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COCOA PRODUCTION IN GHANA: TRENDS AND VOLATILITY

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Abstract

The Ghanaian economy is dependent to a high degree on primary production, in agriculture and mining for exports. The exports of cocoa, gold and timber traditionally account for the greatest bulk of merchandise exports. The production of cocoa beans is thought to employ more than 1.5 million Ghanaians. Cocoa is still the single-most important commodity to the country's economy. For this study econometric methods were used to explore the patterns of domestic production volatility of cocoa under consideration in Ghana from October 2000 to September 2015 major crop seasons by developing GARCH model. From the results it was observed that daily cocoa purchases show a higher purchase follow lower purchase. In particular, high increases of purchases are observed in the October 2011. Crop purchases for 2014/2015 were the lowest over the past six main cocoa seasons. The empirical result shows the average purchase per tonne for cocoa to be 18,896.2 with standard deviation of 17,852.1. The series were positive Skewness (2.3) and longer tails. Excess kurtosis coefficients 12.3 indicated that the distribution of purchase series for cocoa possess leptokurtic characteristics. The Jarque-Bera test statistic indicates that the purchases series is non-normality. Further, the computed ADF test - statistic (-20.80127) was seen to be significant, hence the return of cocoa purchases series doesn't have a unit root problem. The ARCH and GARCH coefficients (0.53 and 0.15) are statistically significant which indicate that shocks to volatility have a persistent effect on the conditional variance. The conditional standard deviation shows periods of high volatility.

Keywords: Cocoa Production, Volatility, GARCH Model, Ghana, Domestic Production

INTRODUCTION

Cocoa originated from around the headwaters of the Amazon in South America. Its cultivation and value spread in ancient times throughout Central and Eastern Amazonian and northwards to Central America. Cocoa beans were used by the Native Americans to prepare a chocolate drink or chocolate and also as a form of currency for trading purposes and payment of tribute to the king. After the conquest of Central America in 1521, Hernan Cortez and his Conquistadores took a small cargo of cocoa beans to Spain in 1528, together with utensils for making the chocolate drink. By 1580 the drink had been popularized in the country and consignments of cocoa were regularly shipped to Spain. The popularity of chocolate as a drink spread quickly throughout Europe, reaching Italy in 1606, France in 1615, Germany in 1641 and Great Britain in 1657.

Large-scale cultivation of cocoa was started by the Spanish in the 16th century in Central America. It spread to the British, French and Dutch West Indies (Jamaica, Martinique and Surinarn) in the 17th century and to Brazil in the 18th century. From Brazil it was taken to SÃO Tome and Fernando Po (now part of Equatorial Guinea) in 1840; and from there to other parts of West Africa, notably the Gold Coast (now Ghana), Nigeria and the Ivory Coast.

The available records indicate that Dutch missionaries planted cocoa in the coastal areas of the then Gold Coast as early as 1815, whilst in 1857 Basel missionaries also planted cocoa at Aburi.

However, these did not result in the spread of cocoa cultivation until Tetteh Quarshie, a native of Osu, Accra, who had travelled to Fernando Po and worked there as a blacksmith, returned in 1879 with Amelonado cocoa pods and established a farm at Akwapim Mampong in the Eastern Region. Farmers bought pods from his farm to plant and cultivation spread from the Akwapim area to other parts of the Eastern Region. In 1886, Sir William Bradford Griffith, the Governor, also arranged for cocoa pods to be brought in from Sao Tome, from which seedlings were raised at Aburi Botanical Garden and distributed to farmers. In recognition of the contribution of cocoa to the development of Ghana, the government in 1947 established the Ghana Cocoa Board (COCOBOD) as the main government agency responsible for the development of the industry. Currently there are seven cocoa growing regions namely Ashanti, Brong Ahafo, Eastern, Volta, Central and Western North and Western South regions (From Atlas on Regional integration in West Africa, 2007).

LITERATURE REVIEW

The Ghanaian economy is dependent to a high degree on primary production, in agriculture and mining for exports. The exports of cocoa, gold and timber traditionally account for the greatest bulk of merchandise exports. Ghana was well known in the past for her top ranking among the world's largest producers and exporters of cocoa. Since the 1977/78 season, Ghana lost this position to Côte d' Ivoire.

Cocoa has historically been a key economic sector and a major source of export and fiscal earnings (Bulir 1998; McKay and Aryteey 2004). In recent years, cocoa production more than doubled, from 395,000 tons in 2000 to 740,000 tons in 2005, contributing 28 percent of agricultural growth in 2006—up from 19 in 2001 (Bogetic et al. 2007). Earlier evidence of the relatively low supply elasticities of cocoa producers in Ghana makes this development even more impressive (Abdulai and Rieder 1995).

Ghana's cocoa production fell significantly in the 2014/15 (October-September) season, which drove the world market into deficit after several years of surpluses. The production of cocoa beans is thought to employ more than 1,5 million Ghanaians. Despite increasing exports of oil, gold and bauxite, cocoa is still the single-most important commodity to the country's economy.

METHODOLOGY

For this study we use econometric methods to explore the patterns of domestic production volatility of cocoa under consideration in Ghana over the study period from October 2000 to September 2015 major crop seasons by developing GARCH model. The period 2000 to 2015 cocoa crop year was used for the study since a major cocoa production boom was observed in Ghana between 2000 and 2003. There is a general belief that this was primarily the result of a mass spraying programme, combined with a dramatic rise in fertilizer use. Yet in the ending cocoa crop year 2014/2015, total production of cocoa in Ghana could barely manage 700,000 metric tones. As a result, we deemed it necessary to research into performance within this period.

Volatility modelling and forecasting have attracted much attention in recent years, largely motivated by its importance in financial markets. Many asset-pricing models use volatility estimates as a simple risk measure, and volatility appears in option pricing formulas derived from such models as the famous Black–Scholes model and its various extensions.

For hedging against risk and for portfolio management, reliable volatility estimates and forecasts are crucial. In an effort to account for different stylized facts, several types of models have been developed. We have the Autoregressive Moving Average (ARMA) models, Autoregressive Conditional Heteroscedasticity (ARCH) models, Stochastic Volatility (SV) models, regime switching models and threshold models.

Volatility provides a measure of possible variation or movement in a particular economic variable. In economic theory, volatility connects two principal concepts: variability and uncertainty; the former describing overall movement and the latter referring to movement that is unpredictable. Volatility affects prices, production, and inventories in two principal ways.

First, it directly affects the marginal value of storage (the marginal convenience yield), i.e., the flow of benefits from an extra unit of inventory. When prices—and hence production and demand—are more volatile, there is a greater demand for inventories, which are needed to smooth production and deliveries and reduce marketing costs. Thus an increase in volatility can lead to inventory build-ups and raise prices in the short run.

Let P_t be the purchase of a cocoa at time period t (t in days, months, etc) as a proxy for production. The purchase return in time period t is defined as

$$R_t = \frac{(P_t - P_{t-1})}{P_{t-1}} \approx \log(P_t) - \log(P_{t-1})$$

Data

To assess daily purchases volatility on cocoa in Ghana, the data for the study were obtained from Bank of Ghana, Research department, as secondary data on daily basis. We used purchases as a proxy for production because COCOBOD reports daily purchases and not daily production. The data spans from 26th October, 2000 to 17th September, 2015 main crop seasons. The main crop season starts from October to May each year. In all 507 data points were used. Eviews 8 was used for this analysis.

Model

The GARCH (p,q) model:

The GARCH models, which are generalized ARCH models, allow for both autoregressive and moving average components in the heteroscedastic variance developed by Bollerslev (1986). The general GARCH (p,q) model has the following form:

$$Y_t = a + \beta' X_t + u_t \qquad (1)$$

$$u_t | \Omega_t \sim \text{iid } N(0, h_t)$$

$$h_t = \gamma_0 + \sum_{i=1}^{p} \delta_i h_{t-i} + \sum_{j=1}^{q} \gamma_j u_{t-j}^2 \qquad (2)$$

$$p \geq 0, q > 0, \gamma_0 > 0, \delta_i \geq 0 \ \forall i \geq 1, i = 1, \ldots, p, \qquad \gamma_j \geq 0 \ \forall \ j \geq 1$$

For $p = 0$ the model reduces to ARCH (q). In the basic ARCH (1) model we assume that: $h_t = \gamma_0 + \gamma_1 u_{t-1}^2$

The simplest form of the GARCH (p,q) model is the GARCH (1,1) model for which the variance equation has the form:

$$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u_{t-1}^2 \qquad (3)$$

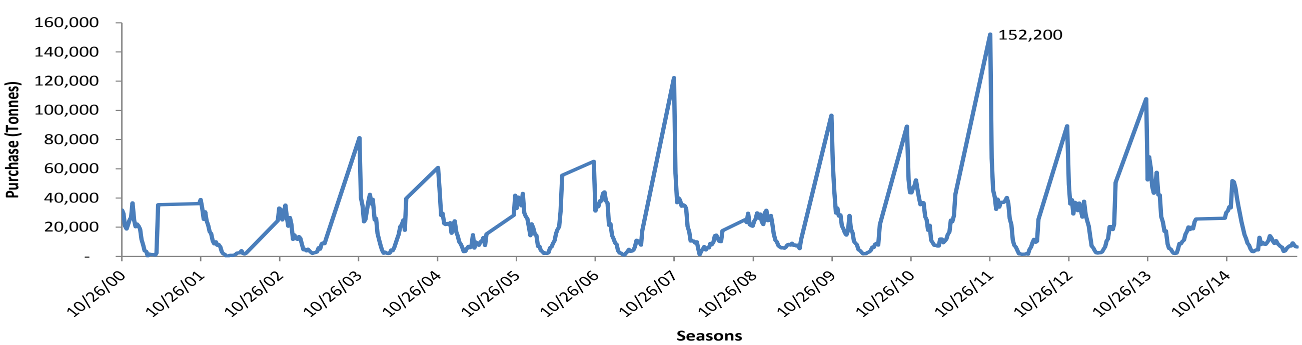
Estimating GARCH Models

GARCH models are usually estimated using numerical procedures to maximize the likelihood function, which produces the most likely values of the parameters given the data. It is important to be aware that the likelihood function can have multiple local maxima, and different algorithms can lead to different parameter estimates and standard errors. Good initial estimates of the parameters are useful to ensure the global maximum is reached. It is also important to be aware that the log-likelihood function can be relatively flat in the region of its maximum value, and in this case different parameter values can lead to similar values of the likelihood function, making it difficult to select an appropriate value. Most GARCH models are estimated using the Berndt-Hall-Hall- Hausman (BHHH) (1974) algorithm. This algorithm obtains the first derivatives of the likelihood function with respect to the numerically calculated parameters, and approximations to the second derivative are subsequently calculated. Computational speed is increased by not calculating the actual Hessian matrix at each iteration for each time step, but the approximation can be weak when the likelihood function is far from its maximum, thus requiring more iteration to reach the optimum. The Broyden-Fletcher-Goldfarb-Shanno (BFGS) method solves unconstrained nonlinear optimization problems by calculating the likelihood function gradient in the same way as the BHHH, but it differs in its construction of the Hessian matrix of second derivatives. The BFGS and BHHH are asymptotically equivalent, but can lead to different estimates of the standard errors in small samples.

RESULTS AND DISCUSSION

Variable Description

Figure 1: Daily Cocoa Purchases from October 2000 to September 2015 main seasons



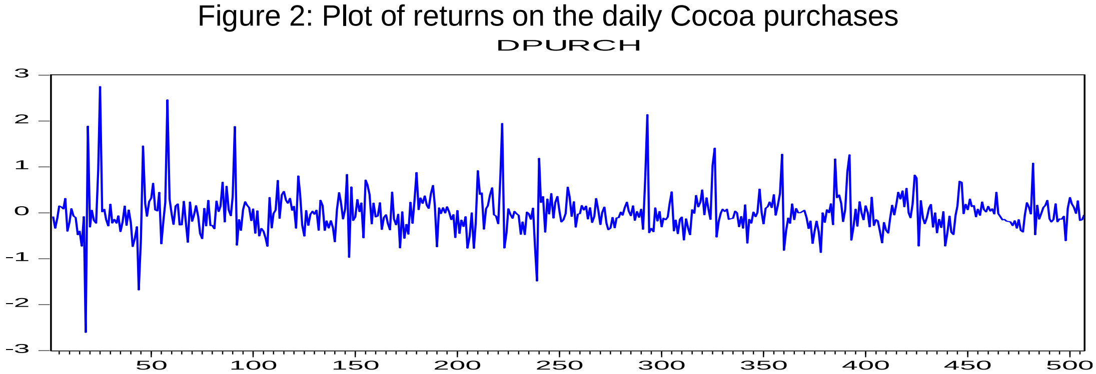
From Figure 1, it can be observed that daily cocoa purchases show that a higher purchase follow lower purchase. In particular, high increases of purchases are observed in the October 2011 this was as a result of massive mop up from the previous season. From the graph it can be seen that crop purchases for 2014/2015 were the lowest over the past six main cocoa seasons.

Table 1: Descriptive Statistics

N=507	**Purchase**
Mean	18,896.2
Median	12,486.0
Maximum	152,200.3
Minimum	137.0
Std. Dev.	17,852.1
Skewness	2.3
Kurtosis	12.9
Jarque-Bera	2,502.7
Probability	0.0

Table 1 displays summary statistics and normality test for the purchase under study. Thus, the empirical result shows that the average purchase per tonne for cocoa was 18,896.2 with standard deviation of 17,852.1. Also displays summary statistics and normality test for the series. The series were positive skewness and longer tails. The coefficient of skewness 2.3 indicates that the series typically had asymmetric distributions skewed to the right. Also the excess kurtosis coefficients 12.3 indicated that the distribution of purchase series for cocoa possess leptokurtic characteristics. Moreover, the implication of non-normality is supported by the Jarque-Bera test statistic which points out that the null hypothesis of normal distribution is rejected at 5% level of significance for the series. Hence, the purchase series appropriately contain time series characteristics such as, long tails and leptokurtosis as documented by Mandelbrot (1963).

Figure 2: Plot of returns on the daily Cocoa purchases



We take the log-difference of the value of the purchase, so as to convert the data into continuously returns. Fig. 2 plots the returns on the purchase over the sample period. The returns display periods of turbulence and tranquility. This suggests there is volatility clustering. Visually, the process looks stationary, mean reverting and with zero mean.

Stationarity Test

The computed ADF test-statistic (-20.80127) is smaller than the critical values - "tau" (-3.443072, -2.867044, -2.569763 at 1%, 5%, 10% significant level, respectively), therefore we can reject Ho. It means the return of cocoa purchases series doesn't have a unit root problem and the series is a stationary series at 1%, 5% and 10% significant level.

Table 2: Unit roots Test

Null Hypothesis: DPURCH has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=17)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-20.80127	0.0000
Test critical values:	1% level	-3.443072	
	5% level	-2.867044	
	10% level	-2.569763	

Table 3: ARCH Test

ARCH Test			
F-statistic	15.48191	Prob. F(1,503)	0.0001
Obs*R-squared	15.07934	Prob. Chi-Square(1)	0.0001

The test statistic is the number of observations, T times R2 of the autoregression, i.e., $T \times R^2$. In the absence of ARCH(1), the coefficient of e_{t-1}^2 is zero, the null hypothesis, and $T \times R^2$ should follow a χ^2 distribution with the number of degrees of freedom 1, which predicts that the $T \times R^2$ exceeds 3.84 (from a table of χ^2 distribution) only 5% of the time. The value of the test statistic for this example is so high that we will not hesitate rejecting the null hypothesis.This result provides justification for the next stage in the analysis which involves estimating the conditional variance using a GARCH (1,1) model.

Table 4: GARCH(1,1) Test

Dependent Variable: DPURCH				
Method: ML - ARCH (Marquardt) - Normal distribution				
Presample variance: backcast (parameter = 0.7)				
GARCH = C(2) + C(3)*RESID(-1)^2 + C(4)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.023570	0.018170	-1.297174	0.1946
	Variance Equation			
C	0.094246	0.009965	9.457522	0.0000
RESID(-1)^2	0.528218	0.068827	7.674558	0.0000
GARCH(-1)	0.146956	0.036998	3.971962	0.0001

The ARCH and GARCH coefficients (0.53 and 0.15) are statistically significant. The sum of these coefficients is 0.68 which indicates that shocks to volatility have a persistent effect on the conditional variance. The volatilities tend to be more 'spiky'. GARCH = 0.09 + 0.53*RESID(-1)^2 + 0.15*GARCH(-1)

Figure 3: Conditional standard deviation of the purchases returns

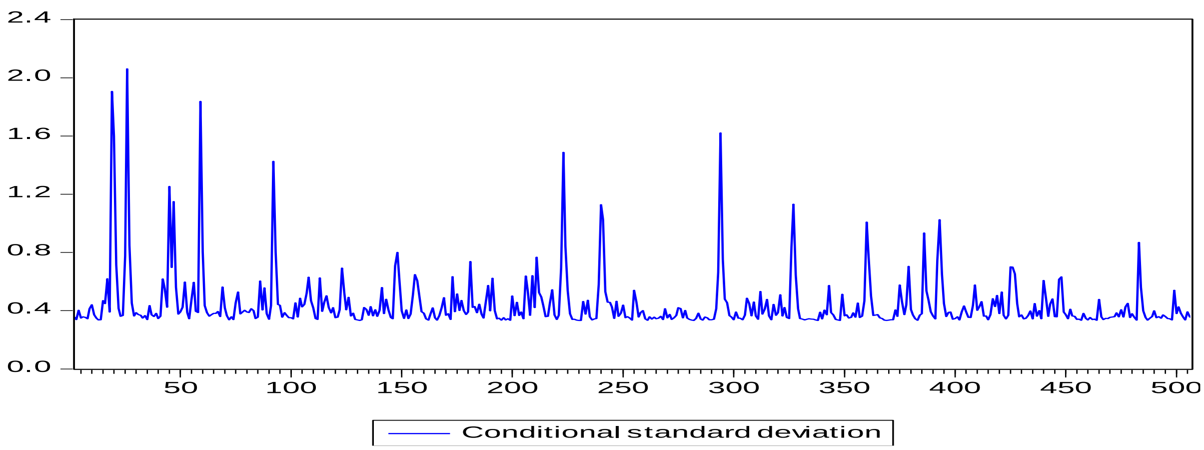


Fig 3 presents a plot of the estimates of conditional standard deviation from the GARCH (1,1) model. The conditional standard deviation shows periods of high volatility.

CONCLUSION

Daily domestic purchase volatility of cocoa under consideration in Ghana over the study period from October 2000 to September 2015 major crop seasons. The results from this study provide evidence to show volatility clustering, leptokurtic distributions and asymmetric effect for daily domestic purchase volatility of cocoa. Thus, from empirical result it can be conclude that, the volatility in the purchase of cocoa has been found to vary from season to season suggesting the use of GARCH family approach, there is strong evidence that there is a persistent volatility in cocoa purchases confirming the seasonality in cocoa purchases.

Some of the reasons given to the poor production for 2014/2015 season were: Bad weather: Heavy rainfall between August and October which prevented cocoa trees from flowering. Lack of pesticides: Other farmers complained about the scarcity and expense of fertilizers and pesticides. There was also a lot of reported smuggling of the pesticides to neighboring countries. Aging farming population: Majority of the smallholder farmers are old and need younger farmers to take over the operations of their farms. Disease: Cocoa husks shriveled by fungal black pod and fat red capsid bugs feeding on cocoa trees. Smuggling: Increased smuggling by farmers and extension workers of both cocoa and pesticides where prices for their goods are more lucrative due to stronger currencies in those neighboring countries. COCOBOD finances Ghanaian buying companies, which act as middlemen, to purchase the cocoa from the farmers.

RECOMMENDATIONS

Dissemination of disease management best practices: The government should work collaboratively with the farmers to develop and disseminate effective disease management practices for the long-term prosperity of the sector.

Fertilizers: Going forward the government should put in place reliable and predictable fertilizer supply programs that farmers can use to plan their farming activities appropriately. This should help mitigate against the incidence of sporadic workflow disruptions as we are seeing in the cocoa farming life cycle this past season. New generation of farmers needed: Ghana's inability to engage more young people in agriculture production to replace the aging farming population is of great concern to actors both local and international. The government should either come up with incentives and new programs to help attract the young farmers and entrepreneurs into this sector or begin working with large-scale agribusiness entities to come in and build mega-plantations to help transform the sector for future prosperity.

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