A MARKET MODEL FOR WATERMELON WITH SUPPLY UNDER RATIONAL EXPECTATIONS: AN EMPIRICAL STUDY ON BANGLADESH

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Abstract

The aim of this paper is to know the cultural practices and market model of watermelon in Bangladesh. The paper also attempts to identify the best model that may be used for forecasting purpose. Three models namely Naive, Cobweb and Rational Expectations (RE) have been considered by using time series agricultural data for a period of 2001/02 to 2012/13. Ordinary Least Square (OLS) and Two Stage Least Square (2SLS) estimation procedures have been used for estimation purpose. Reliable parameter estimates of the Naive, Cobweb and RE model with minimum standard errors, high explanatory power have been obtained in this research. Comparing all the models the RE is the best model, because most of the signs are expected and the results are plausible.

Keywords: Market Model, Watermelon, Rational Expectations Model, Bangladesh, Naive Model, Cobweb Model

Introduction

One of the common characteristics of developing countries is the large share of agriculture in their economies (Boyce, 1985). Bangladesh, being an under developed country is facing numerous economic problems. The economy of Bangladesh is mainly Agricultural and the whole economy of Bangladesh is primarily dependent on agriculture. Agricultural development is still synonymous with the economic development of

Bangladesh. Without a significant development in agriculture sector, there can hardly be any rural or national development in neither Bangladesh, nor can there be any significant reduction of poverty. All efforts will, therefore, be geared to provide the thrust necessary for boosting agricultural production. So the overall economic development depends or the proper development of our agricultural sector to a great extent.

Watermelon is an important summer cash crop, which has great demand in the domestic market. Its demand is increasing day by day but both acreage and production are decreasing. Bangladesh is one of the least developed countries in the world. The great majority of its people depend on agriculture for earning their living. The agriculture sector is the mainstay of the Bangladesh economy. As an agricultural product, watermelon has a great demand in Bangladesh and a major portion of income of farmer come from marketing and distribution of watermelon. Moreover it is established that capacity to adapt physiologically to various types of foods are possessed by humans. Pamplona-roger (2008) demonstrated that there are some foods that cannot be avoided, for example fruits and fresh vegetables. Fruits provide adequate supplies of vitamins, minerals and fibers to people living in the tropics (Ngoddy & Ihekeronge, 1985). Rolls *et.al* (2004) demonstrated that most vegetables and fruits contain low level of energy density and are good for weight management. Watermelon may be used for sorbets or granite, smoothes on the basis of the texture whether smooth or coarse Wada (1930) argued that the rind is also edible and can be used as vegetable. In Bangladesh people are used to eat watermelon as fruits and juice. In some areas it is used as vegetables. But in US, China, Nigeria and Egypt, the watermelon has a number of different using including seeds of watermelon (Mandel *et.al*. 2005). As a food item watermelon is very important for Bangladeshi people. Therefore this is very important to study market model for watermelon. As per our knowledge goes, there is no empirical study on market model of watermelon with supply under RE till today. Then this study will be a contribution to the existing literature.

The present study attempts to know the cultural practices of agriculturists producing watermelon and to construct model for watermelon in Bangladesh with supply under RE by considering the various sources of variations on the time series data for 23 districts of Bangladesh and over a period of 12 years (2001/2002-2012/2013). Relevant information has been collected from various publications of BBS (Bangladesh Bureau of Statistics) and the production cost index data for watermelon has been collected from BARI (Bangladesh Agricultural Research Institute) and the price of watermelon has been collected from BADC, Khamar Bari, Farmgate, Dhaka.

By following Akerman(1957), Nerlove(1958), Mariano(1987), three models namely the Naive, Cobweb and RE have been estimated by OLS and 2SLS method. Before the estimation of the parameters, the Naive, Cobweb and RE models were tested for the presence of multicollinearity, autocorrelation and heteroscedasticity. In the present study the assumptions under different testes have been strictly followed.

The tests for multicollinearity get high attention from econometricians. For the present study VIF (Variance Inflation Factor) method was used to detect the presence of multicollinearity. For testing autocorrelations we used Durbin-Watson d-Statistic. This is widely used in empirical analysis for the most common autocorrelation problem. For testing heteroscedasticity we used several tests. The Goldfeld-Quandt test (Goldfeld & Quandt, 1972) was used to detect the presence of heteroscedasticity. Comparing all the models results show that the RE is the best model, because most of the signs are expected and the results are plausible.

The structure of the remainder of the paper is as follows. Section 2 focuses on data and variables. Section 3 represents econometric model. Section 4 presents results and discussion. Section 5 concludes the paper.

Data and Variables

This section is divided into two parts. Part 1 describes data and part 2 deals with variables.

Data

In Bangladesh there are 7 divisions namely, Dhaka, Chittagong, Rajshahi, Khulna, Barisal, Sylhet and Rangpur and there are 64 districts under 7 divisions. In this study secondary data are used. Annual time series data have been collected from six divisions for the period 2001-2002 to 2012-2013. Mains sources of data are various publications of Bangladesh Bureau of Statistical year book and Agricultural year book of Bangladesh.

Variables

There are many factors that affect the supply and demand response of watermelon in Bangladesh. These are mainly- (i) Price of the watermelon, (ii) Production of the watermelon, (iii) Cultivated area, (iv) Income (Real per capita expenditures goods and services), (v) Population, (vi) Food price deflator, (vii) Rainfall and (viii) Temperature

In this research nine variables are considered. Total production of watermelon is taken as the dependent (endogeneous) variable and Price of the watermelon, rainfall, income, temperature, population, production cost index, food price deflator & time are consider as independent (exogeneous) variables. The number of variables to be included in the model depends on the nature of the phenomenon under consideration and the purpose of the research.

The region wise data on the dependent variable as well as independent variables rainfall, income, temperature, population, production cost index (PCI) and food price deflator are available for all the years considered in this research. The region wise data on production is given in metric tons for each year and the price data is given in per hundred. This per hundred is converted into per half metric tons. The production data and price data for watermelon are available by region for the twelve years. However, the production cost index data for watermelon are not available by region.

The cost of watermelon production included all variable cost times like labor, seed, fertilizer, insecticides, organic manure, interest on etc. both cash expenses and inputted values of the family-owned inputs used in the study were included in calculating cost of production. The data on PCI could not be collected for each year. But we measure the PCI by human labor consider the other items fixed. We consider the food price deflator is the ratio of the consumer price indices to the corresponding price and is expressed as percentage. We consider average of maximum and minimum temperature and data of rainfall is given in millimeters for each year.

Econometric Model

The first and the most important stage for the econometrician is to study if there is any relationship among the variables and to express this relationship in mathematical form. That is, to specify the model, with which the economic phenomenon will be explored empirically. This is called specification of the model or formulation of the mathematically hypothesis.

The purely mathematically model is of limited interest to the econometrician, for it assumes that there is an exact or deterministic relationship between dependent and independent variables. However, the relationships among economic variables are generally inexact. To allow for the inexact relationship among economic variables, the econometrician would modify the deterministic function by introducing disturbance term or error term, which is a random variable with well-defined probabilistic property. The disturbance term may well represent all those factors which affect the dependent variable but which could not be included in the function because of non-availability or non-observability or some other reasons. The specification of the econometric model will be based on economic theory and on any available information related to the phenomenon under study. Thus, specification of the model presupposes the knowledge of economic theory as well as familiarity with the particular phenomenon under study.

The Naive Model

The Naive model is specified as under:

Supply: $Q_t = \alpha_0 + \alpha_1 P^*{}_t + \alpha_2 R_t + u_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$

Demand: $Q_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 X_t + \beta_3 T_t + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$

All the variables are in logs except the time trend t. Where, $Q_t =$ Quantity demand or supplied (both are the same by the assumption of equilibrium), $P_t =$ Price, $P^*{}_t =$ Price at time t as expected at time (t-1), $R_t =$ Annual total rainfall (in millimeters), $T_t =$ Temperature, $X_t =$ Income (real per capita expenditure goods and services), $u_{1t}, u_{2t} =$ Disturbance terms.

Putting $P^*{}_t = P_{t-1}$ in equation (1)

Supply: $Q_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 R_t + u_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$

Demand: $Q_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 X_t + \beta_3 T_t + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$

Now, consider the equation (3) & (4) instead of (1) & (2), since it contains only the exogeneous variables on the right hand side and by the assumption they are uncorrelated with the disturbance terms u_{1t} & u_{2t} and these equations satisfies the classical assumption of OLS. Hence OLS can be applied straightforwardly to these equations. These estimates are

Supply: $\hat{Q}_t = \hat{\alpha}_0 + \hat{\alpha}_1 P_{t-1} + \hat{\alpha}_2 R_t$

Demand: $\hat{Q}_t = \hat{\beta}_0 + \hat{\beta}_1 P_{t-1} + \hat{\beta}_2 X_t + \hat{\beta}_3 T_t$

The Cobweb Model

The Cobweb model explains why price in certain markets are subject to periodic fluctuation. It is an economic model of cyclical supply and demand in which there is a lag between responses of producers to a change of price.

The Cobweb model is specified as under

Supply: $Q_t = \alpha_0 + \alpha_1 (P^*{}_t - C_t) + \alpha_2 Q_{t-1} + u_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$

Demand: $p_t - d_t = \beta_0 + \beta_1 (Q_t - N_t) + \beta_2 X_t + \beta_3 t + u_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$

Where, $C_t =$ Production cost index (PCI), $P^*{}_t - C_t =$ Price index, $p_t - d_t =$ Real price, $Q_t - N_t =$ Per capita demand, $N_t =$ Population (millions), $d_t =$ Food price deflator, $t =$Tim

Putting $P^*{}_t = P_{t-1}$ in equation (5)

Supply: $Q_t = \alpha_0 + \alpha_1 (P_{t-1} - C_t) + \alpha_2 Q_{t-1} + u_{1t}$

$= \alpha_0 + \alpha_1 \acute{p}_{1t} + \alpha_2 Q_{t-1} + u_{1t}$ Where, $\acute{p}_{1t} = (P_{t-1} - C_t)$

From (6)

Demand: $p_t - d_t = \beta_0 + \beta_1 (Q_t - N_t) + \beta_2 X_t + \beta_3 t + u_{2t}$

$$Q_t - N_t = -\frac{\beta_0}{\beta_1} + \frac{1}{\beta_1}(p_t - d_t) - \frac{\beta_2}{\beta_1} X_t - \frac{\beta_3}{\beta_1} t - \frac{1}{\beta_1} u_{2t}$$

$\acute{Q}_t = -\frac{\beta_0}{\beta_1} + \frac{1}{\beta_1}\acute{p}_{2t} - \frac{\beta_2}{\beta_1}X_t - \frac{\beta_3}{\beta_1}t - \frac{1}{\beta_1}u_{2t}$ Where, $\acute{p}_{2t} = p_t - d_t$, $\acute{Q}_t = Q_t - N_t$

Estimating the parameters by OLS, we get

Supply: $\hat{Q}_t = \hat{\alpha}_0 + \hat{\alpha}_1\acute{p}_{1t} + \hat{\alpha}_2 Q_{t-1}$ ……………………………..(7)

Demand: $\hat{Q}_t = -\frac{\hat{\beta}_0}{\hat{\beta}_1} + \frac{1}{\hat{\beta}_1}\acute{p}_{2t} - \frac{\hat{\beta}_2}{\hat{\beta}_1}X_t - \frac{\hat{\beta}_3}{\hat{\beta}_1}t$ ……………………(8)

RE Model

The RE model is specified as under

Supply: $Q_t = \alpha_0 + \alpha_1(P^*{}_t - C_t) + \alpha_2 Q_{t-1} + u_{1t}$ ……………………………………(9)

Demand: $p_t - d_t = \beta_0 + \beta_1(Q_t - N_t) + \beta_2 X_t + \beta_3 t + u_{2t}$ ……………………(10)

In equation (9) & (10) contains the endogeneous variables on the right hand side and by the assumption they are correlated with the disturbance terms u_{1t} & u_{2t} and violet the classical assumption of OLS. Hence 2SLS can be applied straightforwardly to these equations.

Since rational expectation hypothesis implies $P^*{}_t = P_t - V_t$

Where, V_t is an error term and uncorrelated with the variables. We just substitute $P_t - V_t$ for $P^*{}_t$ and combine the error V_t with the error in the supply function. Since V_t has the same properties as u_{1t}. We have

Supply: $Q_t = \alpha_0 + \alpha_1(P_t - C_t) + \alpha_2 Q_{t-1} + u_{1t}$ ……………………………………(11)

Demand: $p_t - d_t = \beta_0 + \beta_1(Q_t - N_t) + \beta_2 X_t + \beta_3 t + u_{2t}$ ……………………(12)

Now we estimate the model by 2SLS

Stage-1: Estimate the reduced form equation by OLS and obtained $\hat{P}_t$

Stage-2: Replace the right hand side endogeneous variables by $\hat{P}_t$ and estimate the equation by OLS.

Putting the value of Q_t in equation (12) we get

$$p_t - d_t = \beta_0 + \beta_1[\{\alpha_0 + \alpha_1(P_t - C_t) + \alpha_2 Q_{t-1} + u_{1t}\} - N_t] + \beta_2 X_t + \beta_3 t + u_{2t}$$

$$p_t = \beta_0 + \beta_1\alpha_0 + \beta_1\alpha_1 P_t - \beta_1\alpha_1 C_t + \beta_1\alpha_2 Q_{t-1} - \beta_1 N_t + \beta_2 X_t + \beta_3 t + d_t + \beta_1 u_{1t} + u_{2t}$$

$$p_t = \beta_0 + \beta_1\alpha_0 + \beta_1\alpha_1 P_t - \beta_1\alpha_1 C_t + \beta_1\alpha_2 Q_{t-1} - \beta_1 N_t + \beta_2 X_t + \beta_3 t + d_t + w_{1t}$$

Where, $w_{1t} = \beta_1 u_{1t} + u_{2t}$

$$p_t(1 - \beta_1\alpha_1) = (\beta_0 + \beta_1\alpha_0) - \beta_1\alpha_1 C_t + \beta_1\alpha_2 Q_{t-1} - \beta_1 N_t + \beta_2 X_t + \beta_3 t + d_t + w_{1t}$$

⇨ $\hat{p}_t = \hat{\pi}_1 + \hat{\pi}_2 C_t + \hat{\pi}_3 Q_{t-1} + \hat{\pi}_4 N_t + \hat{\pi}_5 X_t + \hat{\pi}_6 t + \hat{\pi}_7 d_t + \hat{w}_{1t}$

Where, $\hat{\pi}_1 = \frac{\beta_0+\beta_1\alpha_0}{1-\beta_1\alpha_1}$, $\hat{\pi}_2 = \frac{-\beta_1\alpha_1}{1-\beta_1\alpha_1}$, $\hat{\pi}_3 = \frac{\beta_1\alpha_2}{1-\beta_1\alpha_1}$, $\hat{\pi}_4 = \frac{-\beta_1}{1-\beta_1\alpha_1}$, $\hat{\pi}_5 = \frac{\beta_2}{1-\beta_1\alpha_1}$, $\hat{\pi}_6 = \frac{\beta_3}{1-\beta_1\alpha_1}$, $\hat{\pi}_7 = \frac{1}{1-\beta_1\alpha_1}$, $\hat{w}_{1t} = \frac{w_{1t}}{1-\beta_1\alpha_1}$

Putting the value of $\hat{p}_t$ in (11), we get

$$Q_t = \alpha_0 + \alpha_1(\hat{p}_t - C_t) + \alpha_2 Q_{t-1} + u_{1t}$$

$= \alpha_0 + \alpha_1 P_{2s} + \alpha_2 Q_{t-1} + u_{1t}$, where, $P_{2s} = \hat{p}_t - C_t$

Estimate the parameters by OLS, we get

Supply: $\hat{Q}_t = \hat{\alpha}_0 + \hat{\alpha}_1 P_{2s} + \hat{\alpha}_2 Q_{t-1}$

Similarly, putting the value of P_t in equation (11), we get

$$\hat{Q}_t = \hat{\pi}_8 + \hat{\pi}_9 N_t + \hat{\pi}_{10} X_t + \hat{\pi}_{11} t + \hat{\pi}_{12} d_t + \hat{\pi}_{13} C_t + \hat{\pi}_{14} Q_{t-1} + \hat{w}_{2t}$$

Where, $\hat{\pi}_8 = \frac{\alpha_0+\alpha_1\beta_0}{1-\alpha_1\beta_1}$, $\hat{\pi}_9 = \frac{-\beta_1\alpha_1}{1-\alpha_1\beta_1}$, $\hat{\pi}_{10} = \frac{\beta_2\alpha_1}{1-\alpha_1\beta_1}$, $\hat{\pi}_{11} = \frac{\alpha_1\beta_3}{1-\alpha_1\beta_1}$, $\hat{\pi}_{12} = \frac{\alpha_1}{1-\alpha_1\beta_1}$, $\hat{\pi}_{13} = \frac{-\alpha_1}{1-\alpha_1\beta_1}$, $\hat{\pi}_{14} = \frac{\alpha_2}{1-\alpha_1\beta_1}$, $\hat{w}_{2t} = \frac{w_{2t}}{1-\alpha_1\beta_1}$

Putting the value of $\hat{Q}_t$ in (12), we get

$$p_t - d_t = \beta_0 + \beta_1(\hat{Q}_t - N_t) + \beta_2 X_t + \beta_3 t + u_{2t}$$

$$\hat{Q}_t - N_t = -\frac{\beta_0}{\beta_1} + \frac{1}{\beta_1}(p_t - d_t) - \frac{\beta_2}{\beta_1}X_t + \frac{\beta_3}{\beta_1}t + \frac{1}{\beta_1}u_{2t}$$

$Q_{2s} = -\frac{\beta_0}{\beta_1} + \frac{1}{\beta_1}\acute{P}_{2s} - \frac{\beta_2}{\beta_1}X_t + \frac{\beta_3}{\beta_1}t + \frac{1}{\beta_1}u_{2t}$, where, $Q_{2s} = \hat{Q}_t - N_t$ and $\acute{P}_{2s} = p_t - d_t$

Estimate the parameters by OLS, we get

Demand: $\hat{Q}_{2s} = -\frac{\hat{\beta}_0}{\hat{\beta}_1} + \frac{1}{\hat{\beta}_1}\acute{P}_{2s} - \frac{\hat{\beta}_2}{\hat{\beta}_1}X_t - \frac{\hat{\beta}_3}{\hat{\beta}_1}t$

Results and Discussion

An important stage in any economic research is assessing the model and the method of model estimation by econometric criteria. The acceptability of any set of parameter estimates depends on whether there possess all the econometric criteria. If these criteria are not satisfied, a model though theoretically good enough, may perform badly. That is, the standard errors of the parameters may be low or the marginal effects of the explanatory variables may be entangled. Various problems arise in empirical econometric analysis. Among these problems Multicollinearity, Autocorrelation and Heteroscedasticity are addressed.

Multicollinearity

In this research work the method of Variance Inflation Factor (VIF) is used in order to detect Multicollinearity. The results of VIF values for three models are presented in the following Table 1.

Table 1: Detection of Multicollinearity for various models by VIF:

Models	Equations	VIF values
Naive	Supply	1.22
	Demand	1.80
Cobweb	Supply	1.19
	Demand	1.38
RE	Supply	1.66
	Demand	4.03

From the above table, we observe that the variables are not highly affected by Multicollinearity. In some cases variables are slightly affected by Multicollinearity. So in this research work we do not use any remedial measure of Multicollinearity.

Autocorrelation

For detecting the presence of Autocorrelation we use Durbin-Watson d-test. The results of Durbin-Watson d-test values for three models are shown in the following Table 2. From the below table, we found that for the Cobweb and RE model in demand equation autocorrelation is positive and other exists no decision. After detecting autocorrelation remedial measure of Cochrane- Orcutt Iterative Procedure (Cochrane & Orcutt, 1949) has been taken successfully.

Table 2: Detection of presence of Autocorrelation for various models by Durbin-Watson d-test:

Models	Equations	Durbin-Watson d-test	
		Calculated value of d	Decision
Naive	Supply	1.371	No decision
	Demand	1.64	No decision
Cobweb	Supply	1.188	No decision
	Demand	2.01	+ve autocorrelation
RE	Supply	0.99	No decision
	Demand	2.152	+ve autocorrelation

Note: Limits of d are at 5% level of significance.

Heteroscedasticity

The results of Goldfeld Quandt test values for Heteroscedasticity are presented in the following Table 3.

Table 3: Detection of presence of Heteroscedasticity for various models by Goldfeld Quandt test:

Models	Equations	Goldfeld Quandt test	$F_{tab,5\%}$	Decision
	Supply	0.980	161.4	Homosecdastic
Naive	Demand	2.29	161.4	Homosecdastic
	Supply	0.85	161.4	Homosecdastic
Cobweb	Demand	1.026	161.4	Homosecdastic
	Supply	0.116	161.4	Homosecdastic
RE	Demand	8.104	161.4	Homosecdastic

From the above table, we see that there is no heteroscedasticity in the data.

The main econometric problems, namely, Multicollinearity, Autocorrelation and Heteroscedasticity have been detected. These tests are helpful in judging the desirable properties of good estimates like unbiasedness, efficiency, minimum variance, consistency, etc. After the inspection of the results, the presence of moderate multicollinearity has been detected among the variables. After detecting autocorrelation, it has been removed by Cochrane- Orcutt Iterative Procedure. The test results of heteroscedasticity show that there is no evidence of heteroscedasticity in the model. Finally it can be said that the estimated results are econometrically quite acceptable.

Descriptive Statistics

Before going to analyze the results, the means and standard deviations of the eight variables considered in this research have been presented in the Table 4. From the table it is seen that the average area is 27771.58 with a standard deviation of 2045.784. The average production is 92530.83 metric tons with a standard deviation of 7672.036 metric tons. The average price is TK.1781.00 with a standard deviation of TK.361.738. The mean and standard deviation of income, production cost index, rainfall, temperature and food price deflator are presented in the following Table 4.

Table 4: Descriptive Statistics

Variables	Mean	Standard deviation
Area	27771.58	2045.784
Production	92530.83	7672.036
Price	1781.00	361.738
Income	11591.25	666.887
Production cost index	120.39	24.63
Rainfall	65828.75	9332.82
Temperature	24.17	1.44
Food price deflator	1.11	0.27

Estimation of three models

The level of significance for all the tests is considered to be 0.05. Economic theory suggests that the coefficient of price for supply equation should be positive and the coefficient of rainfall for supply equation should be negative. Here again, the coefficient of price for demand equation should be negative and that of the income & temperature should be positive.

Estimation of the Naive Model by OLS

The estimated equation is as follows

Supply: $\hat{Q}_t = 15.203 + 0.0136P_{t-1} - 0.394R_t;\ R^2 = 0.179 \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (13)$
(0.101) (0.503) (0.229)
Demand: $\hat{Q}_t = 21.105 + 0.0044P_{t-1} - 1.059X_t + 0.008T_t;\ R^2 = 0.57 \dots \dots \dots \dots \dots \dots (14)$
(0.101) (0.549) (0.131) (0.579)
Figures in the parentheses are p-values.

The multiple coefficient of determination (R^2) of the equation (13) is 0.18 and (14) is 0.57, which indicates that 18% and 57% of the total variation of the dependent variable have been explained by the independent variables respectively. It can be said that the goodness of fit of the supply and demand function are not quite good on the average.

A basic economic theory is that as price increases, the corresponding supply increases. That is, there is a direct relationship between price of the watermelon and the quantity supplied. Another economic theory is that as rainfall increases, the corresponding supplies decreases, because excessive rainfall spoils watermelon seeds. The quantity demanded always varies inversely with price. When price decreases, quantity demanded increases and vice-versa.

From the equation (13) we see that the quantity supplied is responsive to both price and rainfall. Moreover, it is seen from the equation (14) that the quantity demanded does not respond to both price and income, but the quantity demanded responsive to temperature.

Estimation of the Cobweb Model by OLS

The estimated equation is as follows
Supply: $\hat{Q}_t = 12.180 + 0.157\acute{P}_{2t} - 0.102Q_{t-1}$
(0.260) (0.249) (0.236) ; $R^2 = 0.159 \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (15)$
Demand: $\hat{Q}_t = -3.1537 + 0.3334\acute{P}_{2t} + 0.8082X_t - 0.0426t$
(0.842) (0.165) (0.617) (0.236); $R^2 = 0.278 \dots \dots .. (16)$
Figures in the parentheses are p-values.

The multiple coefficient of determination (R^2) of the equation (15) is 0.16 and (16) is 0.28, which indicates that 16% and 28% of the total variation of the dependent variable have been explained by the independent variables respectively. It can be said that the goodness of fit of the supply and demand function are not quite good on the average.

A basic economic theory is that as price increases, the corresponding supply increases. That is, there is a direct relationship between price of the watermelon and the quantity supplied. Another economic hypothesis is that as production increases, the corresponding supply increases.

From the equation (15) we see that the quantity supplied is responsive to both price but not to production. The quantity demanded always varies inversely with price. When price decreases, quantity demanded increases and vice-versa. From the equation (16), it is found that the quantity demand is not respond to price, but the quantity demanded responsive to income. We see that in the Cobweb model the value of β_3 is -0.0426. Therefore, we have downward demand curve.

Estimation of the RE Model by 2SLS

From the estimated equation we have

Supply: $\hat{Q}_t = \hat{\alpha}_0 + \hat{\alpha}_1 P_{2s} + \hat{\alpha}_2 Q_{t-1}$

$= 11.154 + 0.0431 P_{2s} - 0.004 Q_{t-1}$

(0.00) (0.792) (0.651); $R^2 = 0.40$ … … … … … … … … (17)

Demand: $\hat{Q}_{2s} = -\frac{\hat{\beta}_0}{\hat{\beta}_1} + \frac{1}{\hat{\beta}_1}\acute{P}_{2s} - \frac{\hat{\beta}_2}{\hat{\beta}_1}X_t - \frac{\hat{\beta}_3}{\hat{\beta}_1}t$

$= 4.1617 + 0.078\acute{P}_{2s} + 0.2271 X_t - 0.041t$

(0.002) (0.000) (0.227) (0.000); $R^2 = 0.75$ … … … … (18)

Figures in the parentheses are p-values.

The multiple coefficient of determination (R^2) of the equation (17) is 0.40 and (18) is 0.75, which indicates that 40% and 75% of the total variation of the dependent variable have been explained by the independent variables respectively. It can be said that the goodness of fit of the supply is not quite good on the average. But the goodness of fit of the demand function is good on the average.

A basic economic theory is that as expected price increases, the corresponding supply increases. That is, there is a direct relationship between expected price of the watermelon and the quantity supplied. Another economic theory is that as production increases, the corresponding supplies increases. The quantity demanded always varies inversely with expected price. When price decreases, quantity demanded increases and vice-versa. From the equation (17) we see that the quantity supplied is responsive to expected price but not to production. Moreover, from the equation (18) we see that the quantity demanded is not respond to price but the effect is significant. However, the quantity demanded is responsive to income.

The results of the three models are presented in the following table

Table 5: Estimated values of the parameters of the supply function

Models Parameters	Naive	Cobweb	RE
α_0	15.203	12.180	11.154
	(0.101)	(0.260)	(0.000)
α_1	0.0136	0.157	0.0431
	(0.503)	(0.249)	(0.792)
α_2	-0.349	-0.102	-0.0042
	(0.229)	(0.236)	(0.656)
DW	1.371	1.18863	0.909

N.B: the values within parentheses indicate p-value

Table 6: Estimated values of the parameters of the demand function

Models Parameters	Naive	Cobweb	RE
β_0	21.105	-30153	4.1617
	(0.101)	(0.847)	(0.002)
β_1	0.0044	0.3334	0.078
	(0.549)	(0.165)	(0.000)
β_2	-1.059	0.8082	0.2271
	(0.131)	(0.617)	(0.143)
β_3	0.0084	-0.0426	-0.0415
	(0.579)	(0.236)	(0.000)
DW	1.646	1.960	2.153

N.B: the values within parentheses indicate p-value

Conclusion

The results of the three models are presented in Table 5 and 6. Regarding the estimates of the supply function, the coefficient of α_0 is significant only when the estimation is done on RE model. The Naive and Cobweb models, which are less efficient models, gave rather worse results.

Regarding the estimates of the supply function, the coefficient of β_0, $\beta_1$and β_3 are significant only when the estimation is done on RE model. Finally, we may conclude that many coefficients are significant in the RE model but not in the Naive and Cobweb models. Therefore, the RE model gives the most precise result than the other models. Comparing all the models we find the RE model is the best model, because most of the signs are expected and the results are plausible.

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