The Economic Journal of Nepal
Vol IV. No. 3 July-Sept 1981 EIC-TU

An Econometric Study of the Supply and Demand for Sugar in Nepal

Atma Ram Ghimire, Raju★

1. INTRODUCTION

Sugar has an important position in the world. Trends of sugar consumption in the world show increments which reflect the progress and growth in methods of production and at the same time an increased appreciation of the benefits of sugar in the diet by the consumer. The increment in the consumption of sugar has several reasons:

(a) Sugar contributes energy and energy enters directly into the health and an economic life of the individual.

(b) Sugar is not only one of the most concentrated of all energy foods, but its source plants are among the most productive of agricultural products.

The latest available estimates place world sugar production at 88 million tons for the 1979–80 season. This means that world output will be lower by nearly 3 million tons as against the 1978-79 level of 91 million tons. As against this the world demand for sugar during 1979-80 is estimated to have increased to over 91 million tons there by creating a wide deficit. The major sugar producing countries i. e. India, Cuba, Brazil Thailand, China, USSR, Holland and the USA had a lower output of sugar during 1979-80. This has resulted in the sharp increase in the price of sugar in the world markets.

★ Mr. Ghimire is a member of the Economics Instruction Committee, Padma Kanya Campus, Kathmandu. This article is based upon the Dissertation submitted by the author to Economic Instruction Committee of T. U. for partial fulfilment of M. A. degree in Economics in 1980.

In our context, there are 3 sugar industries running in the country. Namely Birgunj Sugar factory, Birjung; Morang Sugar Mill, Biratnagar and Mahendra Sugar and General Industries, Bhairahawa. Birgunj sugar factory was established in 1965 with Russian assistance. In that year the factory produced 28,730 quintals of sugar by processing 3,89 ,688 quintals of sugarcane. In 1978-79 this factory produced 1,58,808 quintals of sugar by crushing 17,94,209 quintals of sugarcane. Mahendra Sugar and General Industries established in 1967 produced 78,526 quintals of sugar in 1978-79 and Morang sugar mill produced 34,666 quintals of sugar crushing 4,60, 296 quintals of sugarcane in the year 1978-79.

Table 1

Sugar production and price

Fiscal Year	Total sugar production M/T	% change in sugar production	Annual average sugar price Rs./Kg.	Sugar price base year = 100	indexed 1972-73
1964-65	7300	-	3.1	61	
1965-66	9912	+36	3.7	73	
1966-67	4410	-55	4.25	83	
1967-68	3279	-26	4.79	94	
1968-69	9656	+194	4.59	90	
1969-70	16238	+68	4.42	87	
1970-71	14534	-11	4.26	84	
1971-72	7559	-47	4.48	88	
1972-73	11482	+52	5.09	100	
1973-74	14197	+23	5.76	113	
1974-75	11927	-15	5.87	115	
1975-76	10632	-11	7.29	143	
1976-77	16351	+53	7.33	144	
1977-78	26502	+62	7.63	150	
1978-79	27200	+26	6.15	121	

The above table shows annual sugar production, percentage change in sugar production, price of the sugar, and the price index.

A look at the data of sugar reveals that in 1964-65 production in the country was only 7300 m/t whereas the demand for sugar was 10199 M/T, but in the year 1978–79 sugar production in the country was 27200 M/T and the demand for sugar was 26950/M/T. This fact alone is sufficient to justfy that we can meet our national demand for sugar by domestic production. Yet, per capita sugar consumption in Nepal is quite low campared to India and world average-2.4 Kg. in Nepal as against 6.7 Kg. in India and 21 Kg. in world average.

Table 1 shows the fluctuating sugar production and upward movement of price. Sugar production in 1978–79 increased by 2.6% but it was expected to decrease by 41% in the year 1979–80. This decline might be attributed to a lowering of sugarcane price in 1978–79 and low utilization of available sugarcane by Birgunj Sugar Factory and other sugar mills of the country. The delay in sugarcane crushing, irregularity in the supply of power, and labor strikes have also adversely affected the production of sugar in the current year.

The level of Sugar production depends largely upon sugarcane production. Sugarcane is a cash–crop. Large scale production of sugarcane was started in Nepal only in recent decades after the establishment of the three sugarmills. The cultivated area under sugarcane increased from 9,000 hectres in 1964–65 to 23,000 hectres in 1978–79 while the production of sugarcane has gone up from 126,000 metric tons to 379,000. As sugarcane demands a long growing season, fertile soil and effective manuring it has to face keen competition from cereals and there is also a considerable risk in its cultivation. So the sugarcane production depends on the initiative among farmers, information regarding price, availability of adequate credit and necessary chaminal fertilizers, transportation and irrigation facilities.

In 1978 India was the top producer of sugarcane followed by Brazil and Cuba. Table 2 shows countrywise area, productions, yield and their percentage share in the worl a-output.

Table 2

Sugarcane International Comparison 1978

Country	Area 000 hec.	Production 000 tons	Yield tons/hec.	Percentage Share	
				Area	Production
India	3220	181623	56.4	23.2	23.2
Brazil (2413)	2411	129223	53.6	17.4	16.5
Cuba	1246	66400	53.3	9.0	8.5
China	674	47137	69.8	4.9	6.0
Mexico	480	34500	71.9	3.5	4.4
Pakistan	823	30077	36.5	5.9	3.8
U. S. A.	304	24514	80.6	2.2	3.1
Columbia	290	23100	79.7	2.1	3
Australia	258	21500	83.3	1.9	2.7
Philipines	503	21638	41.4	3.6	2.7
S, Africa	250	19500	78	1.8	2.5
Argentina	246	14600	42.2	2.5	1.9
Egypt	118	9200	7.8	0.9	1.2
Peru	54	8400	155.6	0.4	1.1
Mauritius	82	9260	76.3	0.6	0.8
Nepal	23	373	19.2	0.16	0.05
World total (including others)	13861	781291	56.4	100	100

This table shows that Nepal has a 0.05% share in the area under sugarcane, while Peru has the highest yield with 155.6 ton per hectres followed by Australia and USA. Nepal has the lowest yield as shown in the table. The reason for it is the lack of irrigation, effective manuring and traditional method and tools for planting of sugarcane.

2. PURPOSE OF THE PRESENT STUDY

Recently, Nepal has witnessed the shortage of sugar. Nepal, which exported 50,000 and 80.81 quintals of sugar to Bangladesh and Tibet respectively in 1978–79, imported 100,000 and 50,000 quintals of sugar from the same countries in the year 1979–80. In addition on the one hand, sugarmills are facing the problem of inadequate and delayed supply of sugarcane, as delay in crushing sugarcane after 24 hours of its harvesting will reduce the sugar recovery. On the other hand, cane growers are facing the problems of inadequate irrigation facility, fixation of unremunirative price, delayed payment from mills and lack of transport facility. As such, there exists a higher demand for sugar with inadequate supply. In this context the world sugar situation is also worse with lower production and higher prices. So the present study attempts to estimate demand and supply functions of sugar. The main objectives of the study are:

1. To estimate and project supply and demand for sugar in Nepal over the 15 year period through the analysis of time series data.
2. To construct and estimate a model of sugarcane supply, to examine responsiveness of farmers to previous years price and to derive the supply elasticity of sugarcane.
3. To derive demand and supply elasticities for sugar.
4. To present the best model for the analysis of policy implications and government policy.

However, certain limitations like, few variables, some interpolation of data, and only 15. years time period may affect the conclusiveness of this study.

3. THEORITICAL FRAMEWORK

3 1 Consumer's optimization Problem.

Consumer behaviour is made up of a variety of decisions and choices and even when we keep to its economic aspects several distinct and separate phenomena may be singled out for analysis. So the problem of the consumer consists of three things:

Maximization of his satisfaction, limited resources and making decisions concerning unlimited wants with limited resources. In a simple case using the technique of lagrange multipliers with utility function and budget constraint function can be formed as:

$$V = f(q_1, q_2) + \lambda (y - p_1 q_1 - p_2 q_2)$$

Where, q_1 & q_2 are two goods, λ is undetermined lagrange multiplier, v is the function of q_1, q_2 and λ,

$y - p_1 q_1 - p_2 q_2 = O$ is the budget constraint. Calculating the partial derivatives and transposing them, v will be maximized when

$$\frac{f_1}{f_2} = \frac{p_1}{p_2}$$

Which states that the ratio of marginal utilities must equal the ratio of prices.

Demand functions give the dependence of the quantities demanded on all variables in the problem, namely, both prices and income

$$q_1 = q_1 (p_1, p_2, y) \qquad q_1 = (p_1, p_2, y)$$

$$q_2 = q_2 (p_1, p_2, y)$$

A consumer's ordinary demand function can be derived from the analysis of utility maximization. Forming the expression for a particular utility function, $f(q_1, q_2) = q_1 q_2$

$$v = q_1 q_2 + \lambda (y - p_1 q_1 - p_2 q_2)$$

and setting its partial derivatives equal to zero and solving for q_1, and q_2

$$q_1 = \frac{y}{2 p_1} \qquad q_2 = \frac{y}{2 p_2}$$

* the demand functions are derived.

3.2 Firm's optimization problem

The theory of the firm and industry is related to the notion of the supply curve. The problem of the firm is that maximizing profits subject to a given technology. For the maximization of profit a function is formed as

---

* In this example resulting demand functions are unusual (the price of the other good does not appear). This is the result of the particular utility function selected.

$$\text{Max} = P_1 Q_1 + P_2 Q_2$$

subject to $\quad Q_1 = f_1 (X_1)$ and

$$Q_2 = f_2 (X_2) \qquad X_1 + X_2 = X$$

$$\overline{\Pi} = p_1 f_1 (X_1) + p_2 f_2 (X_2)$$

Where $\overline{\Pi}$ is profit, p_1 and p_2 are prices, X is total land to cultivate and Q_1 and Q_2 are two crops. Setting partial derivatives equal to zero we will have first order condition to maximize the profit.

Supply functions can be derived like demand functions for the following particular production functions:

$$Q_1 = \alpha_1 X_1^{\beta_1} \quad \ldots \ldots \quad Q_2 = \alpha_2 X_2^{\beta_2} \qquad \ldots\ldots\ldots (1)$$

differentiating $\overline{\Pi}$ w. r. t. x_1 and x_2 and combining

$$p_1 \frac{\delta f_1}{\delta X_1} (X_1) = p_2 \frac{\delta f_2}{\delta X_2} (X_2) \qquad \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2)$$

now we can write

$$P_1 \alpha_1 \beta_1 X_1^{\beta_{1-1}} = P_2 \alpha_2 \beta_2 X_2^{\beta_{2-1}} \qquad \ldots\ldots\ldots (3)$$

using $X_2 = X - X_1$

$$\frac{X_1^{\beta_{1-1}}}{(X - X_1)^{\beta_{2-1}}} = \frac{P_2 \alpha_2 \beta_2}{P_1 \alpha_1 \beta_1} \qquad \ldots\ldots\ldots (4)$$

if we take a simple case $\beta_1 = \frac{1}{2}$ $\beta_2 = 1$ then, equation (4) becomes

$$X_1^{-\frac{1}{2}} = \frac{P_2 \alpha_2 \beta_2}{P_1 \alpha_1 \beta_1} \quad \text{or} \quad X_1^{\frac{1}{2}} = \frac{P_1 \alpha_1 \beta_1}{P_2 \alpha_2 \beta_2}$$

$$\text{or,} \quad X_1 = \left(\frac{P_1 \alpha_1 \beta_1}{P_2 \alpha_2 \beta_2} \right)^2 \quad \text{since} \quad Q_1 = \alpha_1 X_1^{\frac{1}{2}}$$

$$\text{we have} \quad Q_1 = \alpha_1 \left(\frac{P_1 \alpha_1 \beta_1}{P_2 \alpha_2 \beta_2} \right)$$

Thus the supply function is derived for good 1. Q_1 is positively related to own price and inversely related to the price of the alternative product.

4. METHODOLOGY

The present study is based upon time series data over 15 years period 1964-65 to 1978-79. The data used were obtained from various sources like, CBS, FAMSD, TPC, Dept. of Industry various issues of NRB.

The specification of some economic models involves more than one equation, these are called simultaneous equation models because these variables simultaneously satisfy all equations. An important type of simultaneous equations system is the recursive system, in which the endogenous variables and the structural equations can be arranged in such an order that the matrix of coefficients of endogenous variables is a triangular matrix and the matrix of variances and covariances of stochastic disturbance terms is a diagonal matrix.

The present study too comes under the category of recursive models in the sense that quantity demanded, quantity supplied and price are not determined simultaneously but in the process that the previous period's price determines quantity supplied of sugarcane, then quantity of sugar supplied is set equal to quantity of sugar demanded and this in turn determines the current price. This system removes the difficulty that arises because of the correlation between disturbances and endogeneous variables.

This study has four sugar demand models two sugarcane supply models and one sugar supply model both in linear and double logarithmic form. Double logarithmic forms of estimated, sugar demand sugarcanesupply and sugar supply models are presented below.

(1) $\text{Log } Q^{s}_{Dt} = \beta_1 + \beta_2 \log \text{Prst} + \beta_4 \log \text{Prct} + \beta_6 \log I_t + u_t$

(2) $\text{Log } Q^{sc}_{st} + A_1 + A_2 \log PK_{t-1} + A_3 \log Pl_{t-1} + \text{Au log } I_t + \text{...}_t$

(3) $\log Q^{s}_{st} + A + \beta \log Q^{sc,}_{st} + G_t$

where

Q^{s}_{Dt} = Quantity demanded of sugar at the time Periodt.

Prs_t = Relative Price of sugar

Prc_t = Relative Price of tea

I_t = Actual G DP of Nepal

Q^{sc}_{st} = Quantity supplied of sugarcane at the time t

PK_t -1 = Last year's Price of sugarcane

Pl_t -1 = Last year's Price of substitutes

T_t = Time trend

Q^{s}_{st} = Quantity supplied of sugar

5. ANALYSIS OF DATA

5.1 Sugar Demand

Among the four different models on sugar demand the following logarithmic form of the Model was chosen as best

$\text{Log } Q^{s}_{Dt}$ = -18.874-1.542 log Prst-0.407 log Prct + 2,936 log It

STD. Errors (0.811) (0.674) (1.045)

T-ratio	(-2.024)	(-0.604)	(12.807)

R^2 =.74 F = 10.475

This model seems to be a good one, as results are sound with respect to theory and practice. In this model all variables have the correct signs, and all except prct all have significant explanatory power. Sugar demand is elastic with respect to GDP. R^2 shows that 74% of the variation in the log of quantity demand is explained by the variables used in our model and from the F statistic, the model has significant explanatory power.

5.2 Su arcane Supply

Among two different models considered, the double logarithmic form has been presented below.

$$\text{Log } Q^{sc}_{st} = 9.684 + 0.389 \log PKt\text{-}1 + 0.131 \log Plt\text{-}1 + 0.161 \log It$$

STD. Errors	(0.164)	(0.18)	(0.85)
T-ratio	(2.372)	(0726)	(2.895)

R^2 = .89 F = 30.077

This model seems to be giving the best results as two of its variables have correct sign with significant explanatory power. Though lagged alternative price has incorrect sign it is insignificant. The F. test shows significant explanatory power of the entire set of variables which explains 89% of the variation on sugarcane supply.

5.3 Sugar supply model

$$\log Q^{s}_{st} = -9.37 + 1.513 \log Q^{sc}_{st}$$

STD. Errors	(0.289)	R^2 = .68
Tratio	(5.23)	F = 27-358

This logarithmic supply model of sugar implies that the dependent variable is elastic with respect to the independent variable. The coefficient has the correct sign with signifcant explanatory power. R^2 shows that 68% of the variation in the dependent variable is explained

by the independent variable $Q_{st.}^{sc}$

The F-statistic proves the significance of the model.

5.4 Main findings

a) Sugar demand is elastic w.r.t income. Demand for sugar increased by 2.396 percent for every one percentage increase in GDP.

b) Price elasticity of demand exceeds unity and has a negative relationship.

c) Sugar demand is inelastic w.r.t the relative price of the complements.

d) Sugarcanesupply is inelastic w.r.t its lagged price and the lagged price of substitutes.

e) Farmers show a positive response to the price of sugarcane.

f) 1,3% trend rate of growth has been achieved in sugarcane supply.

g) Sugar supply is elastic w.r.t sugarcane supply.

h) Projected demand for sugar has been decrased by 9.4% for 1979-80 it is 24411. 453M/T

i) Projected sugar supply has been deceased by 22% for 1979-80. It is 21216.405 M/T

j) Projected absolute sugar price is 9.01 Rs per kg. it is projected to increase by 46%

k) Projected sugarcane supply is 353207.15 M/T, it is projected to decrease by 6.8%

6. RECOMMENDATIONS

The present study enables to give the following recommendations:

1/ If real income grows at the rate of 2% a year. demand for sugar will grow by 5.87%. As technology will meet only 1.3% the remaining 4.57% should be met by incentives for greater supply. As sugarcane supply is in elastic w.r.t sugarcane price and farmers show a positive response to the price of sugarcane, to induce greater supply to meet the increased demand, the price of sugarcane must be raised.

2/ Recently, the price of sugar has increased by 50%, but the price of sugarcane has risen by only 16.65%. This will cut demand by 77% and raise supply by 6.48%. But sugar

demand will not decrease by 77% because of the fact that there are other factors like income which will raise the demand at the same time. Pricing policies could emphasize the supply side of the market to a greater extent by imposing a greater increase in the price of sugarcane. This would provide an incentive for a greater supply response while placing a smaller burden of adjustment on consumersin subsequent years.

3/ There exists a shortage of sugar in Nepal as our projection shows, because of the lower production of sugarcane. Again lower sugarcane production is the result of lower price. In 1978-79 cane price was decreased by 26.9%. Therefore to overcome this shortage cane price must be increased, immediately.

4/ Demand is price elastic. Therefore a small price rise should by sufficient to cut demand by a large amount, our projected 46% rise in price will cut demand by 71.1% But the projected demand has decreased 9.64%. It is because the variables like growing income induce greater demand.

5/ Supply is price inelastic. Therefore a large rise in sugarcane price is necessary to bring forth more supply. The 16.65% rise in sugarcane price will induce only 16.48% increase in supply.

6/ It is obvious from the present study that running three sugar industries can meet the national demang for sugar if they run at full capacity, e.g. in 1978-79 total supply (production) was 27200 M/T and demand 26950 M/T. This shows a surplus. Therefore, a large rise in price of sugarcane would make sugarabundent for sale or export.

7/ Sugar is a good of necessity. As the Govt. fixes the price, it has to control the rising trend in demand if necessary by making subsidies to sugar industries. The reason given by Govt. in increasing the sugar price is the increase in sugarcane price and the world situation especially, conditions in India. On average 11 quintals of sugarcane are needed to produce a quintal of sugar. From this fact a 16.65% increase in caue price will cause only a Rs.35 price rise for a quintal of sugar but the price has increased by Rs. 350/ per quintal. Recently in India sugar price has decreased so the Govt. should decrease the price of sugar.

8/ To increase the supply of sugar not only the rise in cane price but also improvement in the sugar industries and an encouraging policy to establish new sugar industries will be needed. It may enable us not only to meet our domestic demand for sugar, but also to export it and earn foreign exchange.