Modeling price elasticity of demand in pricing strategy

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Abstract: The paper analyzes the different variables with product characteristics that affect the pricing of a (competitive) firm as vibrant productive unit. Based on the firm’s profit maximization problem, the paper brings out the role of demand elasticity as well as customers’ loyalty as the key factors in the firm’s pricing strategy. This is stressed because in marketing a product little has been said about the importance of price demand elasticity in pricing strategy.

Key words: Pricing, Customers (consumers), demand elasticity, firm, product

1) Introduction

There is much literature on creativity and innovation as being crucial for firms to have competitive advantage. Creating and innovating also means having the capacity to satisfy and maintain the loyalty of customers/consumers. Successful forward thinking or looking firms do plan, create, innovate and sell products and services. They must continuously improve and create (new) products and services. As the firms constantly create and innovate, they must do so with enthusiastic employees of the firms, and at the same with their customers. It is critically important to have that collaboration between the consumers and the firms with their employees who are also constantly generating the ideas for innovation and production of goods and services. They all work together for the sustainability and profitability of the firm (123HelpMe, 2012).

Traditionally innovation has been looked at as product and service, with innovation focusing on the attributes and features. There have been three types of innovation mentioned in the literature - customer-centered, customer-focused and customer-driven (Kalyanaram et al., 2011). Whatever it is; it is assumed that, the main point of a firm is to stay in business, continue production, connect with consumers and then make profit.

In this paper, it is assumed that the main objective of the firm is profit maximization and hence, its pricing strategy is to achieve that objective. Therefore, we analyze the firm’s success as putting the customers or consumers at the center of its business as well as paying special attention to the price elasticity of demand of its product. The paper focuses on pricing, with elasticity of demand, which has to be taken as important part of innovation and marketing. Much has been said on the different strategies on connecting the firm’s success (product sales) with the customers. But very little is discussed to emphasize the role of demand elasticity faced by the consumers, which the firm has to include in its marketing equation or strategy. As it is stress here, the demand elasticity is critically important for a firm’s success. It can greatly affect the sustainability of a firm in spite of the customers’ loyalty to the firm’s product. This is why it is crucial to explicitly bring out the role of elasticity of demand in the firms’ marketing equation and innovation.

In the rest of the paper, section two discusses the different variables (including product characteristics) affecting pricing. Section three brings out the competitive firm as productive unit. The production cost and industrial costs are discussed in section four. Section five develops the firm’s production with the firm’s profit maximization problem. The role of elasticity is developed in section six, and the paper concludes in section seven with emphasis on customers’ loyalty and demand elasticity.
2) Pricing: firms and customers

A key element in marketing is pricing as it is particularly related to product positioning and product characteristics. Determining pricing is therefore crucial in a firm, since many factors are involved. What are the pricing method, the price structure, product quality, competitors’ actions, pricing motive/objective? Above all, what is the customer or consumer’s reaction? While pricing is a function of many variables including other products, distribution and promotion, the relationship between price and the demand (curve) is dominant. Pricing is determined by the number of customers or consumers purchasing the product or the number that are continuing to buy the existing and the new products. Firms or producers usually set prices by taking into consideration the quality of the product, the competitive market environment, and consumers’ tastes or preferences. But more important, demand is critical in product pricing by firms. In such cases, it is preferable to apply market based pricing strategy. This becomes important to analyze how sensitive price is to the customers or even potential consumers of the product. Analyzing the price sensitivity should include complete market research, and product life cycle (Netmba, 2010).

As the firm seeks its profit objective it has to be very conscious of its costs and customers, who generate the firm’s revenue. That is, the firm has to develop an innovative pricing model that serves both the interest of the firm and the customers within the market environment which include other firms supplying similar products. In all, the firm tries to develop a sustainable business model as it continues to answer the question: how can the firm make consumers buy its products in a sustainable way? With today’s rapidly changing markets, firms try to develop brand loyalty or generate product loyalty in order to get consumers to become attached or committed to the products and even attached to the firm. Recently the emphasis has been put on customer-driven innovation programs (Desouza and Awazu, 2004; Ulwick and Bettencourt, 2008). In these programs both the customers and the firm work together to innovate or create innovation but the customer is the key player in the working relationship. The interaction is dynamic, with appropriate mechanism to support the interaction. The main purpose of the firm is to make their goods or service as attractive as possible to customers, to stay in business and make profit.

In a market process goods and services are produced by productive units and consumed by individuals. On the supply side there are a number of productive units or firms ranging from legal entities such as large corporations and businesses to individuals and households. Within this set there are some productive units which are not well organized, yet they also provide goods and services. We want to look at market behavior and develop a parsimonious model of production with supply and demand, which incorporates customers’ sensitivity as an element into producer’s price strategy. This makes it easy to analyze the firm’s behavior.

3) Competitive firms

There may be many firms competing in the production of given products or services. In commonplace language, competition generally refers to rivalry in businesses. For instance automobile (motor) industry, the main competitors are General Motors, Ford, Toyota, etc. A firm in the industry can make deliberate decision to bring out a new model of a car or vigorously advertise the current model with offers of certain guarantees. The firm can as well do both, and at the same time paying attention to customers needs. In doing this, the firm must have taken into account the effect of its action on its competitors as well as their response.

Centuries ago much of the goods and services were produced by the households themselves, much of the trade was carried out among themselves – mainly by barter. Today in our modern economy, productive activities tend to be carried out by firms. Firms are able to produce these goods and services at a much lower cost, which is the raison d’être of the firm. But, some products and services are not
necessarily being provided by large firms/organizations. In a market process firms with least cost of production tend to appear. Nowadays firms are intermediaries between households and customers or consumers, and households and owners of inputs (features of production). They are also full participants in the market process to stay in the market. Firms continuously create and generate new products and innovate.

Companies produce goods and services, and in doing this, they work with the consumers to meet their needs. Productive units (firms or companies) possess the relevant information on their production technology, prices of inputs and output prices. They can also work together with the consumers to shape the output prices. On the other hand, consumers know their preferences and prices of goods and services as well as the remuneration for offering their inputs (factors of production). Consumers are usually persuaded to acquire new tastes and preferences, sometimes through advertisements.

A firm may usually try to increase its operation and so expands the industry by utilizing more and more resources (in terms of materials, capital, labor, energy, etc). If there are no artificial and natural barriers hindering the expansion of the industry, as resources move into the expanding industry, so too do resources move out of the contracting industry. Firms in the industry produce at the output that maximizes their profits – where respective marginal costs tend to equal their marginal revenue. In certain cases, the marginal revenue may tend to be less than the price of their output. The market environment is ever changing, so too the industries or firms are also changing- new products are continuously being produced. But as an industry expands and demands more inputs, the price of inputs tends to increase. The increase in input demand is usually accompanied with increase in employment of human resources.

Firms would generally adjust the scale of their operations to fit together with the demand of the consumers at the “prevailing price” and conditions. Changing conditions may change also the scale of operation (and output) of the firm/industry and consequently the prices (Browning and Browning, 1986; Nechyba, 2011). Monopolistic competitive industry differs from competitive industry in the long run. First, in monopolistic industry, there is excess capacity and the industry may produce at inefficient level. Second, the industry carries out nonprice competition such as packaging, advertising and product differentiation. These tend to generate product price difference or dispersion. Whatever, the situation firms tend to take into consideration, the responsiveness of their product to changes in prices consumers pay for their output.

4) Industry production costs

Innovation is important, at any given market price. Each firm in the industry produces at the output that maximizes its profit. But firms that do not create and innovate may find themselves going out of business. In certain industries, increase in the output of few firms may not affect the input prices but if the changes are of big magnitude in the industry, the prices of the input may change. For instance, increase in the automobile production would increase the input prices of items such as steel. Still, the nature of the industry may be such that an increase in the demand of its inputs may not affect the prices of the inputs. This may be in a situation where the input of the industry is a very small fraction of the input market. For instance, an increase in the production of paper clip may have very little effect on the price of steel.

In an increasing-cost industry, an expansion in its operation or output would result to increase in the prices of its inputs. High input prices generate high production cost. The increases in operation or output lead to increase in input price consequently increase in cost of production. Hence, the industry produces higher output at higher output price (Kalyanaram et al., 2011).
An industry may be decreasing cost because of increase in demand for its output; as the industry increases its output it tends to lower its (input and) output prices. This may be due to advances in technology which has resulted to shifts in the supply curves downwards to the right. For instance, it is often seen that in the industries for products such as digital cameras, watches, color TV, personal computer, video cassette recorder and small calculators have had a sharp drop in (output) prices since the introduction of these products. The reasons may be because of rapid technological improvement advances as well as an initial monopoly but later became competitive. In the initial stages, the monopoly situation might have derived huge profits, but as the industry become more competitive, companies within the industry innovate, reduce production cost and also reduce the output price. In the production process of the industry, more output is therefore produced at a lower production cost; consequently output is sold at a lower price.

5) Firm’s production and input demand

The production of the firm generates the supply of goods/products of that producer and the preferences of the customers generate the demand for the products. Both the demand and supply of the product and services determine the market price and quantity produced and demanded. Consequently this also determines the level of employment. The expansion of the industry’s operations means increase in resources (factor inputs) usage. Hence, as the output price and output are determined, implicitly the employment level with inputs prices is also determined.

5.1) Firm’s profit maximization problem

The output or product prices are not depended on production plans of the firm. The first order conditions are necessary and sufficient to determine the solution for profit maximization problem. The production function which shows the input combination for a given output to be produced also reflects the firm’s costs; since the inputs must be paid for. Pricing must consider the variable costs as well as the fixed costs which are incurred even when output is zero. Although in a competitive market most often only the marginal cost in producing an additional output is considered. Innovative pricing could also be designed in such a way that it is satisfactory to both the firm and customers (Taylor, 2004; Mas-Colell, 1995).

Production processes, tend to distinguish the set of goods deemed to be output from the set that can be inputs. That is we can conveniently distinguish a firm’s outputs from its inputs with X being outputs and L being a vector of inputs. We use this to discuss the firm’s production set which is technologically feasible.

Let \( X = (X_1, X_2, \ldots, X_N) \geq 0 \) \hspace{1cm} 1

and

\[ L = (L_1, L_2 \ldots L_{T-N}) \geq 0 \] \hspace{1cm} 2

Represent the amount of the firm’s T-N inputs.

Input-output technology can be described in terms of production function \( f(L) \)

This offers the maximum amount \( X \) of output using

\[ \text{Inputs } X \ (L_1, L_2, \ldots L_{T-1}) \geq 0 \] \hspace{1cm} 3

The firm can be seen as having a choice over the level of its inputs \( (L) \).

The profit maximization problem is:
Max Pf(L) –WL

L>0

P∂f(L)/∂L≤ W; with equality if L > 0

{P-∂c(W,X)/∂x≤0; with equality if X>0 which gives an interior solution.}

Market behavior: Vector of prices for K goods

Denoted by P = (P₁, P₂, …., Pₗ) >0

and

W= ( W₁, W₂,…..) >0.

W is the price of the inputs. For the firm i, the demand for its product would not only depend on the price of the product, but also on the output of other firms in the industry. Hence the total output (production) is given as Xₜ. The demand function of product or output (Xᵢ) would then depend on many factors including the characteristics of the goods or services. But the price of the product and the output of other firms (X₀) would tend to be the dominant determinants. Hence, the demand function of the product can be written as:

Xᵢ = (P , X₀,……)

Which is the demand function of firm i.

In a given market when demand equals supply of a product, it gives the equilibrium price and quantity which also determines the level of inputs employed in producing those outputs. The output is an increasing function of inputs and employment, the labor employed may also include consumers or customers of the firm. They may also buy the output of the firm, and so increase the demand of the firm’s product. For increasing demand for products of increasing cost industry means that the supply of inputs curves would slope upwards as the price of inputs goes up with increase in production. With increase in production the cost curves also increased. This also affects the output markets as the conditions of the input markets may not be the same and vice versa. The inputs are closely related to their cost and therefore measured in terms of input costs. So “the same curve relates input to output and cost to output”. In the short run, the variable costs curve of a firm determines the total output curve, reflecting diminishing marginal returns. This is important as the firm does not only look at the output market, it must as well take into consideration its input market. While the output pricing behavior may be influenced by the market output demand, the firm cannot remain in the market if it cannot sell its product. To remain in business, the firm must continuously offer attractive output pricing to its customers. That is, product pricing is crucially important in business.

6) The role of elasticity

We can, therefore, assume a single firm i with its output (Xᵢ) at a given price. The quantity produced and sold by the firm to consumers plus the quantity produced and sold by other firms give the total amount produced and sold by industry to consumers. At lower price the firm would sell more to consumers as the market demand curve is downward sloping. While quantity sold by other firms would decrease since their supply curve is upward sloping. But what determines the total sales is the price elasticity of demand (the price elasticity of the market demand curve). Similarly, the price
elasticity of the firms’ supply curve determines the decrease or increase in other firms’ output. Hence, the less elastic the demand and supply are, the less the elasticity of the demand facing the firm $i$.

Let us say an industry has $N$ firms ($i = 1, 2, 3\ldots N$). The revenue of firm $i$ from its total output ($X_i$) is $PX_i$ where $P$ is the price of output. The total revenue from the whole industry is $PX_T$ with industrial total output $X_T$; beside $X_i$ the other firms output is $X_0$ and their revenue is $PX_0$. Here the revenue of firm $X_i$ can be given as

$$X_i P = X_T P - X_0 P$$

The elasticity is usually derived from the demand function. For simplicity the elasticity can be derived from the output of the firms and industry as in equation 9.

Let $X_i = X_T - X_0$

That is the total output is $X_T = X_0 + X_i$

Total output ($X_T$) equal output ($X_i$) of firm $i$ plus output ($X_0$) of other firms.

A change in the output of firm $i$ means a change in the total output of the industry, that is,

$$\Delta X_i = \Delta X_T - \Delta X_0$$

To obtain proportionate change equation 7 is divided by $X_i$

$$\frac{\Delta X_i}{X_i} = \frac{\Delta X_T}{X_i} - \frac{\Delta X_0}{X_i}$$

To transform (12) into shares and elasticity we divide and multiply the right side of (12) by their respective outputs and then divide by the proportionate change in price to give the following equation in terms of elasticities and shares. That is we have:

$$\frac{\Delta X_i}{X_i} \frac{P}{\Delta P} = \frac{\Delta X_T P (X_T)}{X_T \Delta P (X_i)} + \frac{\Delta X_0 P (X_0)}{X_0 \Delta P (X_i)}$$

To facilitate the calculation, we regard the demand elasticity as positive. Equitation (13) gives the demand curve for the industry, firm $i$ and supply curve of the other firms in the industry all in terms of elasticities.

$$\varepsilon_i = \varepsilon_T (X_T/X_i) + \varepsilon_0 (X_0/X_i)$$

$$\varepsilon_i = \varepsilon_T S_T + \varepsilon_0 S_0$$

Where $S_T = X_T/X_i$; and $S_0 = X_0/X_i$

and $\varepsilon_i$ is elasticity of demand of firm $i$ with output $X_i$. $S_T$ gives proportion of the firm $i$’s output in the total industry and $S_0$ reflects the share of firm $i$’s output to the other firms, and $\varepsilon_0$ is the elasticity of supply of the other firms. These values could be calculated without deriving the full demand and supply curves with their arguments.

The elasticity of firm $i$ can be calculated from equation 15. If the elasticity of demand for firm $i$ is larger, the smaller would be firm $i$’s share of output in the total industry’s output. This would also reflect a greater elasticity of demand for industry’s output and larger elasticity of supply for the other firms. The firm’s demand elasticity can be large enough to make the firm highly competitive. In other words, if the elasticity is large, the firm tends to be a price taker. Hence, the importance of price
elasticity in the firm’s marketing strategy. In trying to sustain the customers/consumers’ loyalty to the firm’s product, an objective would be to make the demand for the product more inelastic or less elastic.

In table 1 and table 2, the point is brought out more clearly with some simple calculations. In table 1, the market share of firm i increases or varies from 10 percent to 90 percent, given a constant elasticity of market demand for the output and supply of other firms, other than firm i. It is observed that the price elasticity of demand for firm i decreases from twenty eight (28) to almost one (1). In table 2, the market share of the firm i is held constant at a quarter of the market, yet the elasticity of demand for firm i’s product varies, but always larger than the elasticity of market demand for the product.

Table 1. Share of output of firm i and elasticity of demand.

<table>
<thead>
<tr>
<th>Market share of output of firm i</th>
<th>Market share of output of other firms</th>
<th>Elasticity of market demand for output, $\varepsilon_T$:</th>
<th>Elasticity of supply of firms other than firm i, $\varepsilon_o$:</th>
<th>Elasticity of demand for output produced by firm i, $\varepsilon_i$:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,1</td>
<td>0,9</td>
<td>1</td>
<td>2</td>
<td>28,00</td>
</tr>
<tr>
<td>0,25</td>
<td>0,75</td>
<td>1</td>
<td>2</td>
<td>10,00</td>
</tr>
<tr>
<td>0,4</td>
<td>0,6</td>
<td>1</td>
<td>2</td>
<td>5,50</td>
</tr>
<tr>
<td>0,5</td>
<td>0,5</td>
<td>1</td>
<td>2</td>
<td>4,00</td>
</tr>
<tr>
<td>0,75</td>
<td>0,25</td>
<td>1</td>
<td>2</td>
<td>2,00</td>
</tr>
<tr>
<td>0,9</td>
<td>0,1</td>
<td>1</td>
<td>2</td>
<td>1,33</td>
</tr>
</tbody>
</table>

Source: author’s calculation

Table 2. Elasticity of demand and elasticity of supply.

<table>
<thead>
<tr>
<th>Market share of output of firm i</th>
<th>Market share of output of other firms</th>
<th>Elasticity of market demand for output, $\varepsilon_T$:</th>
<th>Elasticity of supply of firms other than firm i, $\varepsilon_o$:</th>
<th>Elasticity of demand for output produced by firm i, $\varepsilon_i$:</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,25</td>
<td>0,75</td>
<td>1</td>
<td>2</td>
<td>10,00</td>
</tr>
<tr>
<td>0,25</td>
<td>0,75</td>
<td>0,5</td>
<td>2</td>
<td>8,00</td>
</tr>
<tr>
<td>0,25</td>
<td>0,75</td>
<td>0,5</td>
<td>1</td>
<td>5,00</td>
</tr>
<tr>
<td>0,25</td>
<td>0,75</td>
<td>2</td>
<td>1</td>
<td>11,00</td>
</tr>
</tbody>
</table>

Source: author’s calculations

Remarkably, each firm in an industry may confront a very highly elastic demand curve even when there are few firms in the industry. That is firms tend to face fairly elastic demand curves. Consumers tend to be very price conscious and would prefer low price products which are easily available with comparable quality (Bariar et al., 2012). Yet consumers may tend to choose a higher price of similar good because of transportation cost of moving to a cheaper location (Gabszewicz, 2009; Shmidt, 2012). According to Achioveanu (2008), firms tend to invest heavily in persuasively advertisement in order to induce consumers to their product away from other (cheaper) substitutes. This may provide an explanation for price dispersion. Yet Achioveanu (2009) in an oligopoly model distinguishes two set of the same product with consumers choosing between those two sets depending on their tastes. Some consumers choose high quality while others choose low quality alternative goods with lower prices. Some firms usually have large customer base in the markets of products but the base of each market could easily be eroded by increases in prices. This usually occurs especially with products having low switching cost (Shmidt, 2010; 2012). Thus, all this shows the importance of price elasticity of demand.

7) Conclusion

Firms developing a market strategy or price strategy must in the final analysis be aware that it faces the demand elasticity and consumers or their customers would be very sensitive to prices, no matter how
attached the customers are to the product. The strategy could generally include making the demand for the product more inelastic. Hence a dynamic firm that innovates must develop ways of taking care of customers interests. In fact, it must be customer-centered as well as develop and sustain customers’ loyalty, which must be balanced with the elasticity of demand for its product or service. Industries with decreasing costs can easily develop and sustain customers’ loyalty than industries with increasing costs. Since they can easily reduce the price of their product as they gain in production cost reduction. Developing and sustaining customers’ loyalty involves trying to make the demand less elastic such that customers can get more attached to the product or service. At the same time, the customers should tend to have the feeling that they are getting more than they are paying for the product. Hence, in the final analysis the lower the price, the higher the quantity bought.

8) References