International Journal of Business and Economics
Vol. 5, No. 2, 2020, pp. 123-128
http://ijbe.ielas.org/index.php/ijbe/index
ISSN (online) 2545-4137

https://doi.org/10.5281/zenodo.4624286

DECISION ANALYTIC PRICING WITH CONSTANT PRICE ELASTICITIES

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Received: 2020-11-13 Accepted: 2020-12-14 Published online: 2020-12-24

Abstract

This article introduces a new pricing model which uses decision analysis and isoelastic demand functions. Using the methodologies discussed here will enable companies to choose prices that will maximize the profit of a given product based on the state of the economy. An exponential utility function is used to incorporate the risk attitude of the company. The use of the model is demonstrated through a case study on 2018 Chevrolet Malibus. The proper use of the model will "take the guesswork out" of the pricing decision and help companies make pricing decisions using the best available data.

Keywords: Pricing, Decision Analysis, Elasticity, Utility.

1. Introduction

Pricing is an important strategic decision for every company for every product that it sells. Through pricing, a company can maximize its profit for a given product. Of course, it is not easy to determine what the optimal price should be. Certainly, there are many different approaches to pricing including: cost-plus pricing, competitive pricing, value-based pricing, price skimming, and penetration pricing.[1] Decision analysis is a proven methodology used to make decisions through taking into account alternatives, values (e.g., maximizing profit), and uncertainty (states of nature). Decision analysis has proved quite effective in helping companies to make business decisions regarding pricing (Khouja and Robbins, 2005; Cobb, 2009).

[1] https://www.bdc.ca/en/articles-tools/marketing-sales-export/marketing/pages/pricing-5-common-strategies.aspx

In order to use decision analysis to make pricing decisions, knowledge ofthe demand function of the product is required. Isoelastic demand functions, which have constant price elasticities, can be used effectively. Furthermore, pricing decisions with the use of constant price elasticities have been examined (McAfee and Veldee, 2008; Helmes and Schlosser, 2013).

The focus of this paper is to introduce a model that uses decision analysis in conjunction with isoelastic demand functions to make pricing decisions. The model is applied to 2018 Chevrolet Malibus to illustrate its use.

2. Model

The basis of decision analysis is to choose the best alternative which takes into account uncertainty to maximize a given objective. When it comes to pricing decisions, the clear decision is to pick the best price that will maximize profit. For modeling purposes, there are three prices: low, medium, and high.

Many different uncertainties could be considered, but the focus will be on the state of the economy as this is perhaps the biggest single factor in determining the overall demand of a product. Simply put, when the economy is strong, people generally have more disposable income and will purchase more, which increases the demand for products. Conversely, when the economy is weak, people generally have less disposable income and will purchase less, which decreases the demand for products. For the purposes of our model, three possibilities for the economy will be considered: a declining economy, a flat economy, and a growing economy. Some assumptions about how specifically the economy will affect product demand are needed. The optimal decision will be the price that maximizes profit taking all of the information into account. A decision tree can be used to not only model the entire situation but also determine the optimal decision.

Information about the product is needed, including price information, cost information, and the price elasticity. As mentioned earlier, isoelastic demand functions are used, and they are fully determined once the elasticity is found. Using the above approach will enable companies to make optimal pricing decisions based on the available information.

In order to choose the optimal price, not only the decision which maximizes the expected value of profit but also the decision which maximizes expected utility should be considered. In order to determine utilities, the exponential utility function is used as it has been shown to accurately model risk averse utility functions: $U(x)=1-e^{-x/R}$ where R is the risk tolerance. Thankfully, there is a good way of determining the risk tolerances of corporations (Howard, 1988): 1) 6.4% of total sales; 2) 1.24 times net income; 3) 15.7% of equity. The risk tolerance of a corporation can be determined through taking an average of these three measures.

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3. Case Study: 2018 Chevrolet Malibu

The use of a model will be illustrated which incorporates decision analysis and price elasticities through a case study involving the Chevrolet Malibu. In 2018, 144,542 Chevrolet Malibus were sold in the United States. Using this as the baseline, a decision analysis model was developed. Please see the expected value decision tree in Figure 1.

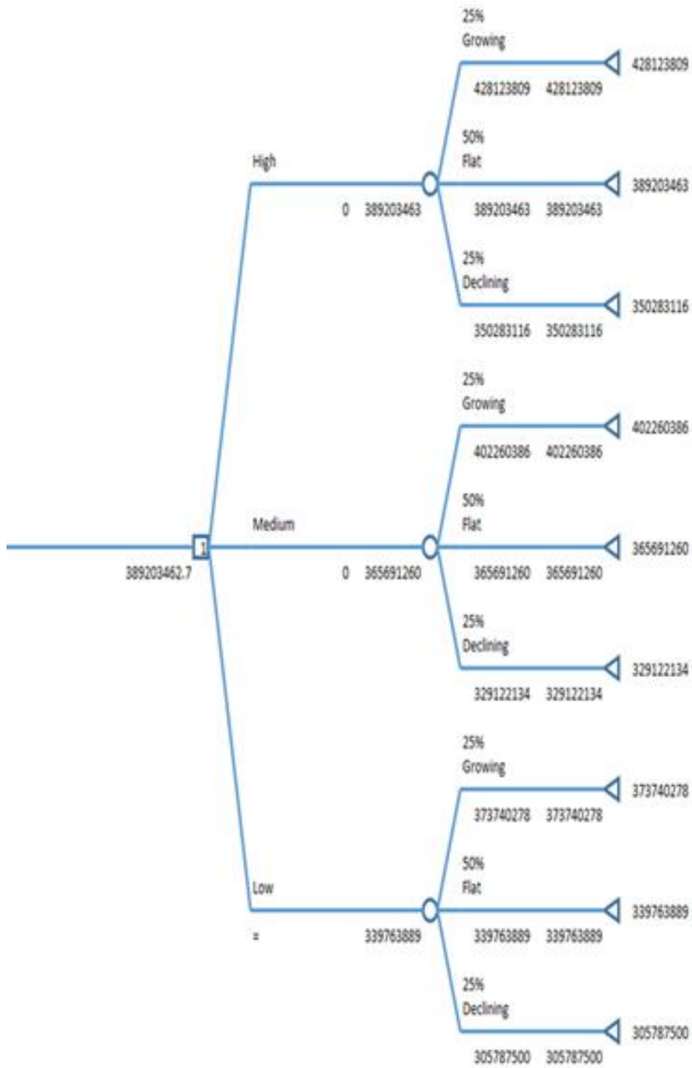

Figure 1. Expected Value Decision Tree

As can be seen from Figure 1, the decision for Chevrolet is to charge a low, medium, or high price. The base model 2018 Chevrolet Malibu L had an MSRP of $22,555. The highest model 2018 Chevrolet Malibu Premier had an MSRP of $31,850. For the medium price, the average of these two prices is used, which is $27,202.50 or approximately $27,200. This price is used as the medium price.

For the high price and low price, 1% above and 1% below the medium price are used, respectively. So, this means that the low price is $26,928, and the high price is $27,472.

From the 2018 General Motors annual report, the net sales and revenue from automobiles is $133,045,000,000 and the cost and expenses for automobiles and other cost of sales is $120,656,000,000. So, this leads to a profit margin per automobile of 10.27%, and to an average cost of $24,670 per 2018 Chevrolet Malibu.

An isoelastic demand function is used: $Q=A*P^{-e}$ where Q is the quantity, A is a constant, P is the price and e is the price elasticity of demand. The price elasticity for Chevrolet automobiles was found to be 4.0 (Gwartney and Stroup 1997). So, given that 144,542 Chevrolet Malibus were sold at the $27,202.50 price point, it is easy to find that $A=7.91*10^{22}$. So, the demand function for Chevrolet Malibus is $Q=(7.91*10^{22})*P^{-4}$.

Furthermore, economic conditions are taken into account. A flat economy is assigned a probability of 50%. A growing economy is given a probability of 25%, and the sales are estimated to be 10% more than in the average economy. A declining economy is given a probability of 25%, and the sales are estimated to be 10% less than in the average economy.

All of the data above is incorporated into the decision tree in Figure 1. From Figure 1, Chevrolet's base case profit for the Malibu is estimated to be approximately $366,000,000 in 2018. However, our analysis shows that given that the price elasticity demand is 4, that Chevrolet could have generated an optimal profit of $389,000,000 had it charged a 1% higher price.

Next General Motors' risk attitude needs to be taken into account in order to maximize its expected utility for this decision. Please see Table 1 for the calculation of its Risk Tolerance.

Table 1. General Motors Risk Tolerance

Financial Measure	Multiplier	Amount	Risk Tolerance
Total Sales	0.064	$147,049,000,000	$9,411,136,000
Net Income	1.24	$8,075,000,000	$10,013,000,000
Equity	0.157	$42,777,000,000	$6,715,989,000
Average			$8,713,375,000

General Motors' utility function is now obtained because the average Risk Tolerance as calculated in Table 1 of $8,713,375,000 can be inserted into the exponential utility function described above. Taking into account the decisions, uncertainties, and utilities, the expected utility decision tree in Figure 2 can be used to determine General Motors optimal decision. As it turns out, the optimal decision given General Motors Risk Attitude is still to choose the highest price as this gives the highest

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expected utility – 0.043678. The certainty equivalent (the certain amount of money that would have the same utility for General Motors given its risk attitude) is $389,160,001.

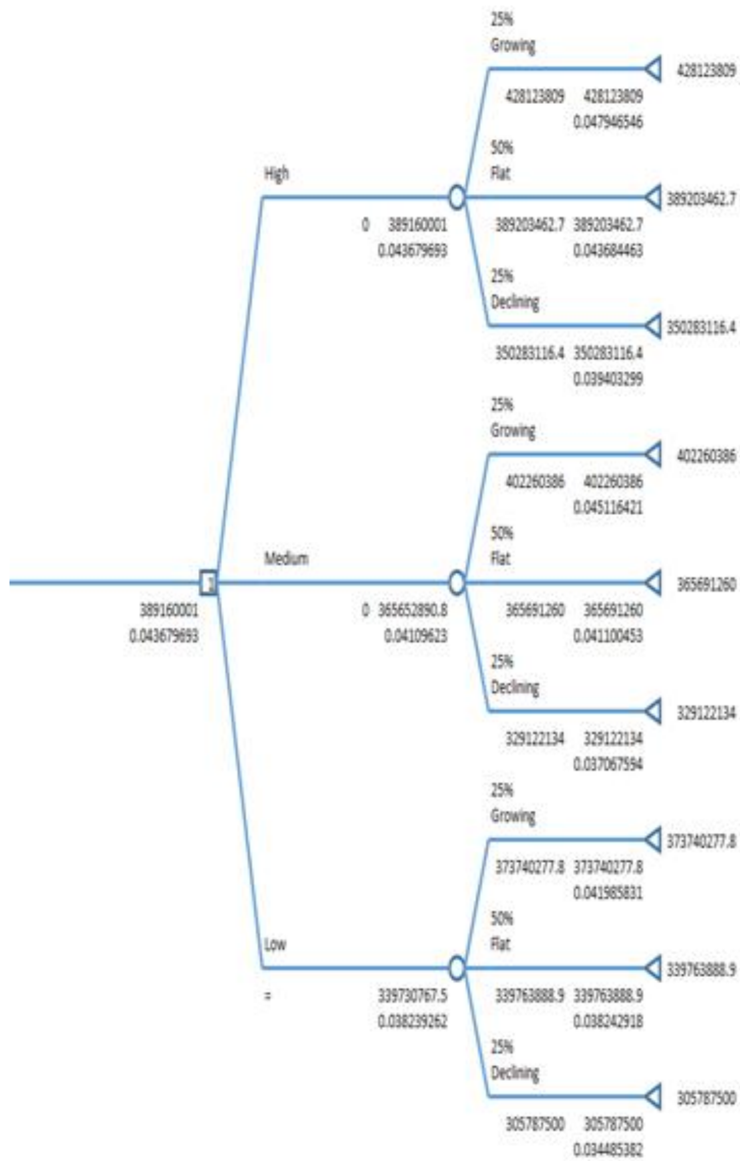

Figure 2. Expected Utility Decision Tree

Doing sensitivity analysis, the price elasticity of demand would have had to gone up to 10.27 before charging the average price of $27,200 would be optimal. (At a price elasticity of 11.32, the low price becomes optimal.) Please see Table 2. Given that an elasticity of 10.27 is well above the actual elasticity of 4.0, it is obvious that Chevrolet should have charged a higher price for the Chevrolet Malibu in 2018. So, this model can be used to not only determine the optimal decision but also do sensitivity analysis.

Table 2. Price Elasticity Sensitivity Analysis

Price Elasticity	Pricing Decision
e <= 10.26	$27,472 – high price
10.27 <= e <= 11.31	$27,200 – medium price
e >= 11.32	$26,928 – low price

4. Conclusion

All companies would like to make the best decisions possible. In this paper, the focus was on using decision analysis to make optimal pricing decisions. Isoelastic demand functions model well the demand for products. So, incorporating decision analysis with the use of isoelastic demand functions provides a rigorous analytic approach which forms the basis of good pricing decision making. In this model, an isoelastic demand function is input into an exponential utility function. The risk tolerance can be computed easily using some key financial measures. The use of the model was shown through a case study involving 2018 Chevrolet Malibus. The model demonstrated that General Motors would have generated an additional $23,507,110 ($389,160,001—$365,652,891) of profit on a certainty equivalent basis for the 2018 Chevrolet Malibu if it would have increased the price by 1%. Furthermore, sensitivity analysis revealed that this optimal price is robust. More generally, the effective use of the modeling techniques described above will enable companies to choose the optimal price that will maximize profit for a given product.

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