

The supply response of cocoa farmers to economic, social and other variables in Trinidad and Tobago

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A major problem that has faced the cocoa industry in Trinidad and Tobago has been a large decline in cocoa beans exported, from approximately 6,213 tonnes in 1970 to 517 tonnes in 2009, despite continuous rises in price over the same period. This research paper presents an analysis of the supply response of the cocoa farmers to prices and other variables. The analysis utilized a modified Nerlovian model (logarithmic form) after statistical tests were conducted to establish if the time series data is stationary over the years 1969-2009. Other statistical test results determined that the regression model met the classical assumptions of Ordinary least Squares (OLS). The regression results indicated a short-run price elasticity of supply of 0.36 and a long run price elasticity of supply at 1.07. Other variables, which significantly determined the supply of cocoa, were the dry season rainfall lagged one year as well as the lagged wet season rainfall. Based on these results, recommendations were suggested to develop and expand cocoa output in Trinidad and Tobago. These included the long term benefits of increasing the price of cocoa paid to farmers and assisting farmers with the negative effects of above average rainfall on storage and disease incidence of this crop through extension advice and infrastructural modifications.

Keywords: Elasticity, unit root, cocoa, Nerlovian model, supply response

Despite Trinidad's fine quality cocoa fetching premium prices in the world market and used heavily as a flavour resource by chocolate manufacturers its exports continue to decline. The traditional crop cocoa is under steady decline or downward trend in output/yield and exports (Figure 1). Over the 44-year period, cocoa exports fell, from as much as 6,213 thousand kilograms in 1970 to 517 thousand kilograms in 2009 (Figure 1). This is approximated to 6,213 tonnes for 1970 and 517

tonnes for 2009. This decline occurred despite the fact that the price of cocoa increased over the same period of time. Furthermore, exports continue to decline. This suggests that other factor(s), be they economic or not, impacted the supply of cocoa in Trinidad.

In Figure 1 the Y axis is the quantity of cocoa exported in 000 kilograms, while the X axis is years 1965-2010. This project endeavours to determine the causes of such a massive decline over the past 44 years.

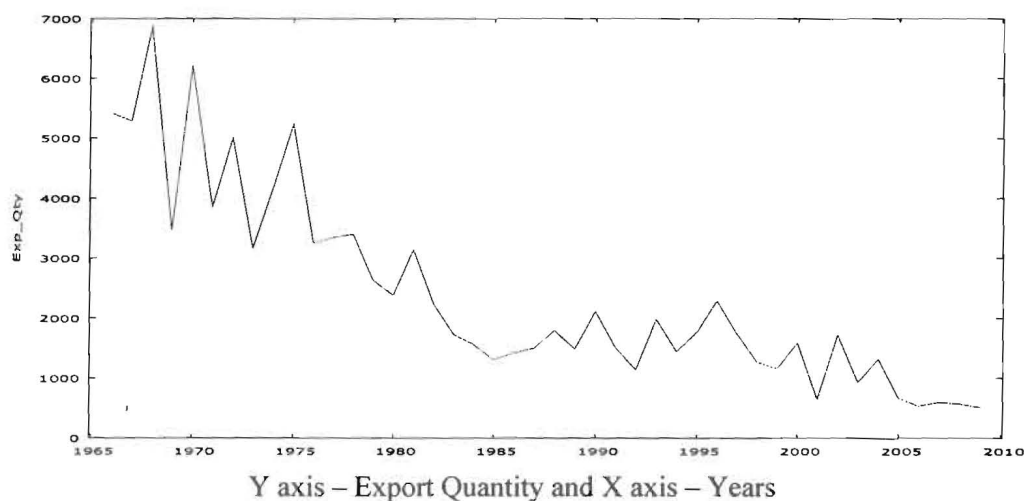


Figure 1: Cocoa Bean Exports from Trinidad and Tobago for 1966-2009

In a paper titled, *A Review of Agricultural Policies: Case study of Trinidad and Tobago*, done under the auspices of CARICOM, Singh, Rankine and Seepersad (2005, 18) stated:

“Although the country produces ‘fine flavoured cocoa’, a premium commodity in the export market, production has continued to decline from historical highs, despite various incentives provided to the industry over the years. The industry is characterized by residual itinerant growers in certain parts of the country. Despite efforts at restructuring raw cocoa processing, the responses have been marginal. Activities within this sub-sector are guided by the State-run Cocoa and Coffee Industry Board. The favourable conditions in the international market for Trinidad and Tobago’s cocoa seem not to have been exploited to the benefit of primary producers.”

Brief history of the cocoa industry

The cocoa industry in Trinidad dates to the mid 18th Century. Forastero (exotic) variety cocoa from Venezuela was introduced to replace the Criollo (native) variety, which was severely damaged by a major catastrophe in 1727 (disease or hurricane).

At that time, most exports of this traditional crop to Europe originated from Spanish territories in South America. However, by the early 19th Century, political upheaval and a drive for independence affected the supply of cocoa from these South American territories and market prices soared. This brought about increased production in Trinidad.

Trinidad and Tobago’s production experienced a major expansion in the early 19th century. However, this was followed by a rapid decline in production, mainly due to excess supply and labour problems resulting from the abolition of slavery. It was only in 1866 that the demand for cocoa once again increased due to the popularity of chocolate drinks and chocolate as a confection. The period 1870-1920 is known as the Golden Age of cocoa production.

The golden age’s production of cocoa had the highest levels in Trinidad and Tobago’s history, with the value of cocoa exports surpassing that of sugar, rum and molasses (Pemberton and Ragbir 2005, 188-222). Production rose from an average annual quantity of 6,241 tonnes in 1880-1889 to an all time high of 26,619 tonnes between 1920-1929.

Production of cocoa steadily declined over the decades after the golden age. It could be said that the golden age was the peak of production in the first ¾ of 20th century time series. There were factors that caused the decline. These include World War I, the great depression of the 1930s, abandonment of estates that were no longer profitable and diseases (Witches’ Broom in 1928) and (Cocoa Wilt in 1957), World War II and the oil boom in Trinidad and Tobago (Pemberton and Ragbir 2005, 188-222).

The fall in production led to government intervention, with subsidy and rehabilitation schemes (Bekele 2004, 4-12). This occurred from 1945-1965 (post World War II to oil boom). A further national rehabilitation programme occurred from 1979-1988, resulting from loss of labour, a contraction of the industry and abuse of the subsidy programme (Bekele 2004, 4-12). In 1980, local output was less than 0.1% of the world’s production.

The establishment of the Cocoa and Coffee Industry Board (CCIB) in 1962 was another effort to resuscitate the industry. The formulation of strategic plans by the CCIB, preparation of reports by technical personnel from Ministry of Food Production and periodic surveys of the cocoa industry (Bekele 2004, 4-12) were all strategies to increase production in the industry.

In recent years, production has declined steadily. It is noted that labour shortages, replacement of cocoa trees with coffee or other perennial fruits, high production costs, losses due to diseases and low prices paid to farmers are possible causes of the decline. (Bekele 2004, 4-12; Pemberton and Ragbir 2005, 188-222)

Labour has declined from 10,000 farmers in the cocoa and coffee industry in 1966 to

3,599 farmers by 2004 (Bekele 2004, 9). Furthermore, with low cocoa yields (less than 200kg per ha) production costs were cited by Bekele (2004, 4-12) as TT \$7- 11/kg. The replacement of cocoa trees involves the farmer's decision to plant what he/she thinks is best and most profitable.

Reasons for decline - The Present Context

In the present context of cocoa farming, there are some possible causes of the decline of cocoa production. Some problems, identified by the Cocoa and Coffee Board of Trinidad and Tobago (CCIBTT), include the two point payment system (with one payment deferred), limited or poor access roads to farms, lack of technology in farming processes (low level of mechanisation or use of technology), availability of skilled labour and abandoned cocoa estates. The Strategic Plan of the Cocoa and Coffee Industry Board of Trinidad and Tobago outlined these reasons and developed major actions/strategy to counteract the negative effects (CCIBTT Strategic Plan 2009-2014).

The two point payment system, which is an initial payment at point of sale followed by a balance payment at the end of the crop year, was in a number of farmers' opinion unfavourable over the years. There have been farmers, who have lobbied for one full payment at the point of sale and a higher price. The one full payment was eventually implemented in 2012. It has been noted that private exporters offer farmers higher prices for cocoa than those offered by the Cocoa and Coffee Board of Trinidad and Tobago (CCIBTT Strategic Plan 2009-2014, 4).

Road accessibility improvement is another goal. Accessibility to farm sites can prove to be problematic and the CCIBTT has outlined this as an area for development (CCIBTT Draft Strategic Plan 2012-2016, 7). According to same strategic draft plan, there is a lack of technological advancement in farming processes (CCIBTT Draft Strategic Plan 2012-2016, 8).

One of the weaknesses outlined of the cocoa industry is an ageing farming

population. Cocoa is very labour-intensive (Hershey 2011). Few young farmers have entered the industry as it is viewed as labour-intensive and tedious with poor remuneration; little pay for the labourer and low salary and rewards for the farmer (Pemberton and Ragbir 2005, 188-222).

Objectives of this study:

- 1) To determine the elasticity of supply of each variable, which includes economic and non-economic variables (dry season rainfall, wet season rainfall), price of cocoa (lagged), quantity of cocoa exported (lagged) exchange rate and available labour force in agriculture.
- 2) To calculate long run price elasticity of supply.
- 3) To determine which variable(s) have the greatest statistical significance on the production of cocoa as measured via exports.
- 4) To analyse results of the supply response model.
- 5) To suggest recommendations with regard to increasing productivity.

Methodology

Any variable that is measured over time in sequential order is called a time series (Keller 2005, 699). In practice it is important to find out whether a time series possesses a unit root (non-stationary) because a spurious or nonsense regression may occur. A time series with unit root suggests it has a time varying mean or a time varying variance or both (Gujarati 2004, 802). Furthermore, it is important because a non-stationary variable regressed on another non stationary variable can be used only in the period it is being studied and therefore is not reliable for forecast and to make generalizations for other time periods. Non stationarity can be found via a unit root test.

The Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) unit root tests can be utilised (Gujarati 2004, 817). The DF test is used if the error terms u_t are uncorrelated.

However, if the error terms u_t are correlated then ADF is utilised. The ADF is conducted by adding the lagged values of the dependent variable.

If the time series is non stationary, spurious or nonsense regression may occur from regressing a non-stationary time series on another non-stationary time series. The non-stationary time series have to be transformed to make them stationary using difference-stationary processes and trend stationary processes. However, the time series can be tested for cointegration and if cointegration exists, a regression of the non-stationary time series with cointegrated variables will be meaningful (i.e. non spurious) (Gujarati 2004, 820).

In an economic context, two variables will be cointegrated if they have a long term, or equilibrium relationship between them. Cointegration finds out if the regression residuals are stationary.

Cointegration can be found via the DF and ADF test on the residuals of the regression, known in present context as the Engel-Granger (EG) and Augmented Engel Granger (AEG) tests (Gujarati 2004, 823) and the cointegration regression Durbin-Watson (CRDW) test (Gujarati 2004, 824). A more powerful test for cointegration that can be used is the Johansen Method (Gujarati 2004, 823).

The Nerlovian approach of stock adjustment and price expectation models are utilized for this paper. If no unit root is found in two (2) or more variables, especially no unit root of the dependent variable then the Nerlovian model can be adhered to.

In order to ensure the assumptions of the Classic Linear Regression Model hold and the model is Best Linear Unbiased Estimators (BLUE), tests of Autocorrelation, Multicollinearity and Heteroskedasticity have to be done (Gujarati 2004, 219).

Nerlovian Model

The Nerlovian model has been at the backbone of supply response studies. This model, developed by Marc Nerlove in 1956, is still as relevant today as the day it was created. The

Nerlovian model has a long history in published research as noted by Askari and Cummings (1977, 257-292) There have been many empirical studies recorded in academia utilizing the Nerlovian model since the early 1960s (Askari and Cummings 1977, 257-292) Nerlovian type models have had slight modifications made, however, the basic price expectation and stock adjustment model has remained an integral part of subsequent developments to supply response models (Nerlove 1979, 874-888).

Nerlovian model

The basic Nerlovian Model (using output instead of area planted). Nerlove's model can be expressed either as area planted or output response (Gafar 1987, 1221-1231):

- 1) $Q_t - Q_{t-1} = \alpha(Q^*_t - Q_{t-1})$,
- 2) $P^*_t - P^*_{t-1} = \beta(P_{t-1} - P^*_{t-1})$,
- 3) $Q^*_t = a_0 + a_1P^*_t + a_2Z_t + U_t$,

Q_t : is actual output or supply in t .

P_t : Actual price of the crop per unit t .

Q^*_t : "desired" or long run equilibrium supply in t .

P^*_t : "expected normal" price in t for subsequent future periods.

Z_t : Other observed presumably exogenous factors.

U_t : Unobserved "latent" factors affecting area under cultivation t .

α And β : are coefficients of adjustment and expectation.

The parameters, β and α , represent the coefficient of expectation and adjustment respectively. Leaver (2004; 113-131) illustrates the simplified form equation, it is:

Equation (4):

$$Q_t = \alpha\beta a_0 + \alpha\beta a_1 P_{t-1} + (2 - \alpha - \beta)Q_{t-1} - (1 - \beta)(1 - \alpha)Q_{t-2} + \alpha a_2 Z_t - \alpha a_2(1 - \beta)Z_{t-1} + \alpha u_t + \alpha(1 - \beta)u_{t-1}$$

Equation 4 contains lagged dependent variables and the possibility of autocorrelation problems: this is where covariance of any two disturbance terms is $\neq 0$.

If this occurs then the assumptions of the regression model do not hold. Thus the relevant autocorrelation tests can be done to determine if autocorrelation is present and what autoregressive scheme (AR_p) is to be used in the presence of autocorrelation. The experiment can be carried out with the linear or log linear formula to attain coefficient estimates.

Equation (5) reduced form equation, which gives:

$$Q_t = b_0 a_0 + b_1 P_{t-1} + b_2 Q_{t-1} +$$

$$b_3 Q_{t-2} + b_4 Z_t + b_5 Z_{t-1} + v_t$$

$$b_0 = \alpha \beta a_0$$

$$b_1 = \alpha \beta a_1$$

$$b_2 = 2 - \alpha - \beta$$

$$b_3 = -(1 - \beta)(1 - \alpha)$$

$$b_4 = \alpha a_2$$

$$b_5 = \alpha a_2 (1 - \beta)$$

$$v_t = \alpha (u_t - (1 - \beta)u_{t-1})$$

Short term elasticity is derived via the following formula (Leaver 2004, 113-131; Gurikah 2007). For the linear model, price elasticity in the short run is:

$$b_1 \times \frac{\bar{P}}{\bar{Q}}$$

Where

b_1 : coefficient of price

\bar{P} and \bar{Q} : The historical means of price and quantity respectively.

For the log linear model, price elasticity in the short run is derived directly from the coefficient estimates (Gafar 1987, 1223).

The price elasticity in the long run for the log linear model is derived (Braulke 1982, 242):

$$\frac{b_1}{1 - b_2 - b_3}$$

Where:

b_1 : The coefficient of price

$1 - b_2 - b_3$: The coefficient of adjustment

The coefficient of adjustment is calculated by 1 minus the coefficients of Q_{t-1} to Q_{t-n} .

Specification of Price and Quantity

Price is a regular component of the Nerlovian model as is acreage of crop planted or quantity produced (weight). Price is measured in Trinidad and Tobago's currency, \$TT/kg. Price can either be nominal or real. Depending on the level of inflation, deflating the nominal price by utilizing some price index may be a more accurate representation of price. Using the nominal price does not make economic sense if the level of inflation is high because farmers will take into consideration the value of the money they earn from producing the crop, the real purchasing power they attain (Leaver 2004, 113-131). Figure 2 depicts the real price of cocoa beans exported, the Y axis is the real price discounted by using the consumer price index (CPI) to the base year 2005 and the X axis is the annual time series from 1965 to 2010.

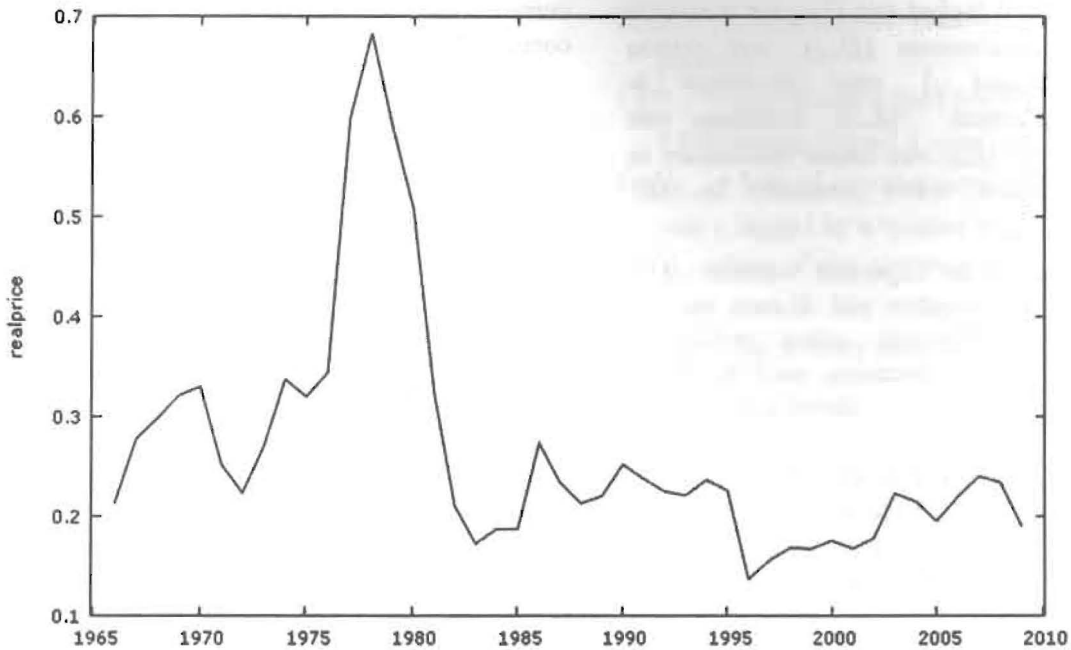


Figure 2: Real Price for Cocoa Bean Exports (1966-2009)

Y axis – Real Price.

X axis – Years.

Perennial crops are slow-to-mature and are productive for over twenty-five years, therefore in each case an individual approach is needed (Askari and Cummings 1977, 257-292). It has been stated that the cocoa crop takes approximately 5 years after planting to begin bearing (UNCTAD 2007). Therefore planting decisions by the farmer are based on current expectations of prices to be realized several years later (Askari and Cummings 1977, 257-292).

Data on quantity of beans exported is the closest data available to represent actual produced weight of cocoa beans in the absence of data on acreage planted. Cocoa in Trinidad and Tobago is primarily produced as a traditional export crop (Bekele 2004, 4-12). The quantity variable is measured as 000' kilograms. This was used in place of acreage of cocoa planted, which is the traditional stock adjustment variable in the Nerlovian Model. The main reason for this was the lack of time series data on acreage planted in Trinidad and Tobago. Whereas, the annual quantity of cocoa exported time series data is available.

The Nerlovian model is an autoregressive model (Leaver 2004, 113-131). The model

contains lagged dependent variables as explanatory variables. Q_t is lagged 2 and 3 years creating the variables Q_{t-2} and Q_{t-3} , respectively. Quantity was lagged to these time periods because, as expected, this perennial crop will take longer to respond to changes implemented by the farmer. Existing stock requires intensive labour as cleaning and pruning are important pre-harvest requirements to maximize yield (Bekele 2004, 4-12).

Farmers, adjusting to increased price by intensifying production, may have to wait a longer period for the respective returns, especially if the farmers are expanding on abandoned estates as described in Bekele (2004, 10) or new and replanted areas that require intensive preparation.

Specification of Z variables

The inclusion of variable Z was anticipated. It is important to include relevant non market variable, Z, (*i.e.* neither price, acreage and yield) to assist estimation of the model (Askari and Cummings 1977, 257-292). The Z variables included in this research are: dry

season rainfall lagged one (1) year measured in millimetres/annum (D_{t-1}), wet season rainfall lagged 1 year measured in millimetres/annum (R_{t-1}), exchange rate US/TT dollar (E_t), and labour availability in the agricultural sector measured in 000' persons (A_t),

Weather is an important variable. It is suggested that weather and disease are the main factors affecting cocoa production (UNCTAD 2007). Diseases, such as Black Pod and Witches' broom, thrive under wet or humid conditions (ICCO 2011). Increased rainfall (above average) can be used as an approximate of increased incidence of diseases affecting cocoa production.

Exchange rate (E_t), US/TT, was incorporated to show the relationship between the US and TT dollar in terms of value of

currency that effects a change on quantity of cocoa beans exported.

The variable labour availability in the agricultural sector A_t was used, where labour in the cocoa industry could not be found. The total labour force willing to work in the agricultural sector was utilized to determine how many people are keen on farming, under the assumption they are motivated by monetary gain. Despite this variable not being specific to the cocoa industry, it gave the general trend and availability of workers for cocoa farming regardless. Figure 3 shows the agricultural labour force in all holdings. There has been a downward trend in the availability of labour from 74,500 persons in 1970 to 22,900 persons in 2009. The X axis is the years 1965 to 2010 and the Y axis is the agricultural labour force (000' persons).

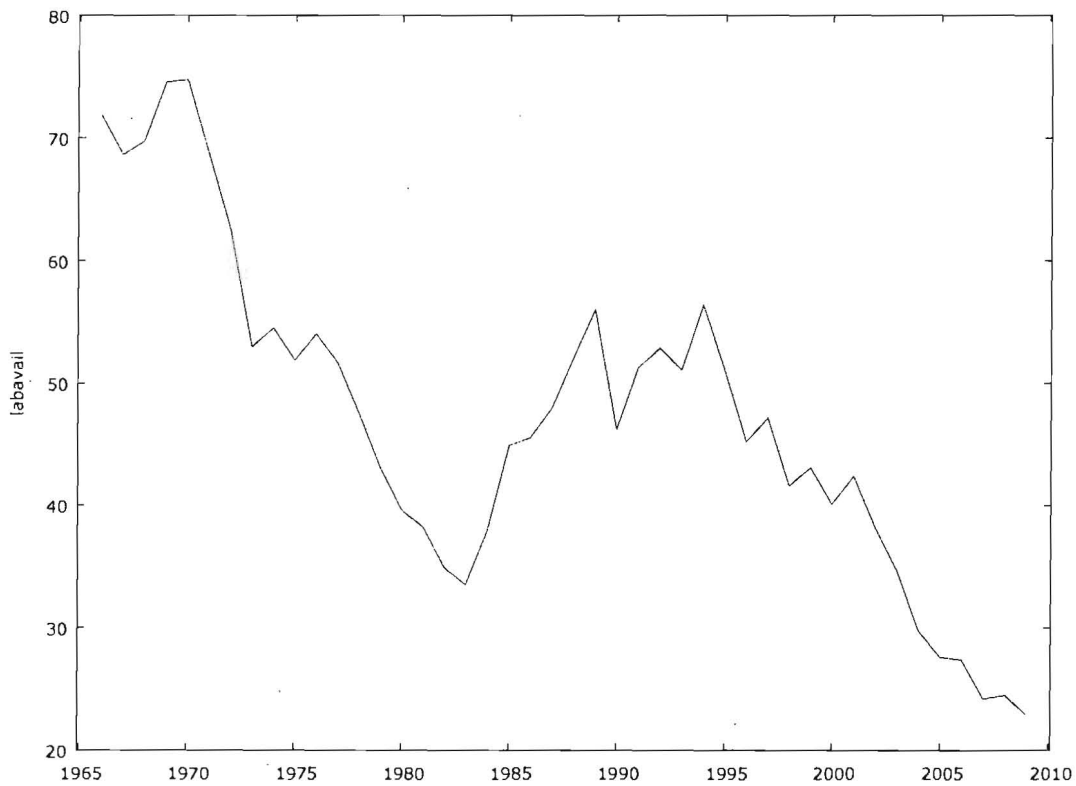


Figure 3: Agricultural Labour Force All Holdings for Trinidad and Tobago (1966-2009)

Y axis – Represents labour availability

X axis – Years

Results

The basic Nerlovian model is modified. The dependent variable, which is used as an explanatory variable, is lagged 2 and 3 years and the real price variable is lagged 3 years to adjust for the perennial nature of the cocoa crop. The model appears initially as:

$$Q_t - Q_{t-n} = \alpha(Q_t^* - Q_{t-n}^*),$$

$$P_t^* - P_{t-3}^* = \beta(P_{t-3} - P_{t-3}^*),$$

$$Q_t^* = a_0 + a_1 P_t^* + a_2 Z_t + U_t,$$

The modified Nerlovian model is:

$$\text{Ln}Q_t = \beta_0 + \beta_1 \text{Ln}P_{t-3} + \beta_2 \text{Ln}Q_{t-2} +$$

$$\beta_3 \text{Ln}Q_{t-3} + \beta_4 \text{Ln}D_{t-1} + \beta_5 \text{Ln}R_{t-1} + \beta_6 \text{Ln}E_t,$$

$$\beta_6 \text{Ln}A_t + u_t,$$

Where:

$\text{Ln}Q_t$ = Log of export quantity of cocoa in period t .

$\text{Ln}P_{t-3}$ = Log of real export price of cocoa in TT/Kilogram lagged 3 years.

$\text{Ln}Q_{t-n}$ = Log of export quantity of cocoa in year t , lagged by n number of years.

$\text{Ln}D_{t-1}$ = Log of dry season rainfall lagged 1 year.

$\text{Ln}R_{t-1}$ = Log of rainy season rainfall lagged 1 year.

$\text{Ln}E_t$ = Log of exchange rate US/TT dollars.

$\text{Ln}A_t$ = Log of agriculture labour force available all holdings per year.

u_t = error term

Table 1: OLS, using observations 1969-2009 (T = 41)

Dependent variable: $\text{Ln}Q_t$

	Coefficient	Std. Error	t-ratio	p-value	
Constant	8.46011	2.49958	3.3846	0.00185	***
$\text{Ln}P_{t-3}$	0.35633	0.139197	2.5599	0.01524	**
$\text{Ln}Q_{t-2}$	0.23829	0.121006	1.9692	0.05737	*
$\text{Ln}Q_{t-3}$	0.428946	0.132251	3.2434	0.00270	***
$\text{Ln}D_{t-1}$	-0.409841	0.102654	-3.9924	0.00034	***
$\text{Ln}R_{t-1}$	-0.705215	0.264588	-2.6653	0.01181	**
$\text{Ln}E_t$	-0.0505471	0.168001	-0.3009	0.76540	
$\text{Ln}A_t$	0.52956	0.196975	2.6885	0.01116	**
Mean dependent variable	7.478315	S.D. dependent variable		0.642053	
Sum squared residual	1.502244	S.E. of regression		0.213360	
R-squared	0.908896	Adjusted R-squared		0.889570	
F(7, 33)	47.03169	P-value(F)		2.32e-15	
Log-likelihood	9.609066	Akaike criterion		-3.218132	
Schwarz criterion	10.49044	Hannan-Quinn		1.773776	
Rho	-0.119700	Durbin-Watson		2.188928	

Legend of important terms used in Table 1 (Gujarati 2005; 81, 129, 137 and 176):

Coefficient – slope coefficient (log-linear model) and measure of elasticity of dependent variable with respect to the independent variable.

Standard Error – the standard deviation of the sampling distribution of the estimator.

t-ratio – ratio of the coefficient to its standard error to test the significance of the coefficients.

p-value – is the exact level of significance.

R squared – measure of goodness of fit of the regression model.

Variable LnP_{t-3} is calculated as 3.56%. It is a positive figure and significant at the 5% level. This price elasticity suggests that a 10% increase in price will have a 3.6% increase in the quantity exported/produced 3 years later.

Variables LnQ_{t-2} and LnQ_{t-3} have elasticity of 0.238 and 0.428 and significant at the 10% and 1% level, respectively. Both figures are positively related to the dependent variable. Therefore an increase in quantity exported will result in a 2.4% increase in quantity exported 2 years later and an increase in quantity exported in the present context will have a 4.3% increase in quantity exported 3 years from now.

Dry Season and Wet season rainfall, both lagged 1 year, were calculated as -0.409 and -0.705 and they are significant at the 1% and 5

% level, respectively. Therefore a 10% increase in rainfall in the dry season will result in a 4.1% decrease in quantity exported 1 year later. While a 10% increase in wet season rainfall will result in a 7.1% decrease in the quantity exported 1 year later.

Exchange rate was calculated as -0.050 but this variable was found to be insignificant in the regression results. Finally, the variable labour availability had a positive coefficient of 0.529; therefore a 10% decrease in labour availability in agricultural holdings (*ceteris paribus*) causes a 5.3% decrease in quantity of cocoa beans exported. Long run price elasticity was calculated utilizing the formula of Brulke (1982; 242). It was calculated to be 1.07. This value is greater than 1. Hence it is elastic.

Unit Root and Cointegration

Table 2: Unit Root and Cointegration Test Results

Constant (c)	Actual (r) tau		Critical (r) tau	
	LO0	LO1	1%	5%
LnQ_t	-1.53754	-0.635614	-3.58	-2.93
LnP_{t-3}	-1.77411	-2.37664	-3.58	-2.93
LnD_{t-1}	-6.23938	-3.44315	-3.58	-2.93
LnR_{t-1}	-5.76038	-3.20546	-3.58	-2.93
LnE_t	-0.791323	-0.885763	-3.58	-2.93
LnA_t	-0.511564	-0.725794	-3.58	-2.93
Uhat	-7.2214	-5.9766	-3.58	-2.93

Unit Root was found in all but two variables at the 5% critical tau. Utilizing the ADF test on the individual variables, dry and wet season rainfall were the only stationary variables where the absolute tau values exceeded the critical tau values. Therefore the cointegration test had to be conducted. The cointegration results concluded that the residuals of the regression were stationary and

therefore the null hypothesis of unit root or non-stationary time series is rejected and the cointegrated regression is not spurious. See table 2. The cointegration tests were conducted on models with constant to lag order 0 and 1 (LO0 and LO1). The actual (r) tau of the residuals of -7.2214 and -5.9766 at LO0 and LO1, respectively exceeds the critical (r) tau at the 1% level.

Autocorrelation and Heteroskedasticity Test Results

Table 3: Autocorrelation and Heteroskedasticity Results

Degrees of Freedom	Actual Chi Square	Critical Chi Square		Result
		5%	10%	
3	6.204304	5%	10%	No Autocorrelation
		7.81473	6.25139	
34	35.505960	48.6024	44.9032	No Heteroskedasticity

The Breusch Godfrey (BG) test (Gujarati 2004) was used to test for autocorrelation. It was observed that the critical chi square does not exceed the actual chi square at the 5 and 10% critical levels. The p value is calculated: $p\text{-value} = P(\text{Chi-square}(3) > 6.20434) = 0.102$. Therefore there is no serial correlation of the error term and the null hypothesis of no autocorrelation is not rejected. The White's Test (Gujarati 2004) was utilized to test for heteroskedasticity, the results in Table 3 show that the actual chi square did not exceed the critical value at the 5 and 10% levels. The p-value was also calculated with $p\text{-value} = P(\text{Chi-square}(34) > 35.505960) = 0.397177$. The null hypothesis of no heteroskedasticity was therefore not rejected.

Conclusion and Recommendations

It was determined that all regressed variables (price and non price) were inelastic. However, the long run price elasticity was determined to be elastic. The regressor dry season rainfall lagged 1 year (LnD_{t-1}) was the most statistically significant with a p-value of 0.00034 and is significant at the 1% level.

To make reasonable conclusions and recommendations one must understand the nature of this perennial crop. Cocoa bean output depends heavily on the harvesting, fermentation and drying process, which is necessary to derive the commercially useful cocoa bean from the fruit or pod.

The quality of harvesting, fermenting and drying of cocoa beans depends on human resource availability and capability. The results show that a decrease in labour

availability in agricultural holdings results in a 5.3% decrease in output/quantity exported. Greater yields depend on having efficient and skilled workers at the farm level.

The negative results of variables LnD_{t-1} and LnR_{t-1} suggest that rainfall increases above average decrease the quantity of cocoa exported. Excessive rainfall and water logging before harvesting can cause diseases such as black pod to thrive (ICCO 2011). Wetness above average in the dry season causes problems with mould and off flavours, as drying occurs too slowly. Excessive rainfall in the wet season prior to the primary harvesting months (January to May) can lead to increased incidence of diseases as the disease-causing pathogens/organisms flourish in wet and humid conditions (ICCO 2011).

The quantities exported variable is used as an explanatory variable lagged 2 and 3 years in the modified Nerlovian Model rather than 1 year as usually observed in Nerlovian Models. This approach was due to the perennial nature of the crop. It is noted that the results are inelastic and this suggests that it takes longer for stock adjustment to occur for this crop. It takes about 2-3 years for quantity exported in a given year to have any significant impact on quantity exported in the future (Howai 2011, 73).

The price variable is lagged 3 years. This variable represents one of the fundamental variables of a supply function. Price had to be lagged 3 years before it yielded statistically significant results. This may be as a result of the perennial nature of the crop and farmers taking a longer time to adjust to increased prices.

Many strategies have been attempted to revitalize the cocoa industry in Trinidad and Tobago over its history. The CCIBTT has attempted in recent times, through its strategic plan, to address some of the problems. These are primarily aimed at assisting farmers with the negative effects of above average rainfall on storage of beans and disease incidence of this crop through extension support and infrastructural and technological improvements and advancements as well as labour shortages and income generation. Primary changes have been the conversion to a full payment system from the 2 point payment approach. In October 2012, full payments were introduced and an increase in the guaranteed price from TT \$18.00 per kg to TT \$19.00 per kg was implemented (CCIBTT Strategic Plan 2012-2016, 4).

In terms of skilled labour availability, CCIBTT Extension staff have been working closely with the Unemployment Relief Programme (URP) to train potential workers in the necessary skills for cocoa farming. This is hopefully a medium to increase the labour availability to cocoa farmers. Other such social programmes should be targeted to recruit and guarantee skilled workers for the cocoa industry.

Continuous and ongoing educational campaigns and awareness of the importance of the cocoa industry, and by extension the agricultural sector, should be undertaken targeting schools (primary and secondary) using a variety of media.

It is also recommended that there is continuous development in the export, marketing and sale of cocoa beans, as mandated by government, as a primary function of the CCIBTT to boost international sales of Trinidad and Tobago's fine/flavour cocoa. If export sales do not improve, then the cocoa beans should be utilised locally, and the stakeholders should aggressively investigate the possibilities of further processing and value addition of cocoa beans especially for chocolate products. This will address the problem of unsold beans being kept in storage over a prolonged period of time and curb wastage and downgrading of bean quality over time.

International certification of the cocoa will also assist in making it more marketable to international buyers. This level of certification should be a main objective for the cocoa industry. In the field at the farm level, good agricultural practices (GAPs), Sustainable Agricultural Practices (SAPs) and cocoa tree plantings with adequate spacing that utilize disease tolerant and high yielding hybrids of Trinidad Selected Hybrid cocoa trees available from the Ministry of Food Production will assist in the prevention of disease. Disease has been identified as a major non-economic factor affecting cocoa production.

Ultimately, different strategies should be utilized to improve the livelihood of farmers and their well-being holistically. An adequate labour force obtained through social programmes, educational campaigns to encourage persons to get involved in cocoa production, an improved payment system, GAPs, value addition locally through downstream processing of cocoa beans and international certification are just some strategies to achieve the objective of increased productivity and revenue earnings from the cocoa industry.

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