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# Hedonic Pricing under Uncertainty: A Theoretical Consumer Behavior Model

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Abstract

A model of consumer behavior has been formulated by using an additive utility function and the hedonic pricing approach, in a virtual market. Since, there is a time lag between ordering and purchasing products (goods and services) online and receiving them, it means the consumer makes decision under uncertainty. The level of satisfaction with products with distinctive characteristics is described by the probability vector of their expected quality. Consumer choice, as well as interpretation of the equilibrium, is derived from a mathematical process. The results show that hedonic pricing which indicates willingness to pay is affected by probabilities of the expected quality or satisfaction with product characteristics. In addition, the expected marginal rate of substitution for every two characteristics of the product equals to the ratio for probabilities of the expected quality of them.

## 1. Introduction

In the present study, a model inspired by the Hedonic pricing model has been introduced. In addition, a utility function containing two variables has been considered. One of the variables is a product (goods and services) with different characteristics. Hence, the Rosen (1974) approach has been adopted. While the second variable consists all the other goods.

"Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them" (Rosen, 1974).

A number of scholars has developed the Rosen approach. Bajari and Benkard (2005), for instance, used Hedonic models for estimating demand systems. Accordingly, the researchers followed the two-stage Rosen's

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estimation procedure. They estimated the demand for heterogeneous consumers and for unobserved product characteristics.

Many researches in different economic fields, such as housing economics, public economics, environmental economics, and labor markets have benefitted from the Rosen's approach (Bajari and Benkard, 2005). However, only a few number of studies in the field of tourism economics in general and in relation to accommodation in particular have employed the hedonic pricing method (e.g., Chen and Rothschild, 2010, Espinet et al., 2003, Monty and Skidmore, 2003, Thrane, 2007 and White and Mulligan, 2002).

In this regard, many theorists believe that price of composite commodities, depends on their characteristics, which for instance, the cost of accommodation in a hotel depends on a number of factors including its location, facilities, service quality, and star rating (Thrane, 2007). Factors such as natural hazards, imprecise information, asymmetric information, buying and selling second-hand goods, and construction contracts make individuals be involved in decision-making in uncertain conditions. Therefore, some researchers have used the hedonic pricing approach for consumer behavior through considering conditions of risk and uncertainty. For example, Kask and Mani (1992) considered levels of information and uncertainty in a hedonic pricing model in order to determine the value of nonmarket goods. They derived a set of rules from an expected value model in order to analyze hedonic prices estimated for probabilistic nonmarket goods.

Yang (2001) used a hedonic pricing model in order to study behavior of households in Beijing facing the risk of construction quality. The researcher reported participants' level of willingness to pay for reducing the risk of construction quality. The study also provided the readers with a mechanism for assessing competence of economic policies that can affect construction quality.

Chen and Rothschild (2010) did a hedonic pricing analysis of hotel rooms from the supply side.

With regard to the entire above, no study has yet provided a model for studying behavior of consumers who make decision in a virtual market. The present study is an attempt to fill this gap. Accordingly, it is supposed that a consumer would like to reserve a hotel room online. Obviously, the reservation fee is influenced by the hotel’s characteristics. However, the consumer cannot be sure about the hotel's quality of services. Indeed, she makes decision in a condition of uncertainty. Based on her expectation about the quality of services, it is possible that she will not be satisfied completely when she be there. Therefore, the probability of consumer satisfaction can be between zero and one. The following section provides the readers with a partial explanation of the model.

## 2. The Model

Suppose that $H$ refers to a product, such as a hotel, with different or characteristics and described by two attributes or characteristics:

$$H = H(z_1\,,\ z_2) \tag{1}$$

where $z_1$ stands for the hotel room services, such as housekeeping, and food and beverage ordering, and $z_2$ stands for external services offered by the hotel, services such as internet access, public transportation access and access to a good restaurant. It should be mentioned here the aforementioned attributes $z_1$ and $z_2$ are independent. Additionally, it is assumed that consumers rent a room, as a unit of H, online through the hotel website. Some differences are assumed between the real quality and the expected quality of hotel attributes arisen from the information provided by the hotel website. Considering the fact that there is usually a lag of time between consumer's online purchase and her accommodation, it is possible the consumers will not leave the hotel completely satisfied. Indeed, a probability between zero and one is assumed for the expected quality in relation to each characteristic, i.e. $z_1$ and $z_2$, of the hotel. According to Equation 1, the probability of the expected quality of the hotel (*H*) depends on probabilities of the expected quality of its characteristics ($z_1$ and $z_2$). Hence, for the expected quality of *H*, a probability should be considered.

Assuming that the consumers are similar, an additive utility function for a consumer is:

$$U(\,H.\pi_1\,,X) = U_1(\pi_1.H) + U_2(X) \tag{2}$$

where H is a mentioned product whose attributes or characteristics are represented by the vector $\begin{bmatrix} z_1 \\ z_2 \end{bmatrix}$. $\pi_1$, is the probability of expected quality of *H*, and, $X$ stands for all the other goods, which are consumed.

Consumer maximizes her/his level of satisfaction in uncertain situations through the selection of *H* attributes ($z_1$ and $z_2$). Considering this, consumer utility function is constructed through being confirmed to the Von Neumann-Morgenstern axioms including complete-ordering, continuity, independence, unequal-probability, and compound lottery[1].

Buying or renting a product online with different characteristics, *H* has two alternatives as follows:

$$h = (\pi_1, A, B) \tag{3}$$

Therefore, *H*'s attributes, namely $z_1$ and $z_2$, have two alternatives:

$$z_1 \ = (\pi_3\,, A, B) \tag{4}$$

$$z_2 = (\pi_4\,, A, B) \tag{5}$$

where $A$ represents an alternative when consumer is satisfied, i.e. when an expected quality is shown, and $B$ represents another alternative in which she/he is not satisfied, i.e. when an unexpected quality is shown. It is assumed that consumer prefers $A$ to $B$. In addition, $\pi_1\,, \pi_3$, and $\pi_4$ are the probabilities of occurrence of A, i.e. the when an expected quality is shown, for h, $z_1$ and $z_2$, respectively. Obviously, $(1 - \pi_1\,), (1 - \pi_3\,)$ and $(1 - \pi_4\,)$ are the probabilities of occurrence of B, i.e. when an unexpected quality is shown, for h, $z_1$, and $z_2$, respectively.

[1] For more studying the Von Neumann- Morgenstern's axioms, see Henderson and Quandt (1980).

Considering *H*'s characteristics and the compound lottery axiom, $h'$ is defined as:

$$h' = (\pi_2 , z_1 , z_2) \tag{6}$$

In this model, it is assumed that the probabilities of gaining satisfaction with attributes $z_1$ and $z_2$ are $\pi_2$ and $(1 - \pi_2)$, respectively.

The probability of expected quality of H, which is derived from compound lottery axiom (6), will be:

$$[\pi_2 . \pi_3 + (1 - \pi_2) . \pi_4] \tag{7}$$

In Equation (7), probability of the expected quality of *A* is calculated through $z_1$ and $z_2$ that their expected quality equal $\pi_2 \pi_3$ and $(1 - \pi_2)\pi_4$, respectively.

Consequently, the probability of occurrence of *A* which is the probability of expected quality of *H*, can be gained through $h'$ is calculated via sum of both above mentioned calculations as follows:

$$\pi_1 = [\pi_2 . \pi_3 + (1 - \pi_2) . \pi_4] \tag{8}$$

Suppose that the price of *X* equals to 1. $P_h$ refers to the price of *H* and y is considered as consumer income. Accordingly, consumer income constraint can be assessed as:

$$y = X + H . P_h \tag{9}$$

For maximizing the utility function (2) subject to the constraint (9), $z_1$ and $z_2$ are chosen as decision variables.

The expected utility function is derived from replacing the constraint (9) on the utility function (2).

$$max: \quad E\{ U_1[H(z_1 , z_2)\pi_1]\} + U_2[y - H(z_1 , z_2)P_h] \tag{10}$$

The first-order conditions are yield through setting the first partial derivatives of (10) with respect to attributes $z_1$ and $z_2$ equal zero:

$$\frac{\partial E(U)}{\partial z_1} = \frac{\partial U}{\partial U_1} . \frac{\partial U_1}{\partial(\pi_1 . H)} . \frac{\partial(\pi_1 . H)}{\partial z_1} - \frac{\partial U}{\partial U_2} . \frac{\partial U_2}{\partial H} . \frac{\partial H}{\partial z_1} . P_h = 0 \tag{11}$$

$$\frac{\partial E(U)}{\partial z_2} = \frac{\partial U}{\partial U_1} . \frac{\partial U_1}{\partial(\pi_1 . H)} . \frac{\partial(\pi_1 . H)}{\partial z_2} - \frac{\partial U}{\partial U_2} . \frac{\partial U_2}{\partial H} . \frac{\partial H}{\partial z_2} . P_h = 0 \tag{12}$$

Using (8) in (11) and (12), we have:

$$\frac{\partial E(U)}{\partial z_1} = \frac{\partial U}{\partial U_1} . \frac{\partial U_1}{\partial(\pi_1 . H)} . \pi_2 \pi_3 - \frac{\partial U}{\partial U_2} . \frac{\partial U_2}{\partial H} . \frac{\partial H}{\partial z_1} . P_h = 0 \tag{13}$$

$$\frac{\partial E(U)}{\partial z_2} = \frac{\partial U}{\partial U_1} . \frac{\partial U_1}{\partial(\pi_1 . H)} . (1 - \pi_2)\pi_4 - \frac{\partial U}{\partial U_2} . \frac{\partial U_2}{\partial H} . \frac{\partial H}{\partial z_2} . p_h = 0 \tag{14}$$

After solving the above equations, the willingness to pay is assessed through Equation (15):

$$p_h = \frac{\frac{\partial U}{\partial(\pi_1 H)} \pi_2 \pi_3}{\frac{\partial U}{\partial z_1}} = \frac{\frac{\partial U}{\partial(\pi_1 H)} (1 - \pi_2)\pi_4}{\frac{\partial U}{\partial z_2}} \tag{15}$$

Equation (15) being simplified, the equilibrium condition can be expressed as:

$$\frac{\pi_2\pi_3}{Uz_1} = \frac{(1-\pi_2)\pi_4}{Uz_2} \tag{16}$$

The above equation may also be written as:

$$\frac{U_{z1}}{U_{z2}} = \frac{\pi_2\pi_3}{(1-\pi_2)\pi_4} \tag{17}$$

It shows that the expected marginal rate of substitution (EMRS) between the two attributes or characteristics ($\frac{U_{z1}}{Uz_2} = \text{EMRS}$) of the product with different characteristics (*H*) depends on probabilities of their expected quality or satisfaction with product characteristics.

Equation (17) can be written as below, as well:

$$\frac{U_{z1}}{\pi_2\pi_3} = \frac{U_{z2}}{(1-\pi_2)\pi_4} \tag{18}$$

Equation (18) indicates equilibrium condition. It states that the ratio of the expected marginal utility to the probability of the expected quality needs to be the same for the two characteristics. Indeed, this ratio shows how much satisfaction of each attribute will increase if an additional probability of the expected quality were considered for that attribute.

## 3. Conclusion

Present study has adopted a new approach to hedonic pricing theory via considering probability of the expected quality (or level of satisfaction) of product which is bought online from a virtual marketing.

This view important because, due to the lag of time between online ordering of the product and offering it by the seller, consumer might face some uncertainty, which might affect her/his willingness to pay. Therefore, hedonic pricing, which is related to consumer's willingness to pay, is affected by probabilities of the expected quality of product’s characteristics. Obviously, uncertainty level or probability of the expected quality, or satisfaction with product characteristics, depends on information transparency in virtual markets.

The applied results of the presented model show that the expected marginal rate of substitution between the two characteristics of the considered product equal to the ratio of probabilities of the expected quality of them, i.e. levels of satisfaction with product’s characteristics. In other word, according to equilibrium condition (18), there is a similar ratio for marginal utility of any characteristic to its probability of the expected quality (satisfaction).

## References

Bijari, P., & Lanier, B. (2005). Demand estimation with heterogeneous consumers and unobserved product characteristics: A Hedonic approach. *Journal of Political Economy*, 113 (6), 1239-1275

Chen, C. F., & Rothschild, R. (2010). An application of hedonic pricing analysis to the case of hotel rooms in Taipei. *Tourism Economics: The Business and Finance of Tourism and Recreation*, 16 (3), 685-694.

Espinet, J. M., Saez, M., Coenders, G., & Fluiva, M. (2003). Effect on prices of the attributes of holiday hotels: A Hedonic price approach. *Tourism Economics*, 9, 165–177.

Henderson, J. M., & Quandt, R. E. (1980). *Microeconomic Theory: A Mathematical Approach*, McGraw-Hill, Third Edition.

Kask, S. B., & Maani, S. A. (May 1992). Uncertainty, information and Hedonic pricing. *Land Economics*, 68 (2), 170-184.

Monty, B., & Skidmore, M. (2003). Hedonic pricing and willingness to pay for bed and breakfast amenities in Southeast Wisconsin. *Journal of Travel Research*, 42, 195–199.

Rosen, S. (1974). Hedonic prices and implicit markets: Product differentiation in pure competition. *Journal of Political Economy*, 82 (1), 34-55.

Thrane, C. (2007). Examining the determinants of room rates for hotels in capital cities: The Oslo experience. *Journal of Revenue and Pricing Management*, 5, 315–323.

White, P. J., & Mulligan, G. F. (2002). Hedonic estimates of lodging rates in the four corners regions. *The Professional Geographer*, 54, 533–543.

Yang, Z. (2001). An application of the Hedonic price model with uncertain attribute- The case of the people's republic of China. *Property Management*, 19 (1), 50-63.