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COBWEB THEORY APPROACH : AN APPLICATION TO RICE PRODUCTION IN KERALA

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Abstract: An attempt is made to examine how rice fanners respond to output with movements in prices, over the last fifteen years, using Cobweb model. It is found that the slope of the demand curve to be greater than the slope of the supply curve of paddy and the price structure of paddy in Kerala is following a convergent Cobweb starting above the equilibrium. The projected values based on the model show that the instability of the supply behaviour to adjust to changes in price should be changed to reduce the time lag in achieving the equilibrium price and output.

Key words: Cobweb model, price prediction and rice production.

INTRODUCTION

Agricultural policy makers, searching for long term economic projection certainly need the use of Cobweb models which describe the simultaneous adjustments in prices and outputs. The model can be used to examine the responsiveness of output individual crops to price movements and other factors and also for inter-regional comparisons of output responses. Kerala is a typical agricultural economy, the important food crop being rice. A crop-wise study to analyse the responses of output to prices and other factors seems to be in order. The study can also apply to understand how present patterns of prices and outputs are likely to affect future movements around their projected values. The inclusion of the factors like government policies, foreign trade, population etc. influencing output response along with prices, in the Cobweb model, causes serious estimation problems. In this paper, an attempt is made to examine how rice farmers of Kerala respond to output with movements in prices, over the years 1975-76 to 1989-90.

MATERIALS AND METHODS

The annual details on farm prices, and yield of paddy over the years 1975-76 to 1989-90 published by the Directorate of Economics and Statistics, Kerala, were used for the study. Since published data on market prices are discontinuous, only farm price which is the important price factor of output response of primary producers has been considered.

In real life supply consumes time and the adjustment of supply to price changes is not instantaneous, although demand may adjust to price variations instantaneously and therefore requires to time lag. Cobweb theorem is the simplest model of these dynamics of demand, supply and price.

Taking the linear versions of lagged supply and current demand function as,

$D_t = a + b P_t$ where $a>0, b<0$ ..... (1.1)
and $S_t = c + d P_{t-1}$ where $d>0$ ..... (1.2)
where D_t = Demand for a **commodity** in period t; S_t = Supply of a commodity in period t; P_t = Price of a commodity in period t and P_{t-1} = Price of a commodity in period t-1

Inequilibrium,

$D_t = S_t$ ..... (1.3)

Hence $a + b P_t = c + d P_{t-1}$

or, $P_t = (c-a)/b - d/b P_{t-1}$.

Shifting the time period subscripts ahead by one period as done by Agarwal (1976) and Mehta (1991), the general equation of time

path will be

$$P_t=[P_0-(c-a)/(d-b)](d/b)^t+(c-a)/(d-b) \quad \ldots\ldots(1.4)$$

Table 1. The supply, demand and farm price of paddy in Kerala (1975-76 to 1989-90)

Year	Time, period	Supply, kg ha^{-1}	Demand, kg ha^{-1}	Farm price, Rs kg^{-1}
1975-76	0	1520	1468	1.83
1976-77	1	1468	1541	1.07
1977-78	2	1541	1592	0.97
1978-79	3	1592	1638	1.29
1979-80	4	1638	1587	1.37
1980-81	5	1587	1660	1.52
1981-82	6	1660	1678	1.79
1982-83	7	1678	1632	2.08
1983-84	8	1632	1720	2.52
1984-85	9	1720	1729	2.01
1985-86	10	1729	1708	2.41
1986-87	11	1708	1709	2.44
1987-88	12	1709	1753	2.62
1988-89	13	1753	1956	2.95
1989-90	14	1956	1942	2.90

The price in period t will be just equal to the price in the initial period i.e., $P_t = P_0$ when t = 0. On the basis of equation (1.4) the following propositions have been derived:

(1) The amount (c-a)/(d-b) of equation (1.4) can be taken as the equilibrium price of the model denoted by P = (c-a)/(d-b) substituting in (1.4), the equation can be rewritten as

$$P_t = (P_0-\bar{P})\,(d/b)^t + \bar{P} \quad \ldots\ldots(1.5)$$

(2) In equation (1.5) $P_0-\bar{P}$ shows the difference between the initial price and the equilibrium price and its sign will determine whether time path will commence above or below the equilibrium.

(3) The difference between b and d will determine the Cobweb phenomenon (or disequilibrium phenomenon).

In this case there will be oscillations: (i) If $|d| > |b|$ it is a diverging or explosive Cobweb; (ii) If $|d| < |b|$ it is a converging or damped Cobweb and (iii) If $|d| = |b|$ it is a regular Cobweb where b is the slope of the market demand curve of equation (1.1) and d is the slope of the market supply curve of equation (1.2).

RESULTS AND DISCUSSION

The yield or production per hectare in any year has been considered as the quantity supplied in the corresponding year and it is considered to be the quantity demanded in the previous year. Table 1 shows the supply, demand and farm prices of paddy in Kerala for the period (1975-76 to 1989-90). The demand side of paddy estimated according to equation (1.3) is

$$D_t = 1391.56 - 154.52\ P_t \quad \ldots\ldots(2.1)$$
Std. error: (126.51) (61.004)
t value: , (2.533*)

and the equation (2.2) explaining the supply side of paddy in Kerala which is estimated according to equation (1.7) is

$$S_t = 1373.53 - 144.08\ P_{t-1} \quad \ldots\ldots(2.2)$$
Std. error: (112.988) (50.102)
t value: (2.876**)

At equilibrium, according to equation (1.5) the resulting equation of time path obtained is

$$P_t = (1.83 - 1.73)\ (0.93)^t + 1.73 \quad \ldots\ldots(2.3)$$

Equation (2.3) reveals the following:

(1) The equilibrium price ($\bar{P}$) and equilibrium quantity ($\bar{Q}$) of paddy are 1.73 Rs kg^{-1} and 1382.23 kg ha^{-1} respectively.

(2) $P_0-\bar{P}$ which is the difference between initial price and equilibrium price is Rs 0.10 per kg of paddy and the positive sign indicates that the time path starts above the equilibrium price.

(3) Since slope of the supply curve (d) is less than slope of the demand curve (b), the price

Table 2. Projected time path of farm prices and equilibrium quantities of paddy in Kerala

Year	Time, period	Time path of farm prices, Rs kg^{-1}	Equilibrium quantities, kg ha^{-1}
1975-76	0	1.73	1124.24
1976-77	1	2.75	966.63
1977-78	2	2.68	977.45
1978-79	3	2.53	1000.62
1979-80	4	2.55	997.53
1980-81	5	2.50	1005.26
1981-82	6	2.44	1014.53
1982-83	7	2.39	1022.26
1983-84	8	2.35	1028.44
1984-85	9	2.30	1036.16
1985-86	10	2.26	1543.82
1986-87	11	2.23	1046.98
1987-88	12	2.19	1053.16
1988-89	13	2.16	1057.80
1989-90*	14	2.13	1062.43
1999-2000	24	1.92	1094.88
2050-51	75	1.73	1124.24

* Projections

structure showed a converging or damped Cobweb with positive shift in demand and supply curves. Table 2 clearly explains the damped Cobweb price structure of paddy in Kerala. The time path of prices of paddy projected using equation (2.3) is shown *in* Table 2.

The price fluctuations tend to become smaller and smaller while moving towards equilibrium price with time. Farmers' reactions to movements in prices can be explained in a convergent Cobweb framework as follows.

The Cobweb starts above the equilibrium price of Rs 1.73 per kg of paddy. The initial quantity of supply (S_0) is 1124.25 kg ha^{-1} and the corresponding initial price (P_0) is 1.73 Rs kg ha^{-1}. Consumer demand (D_0) for paddy is 1124.25 kg ha^{-1} and this quantity equals the initial market supply. The producers of paddy induced by the higher price in period '0' (i.e., 1975-76) increase their supply to S_1 in the next period '1' (i.e., 1976-77). Due to this initiation market supply has increased in the next year, but the price per kg of paddy falls instantaneously to P_1. The quantity demanded per hectare at this lower price is D_1 and is equal to the supply in period 't', S_1. But this lower price P_1 induces producers to lower the supply of paddy to S_2. This process continues indefinitely, producing a Cobweb pattern which is known as damped Cobweb. However, over time this gap between market demand and supply narrows down and the price coverages towards the equilibrium price level P = 1.73 Rs kg ha^{-1}. The farmers output response to changes in prices, in a convergent framework, thus explained in Table 2 indicates how the present pattern of price and outputs are likely to affect the future movements. Hence, under the present conditions Cobweb will disappear only after 60 years.

Adjustment time is a factor affecting the stability of a market model. In order to reach the equilibrium position, an excess of price over equilibrium price must induce a decrease in price. To reduce the time lag in achieving the equilibrium price, the instability of supply to adjust immediately to change in price should be changed. Thus, a stable supply behaviour can reform the price structure of

paddy in Kerala. In other words, the study of the system of price-quantity relationship of paddy over the years reveals the need for a stable supply model for the farmers in order to achieve the equilibrium position at the earliest. This is in conformity with the relationships established by Waugh (1970).

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