Managers' Practice about Demand Estimation and Demand Forecasting in Pakistan: An Analysis

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Abstract
The article is about estimating the demand of Medicam Toothpaste by viewing the effect of various variables like price of Medicam toothpaste, price of Shield toothbrush, price of Colgate toothpaste, advertisement and total revenue. The methodology used is multiple regression analysis using Ordinary least Square method applied on time series quarterly data. The results of this research show that coefficient of price of Medicam and the price of shield toothbrush have negative influence on demand of Medicam. The coefficient of price of Colgate toothpaste has a positive value. Similarly advertisement has direct relation with demand. Total revenue has also direct relation with demand of product. Price elasticity of demand is -0.15, cross price elasticity of demand w. r. t price of Colgate is 0.01, and w. r. t price of shield tooth paste is -0.05, advertisement elasticity of demand is 0.07 and total sales elasticity of demand is 0.02. The forecasting results show that the demand will increase in the 1st quarter of 2013 up to 48181.53 units.

Keywords: Demand estimation, Demand Forecasting, Elasticities of demand, Exponential Smoothing, Econometric Methods, Quarterly data.

1. Introduction

Demand estimation is one of the most important aspects of managerial economics, since a firm would not be established or survive if a sufficient demand for its product did not exist or could not be created. If manager is successful in determining the appropriate demand function based on important variables, so the decision making by the Manager may be valid for the business. Best estimated demand function may enable the management to forecast demand with few errors.

Demand estimation can be done by various methods like consumer surveys and observational research or market experiments but the most useful method for estimating demand is regression analysis. Here, the demand estimation starts by examining the determinants of demand for a commodity. There may be several determinants of demand function such as price of commodity, prices of substitute commodity, price of complementary products, taste, income and preferences of the consumer, quality of the product and advertisement etc. It can lead to the understandings regarding relationship of variables with the demand of a product. For example, if price of the commodity increases, its demand will decrease or if the price of the substitute increases, the demand for the product will increase etc. Based on demand function, by employing Smoothing and Econometric technique, forecasting may be made possible.

The current study is important in many aspects like it helps the managers to estimate the demand using econometric methods. It also enables them to learn about forecasting techniques especially with reference to Pakistan. The objective of this study is explained as follows;

1. To estimate the demand function using regression analysis on time series data of the firm.
2. To find Elasticities of demand with respect to various variables.
3. To learn about decision making based upon the values of elasticities.
4. To forecast demand through exponential smoothing technique and econometric methods.
5. To Conclude and suggest some policies.

Apart from introduction in section 1, the rest of the paper is organized as follows: section II portrays review of literature; section III discusses about the data and methodological issues. Results are interpreted in section IV. Finally, conclusions and policy implications are given in section V.

2. Literature Review

A vast literature is available relating to demand estimation and demand forecasting at national and international level. But few are summarized in this study described below. Hakimi et al. (2010) considered the case where member of supply network wanted to assess the end customer demand at retail store level. The purpose was to illustrate the other members of supply network, the benefits of collaborative initiatives and information sharing. Transactional data was collected through public, media, and concerned retailers. They used demand modeling and estimation for store demand. They used variables like Quantity of product ordered by retailer, shipped by retailer, ordered by customers and sold to customer. They concluded that they have been enabled to generate demand scenarios, demand trends and exploitation of market and product knowledge as well as demand estimation at store level even when manufacturer has no access to retailer's store information.

Navok et al. (2001) investigated demand for agricultural processing co-products. The purpose was to propose such a method in which no time series data would be needed and to present an empirical application as well as estimation of demand for sugar pulp, wheat middling and potato waste by livestock in Central Crop Reporting District of North Dakota. Normative estimation technique was used due to lack of data. Linear programming was used as data source to obtain details of various livestock classes. Econometric and Primal optimization was used to estimate demand. Variables used for each co products were characteristic of individual ration component, number of animals and current prices for product. The study concluded that unique characteristic of each co-product influenced their value in livestock nutrient requirement. Identification of livestock classes would facilitate efforts by processors to target and to educate producers and it would influence decisions like co-product pricing, processing and plant location.

Besanko et al. (1998) had investigated the impact of price, unobservable product attributes on consumer utility. Data was collected through time series data and source of data was retailers. For estimation, they used assumptions like prices were assumed to be endogenous variables. To empirically validate this assumption, they estimated logit demand systems jointly with equilibrium pricing equations for two product categories using retail scanner data and cost data on factor prices. They found statistical evidence for price endogeneity and they also found that the estimates of the price response parameter and the brand-specific constants were generally biased downward when the endogeneity of prices was ignored. They developed theoretical propositions about the relationship between value creation and competitive advantage for logit demand systems and used empirical results to illustrate how firms used alternative value creation strategies to accomplish competitive advantage.

Rojas (2005) estimated demand with differentiated products for the years 1940-2002. Analysis was conducted in two stages. At first stage, Distance Metric Method devised by Pinkse, Slade and Brett was used to estimate demand and in second stage different pricing models were compared and ranked. The study concluded that antitrust concern should be low in terms of use of market power by the leading beer producer to obtain large price-cost margins. Actual price increases for large brewers' brands as a result of tax increase had minimal variation across cities and leading brewers' brands set a common cost mark-up for all brands regardless of where they were sold and smaller brewers' matched these mark-ups.

Raymond B. Palmquist (1984) estimated the demand for the characteristics of housing for the year 1984. The purpose of this study was to implement the estimation technique for determining the demand for the characteristics of housing. He took primary and secondary data from the different cities and the endogenity of marginal prices was applied by using the regression technique as an estimation technique. Variables used in the study were the prices of the characteristic, prices of related characteristics, expenditure or income and socio economic variables. The conclusion of the study was that demand equation estimates behaved remarkably well. The coefficients had the expected signs and magnitudes and all almost were highly significant. The price elasticity of demand for living space was approximately unitary, while the demands for other characteristics were more inelastic, the cross price effects were significant and the expenditure and income Elasticities were found to be somewhat inelastic.

Haung et al. (2000) had evaluated many food programs' effects by demand Elasticities. Time series data was collected ranging from 1987-1988 for demand Elasticities. They developed an approach for estimating demand system from household survey data for entire sample of households and for each group of households. They also measured nutrients income Elasticities. The variables used in demand equation were unit values of food category and income, while in cost function, there were unit values and utility level. A modified version of cost function was used and variables used were unit values and related food expenditures. They concluded that most estimated demand Elasticities were

statistically significant and acceptable in sign and magnitude. Estimates of food quality effect obtained in this study showed that food quality was playing a significant role in household budget allocation, and that food quality was an important factor in modeling a food demand system from household survey data.

Espey et al. (1997) investigated the factors that systematically affected price elasticity estimates in studies of residential water demand in United States. Demand variables were income, population density, household size, seasonal dummy, evapo – transpiration, rainfall and temperature. They concluded that population density; household size and temperature did not significantly influence the price elasticity while pricing structure and season significantly affected the estimate of price elasticity.

Bajari et al. (2003) studied the identification and estimation of Gorman-Lancaster style hedonic models of demand for differentiated products for the case when one product characteristics was not known. They applied methods to the personal computers demand and followed two steps Rosen Approach for identification and estimation. The revealed preferences conditions from the hedonic model were used to develop Gibbs sampling estimator for the distribution of random coefficients. The analysis avoided criticism of hedonic literature by imposing less homogeneity across individuals.

3. Data and Methodology
Considering objectives of the article, time Series data about some most important variables are collected from few retailers of Cantonment market, Multan, Pakistan for the period from 1st quarter of 1992 to 2nd quarter of 2012. We have run multiple regression analysis using Ordinary least Square method.

3.1 Demand estimation and Elasticities
To examine the determinants of demand, we have formulated following linear demand function,

$$Q_M = f (Pm, Ps, Pc, Adv, Tr)$$

Where Q_M is demand of medicam toothpaste in units, Pm is price of medicam toothpaste in Pakistani Rupees, Ps is price of shield tooth brush in Pakistani Rupees, Pc is price of Colgate toothpaste in Pakistani Rupees; Adv is expenditure on advertisement in Pakistani Rupees and Tr is total revenue of the firm in Pakistani Rupees. By moving data into the software we will get the values of constant, coefficients, t-statistics and probability values. Along with it will also give us the results of R-square and probability of F-statistics.

For the estimation of Elasticities, we will take natural log of all the variables and will use log – log demand model. This will give us the respective Elasticities of demand.

3.2 Demand Forecasting
For demand forecasting, we will use single equation econometric method. In this method, we shall forecast the values for all the variables by assigning weights equal to 0.3 and 0.5 using exponential smoothing forecasting technique. Then we will find the root mean square error for each forecasted value for all variables with both 0.3 and 0.5. The values of 1st quarter of 2013 having less RMSE will be considered as more accurate and will be used as forecasted quantity demanded of Medicam for next time period (1st quarter of 2013).

The formula which will be used for this purpose is,

$$F_{t+1} = w A_t + (1-w) F_t$$

Where A_t is actual value for t period and F_t is forecasted value for t period, w are weights, F_{t+1} is forecasted value for next time period.

4. Results and Discussion
Based on quarterly time series data, this section provides some important information about the determinants of demand of medicam toothpaste. Table 1 portrays the results of study which are arranged in five columns. The 1st column indicates the explanatory variables, 2nd column is about value of coefficients, and standard errors are given in

third column. For reliability of our coefficient values, two tailed t-test is used whose values are given in 4th column. It determines whether we may reject or may not reject null hypothesis at some level of significance (1%, 5%, 10%). For level of significance, we have included probability values in 5th column.

4.1 Demand Estimation

The first variable is price of medicam toothpaste that is endogenous variable as well. As expected the study finds negative relationship between price of medicam and demand for medicam. The negative sign shows that as the price of medicam increases its demand will decrease. Coefficient value shows that if price of medicam decreases by one Rupee, the demand of medicam increase by 372.32 units on the average. According to the t-statistics and probability value, its value is significant at 1 percent level of significance.

With regards to price of Shield toothbrush which is expected to be complementary product for Medicam toothpaste. This is found to be negatively related to the demand of Medicam. When the price of toothbrush increases the demand of toothpaste will decrease due to having complementary nature and it is justified the empirical findings. It may be interpreted as 1 rupee decline in the price of shield toothbrush increases the demand of Medicam by 342.9702 units on the average. It is statistically significant at 1 percent level.

Theoretically, price of substitute commodity are inserting direct effect on the demand for the commodity. This study proves such hypothesis with positive coefficient value with the variable Price of Colgate toothpaste. The study found substitution effect on demand but with statistically insignificant coefficient value. This may be justified as people will rush towards purchase of Medicam toothpaste whenever management of Colgate toothpaste will increase their prices. Advertisement is another important variable for the demand promotion of any commodity. As expected, we have examined positive sign with the coefficient of advertisement. It shows direct relationship with the demand of medicam. The coefficient value shows that on the average demand of Medicam increases by 0.007454 units due to 1 rupee increase in advertisement. This variable is statistically significant according to statistical point of view.

As regards to total revenue of the firm, it has turned out to be positive with demand for medicam toothpaste. When revenue from a product increases it increases its demand as well. Coefficient value shows that if total revenue increases by 10000 Rupees, the demand of medicam increase by 5.06 units on the average. It is statistically significant variable at 5 percent level of significance.

Value of R-square shows that there is 81 percent variation explained in demand for Medicam toothpaste due to variations in price of Medicam, price of shield tooth brush, price of Colgate toothpaste, advertisement, and total revenue. Result of F-statistic says that demand model is a significant and econometrically reliable because the probability value of F – statistics is between 0.00 and 0.10. The effect of the variables that we have not included in the demand model is 56409.83 as shown by constant value.

4.2 Demand Elasticities

The study calculates various elasticities of demand with respect to price of the commodity, prices of other commodities, advertisement, total sales etc. These elasticities of demand are examined by regressing the whole time series data in log – log form of demand equation. The values of elasticities are given in table 2. Table 2 shows that price elasticity of demand is – 0.15, Cross price elasticity of demand with respect to price of Shield toothbrush is -0.05, Cross price elasticity of demand with respect to price of Colgate toothpaste is 0.01, Advertisement elasticity of demand is 0.07 and total sales elasticity of demand is 0.02.

4.3 Demand Forecasting

The study follows econometric technique for demand forecasting that is based upon single equation method and exponential smoothing technique for individual variable forecasting. Following tables show forecasted results of all the variables like price of Medicam, price of Shield toothbrush, price of Colgate toothpaste, advertisement and total revenue in tables 3, 4, 5, 6 and 7. The forecasted value which is having lowest root mean square error (RMSE) will be selected for the forecasting of demand of Medicam toothpaste for first quarter of 2013.

Table 3 shows the result of forecasting for the price of Medicam toothpaste for the given data in column 3. We have taken average of prices of Medicam toothpaste over all the quarters to forecast the first value and have value for F_1 (forecast value for first quarter) to get the calculation started and also we have assigned weight of 0.3 and 0.5 to actual values for all quarters and 0.7 and 0.5 similarly to forecasted values of all the quarters as calculated below for second quarter.

$$F_2 = 0.3(15) + (1- 0.3)15 = 15$$

Forecast for other quarters were similarly obtained until F_n. Starting again with average prices of the Medicam toothpaste for all the quarters, for which we have data of F_1 that is 15, but now using 0.5 weights for actual value, A_1. Forecast for second quarter is calculated by

$$F_2 = 0.5(15) + (1- 0.5)15 = 15$$

The root mean square error values are also given in each table for w = 0.3 and 0.5. The same procedure for table 3 will be repeated for all the variables given in table 4, 5, 6, and 7.

Based upon lower root mean square error, the values of price of medicam, price of Shield toothbrush, price of Colgate toothpaste, advertisement and total sales/ revenue are respectively forecasted as 32.94, 24.37, 29,68, 874092, and 9725088 for the first quarter of 2013.

By putting best forecasted values into the estimated regression equation, we can get the actual forecasted demand for Medicam for first quarter of 2013. Estimation is given as below.

Q_M=56409.83 – 372.3234 Pm – 342.9702 Ps + 32.27227 Pc + 0.007454 Adv + 0.000506 Tr

=56409.83 – 372.3234*(22.94) – 342.9702*(24.37) + 32.27227*(29.68) + 0.007454*(874092) + 0.000506*(9725088)

= 48181.53072

This is forecasted demand for the first quarter of 2013.

5. Conclusions and Policy Recommendations

The objective of the analysis is the estimation of demand, forecasting of demand for commodity, and to suggest Managers about demand forecasting technique. The estimates of this study show that the price of Medicam and the price of its complementary product that shield toothpaste have inverse relation with the demand of Medicam, while price of Colgate toothpaste, advertisement and total revenue have a direct relation with the demand.

The results of elasticities are that the price elasticity of demand of medicam toothpaste is -0.15, Cross price elasticity of demand with respect to complementary good i.e. shield tooth brush is -0.05, cross price elasticity of demand with respect to substitute that is Colgate tooth paste is 0.01, Advertisement elasticity of demand is 0.07 and Total sales elasticity of demand is 0.02. The forecasting results show that the demand has increased in the 1st quarter of 2013 from 47380 to 48181.53.

On the basis of these results we can conclude that price elasticity of Medicam, cross price elasticity of its complementary product that is Shield toothbrush, and the cross price elasticity of Colgate toothpaste that is a substitute of Medicam, have an inelastic impact on the demand of Medicam, so we can say that the firm should increase its prices to get an increase in total revenues because even if the price will increase the demand will be affected less proportionately. But increase in price will lead to more and more revenues of the firm. And through forecast results we can see that demand is already increasing gradually. Moreover we should not focus on its substitutes and complementary products a lot because they have very less elastic impact on its demand and people are loyal with Medicam and have faith in it. Medicam firm can make decisions irrespective of these products. As the advertisement also keeps demand inelastic and even if there are made any extra expenditure on this, it will not affect the demand of Medicam so the firm should not increase its cost by doing expense on aggressive advertisement but firm can improve its quality to increase its future demand significantly.

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Tables

Table 1: Demand Estimation

Variable	Coefficient	T-statistic	Probability
Constant	56409.83	51.00	0.00
Price of Medicam	-372.32	-2.87	0.00
Price of Shield toothbrush	-342.97	-2.81	0.00
Price of Colgate toothpaste	32.27	0.28	0.77
Advertisement	0.01	1.78	0.08
Total Revenue	0.001	1.98	0.05
R – Squared	0.81	F – Stats	0.00

Table 2: Elasticities

Variable	Coefficient
Price Elasticity of Demand	-0.15
Cross price Elasticity of demand with respect to price of Sheild tooth Brush (Complementary Commodity)	-0.05
Cross price Elasticity of demand with respect to price of Colgate tooth paste (Substitute Commodity)	0.01
Advertisement Elasticity of demand	0.07
Total Sales Elasticity of demand.	0.02

Table 3: Price of Medicam toothpaste

Year	Quarter	Price of Medicam	F(0.3)	F(0.5)
1992	1	15	15	15
1992	2	15	15	15
1992	3	15	15	15
1992	4	16	15	15
1993	1	16	15.3	15.5
1993	2	16	15.51	15.75
1993	3	17	15.66	15.88
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
2011	2	27	24.68	25.6
2011	3	30	25.38	26.3
2011	4	30	26.76	28.15
2012	1	30	27.74	29.08
2012	2	30	28.41	29.54
2012	3	34	28.89	29.77
2012	4	34	30.42	31.88
2013	1		31.5	32.94
RMSE			3.03	2.45
				Low Error

Table 4: Price of Shield toothbrush

Year	Quarter	Price of Shield	F(0.3)	F(0.5)
1992	1	8	8	8
1992	2	8	8	8
1992	3	8	8	8
1992	4	8	8	8
1993	1	8	8	8
1993	2	10	8	8
1993	3	10	8.60	9.00
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
2011	2	19	17.37	18.42
2011	3	19	17.86	18.71
2011	4	19	18.20	18.85
2012	1	23	19.64	20.93
2012	2	23	20.65	21.96
2012	3	23	21.35	22.48
2012	4	25	22.45	23.74
2013	1	25	23.21	24.37
RMSE			2.91	2.34
				Low Error

Table 5: Price of Colgate toothpaste

Year	Quarter	Price of Colgate	F(0.3)	F(0.5)
1992	1	12	12.00	12.00
1992	2	12	12.00	12.00
1992	3	12	12.00	12.00
1992	4	12	12.00	12.00
1993	1	12	12.00	12.00
1993	2	15	12.00	12.00
1993	3	15	12.90	13.50
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
2011	2	27	23.80	25.59

2011	3	27	24.76	26.30
2011	4	29	25.43	26.65
2012	1	29	26.50	27.82
2012	2	29	27.25	28.41
2012	3	30	27.78	28.71
2012	4	30	28.44	29.35
2013	1		28.91	29.68
RMSE			3.07	2.43
				Low Error

Table 6: Advertisement

Year	Quarter	Advertisement	F(0.3)	F(0.5)
1992	1	200000	200000	200000
1992	2	200000	200000	200000
1992	3	200000	200000	200000
1992	4	200000	200000	200000
1993	1	300000	200000	200000
1993	2	300000	230000	250000
1993	3	300000	251000	275000
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
2011	2	750000	697769	733724
2011	3	800000	713439	741862
2011	4	800000	739407	770931
2012	1	800000	757585	785466
2012	2	800000	770309	792733
2012	3	900000	779217	796366
2012	4	900000	815452	848183
2013	1		840816	874092
RMSE			597	474
				Low Error

Table 7: Total Revenue

Year	Quarter	Total revenue	F(0.3)	F(0.5)
1992	1	1500000	1500000	1500000
1992	2	1550000	1500000	1500000
1992	3	1780000	1515000	1525000
1992	4	2200000	1594500	1652500
1993	1	2750000	1776150	1926250
1993	2	3290000	2068305	2338125
1993	3	3580000	2434814	2814063
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
2011	2	8309000	7429681	7830240
2011	3	8630000	7693476	8069620
2011	4	8827000	7974434	8349810
2012	1	9401000	8230203	8588405
2012	2	9682000	8581442	8994702
2012	3	9748000	8911610	9338351
2012	4	9907000	9162527	9543176
2013	1		9385869	9725088
RMSE			2093	1656
				Low Error

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