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AN ESTIMATE OF SUPPLY FUNCTION FOR BANANAS IN ST. LUCIA

by

Melaku Teshome
and
Albert O. Yeboah

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INTRODUCTION

St. Lucia, the second largest windward island, is situated between Martinique and St. Vincent in the Eastern Caribbean Sea. The country is a part of the eastern Caribbean group including Grenada, the Grenadines, St. Vincent and St. Lucia. It is a small island with 238 square miles of land area endowed with towering mountains, beautiful valleys, scenic areas and picturesque beaches all around. The population of St. Lucia has grown at a steady rate of 7.5 percent annually since the second World War, making it among one of the higest rates of population growth in the world.

Agriculture is the mainstay of the economy of St. Lucia, and 40 percent of the employed are engaged in it. The persistent problem is one of declining profitability from the late fifties and early sixties as a result of unfavorable weather conditions, declining prices, rising costs, and employment competition from other growing sectors. The agricultural sector has undergone many changes during the recent past and as a result, sugarcane and coffee, once important crops, are now rarely grown. Banana has, however, become the major export crop and the major foreign exchange earner for St. Lucia.

The case of St. Lucia has the distinction of being the only Caribbean island to have switched completely from one commercial crop (Sugarcane) to another commercial crop (Banana). Even though there are differences from grower to grower, yields of banana are believed to be lower compared to the yields in Central America, Africa and the French Antilles.

The pricing mechanism in the region is similar for Jamaica and the windward islands. In the case of the windward islands, the Green Market Price (defined as the price at which bananas are sold to green ripeners in the United Kingdom) is fixed by consultation between Geest Industriest and WINBAN.*

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*The Banana Growers Association of the four windward islands are grouped together in the windward islands Banana Growers Association (WINBAN).

From the basic negotiated prices (GMP) a series of marketing expenses are deducted in order to arrive at the actual prices paid to the associations (Banana Grower Association). These include: importers margin, freight, insurance, landing costs, cost of shrinkage and wastage. In St. Lucia, as well as in all windward islands, these various costs constitute the "contract costs" which Geest automatically deducts from the GMP. In theory, Geest pays the same price to all four associations in the windwards. There are, however, differences in the actual prices paid since each association may have a different debt position with Geest. The balance of GMP due to the association is included in a schedule of prices periodically negotiated between Geest and WINBAN whereby the various levels of the GMP correspond to the basic price received by the associations.

St. Lucia has become one of the biggest suppliers of banana to the UK and heavily dependent upon its export for foreign exchange. The production of banana has become dependent upon purchased farm inputs. These fluctuations in the supplies and costs of inputs are a growing threat to production stability. The relative importance of the main items of cost, labor and materials, give an indication of the serious problems which the industry experiences as a result of wide fluctuations in availability or price of these items.

The composition of the production cost before harvesting is as follows:

ITEM	PERCENTAGE
Labor	38.9
Materials	44.3
Plant Protection	7.4
Depreciation	9.4
TOTAL	100.0

In addition to total fluctuations, the cost of physical inputs (fertilizers,

chemicals, labor, etc.) has increased dramastically in recent years while the price of bananas has increased at a much slower rate. This cost-price squeeze has had a large negative impact on the use of inputs and is a major cause of both a decline in the profit-margin and the output of bananas.

Since it is the main export crop, the decline in banana production critically affects foreign exchange revenues needed for economic development. In looking for a solution to the problem, the basic questions which come to mind are: what are the most important factors which determine banana production? What measures are available to policymakers to halt or reverse the downtrend in banana production?

The general purpose of this study was to provide information that will be useful in finding answers to these questions. The specific objectives were: (1) to estimate the supply function for banana in St Lucia, (2) to evaluate banana farmers' response to price changes, and, (3) to evaluate the impact of other exogenous variables on the supply of banana.

THEORETICAL MODEL

In this study, an expectation model was used as the main model. Accordingly, it was postulated that quantity supplied is a function of expected price and cost of production. This can be represented by equation (1) below.

$$Q_t = a + b_1 P^*_t + B_2 C_t + U_t$$

where Q_t is quantity supplied in period t, P^*_t is expected price, C_t represents cost of production, a, b_1, b_2 are parameters and U_t is a random residual term. Producers are assumed to generate their expectations "adaptively." The 'adaptive" procedure does not allow the forecaster to use all available information in forming his prediction. With the adaptive expectations, producers

are supposed to make their supply decisions on the basis of anticipated prices. The assumption that these expectations are formed adaptively is described by the equation:

$$P_t^* - P_{t-1}^* = \beta(P_{t-1} - P_{t-1}^*) \quad 0 \leq \beta \leq 1$$

This equation asserts that the change in expectations equals some fraction of the previous period's forecast error, where β, the coefficient of expectation, describes the rate of adaptation. If β equals one, equation (2) becomes $P_t^* = P_{t-1}$. In this case, P_t^* in equation (1) can be replaced by P_{t-1}. This is equivalent to saying that farmers rely solely on last year's price in making their decisions. However, we assume that farmers do not respond solely to last year's price but also to expected price and that they revise their expectations continually; therefore, the value of β will be other than, but no more than, one.

We cannot observe P_{t-1}^*, so that an estimated equation containing P_t^* cannot be fitted from empirical data. However, given equations (1) and (2), an equation may be derived whose coefficients can be estimated from observed variables. Estimates of these coefficients, in turn, can be used to estimate the parameters in equation (1), namely, P_t^*. Finally, a reduced form of the equation can be used to obtain estimates of the parameters from which we can compute algebraically the coefficient of expectation, β in equation (2) and also estimate the parameters in the output response relation in equation (1). The data used for this study were obtained mainly from a survey conducted by Weir's Agricultural Consultation Services Ltd. (1980), and FAO Output Yearbook (different issues). Quantity exported and export price were used as proxies for quantity supplied and price received by farmers respectively.

ESTIMATION

The reduced form of supply equation for the expectation model was estimated using time series data and ordinary least squares regression technique. The resulting equation is presented below:[1]

$$Q_t = 89482 + 106.4P_{t-1} + 0.0658Q_{t-1} + 2503C_t - 2836C_{t-1} - 7667T \qquad (3)$$

$$(3.44) \quad (1.24) \quad (0.25) \quad (0.51) \quad (-0.51) \quad (-1.86) \quad R^2 = 61.2$$

where Q_t is quantity supplied and P_{t-1}, Q_{t-1}, C_t, C_{t-1} and T represent lagged export price, lagged supply, cost of inputs, lagged cost of inputs and trend, respectively.

As expected, the elasticity of supply is positive indicating a direct relationship between output and expected price of banana. That is, an increase in expected price leads to an increase in quantity supplied. From the equation above, the elasticity of supply with respect to expected price was estimated to be 0.44. The regression coefficients for price lagged and the trend variable were significant at .10 and .05 significant levels, respectively. However, the coefficients associated with quantity lagged, cost of inputs and cost of inputs lagged, were not significant at either of the above significant levels.

The coefficient associated with trend was large and negative. This may be explained in part by the fact that banana farmers tend to utilize less modern agricultural technology, and this may be attributed to the high cost attached to adoption of technology. The regression coefficient on price lagged one year was high (106.4). When this coefficient was expressed as elasticity of output with respect to previous year's price, it was found to

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[1]See Appendix for mathematical derivation.

be .40 -- a value less than the elasticity with respect to expected price.

A relatively high value (0.93) was obtained for the coefficient of expectation, β , from the regression equation. This implies that farmers tend to revise their estimates of expected price by about 93 percent of the amount by which the previous year's actual price differed for previous year's expected price (see relation 2). This result indicates that farmers' expectation of price is based principally on the actual price received last year and that last year's price is the major factor in producer decisions for making adjustments in production plans that affect output. In view of this, other supply equations (fully linear and linear in logarithm) were estimated in addition to the expectation model. The empirical results of the different estimates are summarized in Tables 1 and 2.

The main things we want to compare are: (1) the magnitudes of the elasticities of output with respect to price lagged, and, (2) the percentage of the variance of output, i.e., the R^2's.

From the table we can clearly see that all the price coefficients are positive, hence, their elasticities. However, when the price coefficients in the linear models were expressed in terms of elasticity, they all have yielded a slightly lower value than the expectation model (all the values obtained were inelastic,. Interestingly, all the equations are consistent with the theory of supply, where a direct relationship between quantity supplied and price is depicted by positive price coefficients when supply is the dependent variable. The R^2's are moderate, and explain about 60 percent of the variation in output with most of the coefficients of price being significant at 10 percent level.

Our findings indicate small, but definitely positive supply elasticities.

Table 1: Estimates of Supply Function For Banana's (Fully Linear Equations)

Equation	Constant	P_{t-1}	Q_{t-1}	C_{t-1}	C_t	T	Estimated Elasticities	R^2
1	83812	106.7	0.00835	4.04	-	-6462	.41	60
	(3.70)	(1.29)[b]	(0.33)	(0.02)	-	(-1.93)		
2	83971	104.1	0.0809	-	12.38	-6581	.40	60
	(3.68)	(1.27)	(0.31)	-	(0.06)	(-1.85)		
3	90738	103.5	-	16.67	-	-6944	.41	60
	(11.38)	(1.37)	-	(0.08)	-	(-2.41)		
4	38791	107.9	0.0343	-	-	6420	.41	60
	(3.88)	(2.12)	(0.35)	-	-	(-2.87)		
5	90917	113.3	-	-	-	-6784	.43	58
	(12.99)	(2.43)	-	-	-	(-3.55)		

Table 2: Estimates of Supply Function For Banana's (Log-Log Equations)

Equation	Constant	P_{t-1}	Q_{t-1}	C_t	C_{t-1}	T	R^2
1	4.133	.4651	0.1074	1.916	-2.203	-.4983	60
	(2.88)	(1.17)[b]	(0.35)	(0.62)	(-0.86)	(-0.89)	
2	4.073	0.5436	0.86	-	-0.6554	-0.747	58
	(2.94)	(1.49)[b]	(0.86)	-	(-1.14)[c]	(-0.93)	
3	4.039	0.5292	0.2195	-	-0.6419	-0.1711	55
	(2.90)	(1.45)[b]	(0.89)	-	(-1.11)[c]	(-0.92)	
4	5.203	0.5968	-	-	0.7689	-0.1691	56
	(12.53)	(1.68)[a]	-	-	(-1.39)[b]	(-0.91)	

Significant Levels

a = .05, b = .10, c = .15

All the estimated parameters were at the same general order of magnitude, indicating short-run elasticities of supply values ranging from .40 to .59 for the various equations tested.

CONCLUSION

Banana producers normally plan production under conditions of price uncertainty because of the year to year fluctuations in the market price of bananas in the UK. Because of this price uncertainty, producers tend to make adjustments in production plans based on some notion of expected price. Our results indicate that banana growers' price expectations are strongly based on previous year's prices. This relationship has been depicted by the high value of β, the coefficient of expectation. The results further show that banana farmers in St. Lucia are responsive to price in adjusting their output. One percent change in price apparently results in about .5 percent change in supply.

With some caution in explaining the results obtained, strategies should be aimed at increasing output to the levels of 1968/69, the peak years for banana production. In order to attain this production and sustain that productivity, special emphasis should be placed on the government's role to facilitate these objectives. In other words, since the price elasticity is both positive and significant, the government may be successful in increasing output by instituting policies that will effectively raise prices. This can be achieved through price supports and/or deficiency payments. Certain basic conditions required for the existence of the banana industry and augmenting production may be to improve efficiency of production, and to provide a lucrative and stable pricing system to the grower. It is possible that these

or similar conditions may imply action at all levels of the industry. This may well avoid the problems currently faced by each stage of the industry and particularly those problems which are eventually transferred to the growers through the price mechanisms.

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APPENDIX

Assumption 1: We assume that farmers adjust their production plans to a desired output level in relation to expected price.

$$Q_t = a_1 + b_1 p_t^* + b_2 C_t + U_t \qquad (1)$$

where

Q_t = output

a_1 = the constant

p_t^* = expected price

C_t = cost of inputs

U_t = random residual term

Assumption 2: Banana producers make their expectation of price in the year of harvest in proportion to the price expected and actually received price in the previous year. This takes the following form:

$$P_t^* - P_{t-1}^* = \beta\{P_{t-1} - P_{t-1}^* \quad 0 < \beta < 1\} \qquad (2)$$

where

P_{t-1}^* = expected price for previous year

P_{t-1} = actual price for the previous year

β = coefficient of expectation (the proportion of the margin by which farmers adjust their expectation).

We assume that β will lie between zero and one.[1] If β equals one equation (2) becomes $P_t^* = P_{t-1}$. Thus P_t^* in equation (1) can be replaced

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[1]Although it is not a necessary assumption, this mathematical property conveniently places a restriction on the limits on values of

by P_{t-1}. This is equivalent to saying that farmers rely solely on last year's price in making their decisions. However, we assume that farmers do not respond solely to last year's price but to expected price and that they revise their expectations continually; therefore, the value of will be less than one (β is restricted).

We cannot observe P^*_{t-1}, so that an estimating equation containing P^*_t cannot be fitted from empirical data. However, given relationships (1) and (2), an equation may be derived whose coefficients can be estimated from observed variables. Estimates of these coefficients, in turn, can be used to estimate the parameters in equation (1). From equation (1), we know that output (Q_t) is a function of expected price (P^*_t), cost of production (C_t) and other influences (U_t). Last year's output (Q_{t-1}) must also be a function of last year's expected price (P_{t-1}), last year's cost of production (C_{t-1}) and other influences (U_{t-1}); thus,

$$Q_{t-1} = a_1 + b_1 P^*_{t-1} + b_2 C_{t-1} + U_{t-1}$$

$$P^*_t = \frac{-a_1}{b_1} + \frac{1}{b_1} Q_{t-1} \frac{-b_2}{b_1} C_{t-1} \frac{-1}{b_1} U_{t-1} \qquad (3)$$

substituting (3) for P^*_{t-1} in (2), we get

$$P^*_t + \frac{a_1}{b_1} + \frac{1}{b_1} Q_{t-1} + \frac{b_2}{b_1} C_{t-1} + U_{t-1} =$$

$$\beta\{P_{t-1} + \frac{a_1}{b_1} - \frac{1}{b_1} Q_{t-1} + \frac{b_2}{b_1} C_{t-1} + \frac{1}{b_1} U_{t-1}\} \qquad (4)$$

multiplying the right hand side of the equation by β we get,

$$P^* + \frac{a_1}{b_1} - \frac{1}{b_1} Q_{t-1} + \frac{b_2}{b_1} C_{t-1} + \frac{1}{b_1} U_{t-1} =$$

$$\beta P_{t-1} + \frac{\beta a_1}{b_1} - \frac{\beta}{b_1} Q_{t-1} + \frac{\beta b_2}{b_1} C_{t-1} + \frac{\beta}{b_1} U_{t-1}$$

combining like terms and expressing in terms of P_t^*, equation (4) becomes,

$$P_t^* = \frac{\beta a_1 - a_1}{b_1} + \beta P_{t-1} + \frac{(1-\beta)}{b_1} Q_{t-1} + \frac{(1-\beta)}{b_1} - b_2 C_{t-1} + \frac{(1-\beta)}{b_1} - U_{t-1} \tag{5}$$

substituting equation (5) for P_t^* in (1) results in

$$Q_t = a_1 + b_1 \frac{\beta a_1 - a_1}{b_1} + \beta P_{t-1} + \frac{(1-\beta)}{b_1} - b_2 C_{t-1} + \frac{(1-\beta)}{b_1} - U_{t-1} + b_2 C_t U_t \tag{6}$$

which simplifies to

$$Q_t = a_1 + \beta a_1 - a_1 + b_1 \beta P_{t-1} + (1-\beta) Q_{t-1} + (1-\beta) - b_2 C_{t-1} + (1-\beta) - U_{t-1} + b_2 C_t + U_t = a_1 \beta + b_1 P_{t-1} + (1-\beta) Q_{t-1} + b_2 C_t + (1-\beta) - b_2 C_{t-1} + U_t - (1-\beta) U_{t-1} \tag{7}$$

$$Q_t = \pi 0 + \pi 1 P_{t-1} + \pi 2 0_{t-1} + \pi 3 C_t + \pi 4 C_{t-1} + V_t \tag{8}$$

Estimates of the parameters obtained from equation (8) was then used to compute algebraically the coefficient of expectation β in equation (2) and to estimate the parameters in the output response relation (equation 1).