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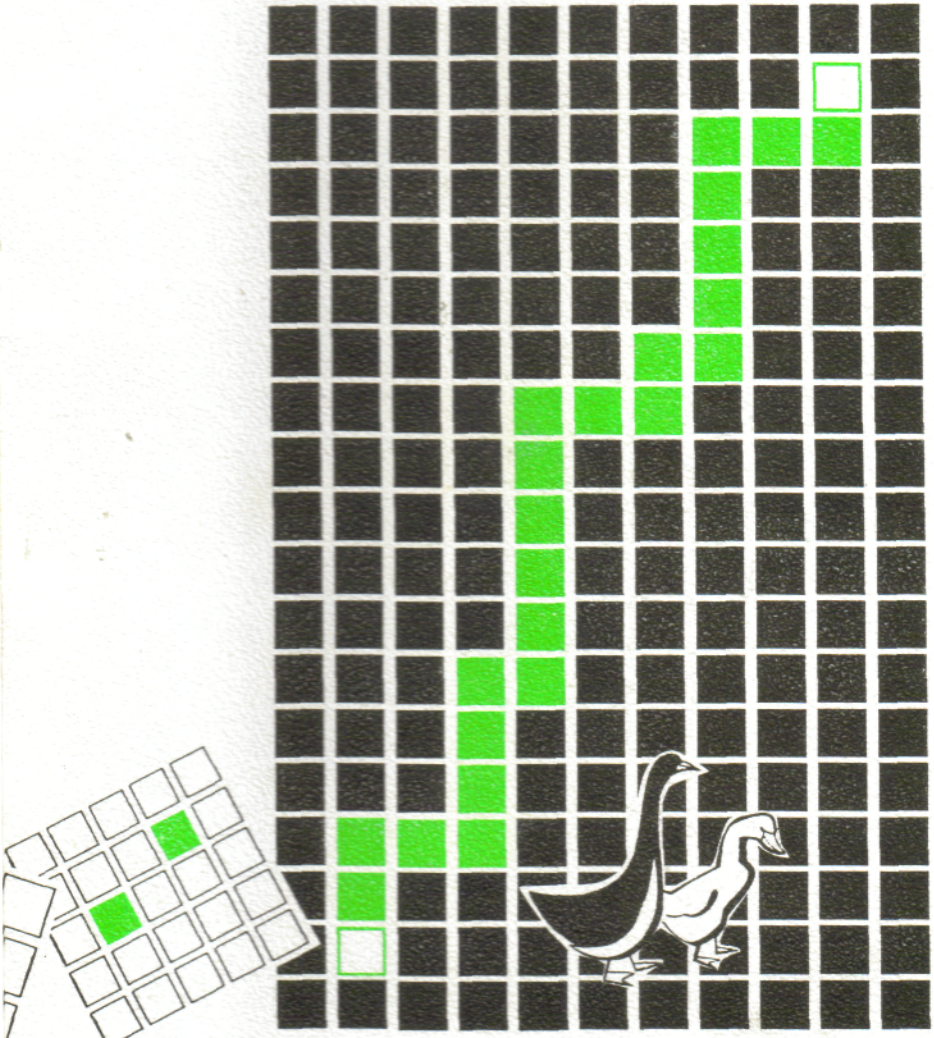

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RESPONSE TO UN-COMPETITIVENESS: RATIONAL OR IRRATIONAL? - THE CASE OF THE ST. LUCIAN BANANA INDUSTRY

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Introduction and Problem Analysis

Competition in the world banana market has become more and more fierce in recent years, as major exporters vie for greater and more secure market shares in existing and new markets. Banana marketing has been dominated by the corporate giants of Dole, Del Monte and Chiquita, and new and more complex trade policies have subtly changed the beneficiaries in this game

As a banana importer, the European Union (EU) is the largest, capturing in 1993 approximately 40 per cent of total world imports. In 1993, this market was supplied from three mam sources:

- EU overseas production (Guadeloupe, Martinique, Madeira and the Canary Islands) which had free access and an average GIF price of ECU 740/tonne;
- African, Caribbean and Pacific countries (ACP) production with free access for traditional quantities and an average GIF price of ECU 665/tonne; and
- Latin American supplies with an average GIF price of ECU 400/tonne.

The volume of supply from the EU overseas countries has been fairly constant at approximately 700 tonnes or 20 per cent of the EU market in the last 25 years, and this was expected to remain fairly steady. Supplies from ACP countries (which represented approximately 16 per cent of the EU market) have risen slightly over time, going from 502,000 tonnes in 1988 to 603,000 tonnes in 1991. In contrast, the volume of imports from Latin America into Europe has risen sharply in the 1980s: from 1,252,000 tonnes in 1985 to 2,391,000 tonnes in 1991, to reach a market share of 64 per cent in the EU. In fact, the Latin American exporters, which accounted for almost 75 per cent of world exports in 1993. are more efficient producers than the ACP and overseas EU territories. Latin America therefore has the potential to expand output and is considered to be the lowest cost supplier, with productivity up to double that of other producing areas. In addition, the quality of bananas from Latin America is considered to be more reliable. Furthermore, real prices of bananas has been on a downward trend, despite the fixing of prices for the preferred suppliers.

Another pressure for change will be the expiring of the ACP-Lome agreement in 2002. Preferential access is likely to be lost, especially since the quota on the Latin American bananas is subject to annual review, and is adjusted in line with forecasts of:

- performance of the previous year;
- EU territorial and ACP production trends; and
- consumption trends in the EU

Bananas from St. Lucia, along with those from the other Windward Islands, have traditionally been exported to the UK under Lome preferential trade agreements, which afforded these islands prices greatly in excess of world market prices. However, decisions taken at the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) encourage more international free trade, and the pressure to remove the preferential agreement has intensified. Coupled with this, it is generally agreed that at least some of this preferential treatment will soon be lost. The precise time is uncertain, but whether it occurs in the next year, or the next five years (when the present agreement is due to be reformulated), banana prices offered to St. Lucia will fall.

St. Lucia is the largest banana producer in the Windward Islands. Agriculture has historically been the main contributor to GDP. accounting for an average of 14.31 % of GDP from 1982 to 1991 (data extracted from UN-ECLAC, *Agricultural Statistics,* Vol. X and XI, 1993), with export earnings totaling 69.1% of total income earned by the agricultural sector in 1990 (Economic and Social Review, 1990). The Government of St. Lucia has embarked on a diversification programme which seeks to encourage non-banana production, but its success has been very limited (Alcee, 1994). In light of the international uncertainty, and the proposed agricultural goals, some questions need answers. How do farmers respond to a rise or fall in banana prices? Is their response equal (in absolute terms) in both cases? Until these questions are answered, the policy makers of St. Lucia can only make a poor forecast of the response farmers would make when the market price falls, and diversification programmes may continue to be ill-advised.

According to Behrman (1968), the selection of the proper policies is a matter of considerable dispute, partly because of widespread disagreement over the responsiveness of the agricultural sector in developing countries to various incentives. In theory, producers respond to many factors including product and input prices, technology and access to certain constraining non-price factors of production. The analysis of supply response has been useful in explaining the impact that alternative policy packages or external shocks may have on the producers themselves (Sadoulet and de Janvry, 1995), but at a more basic level, supply response models also serve as a test of the many a *priori* hypotheses about the supply response to price changes In developing countries, these hypotheses may be divided into three major categories:

1. The hypothesis that farmers respond quickly, normally and efficiently to relative price changes
2. The hypothesis that the marketed production of subsistence farmers is inversely related to price; and
3. The hypothesis that cultural and institutional constraints are so limiting that any price response is insignificant.

None of these hypotheses can simply be assumed to be appropriate for any country. So, for each economy, and for each economy sub-sector, the degree of supply responsiveness is basically an empirical question.

The Hypotheses

This paper reports the findings of a study in which two main hypotheses were tested:

1. That a one per cent increase in banana price will have *a* different absolute impact on the quantity of banana exported from St. Lucia, than a one per cent decrease in price.
2. In addition to banana price, there are significant non-price variables that affect the quantity of bananas exported from St. Lucia.

Asymmetric Supply Response

If the response of a producer to a unit increase in price is different (in absolute terms) to the response to a unit decrease in price, the producer is said to have an asymmetric supply response. To capture these possible differences, specific modeling techniques need to be employed. This paper uses three models: an asymmetric supply response model as developed by Wolffram (1971), a modified Woiffram asymmetric model and a symmetric response model.

For the Wolffram model, the price response equation can be written as:

$$Vi = {}^{a}iO + {}^{a}\, ik^{x}\, i_{k} + 3\, i_{k}X\ iii$$

i = 1.... n; (number of observations) k = 1,..., m (number of independent variables)

where y, = dependent variable $a_{,0}$ = additive constant a,k = coefficients of regression x_{ik} = independent variable

Wolffram splits the price variable into two: a phase of increasing prices, and a phase of decreasing prices (x'_{k} and x^{f}_{k} respectively). His procedure is based on the calculation of first differences (A x_{ik}) of observations of the independent variable:

$$A\ Xjk = X,k - X;.1\ j,$$

for i = 2.3 ..... n
andj = 1.2 .....n-1

These first differences are used for the formation of variables for increasing and decreasing phases. Considering the above condition, therefore, the variables x'_{ik} and $x^{!}_{lk}$, should have the following requirements:

1. (a) $x_{,k}$ should be separated into A $X|_{k} > 0$ and A $x_{mk} < 0$:

(b) $x_{,,} = x^{r}$. ; „, if A x_{ik} < 0 and $^{!}_{lt}$ = Xj.i.$_{k}$, if A 0

2. The number of observation values must remain constant; this is fulfilled by realizing (1) above.

3. The sequence of rates of change and therefore the position of the respective positive or negative changes within the sequence may not be altered.

Starting from these requirements, the formation of the two variables is effected in the following manner: the x^r_k variable is formed by adding the first difference A x_{tk} >0 to the first observation which can be any value 0. With the data transformed into logarithms, the mathematical procedure for obtaining the Wolffram price rise variable x^r_k, is summarized below:

$$(X_{2k} - X_{1k})$$

$$X\ nk \sim X_{n\_1\ k}\ ^{+}\ 4> (^{x}nk \sim X_{n\_}\ 1\ _{k})$$

$x_{,k}$ = the first observation of the initial variable x_k

<l> = 1 if $(x_{ik}-x_{i.1.k})>0$
4>= 0 if $(x_{lk}$ - $x_{,.,\ k})$ < 0

The fall variable is obtained in a similar fashion:

$$x^f2k ^= x'_{1k} + (1\ -4)\ )(x_{2k}-x_{1k})$$

$$x'nk = X^{f}{}_{n\_1\ k}\ ^{+} (1\ \ -<t>\ )\ (Xnk-\ X_{n.,.k})$$

where the requirements for the value of 4> remain the same.

Careful interpretation is needed for the signs of the computed coefficients. As is expected, a rise in the price rise variable indicates a rise in the price of y, which leads to a rise in its supply, so a positive coefficient is expected for this variable. However, a rise in the price fall variable is really a fall in prices, and so it is expected that the supply of y will fall as this variable rises, so a negative coefficient is expected for the price fall variable.

The Mode! of Traill ef a/. (Modified Wolffram Model)

Traill ef a/. (1978) later reformulated the asymmetric supply response model. In their estimation, the equation could be written as Q, = p_0 + P, WR, + (3_2 WF, where WR, is the sum of all period-to-period increases in expected price (P^*_t) from its initial value up to period *t*\ WF, is the sum of period to period decreases in P^*_t. It should be noted that in the Modified Wolffram Model, the coefficient of MWR, no longer represents the response of output to every price rise, but the response to a price rise beyond the previous maximum. The coefficient of MWF, shows the response of output to price movements in either direction below the historical high. Therefore, estimating the Modified Wolffram Model: Q, = Po + p, MWR, + P_2 MWF, + e, is equivalent to estimating Q, = a_c + a, P*. + a_2 P^*_{max} , + e,, where P^*_{max}., is the previous maximum expected price, p, = a-, , p_2 = a, +a_2, and that P*, = P*,. ,. In Wolffram's presentation , the variable WF, is positive rather than negative. It is anticipated that the estimated response of output to a rise in price (Pi) would be greater than the response to a fall in price (p_2).

The criticism by Traill *et al.* of the Wolffram technique in supply response studies is its implication that for given starting and finishing prices, the greater the price changes in the intermediate period, the larger is output at the end of the period. Most economists would probably argue that given a high correlation between price variability and uncertainty, highly variable prices would lead to a reduction in output due to risk considerations Therefore, it is possible that the poor empirical results obtained when trying to estimate nonreversible supply functions using this model may be attributed to the unrealistic pattern of supply response which it implies, rather than to multicollinearity between the price series as suggested by some authors.

Asset Fixity

Johnson's work (as cited by Traill ef a/., 1978) on asset fixity provides the main theoretical justification for the asymmetric supply relationship, and implies a pattern of response which is unlike that proposed by Wolffram. According to this theory, changes in the use of an input as the price of the end product varies can be represented by a step function, one in which the step part of the function always moves to the point of existing factor use. This results from a divergence between the acquisition cost (AC) of an input and its salvage value (SV). As shown in figure 1, at the point a. where the marginal value product (MVP) of the input is equal to its acquisition cost at an expected product price of PO, an increase in product price would shift the factor demand curve to the right along the AC curve, increasing factor use (Q). However, in the reverse direction, factor use would not fall until the input's demand curve intersected the SV curve to the left of point *b* (at P2 in the diagram) when factor use would also become inelastic in the downward direction. What is important, in view of the current discussion is that following a product price fall from PO to P2, price would have to rise beyond PO before input use would again become elastic. As the factor use and product supply functions are closely related through the production function, it is reasonable to represent product supply as a similar step function.

For empirical purposes, it is assumed that the elastic portion of the supply curve in response to falling prices is unimportant (that is, prices do not fall sufficiently to warrant disposal of large fixed assets). The AC curve down to a together with the vertical extension to the point Q1 can therefore be viewed as the product supply function. Then, following a fall in price and movement down the inelastic portion of the supply function, price must regain its previous high level before response becomes elastic. A ratchet mechanism is therefore obtained. This can be represented easily by a simple modification of the Wolffram method; when price rises but remains below its previous high level, the amount of the price change is added to the price fall series (MWF.) rather than to the price rise series (MWR_t). Table 1 provides a comparison of the Wolffram and Modified Wolffram variables and output implications for hypothetical expected price series and supply equations.

There are, however, according to Traill *et* a/., two noteworthy issues First, asset fixity, the source of asymmetry, is a short-run phenomenon In the long run, as fixed assets wear out, they are not replaced if their marginal value product is below their acquisition cost, thus c is a long run equilibrium at price P2 in figure 1, implying a symmetric long run supply function. In order to permit an empirical model to display asymmetric short run but symmetric long run response, an Almon lag could be applied to each price series. Second, not only may the expected price of the commodity under consideration be important in determining its production, but also the expected price of substitutes or complements.

Data

Monthly time series data was collected for January 1984 to December 1994. The monthly quantity of bananas exported from St. Lucia was regressed against the price of bananas received by farmers from the Banana Growers' Association , the prices of the major root and vegetable crops yam, dasheen, sweet potato, tannia, cabbage, lettuce, tomato, cucumber, sweet potato, corn and pumpkin, the price of plantains (a member of the banana family which is also intercropped), rainfall, and the presence of crop insurance. WINCROP (The Windward Island Banana Crop Insurance) was introduced by the St Lucia Banana Growers' Association (SLBGA) in late 1987 for banana farmers, to compensate for loss due to windstorms. This is therefore included to capture the response of banana farmers to this risk reducing activity.

Banana prices and quantity was obtained from WIBDECO. Reliable figures on the monthly banana production could not be obtained for the specified period, so the quantity of bananas exported from St. Lucia was used as a proxy. The quantities are quoted in tonnes and reflect to a very large extent the amounts produced, because almost all the bananas produced are exported with only a small proportion used domestically or traded regionally.

The time series data for the interplanted crops' prices was obtained from *the Prix Produit* annual statistical data series produced by the Agricultural Statistical Unit, Ministry of Agriculture, St. Lucia.

A dummy variable for the introduction of WINCROP was developed. A value of 1 was used for each period of its existence (October 1987 to December 1994), and a value of zero was used for all periods preceding its introduction.

Monthly rainfall data was obtained from the database of the Agricultural Engineering Services Division, Ministry of Agriculture, St. Lucia. This data was for La Caye, a representative banana producing area, for which a full data series was available for the period under investigation.

All nominal prices were quoted in cents per kilogram, and deflated using the Retail Price Index (RPI) obtained from WIBDECO for April 1984 to December 1994, with April 1984 as the base year. The values of the RPI for January to March 1984 was calculated using Consumer Price Index values

This price is less the charges for administration costs, cartons and **WINCROP.**

Detailed information on the occurrences and impact of storms and hurricanes for St. Lucia could not he reliahlv obtained for the entire sample period, so the effect of this variable could not be modeled.

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obtained from the *International Financial Statistics.* (August 1984).

The Model

An initial symmetric model was constructed. This was a log-linear equation of prices deflated with the St. Lucian Retail Price Index, and regressed using OLS with EViews Version 1 0 (MicroTSP for Windows, 1994):

(1) $Q_t = C + a_1B_{t} + a_{2l} P_{lt} + a_3R_{t-3} + a_4D_{t-6} + u_t \quad i = 1....6$

where Q = banana exports C = constant term B = banana price Pl = local market prices of yellow yam, dasheen, tannia, sweet potato, plantain and pumpkin Dj = dummy variable for the introduction of WINCROP R = rainfall u = error term and a subscript *i* applied to all variables to represent time periods.

All insignificant variables were then systematically removed, and the length of the lag for banana prices was also increased until a significant response was obtained:

(2) $Q_t = C + a_1B_{t-18} + a_2S_t + a_3Pl_t + a_4Pu_{t-9} + a_5R_{t-6} + a_6Dummy_t + u_t$

The significant 18-period lag for the banana variable was used in subsequent models to determine if this significant response was in fact asymmetric. This lag (an 18 month lag). relates well to the physiological development period of the banana plant. According to Purseglove (1978), the time from planting to harvesting for the plant crop is 9 - 18 months, depending on factors such as the cultivar, local climate and cultural conditions. This period depends on the fact that different types of planting materials can be used: from sword suckers to bits of large corms. Purseglove (1978) further outlines that a sucker is planted when it is 6 - 8 months old. Seven (7) to 9 months after this planting, the inflorescence is formed which takes approximately 1 month to emerge. It then takes about 3 months to the time of harvesting the bunch.

The simple symmetric model was then compared with the Wolffram and Modified Wolffram asymmetric models. The banana price variable (B) was replaced by price rise and price fall Wolffram variables denoted as WRI and WFA respectively. In the first instance, both rise and fall variables were lagged 18 periods (equation 3).

(3) $Q_t = C + a_{1r}WRI_{t-18} + a_{1f}WFA_{t-18} + a_2S_t + a_3Pl_t + a_4Pu_{t-9} + a_5R_{t-3} + a_6Dummy_{t-6} + u_t$

Then these variables were lagged alternatively, and finally, the lag on both variables were removed.

This procedure was repeated for the Modified Wolffram Model, where the price rise and fall variables are respectively MWRI and MWFA (equation 4):

(4) $Q_t = C + a_{1r}MWRI_{t-18} + a_{1f}MWFA_{t-16} + a_2S_t + a_3Pl_t + a_4Pu_{t-9} + a_5R_{t-3} + a_6Dummy_{t-6} + u_t$

Results

The Symmetric Model

The OLS estimate of the symmetric model is shown in table 2. All variables in the model were significant at the 5% level, and an adjusted R^2 value of 0.467 was obtained. The coefficient of the banana variable, which is the own price elasticity of supply was found to be 0.258.

While this coefficient had the expected sign, the symmetric response of banana production was very inelastic. Sweet potato and plantain had negative signs, which suggested that these crops are substitutes for bananas in the banana sub-system. It was expected however, that in the banana sub-system, plantain would be a substitute, as it is a member of the banana family, and shares similar cultivation and harvesting practices. In addition the inputs of fertilizer, pesticides and labour can be easily transferred from one crop to the other. On the other hand, it was expected that other crops such as sweet potato and pumpkin should serve as complements, since based on the planting system, these crops can easily be grown in the spaces between the banana plants, so that the result of a negative coefficient for sweet potato is not expected.

The pumpkin variable had a positive coefficient which suggested that it was a complement in the banana sub-system, which fits the expectation for this variable. Further, the rainfall and dummy variables had positive coefficients as expected, since an increase in rainfall was expected to improve the development of the banana fruit (up to a tolerant level), and the presence of crop insurance was expected to prompt banana farmers to increase investments in the banana oroduction. Therefore, these results are consistent.

The Wolffram Model

The OLS output of equations 3.1 - 3.4, which are variations of the Wolffram Model are given in table 2. The results indicated that when the price rise and fall variables were both lagged 18 periods (equation 3.1), all the variables in the model were shown to be significant at the 5% level, and the model had a fit of 0.464, which was almost identical to the fit of the symmetric model. The fall variable had a negative coefficient as expected, and the value of -0.252 indicated that a one per cent fall in banana prices led to a 0.252 per cent fall in banana exports. What is interesting here is that the absolute values of the price rise and fall variables in this model were similar (coefficient of WRI is 0.245), and therefore a t-test was done to determine if the absolute values of the two coefficients were significantly different from each other. All other variables have the same sign and approximately the same values as in the symmetric model.

For equations 3.2 - 3.4 (see table 2), the banana price variables were insignificant, and all other variables, except the plantain variable were significant (the plantain variables in these models however, continued to have a negative sign), which suggested that banana prices, as modeled, had no impact on the quantity of bananas exported from St. Lucia. All non-banana variables had the same sign as in the symmetric model

Testing the Equality of the Regression Coefficients

For a regression model of the form: Yi = ai + a_2 X_2, + a_3 X_{3i} + a, the hypothesis that the coefficients of the banana price variables of equation 3.1, $<x_2 = <x_3$, was equal, was tested using the t-statistic:

t =

[var ($<x_2$) + var (a_3) - 2 cov (a_2, a_3)]

which follows the t distribution with N - 3 degrees of freedom (in general, for the k-variable case the degrees of freedom are N - k) (Gujurati, 1978). The results of the test of equality of the regression coefficients for equation 3.1 is given in table 3.

It was found that for equation 3.1, the coefficients of the price rise and fall variables were significantly different from each other. However, to test the equality of *the absolute values of these coefficients,* under the title Eqn 3.1 (New), it was assumed that the value of the price fall variable is +0.252. and that the covariance of both variables was positive (+0.009627). The t-statistic computed showed that for the absolute values of the price rise and fall variables, the coefficients were not significantly different from each other, which implied that an asymmetric relationship between banana prices and banana exports did not exist.

The Modified Wolffram Model

The estimates of the Modified Wolffram Model (equations 4.1 - 4.4) are shown in table 4. Of all the equations, only equation 4.3, in which the rise variable (MWRI) is in the current period, and the fall variable (MWFA) is lagged 18 periods, gave price variables which were both significant at the 5% level. In addition, all other variables in the model were significant, and had the same sign as equation 3.1. As was expected in equation 4.3, the rise and fall variables were both positive, and further, their values were very different from each other. What is noteworthy here is that the only equation which showed significant price variables was that in which the rise variable was not lagged, and the fall variable was lagged 18 periods. Initially, the results implied that a one per cent rise in banana prices above the previous maximum led to a 0.961 per cent rise in the quantity of banana exported. Further, a one per cent increase in banana prices below the previous maximum led to only a 0.231 per cent increase in the quantity of bananas exported. As was expected, the response to the price rise variable here was much more elastic than the response to the price fall variable.

The result of the test of the equality of these coefficients is shown in table 5.

From a cursory glance, it appeared that the coefficients of the price rise and fall variables were very different from each other. However, table 5 indicated that these coefficients were not significantly different from each other, which like equation 3.1. showed that an asymmetric relationship between banana prices and banana exports did not exist.

Further, it was not shown by the results in table 5 that the Modified Wolffram Mode! is superior to the Wolffram Model. as the same relationship was found in both, and the R^2 values were only slightly different from each other.

Conclusions

Non-price variables were shown to have a significant influence on the quantity of banana exported in St. Lucia. According to the models, the most important crops were sweet potato, plantain and pumpkin. The former two acted as substitutes in the banana sub-system, and the latter acted as a complement. Other significant non-price variables were rainfall, whose influence was shown as a lag of 3 periods, and the presence of WINCROP, a crop insurance whose influence was shown by a lag of 6 periods.

It was also concluded that the response of banana farmers in St. Lucia to changes in banana prices is symmetric. The elasticity of response in the symmetric model was 0.258, which is very well supported by the Wolffram equation (3.1), whose rise and fall variable coefficients are 0.245 and 0.252 respectively. Since the Modified Wolffram Model further supports the existence of a symmetric relationship, the symmetric model appeared to best provide all the supported results. The price response was determined to be inelastic, which means that there would be a slow response to the eventual fall in banana prices. This implies that as banana prices fall, farmers would continue to grow bananas, and be placed in a less and less competitive position on the world banana market. Not only would these farmers be making less profits, but this behaviour also means that the economy's resources would be tied up in banana production, leading to a steady increase in the opportunity cost of banana production, so that not only would the banana sub-sector suffer, but all other sectors which compete for the use of its resources.

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Table 1: Wolffram and Modified Wolffram Methods of Segmenting the Price Series and Their Output Implications

Time (t)	P,	WR,	WF,	WQ,[a]	MWR,	MWF,	MWQ,[b]
1	9	0	0	20	0	0	20
.	1	5		30	5	0	30
	i	5	'	23	5	-7	23
I	-		-10		5	-10	20
		.	-10	34	"	-3	27
		12	-12	[illegible]	5	-5	25
	-	*1*	-12	42	5	0	30
	e	19	-12	16	7		34
		19	-17	1	7	-5	29
10	18	26	-17	55	9	0	38

[3] Employing the equation WQ, = 20 + 2WR, •*• WF. "'

Employing the equation MWQ. = 20 + 2MWR, + MWF.

Source. Traill *et at.* (1978).

Table 2: Estimation Results : Symmetric and Wolffram Models

Eqn	°	MS)	WRI t!8L	WFA (-18)	WRI	WFA	S	PL	PU (-9)	R(-3)	Dummy (-6)	R^2	d
2	7.280 (11.05)	0.258 (2.64)					-0.294 (-3.66)	-0.244 (-2.25)	0.176 (2.96)	0.068 (2.70)	0.299 (6.93)	0.467	1.567
	6.838 (9.35)		0.245 (2.33)	-0.252 (-2.642)			-0.280 (-3.26)	-0.253 (-2.31)	0.179 (3.00)	0.072 (2.74)	0.331 (4.74)	0.464	1.569
; 2	6.945 (8.06)		0.133 (1.06)			-0.134 (-1.27)	-0.287 (3.048)	-0.238 (-1.941)	0.184 (3.00)	0.087 (3.37)	0.340 (4.74)	0.435	1.499
• 3	7.417 (10.05)			-0.104 (-0.85)	0.081 (0.55)		-0.222 (-2.59)	-0.181 (-1.67)	0.180 (271)	0.093 (3.67)	0.356 (4.66)	0.436	1.488
i-1	8.645 (14.11)				-0.055 (-0.54)	0.023 (0.28)	-0.197 (-2.52)	-0.075 (-0.77)	0.267 (5.56)	0.083 (3.25)	0.334 (4.61)	0.507	1.432

Values in parenthesis indicate the t-statistic for the variable.

Table 3: The Equality Of the Regression Coefficients : The Wolffram Model

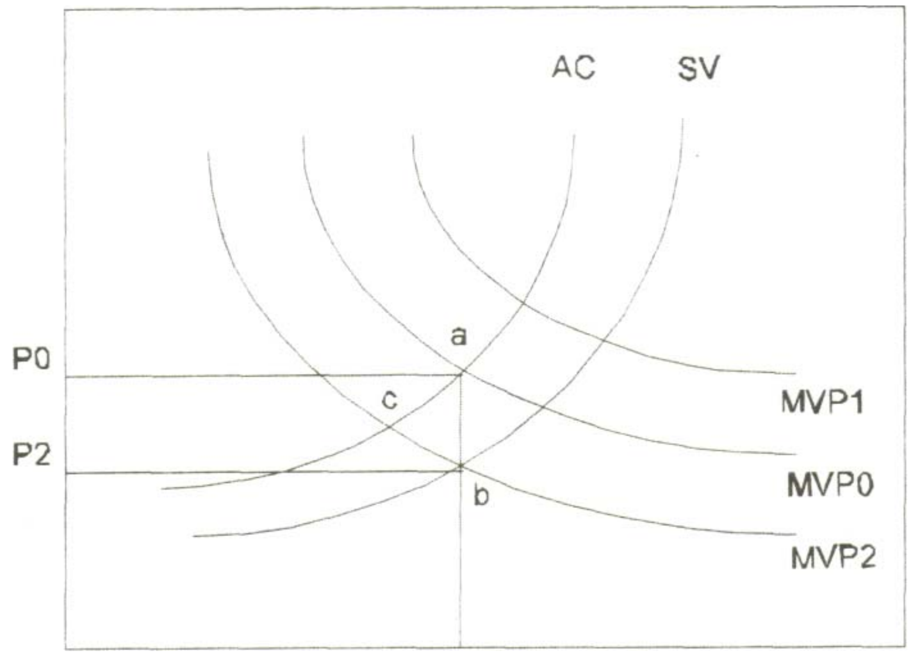
	Eqn 3.1	Eqn 3.1 (New)
0.2	0.245	0.245
,	-0.252	0.252
Var(«2)	0.011062	0.011062
Var(tt3)	0.009120	0.009120
COV(*0.2, 0.3)*	-0.009627	+0.009627
d.f	96	96
t-statistic	2.503	-0.1717
Fail to Reject H_0	x	/

Table 4: Estimation Results: Modified Wolffram Model

Eqn	C	TYaT	%?	MWRI	MWFA	S	PL	PU(-9)	R(-3)	Dummy (-6)	2	d
4.1	6.359 (7.03)	0.408 (1.86)	0.229 (2.18)			-0.331 (-3.53)	-0.265 (-2.37)	0.152 (2.27)	0.064 (2.43)	0.251 (3.31)	0.465	1.590
4.2	6.399 (6.52)	0.378 (1.60)			0.014 (0.17)	-0.344 (-3.59)	-0.221 (-1.88)	0.135 (1.88)	0.074 (2.75)	0.205 (2.72)	0.438	1.516
4.3	6.008 (6.20)		0.231 (2.20)	0.961 (2.11)		-0.320 (-3.63)	-0.241 (-2.26)	0.164 (2.59)	0.072 (2.92)	0.259 (3.79)	0.470	1.594
4.3	7.363 (9.75)			0.599 (1.92)	-0.035 (-0.45)	-0.276 (-3.40)	-0.087 (-0.91)	0.199 (3.90)	0.077 (3.02)	0.196 (3.07)	0.522	1.480

Table 5: The Equality Of the Regression Coefficients : The Modified Wolffram Model

	Eqn 4.3
0.2	0.961
«3	0231
Var(ce_2)	0.206630
Var(a_3)	0010964
Cov(a_2, a_3)	0.004139
d.f.	96
t-statistic	1.596
Fail to Reject H_0	*S*



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Source. Adapted from Figure I: -\sset Fixity b\ Trail et. a l . (I978)

Figure 1: Asset Fixity