad (7)$$

Stability compared with maximization means that the Gumbel variable is a hypothesis particularly convenient for the distribution of the uncertain residue in the models just described, as these express the probability of choice of an alternative to the probability that the utility perceived for that alternative is the maximum among those relating to all the alternatives available. In fact, in the hypotheses made, the probability of choosing alternative j from among those available belonging to the set of choices supplied by (3) can be expressed in closed form as:

$$p\left[j\right] = \frac{\exp(V_j/\theta)}{\sum_{k=1}^{m} \exp(V_k/\theta)} \qquad (8)$$

Expression (8) defines the Multinomial Logit model which is among the more used models of uncertain utility (, Allemby G. 1997, Ben Akiva M. Lerman S. 1985). The main hypothesis, usually assumed, that the alternatives are i.i.a from the attributes that make them up. On the contrary the main elements of the heteroscedastic extreme value (HEV) model are not constrained to the i.i.a assumption (Bhat C. 1995). The algorithm and interpretation is the one adopted in NLOGIT (Greene W.H. 2002),). Generally, with a significant number of

observations (not the case here), the heteroscedasticity can be implemented by Halton draw (Train K. 1999-2003).

The heteroscedastic model consents a utility calculation in the analysis of choices pricing class (Greene W.H**.** 2003).

$$U_{in} = \alpha_i + X_{in}\beta + \sigma_i \xi_{in} + \nu_{in}, \qquad i \in C_n. \tag{9}$$

The explanatory variable, X, is simulated as a normal variable with standard deviation σ_i, independent across alternative and observations. The utility for each observation is generated by drawing a single draw for each ξ_{in} from independent standard normal distribution and ν_{in} from an independent standard Gumbel distribution. More succinctly, the application performing CDF for each ε_j is the extreme value distribution type with precision parameter θ_j, the scale parameter is $\sigma_j = \frac{1}{\theta_j}$ (10)

$$F_{\varepsilon\varepsilon_j} = \exp(-\exp(-\theta_j)) \tag{11}$$

5. EMPIRICAL RESULTS

The sample has been weighted on total passengers transported in the spring period by the cruising operator and amount to a percentage of about 7% of total pax transported. We esteemed two different models in the application : a multinomial logit model and a heteroscedastic extreme value model. A number of different variables are analysed to determine the preferred utility function specification. We adopted the criteria to eliminating variables found to be insignificants in various iteration of the Nlogit code. The final estimation of the results are shown in table 3 for multinomial logit and heteroscedastic model. A comparison of all two models with scale constrained to 1 evidences that the parameter estimates ,their standard error and the log likelihood function are close to each in the two models. Adjusted likelihood ratio index is quite different (McFadden D. and Train, K.(2000)).
Again a likelihood ratio test between heteroscedastic extreme value model and the multinomial logit is at favour of the heteroscedastic specification (t test statistic is 56.18 which is significant when compared to a chi-squared statistic with four degree of freedom Greene W.H 2003, Asteriou D. 2006). Table 3 also evaluates the models in terms of adjusted likelihood ratio index. These values also indicate that heteroscedastic model evidence a better fit as regard MNL. As regard the signs we can say that parameters in the two models are as expected. A heteroscedastic model evidence better probability of choice class 3 and income constrained respect to MNL model as regard, comfort attributes. That is to say the location of the cabin, bow or stern, inside or outside the ship, the noise of the motor, the deck positioning etc ,are important parameters to be considered in the choice of class.
Table 4 shows the matrix elasticity respect to a change of level of service characteristics for multinomial logit and heteroscedastic extreme value models. An important consideration

can be found. The multinomial logit model predict high percentage decreases in class 2, class 3, class 4 , and class 5, and a low percentage increase in class 1 choice probability in response to a variation of class 1 pricing, in for direct elasticity, than the heteroscedastic extreme value(0,390 and 0.667). As regard comfort and age the cross elastic evidence, in respect to the signs, a better positioning of heteroscedasticity.

Table 3 Results of two models

Variable	MNL		HEV	
	Estimates	t-stat	Estimates	t-stat
Alternative constant (class 5 base)				
Class 1	**0.392**	**1.473**	**7.728**	**1.645**
Class 2	**0.506**	**1.893**	**6.260**	**1.941**
Class 3	**-0.158**	**- 0.581**	**-5.995**	**-1.046**
Class 4	**0.992**	**0.372**	**4.380**	**1.416**
Income (class 5 base)				
Class 1	**-0.150**	**-1.072**	**-0.341**	**-1.323**
Class 2	-0.273	-1.882	**-2.102**	**-1.917**
Class 3	0.108	1. 294	**1.108**	**1.925**
Class 4	-0.065	**-0.472**	**-0.006**	**-0.009**
Pricing	**-0.330**	**-3.955**	**-2.233**	**-1.261**
Comfort	**0.395**	**2.383**	**2.276**	**3.172**
Age	**-0.190**	**-1.057**	**-0.244**	**-0.283**
Scale Parameters (Class 5=1)[2]				
Class 1	**1**		**0.905**	**12.147**
Class 2	**1**		**0.905**	**12.147**
Class 3	**1**		**0.735**	**6.874**
Class 4	**1**		**0.735**	**6.674**
Loglikelihood at convergence	**- 1016.128**		**-1008.662**	
RsqAdjusted	**0.1649**		**0.2854**	

ratio index		

Table 4. Elasticity matrix changing class 1 attribute for MNL and HEV model

Class 1 level of service	Multinomial logit model					Heteroscedastic extreme value model				
	class 1	class 2	class 3	class 4	class 5	class 1	class 2	class 3	class 4	class 5
Pricing	.390	-.114	-.114	-.114	-.114	.667	-.103	-.146	-.178	-.251
Comfort.	-.312	096	.096	.096	.096	-.187	.037	.053	.051	.232
Age	-.205	.069	.069	.069	.069	.-032	.004	.008	.009	.089

6. CONCLUSION

More generally we can say that the research shows a positive trend in the global passenger-cruise sector. The positioning of new capacity in Mediterranean has revealed great interest of this market by shipping companies characterised also by the increasing emphasis on the deployment of large modern ships. This suggest to invest in improving facilities capable to receive such ships. At the moment is not clear if the demand in the Mediterranean cruise market from North Americans is again expanding in front of a recession in Europe and USA. On the contrary it is clear that the main operators are continuing to invest in this area as MSC with Fantasy and Splendid two great cruises liners. On the other hand the results of the passenger comment form evidenced, for a post panamax cruise, a very interesting degree of satisfaction with a point of excellence as regard cleanness and restoration. Interesting are the results of the RP survey on board the cruise ship. They are used to test a behavioural model of passengers choosing about different classes on board a cruise ship.
This paper has developed two random utility model : multinomial logit and heteroscedastic extreme value model. The results of the application evidencing heteroscedastic extreme value has a number of advantages over others discrete choices models. The paper used a Nlogit software for application.
The two MNL and HEV models evidence a good level of fit but with a preference for HEV. Relevant is the preference in terms of maximum likelihood at convergence and R square adjusted ratio index. Also if the parameters estimates from multinomial logit model and heteroscedastic model are close to each other, there are significant differences. Firstly the heteroscedastic model suggests higher positive probability of choice class 3 and class 4 characterized by an high level of comfort with external balcony low level of noise due to engines and a good barycentre position to limit the vibration and low level of rolling and pitching as regard aft and bow location. Secondly the multinomial logit elasticity matrix exhibits the IIA property with the elements of the class two, class three, class four and class five are identical in each row and not comparable between them. The heteroscedastic model does not exihibit IIA property. Again a change in class 1 level of service results in a larger

percentage change in the probability of choosing class 2 and class 3 . On the contrary as regard the comfort in class 5 is more advantageous then other same classes and also respect MNL. This is a consequence of the lower variance of the random component of the utility function of the class 2 and 3 to the other random component. As regard class 5 the same consideration. As regard the pricing system changing ,direct demand elasticity evidence for class 1 the higher value of .667. That is to say the passenger demand is moderately elastic for this class . The scale parameters are lower as MNL as not expected. Other investigation would be done.

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