Determining the Factors Affecting the Price of Beetle in Turkish Market via Hedonic Price Model

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Abstract

Beetle, as a legendary car, which its production dates back to 1938 and continues until 2003, sold more than 25 million in the world. It is also at premium and has many fans in Turkey too. Beetle, called as "Vosvos" or "turtle" in Turkey, may even be more expensive in the spot market than top model cars. Since automobiles have heterogeneous characteristics, to determine the factors which affect its price, Hedonic Price Model can be used. The aim of this study is to explore the factors that affects Beetle price and to get a model which can be used to price the automobile.

Keywords: Beetle; Hedonic Price Model; Multiple Regression Analysis; Information Criteria.

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1. Introduction

There are various breaking points in the history of humanity. One of the most important of these breaking points undoubtedly is invention of the wheel. It makes the lives of humans a lot easier. Then, with the development of motor vehicles, loads, which cannot be carried with human power, are able to be carried through the usage of motor vehicles. However, in recent days, motor vehicles are not preferred to carry heavy loads or fast transportation. Automobiles, which are designed especially for individual use, are used, in addition to satisfy the needs, to satisfy the feelings of pleasure. It is so that manufactured automobiles are preferred according to characteristics that make consumer feel pleasure right along with indicators based on performances such as engine power, fuel consumption etc.. In addition to these characteristics, some automobiles can have fans. These situations cause automobiles to have heterogeneous characteristics. In literature, factors affecting the prices of heterogeneous goods in this way are explored with hedonic models.

The word "hedonic" means the pleasure, satisfaction, contentedness or benefit that shows up after consuming goods and services. And hedonic price is the amount which one prepared to pay [2].

In Turkey, studies about hedonic price model usually are studied with the intent of determining the factors affecting residence prices. In some of these studies; İzmir, Kördiş and his colleagues [11]; Antalya [9], Mersin[12], Denizli [4], and Bulut and his colleagues [1]; determined the factors, which are affecting residence prices in Samsun, with hedonic price model.

In Turkey, there are also studies that aim to determine the factors affecting automobile prices. The studies that resemble our study are the ones, where factors affecting spot market prices of the cars are determined by [6] and Daştan [5], and the ones, where factors affecting private car prices are determined by [3].

The real aim of this study is to determine the factors affecting the price of Volkswagen Beetle, which is the most selling car in the world as selling more than 21.5 million, with hedonic price modelling.

2. Hedonic Price Modelling

Hedonic price modelling is frequently used to determine the factors affecting automobile prices. In hedonic pricing, the fundamental assumption is that consumers price according to, instead of goods or services it, their characteristics they provide [9]. With this assumption, it is accepted that each characteristics belonging to automobile have implied contribution and hedonic price model tries to estimate this implied contribution.

Rosen [10] defined a good (Z) as the sum of n characteristics as following;

$$Z = (Z_1, Z_2, \dots, Z_n) \tag{1}$$

When goods in the market have a heterogeneous structure, there will be different combinations in terms of these characteristics. Consumers will want to buy optimum good for them. Of course, each good will have a market price and this situation is related with the fixated value of Z vector. So, there will be a function between the

market price and characteristics of the good as following;

$$P(Z) = P(Z_1, Z_2, \dots, Z_n) \tag{2}$$

Here, P is the price of a good and Z is the characteristic vector of that good. This function is the hedonic price regression equation, which is obtained as result of the comparison of heterogeneous good prices [9].

Through price regression model, total contribution of each characteristics belonging to automobile to the price can be explored. If model in the use is a logarithmic model, then, obtained coefficients are called coefficients of elasticity and when all other characteristics are subtle, it gives the information about what percent coefficient of related characteristic increases/decreases the price of the automobile [4].

Equation (2) states that there is a functional relation between price and characteristics of automobile. The aim of hedonic price modelling is to determine the model that will state this functional relation in the best way. In literature, hedonic price regression model is seen in 4 different model structures. These models are given in Table 1.

Table 1: Hedonic models which can be used in the application

Model Name	Model Equation
Linear Model	$P = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$
Full Logarithmic Model	$\ln(P) = \alpha + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \cdots + \beta_n \ln(X_n) + \varepsilon$
Linear Logarithmic Model (Lin-Log)	$P = \alpha + \beta_1 \ln(X_1) + \beta_2 \ln(X_2) + \cdots + \beta_n \ln(X_n) + \varepsilon$
Logarithmic Linear Model (Log-Lin)	$\ln(P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$

Some variables cannot be measured quantitatively and their existences are able to be evaluated with only existent/nonexistent, yes/no etc.

These kinds of automobile characteristics can be added to the model only with dummy variables. When there is a dummy variable in the model, logarithmic linear model is like in Equation (3).

$$Y = \ln(P) = \alpha + \sum b_i X_i + \sum c_j D_j \tag{3}$$

where X_i indicates dependent variable, Y, and D_j indicates dummy variables [8].

3. Application

Data used in the study are compiled from 300 advertisements in *Sahibinden.com* [13]. Used independent variables and their levels are given in Table 2.

Table 2: Used independent variables and their levels

Variable Name	Code	Levels
Model	Mod	Other*, 1100, 1200, 1302 L, 1302 S, 1302 VW, 1303 S, 1303 W, 1303 VW Big
Engine Volume	EV	1300*, 1600
Fuel	Fuel	Gasoline*, LPG
Color	Col	Other*, White, Red, Blue, Green, Beige, Orange, Claret Red, Dark Colors
Case Type	Type	Cabriolet*, Sedan
Seller	Seller	From the owner*, Gallery
Restoration	Rest	Nonexistent*, Original Exists, Exists for Pleasure (Restoration different than original output of the vehicle)
Sunroof	Sun	Nonexistent*, Existent
Windshield	WS	Camber*, Flat
Headlight	HL	Normal*, Almond-shaped
Torpedo	Torp	Plastic*, Metal
Upholstery	Uph	Fabric*, Leather
Age		Quantitative Variable

* *Related variable levels are out of the model for the purposes of control.*

When we look into used variables, we see that categorical variables are in question and dummy variable is needed to be used. While dummy variable is being used, one of categorical variable levels is kept out and new variable is defined as level number minus one times [7].

To determine the price model, four different models (Lin-Lin, Lin-Log, Log-Lin and Log-Log) and to choose variable, four different methods (Enter, Forward Selection, Backward Elimination, and Stepwise) can be used. While deciding which one of these 16 models is the best, R^2_{Adj}, AIC, BIC and Standard Error criteria are considered. It is decided that AIC, BIC, whose adjusted coefficient of determination is the biggest, and the model with the lowest standard error are the best models. Obtained models and criteria are given in Table 3.

According to this, the best model for Log-Dog and Log-Log data are the model suggested by Backward Elimination and Stepwise. When we look into it more carefully, all of the four models in question are the same. The reason for this is that Age variable, whose logarithm can be taken, is out of the model. Because of this, taking logarithms of dependent variables does not have any effect on the results. Since the same models are suggested in the Stepwise and Backward Elimination method, it is expected for the results to be different. However, results obtained for four different models are the same. As a result the best model equation is given in Equation (4) and statistics belonging to the model are given in Table 4.

Table 3: Obtained models

Criteria

Model	Method	R^2_{Adj}	Std. Error	AIC	BIC
Lin-Lin	Enter	0.46	7.38	2079.58	2186.99
	Forward	0.46	7.38	2079.58	2186.99
	Backward	0.46	7.38	2061.33	2098.36
	Stepwise	0.46	7.38	2061.33	2098.36
Lin-Log	Enter	0.45	7.40	2080.96	2188.37
	Forward	0.45	7.40	2080.96	2188.37
	Backward	0.45	7.40	2062.91	2099.95
	Stepwise	0.45	7.40	2062.91	2099.95
Log-Lin	Enter	0.46	0.29	146.42	253.83
	Forward	0.46	0.29	146.42	253.83
	Backward	*0.47*	*0.29*	*129.55*	*196.21*
	Stepwise	*0.47*	*0.29*	*129.55*	*196.21*
Log-Log	Enter	0.46	0.29	146.54	253.95
	Forward	0.46	0.29	146.54	253.95
	Backward	*0.47*	*0.29*	*129.55*	*196.21*
	Stepwise	*0.47*	*0.29*	*129.55*	*196.21*

Table 4: Summative information for the best model

Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)	Coefficients:	Estimate	Std. Error	t value	Pr(>|t|)
Constant	2.84	0.15	19.45	0.00	Col1	-0.16	0.10	-1.63	0.10
Type	-0.27	0.13	-2.07	0.04	Col 2	-0.07	0.09	-0.82	0.41
Rest1	0.30	0.05	6.44	0.00	Col 3	-0.15	0.09	-1.78	0.08
Rest2	0.72	0.09	8.26	0.00	Col 4	-0.07	0.09	-0.79	0.43
Sun1	0.15	0.08	1.81	0.07	Col 5	-0.28	0.09	-2.97	0.00
Gl1	-0.24	0.10	-2.37	0.02	Col 7	-0.13	0.10	-1.34	0.18
Lamp1	0.58	0.07	7.88	0.00	Uph1	0.10	0.04	2.59	0.01
Torp1	0.21	0.10	2.06	0.04					

$$Price = \exp\{2{,}84252 - 0{,}26906Type1 + 0{,}29503Rest1 + 0{,}71714Rest2 + 0{,}14825Sun1 - 0{,}23699Gl1 + 0{,}58396Lamp1 + 0{,}20618Torp1 + 0{,}10051Uph1 - 0{,}1623Col1 - 0{,}07415Col2 - 0{,}15201Col3 - 0{,}06798Col4 - 0{,}28171Col5 - 0{,}13225Col7 - 0{,}24562Col8 - 0{,}08517Col9\}$$

(4)

When we look into the model in Equation (4), factors, which affect the spot market price of Beetle in Turkey, are determined according to Case Type, existence and nonexistence of Restoration, Sunroof, Leather Upholstery, shape of the Windshield, Headlights, for torpedo to be plastic or metal and Color of the vehicle. Here, price increasing factors are restoration, which is true to its original, restoration, which made some difference to the vehicle, having sunroof, almond-shaped headlight, metal torpedo and leather upholstery. Price decreasing factors are for case type to be sedan. Also, it is concluded that seller of the vehicle, engine size, model, fuel type and age are insignificant in determining price.

4. Conclusion

VW Beetle is a legendary car that dates back to World War II, which you can see everywhere in the world, in a parking lot or in street. With this study, factors affecting Turkey spot market price of Beetle, which can be sold even more expensively than top model cars, are tried to be determined with hedonic price model. In this regard, it is determined that color of the vehicle, case type, having restoration or not, having sunroof or not, having camber or flat windshield, normal or almond-shaped headlight, plastic or metal torpedo, fabric or leather upholstery affects it.

Since there are large differences in prices for beetle, there may be an outlier problem in the data set. For this reason robust hedonic price models will be used in the next our study.

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