Optimal Pricing of Products at Electric Supply Stores

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ABSTRACT

Examples of price setting by firms suitable for classroom discussion are hard to come by. This is often due to lack of reliable data as well as the uncertainty of demand for the firm's product. This case illustrates a technique whereby a linear approximation to the true market demand can be used to find optimal price. Further, no knowledge of price elasticity of demand is required, only a good estimate of the "choke price." As an application, sales of items characterized as tools at a large US electric supply distributor are used to demonstrate this pricing approach.

Keywords: economics, pricing, uncertain demand, managerial economics

INTRODUCTION

Much of the content of a typical managerial economics course is focused on how firms behave in different competitive environments; specifically, how they determine quantities of output to produce and sell and how they set prices. The theories underlying these mechanisms are well understood and form some of the most fundamental results in microeconomic theory; however, the practical application of these results is harder to come by for a number of reasons. First, many of the models economists rely on to inform managerial decisions assume knowledge of consumer demand (typically, the exact demand function is assumed). Second, detailed data on consumer behavior – purchases of various quantities of goods at different prices – are rarely available, which makes demand estimation challenging. Third, profit-maximizing choice of price needs to take into account the incremental (i.e., marginal) cost of producing output, which is not always easy to measure.

This case describes a method of determining optimal price of a product in a scenario where demand is unknown (or at least, uncertain). The method is presented both graphically and algebraically to further convey the intuition behind it. The method is then applied to a real-world sales transaction data from a large electric supply retailer with stores in the southern United States.

BACKGROUND

Elliott Electric Supply (EES) is a leading distributor of electrical supplies and related products in the southern United States. Founded in 1972 in Nacogdoches, Texas, the company has grown to over 185 stores in 11 states. EES has enjoyed average annual growth of about 15 percent, enabling its expansion into new markets and product lines. In 2023, the company was ranked the 8th largest distributor of electrical supplies in the US. EES and its founder, Bill Elliott, have received numerous recognitions and accolades throughout the years. The company employs over 2,100 people and had total sales that exceeded $2 billion in 2022.

The Pricing Challenge

In all, EES sells thousands of items through its many stores as well as by filling orders placed online or by phone. Official prices of all goods, called “book prices”, are listed in the company’s catalog, which is published regularly and is available online. However, many items are often sold at a discount. The size of the discount can vary, sometimes substantially, depending on the store where the transaction takes place, the customer, the size of the order, and often the discretion of sales staff conducting the sale. For example, repeat customers often receive discounts off the book price as do customers who place very large orders. In other words, many sales occur at prices significantly below book prices.

Pricing managers at EES are interested in getting the pricing right. Specifically, it is important that the majority of transactions occur at the optimal price of each item. Practically, this means setting the book price at such a level so that, given the frequent discounting, items are sold at prices that maximize profit. Additionally, management has an incentive to monitor the level and frequency of discounts, particularly ones made at the discretion of sales staff, to ensure they are not excessive.[1]

PRICE SETTING WHEN DEMAND IS UNCERTAIN

Typically, optimal price determination requires reliable estimate of demand elasticity. This is often challenging: sales data are often unavailable, and even when they are, precise demand estimation entails assuming no changes in other factors affecting consumer behavior and supply conditions, and that is rarely realistic.

A method detailed in Cohen et al. (2015) of determining an optimal price with limited knowledge of consumer demand can be relied on when one has reliable data on marginal cost and at least a decent estimate of the "choke price" – i.e., the maximum price that a consumer is willing to pay for one unit of the good.

Let (inverse) demand for good *X* be given by:[2]

$$P = P_m - bQ \tag{1}$$

where P is price per unit of good *X*, Q is the quantity of good *X* demanded, and P_m is the choke price. In other words, it is assumed that the true demand can be approximated by a linear function in (1).[3] Further, let *c* be the constant marginal cost of good *X*.

The standard optimal price-output determination by a firm with price-setting ability involves equating marginal revenue and marginal cost to find the quantity Q^*. Marginal revenue is the first derivative of total revenue:

$$\frac{\partial TR}{\partial Q} = \frac{\partial (P_m Q - bQ^2)}{\partial Q} = P_m - 2bQ \tag{2}$$

and setting (2) equal to marginal cost *c* produces

$$P_m - 2bQ = c \tag{3}$$

which yields $Q^* = (P_m - c)/2b$. Substituting this result into the demand in (1) produces the optimal price P^*:

$$P^* = P_m - b\,(P_m - c)/2b = (P_m + c)/2 \tag{4}$$

[1] This aspect of managerial oversight is outside the scope of this case.
[2] The notation used here is the same as in Cohen et al. (2015) for ease of reference.
[3] Cohen et al. (2015) demonstrate that the method described here produces very similar results regardless of the true functional form of demand.

What is noteworthy about the expression in (4) is that it does not depend on b, the "slope" parameter of demand. In other words, one does not need to know the exact function of market demand or even an estimate of elasticity; all that is required is knowledge of marginal cost c and an approximate measure of the choke price, P_m.

A graphical illustration is useful to highlight this characteristic of linear demand functions. Figure 1 displays two demand functions, D_1 and D_2, that share a vertical intercept but have different slopes. The marginal revenue functions MR_1 and MR_2 correspond to these two demands. Note that while the optimal levels of output are different, optimal prices are the same.

APPLICATION

Elliott Electric sells thousands of items categorized as "tools." Because of the occasional discounting described above and the simple fact that sales occur at various times to many different customers in nearly 200 stores, there is quite a bit of price variability.

Table 1 displays sales data for the top 10 selling tools in 2019. Average price is the mean price of each item sold across all transactions. Average item cost is the acquisition cost of each item that EES pays the manufacturer. This is a natural measure to use as an estimate of marginal cost c.

What remains is identifying an estimate for P_m, the choke price. Management of EES suggested that the top ten percent of all observed prices of each item sold is used.[4]

With these estimates in hand, optimal price of each item can be calculated using the expression in (4), and the results can be compared to actual mean prices observed. Additionally, it is instructive to calculate the implied price elasticity of demand, ε, at the estimated optimal price point. Demand should be price elastic (i.e., $|\varepsilon| > 1$) at each optimal price; otherwise, it cannot be a profit-maximizing solution.[5]

Example

The two most frequently sold items in the tools category (by the number of units sold in 2019) are "Red and Yellow Wire Connectors" (RY+BULK) and "Tan and Red Wire Connectors" (TY+JUG). Each item is sold in boxes or jugs of 500 plastic connectors; a jug is treated as one unit. Figures 2 and 3, respectively, show an example of a single wire connector and a jug of wire connectors.

For RY+BULK, marginal cost is on average \$59.78, and the 90th percentile observed price is \$99.79. The optimal price calculation recommends that a typical transaction occur at \$79.79, which is quite close to the mean observed price of \$81.89, so no pricing changes are recommended.

For TY+JUG, marginal cost is \$57.38, and the 90th percentile price is \$141.91. The optimal price estimate is \$99.65, which is substantially higher than the observed mean price of

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[4] Other approaches are possible, of course, such as the highest price observed or the highest price observed plus ten percent. It is worth pointing out that the optimal price calculation is quite sensitive to the choice estimate for P_m, so care should be exercised in making this decision.

[5] A profit-maximizing firm should not find itself operating in the inelastic portion of its demand, as raising price will lead to higher profit.

$87.03. The recommendation would be to consider increasing the price (or perhaps, more accurately, consider not discounting this item as heavily).

The implied elasticity for RY+BULK is -3.989, while for TY+JUG it is -2.358. In each case, the demand is quite elastic.

TEACHING NOTES

The case is best used when presenting the topic of monopoly profit maximization or any other time when discussing price setting behavior by firms possessing some degree of market power. The material can be included as part of a lecture as an illustration of price determination with a linear demand; alternatively, it can be assigned as an in-class presentation to a group of students, where they familiarize themselves with the method and "teach" it to the rest of the class.

There are several issues that should be considered in assessing whether this method is an accurate approach to optimal price estimation. These are presented below as questions that can be posed to the class during case discussion.

- Does Elliott Electric have monopoly power in the relevant market(s)?

It certainly is not a monopoly, as there are other electric supply stores in the areas where its stores are located. On the other hand, a deliberate corporate strategy of EES is to open stores in underserved areas – i.e., where competition by definition is not strong.

- What is being overlooked by treating each item sold as an individual sale?

This is a major issue, of course. While prices are set for items individually, the seller knows that some items are often purchased together, and these patterns can be taken into account – this is what is known as "joint pricing." In fact, it is common for sales staff to discount some items more than others when a customer makes a large purchase. On several occasions, a version of the following story has been reported: an electrician places a large order of wire, receptacles, switches and light fixtures for a major wiring project and at pick up asks the store salesperson to add a set of screwdrivers to the order. The salesperson grabs the screwdriver set off the shelf and "throws it in" to the order by not charging anything extra. This "sale" is recorded as a transaction for a tool (screwdrivers) at $0, when in reality it is a sort of a goodwill gesture by the store manager in recognition of a large purchase made by a likely repeat customer.

This suggests that relying on transaction data may inadvertently introduce some noise into the price measurement. Also, it is apparent that sale of some items can affect sales of other items.

- What variables could be mismeasured in this exercise and what would be the consequences?

Both the marginal cost and the choke price could be mismeasured. The average unit cost is likely a very good approximation to the true marginal cost, but it varies by region and is not constant over time. In other words, optimal price based on the correctly measured unit cost should also vary by location and across time, but this may not be practical given the complexity of price listings that this would imply.

Measurement error in the maximum price, P_m, is more likely because it is a true estimate: i.e., no one knows the exact price that is just high enough to result in zero units demanded. It may be worthwhile to use several different measures of P_m and produce a range of optimal price recommendations.

REFERENCES

Cohen, M., Perakis, G. & Pindyck, R. (2015). *Pricing with Limited Knowledge of Demand* (NBER Working Paper No. 21679). National Bureau of Economic Research. http://www.nber.org/papers/w21679

APPENDIX

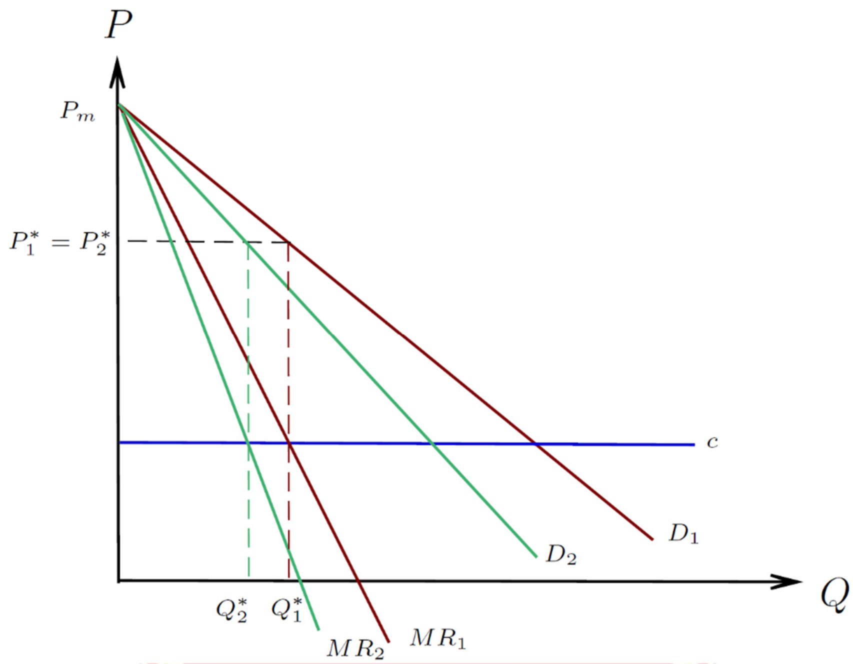

Figure 1: Two Linear Demand Functions

Item	Description	Total Quantity Sold	avg. item cost	avg. price	avg. of top 10% prices
RY+BULK	Red/Yellow Wire Connector	3,132,000	59.78	81.89	99.79
TR+JUG	Super Tan/Red Wire Connector	1,581,750	57.38	87.03	141.91
0B+BULK	Orange/Blue Wire Connector	1,051,100	41.25	64.18	97.81
RMC6322	#6-32 X 2" Phil/Slot Machine Screw	885,800	3.39	4.96	6.31
TEKHW1034	#10 X 3/4" HWH Self Drilling Screw	802,000	5.81	9.32	12.48
RMC8322	#8-32 X 2" Phil/Slot Machine Screw	730,900	3.76	5.66	7.65
HN38	3/8"-16 Hex Nut	695,650	5.18	8.15	10.95
FENW14114	1/4" X 1-1/4" Fender Washer	689,200	3.77	5.69	7.34
HN14	1/4"-20 Hex Nut	651,500	1.79	2.81	3.75
0B+JUG	Orange/Blue Wire Connector	634,500	40.94	63.80	100.17

Table 1: Top Ten Selling Items in Tools Category

Figure 2: Red/Yellow Wire Connector (Item RY+BULK)

Figure 3: Jug of 500 Wire Connectors