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Analysis of Structural Breaks and Time Series Properties of West African Coffee Production: An Application of the Perron Test

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This paper examines the structure of the West African Coffee Agriculture by analyzing three pertinent annual series, namely; acreage, yield and producer price of coffee, in Cote d'Ivoire, Ghana, Nigeria and Togo during the 1961- 2010 period. The Perron (1989) test which examined the null and alternative hypotheses of a unit root or `trend-stationary.` series respectively, in the presence of possible slope and/or level shifts was particularly adapted to examine the effect of date - specific market reform policy among coffee- producing West African countries. The results for the Perron unit root tests indicates that while coffee producer price,yield and acreage in Nigeria, coffee acreage and producer price in Ghana, coffee producer price in Cote d'Ivoire and coffee yield in Togo were stationary around a linear deterministic trend. The Perron changing growth model also revealed that SAP, otherwise refered to as structural break significantly and positively affected only coffee yield in Nigeria and Cote d'Ivoire, but has no impact whatsoever in Ghana and Togo.

Key words: Structural break, Unit root, Coffee, Structural Adjustment Programme, Growth model, and ECOWAS

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INTRODUCTION

Structural change is of considerable importance in the analysis of macroeconomic time series. Structural change occurs in many time series for any number of reasons, including economic crises, changes in institutional arrangements, policy changes and regime shifts. Detecting structural changes in linear regression relationships has therefore been an important topic in statistical and econometric research. The economic content of such a result is to incorrectly conclude that the series under investigation has a stochastic trend. This in turn implies that any shock – whether demand, supply, or policy-induced – to the variable will have effects on the variable into the very long run. It is therefore very important to allow for the presence of a structural break in the data so as to more reliably conduct the test of non-stationarity.(Perron, 1989; Perron, 1997). The economic content of such a result is to incorrectly conclude that the series under investigation has a stochastic trend. This in turn implies that any shock – whether demand, supply, or policy-induced – to the variable will have effects on the variable into the very long run. It is therefore very important to allow for the presence of a structural break in the data so as to more reliably conduct the test of non-stationarity.

The methods of estimation of economic relationships and modeling fluctuations in economic activity have been subjected to fundamental changes in last four decades. Most of the work has concentrated on detecting the presence of structural break(s) and estimating the location of the break(s). The method of estimation of the standard regression model, OLS (Ordinary Least Square) method, is based on the assumption that the means and variances of these variables being tested are constant over the time. Variables whose means and variances change over time are known as non-stationary or unit root variables. Therefore, incorporating non-stationary or unit root variables in estimating the regression equations using OLS method give misleading inferences. Instead, if variables are non stationary, the estimation of long-run relationship between those variables should be based on the cointegration method. Since the testing of the unit roots of a series is a precondition to the existence of cointegration relationship, originally, the Augmented Dickey-Fuller (1979) test was widely used to test for stationarity.

However, there are two well-known problems with structural break estimation. The first one is the difficulty of differentiating data that is subject to a structural break (before and after which data shows stationary and trend stationary patterns) from data having a unit root. The second one is that although break locations in data can be estimated consistently, there is no efficiency condition for the limiting distribution of the estimates. Although consistency is a sufficient condition for the purpose of many empirical studies, efficiency could still be of interest if the aim is to obtain the smallest confidence intervals around the break dates. The stated reason behind these difficulties of estimating structural breaks is that the problem is nonstandard; a break date only appears under the alternative hypothesis, not under the null of no break. Perron (2005) empirical study makes a comprehensive review of both problems; however it is very technical, and seemingly there is a lack of resources summarizing the relevant literatures. To overcome this, Perron proposed allowing for a known or exogenous structural break in the Augmented Dickey-Fuller (ADF) tests.

Conventionally, dating of the potential break is assumed known *a priori* in accordance with the underlying asymptotic distribution theory. Test statistics are then constructed by adding dummy variables representing different intercepts and slopes, thereby extending the standard Dickey-Fuller procedure (Perron 1989). This is particularly useful when the actual date of the brake is known and one is left with a task of examining the impact of the break.

Some Sub-Saharan African countries introduced measures to liberalize their commodity export markets under the structural adjustment programme (SAP) adopted by many of the SSA countries in the 1980s. The policy changes introduced included the removal of trade restrictions, price controls, and export taxes, and in some countries the state-owned marketing boards were abolished. Meanwhile these policy changes, have led to concern about their impact on world prices of commodities such as cocoa and coffee and, in turn, on the countries exporting them. The policy changes have, in the main, encouraged production and exports of commodities and likely led to lower international commodity prices than would have otherwise occurred (Coleman *et al*,1993)

From 1980s inwards, all countries in ECOWAS like others in the SSA have been through a process of structural adjustment involving liberalization of the economy, devaluation of the currency and a range of associated measures to achieve the process of modernization like other Sub- Saharan African countries. Studies have shown that many ECOWAS countries have been remarkably successful, in generating rising level of output, in response to market demand at national, regional and global levels. However, there is need today to analyze the effects of these policies of stabilization and liberalization on one of the important export crops in ECOWAS which is coffee. More importantly, after three decades of implementation of structural adjustment programs in ECOWAS, it is now appropriate to assess the effect these policy reforms have had on the agricultural export crops sector with a specific focus on coffee.

Coffee plant is native to Africa; the origin of Coffee arabica has been traced to Ethiopia, while Robusta coffee was believed to come from Central to West Africa (Williams, 2008; Opeke, 2005; and Ngussie and Dererse, 2007). Its preparation and cultivation was first done by the Arabs; and was introduced to most parts of Africa during the colonial era (Williams, 1998). Trends in the world production of African coffee shows that annual production in the last 10 years fluctuated between 14 and 19 million (60kg) bags, with an average of about 16 million bags; and has since fallen considerably due to varied factors (Surendra, 2002). Although Coffee is grown and exported by more than 50 developing countries, it's mainly consumed in the industrialized countries namely United States of America, Finland, Sweden, Belgium and Japan among others (Agbongiarhuoyi et al., 2006; and Daviron and Ponte, 2005). In the world market, Coffee plays a vital role in the balance of trade between developed and developing countries; being an important foreign exchange earner, contributing in varying degrees to the national income of the producing countries (Cambrony, 1992). Arabica coffee provides employment for a lot of people in all producing countries (Muleta, 2007); and Surendra (2002) reported that about 33 million people in 25 African countries derived their livelihoods by growing coffee in subsistence level from about 4.5 million square kilometers of land.

This particular study selects coffee, which is an important export commodity in the West African sub-region. Coffee production in West Africa is concentrated in Cote d'Ivoire, Togo, Ghana and Nigeria. This study seeks to evaluate how the SAPs policy shifts of the 1980s has affected the coffee sub-sector in the sub-region. In order to meet this objective, this study employed the Perron (1989) test for structural break to empirically examined how SAP policies have affected coffee acreage cultivated by farmers, coffee output and the domestic coffee prices received by farmers.

The plan of the paper is as follows. Section 2 describes materials and method involved which include the data source and their measurement with the procedure for testing the null hypothesis that the selected crop series have a unit root with a possible non-zero drift against the alternative that it is trend-stationary and experiences a one time change in the slope of its trend (with the implementation of SAP policy). Section 3 presents the Perron (1989) standard unit-root test results and Perron (1989) unit root results with structural break coefficients. The findings are summarized and an interpretation of the results, as well as an assessment of the impact of the structural adjustment programme in the study countries is offered. The conclusion and policy recommendation to the work are offered in section 4

MATERIALS AND METHODS

Data source and measurement.

This study is based on annual country level cocoa data pertaining to Cote d'Ivoire, Ghana and Nigeria for the period 1961- 2007 . The data were sourced from the FAOSTAT database of the Food and Agricultural Organization of the United Nations. Data on exchange rate were taken from Penn World table of the Penn World database of the University of Pennsylvania. The own price data on price and quantities for Cocoa were used. The price and output indices were constructed using Laspeyres formular. The Laspeyres price and output indices were constructed as follows

$$P_t = \left[\frac{\sum P_1 Q_0}{\sum P_0 Q_0}\right]100 \qquad \text{..... (1)}$$

Where

$\sum P_0$ = Total of previous year price

$\sum P_1$ = Total of current year price

$\sum Q_0$ = Total of previous year output

$\sum Q_1$ = Total of current year output

The period covers 1961 – 2007 with indices benchmarked to the year of adoption of the SAP Policy which is 1986 for Nigeria, 1983 for Ghana and 1994 for Cote d'Ivoire (i.e. $Q_0 = P_0 = Q_{1986} = P_{1986}$ =100 for Nigeria as an example).

Analytical Technique: The Perron's test for Structural Break.

This study adopted the definition of Alemu, *et al* (2003) for "Structural Breaks". The authors defined it, as "changes in economic systems". The study, first focused on the measuring the significance of changes in economic systems (which was thereafter referred to as "breaks") on trends in the agricultural GDP. Secondly, the study's emphasis is on the sustained impact of those changes on economic systems in the agricultural GDP. The first was measured based on a regression analysis while the second was measured by conducting a time series analysis in order to determine to which class of non-stationary process that agricultural GDP belongs. Therefore, in this study, by "structural breaks", policies changes of stabilization and market liberalization inherent of SAP in West Africa are referred to. This study examined how these policies changes affect the acreage, yield and producer price of cocoa in West Africa.

While Coleman *et al*, (1993) used the Counter –

Factual Simulations technique to examine the effect of SAP on cocoa production and prices in West Africa with data covering only up to about 2002(which is just some few years after the adoption of SAP by many of the ECOWAS cocoa producing countries), this study employs, the Perron (1989) crash and changing growth model with data spanning up to 2007 which allows this study to examine the full effect of SAP.

In order to examine the effect of the structural break on the cocoa series in the West African sub - region,; this study adopted the Perron (1989) crash and changing growth model. In Perron (1989), the main concern is to determine whether structural breaks in a "trend stationary" series may reverse a failure to reject the null hypothesis of a unit root. That is, random walks with possible non-zero drift. Traditional tests for unit roots (such as Dickey-Fuller, Augmented Dickey-Fuller and Phillips-Perron) have low power in the presence of structural break. Perron (1989) showed that in the presence of a structural break in time series, many perceived nonstationary series were in fact stationary. Perron (1989) re-examined Nelson and Plosser (1982) data and found that 11 of the 14 important US macroeconomic variables were stationary when known exogenous structural break is included. Perron (1989) allows for a one time structural change occurring at a time *TB* (1 < *TB* < T), where T is the number of observations.

According to Perron (1989), the null hypothesis considered is that a given series $\{y_t\}_0^T$ (of which a sample of size T + 1 is available) is a realization of a time series process characterized by the presence of a unit root and possibly a nonzero drift. However, the approach is generalized to allow a one-time change in the structure occurring at a time $T_B(1<T_B<T)$. Three different models are considered under the null hypothesis: one that permits an exogenous change in the level of the series (a "crash"), one that permits an exogenous change in the rate of growth, and one that allows both changes. These hypotheses are parameterized as follows:

Null hypotheses:

Model (A) $$y_t = \mu + dD(TB)_t + y_{t-1} + e_t, \quad \text{..... (2)}$$

Model (B) $$y_t = \mu + y_{t-1}(\mu_2 - \mu_1)DU_t + e_t, \quad \text{.....(3)}$$

Model (C) $$y_t = \mu + y_{t-1}dD(TB)_t + (\mu_2 - \mu_1)DU_t + e_t, \text{.....(4)}$$

where

$D(TB)_t = 1$ if $t=T_B+1$, 0 other wise;
$DU_t = 1$ if $t>T_B$, 0 otherwise; and
A (L) et = B (L) U_t,

$u_t \approx I.I.D.(0,\sigma^2)$, With A (L) and B (L) pth and qth order polynomials, respectively, in the lag operator L. The innovation series (e_t) was taken to be of the ARMA (p, q) type with the order p and q possibly unknown. This postulate allows the series (y_t) to represent quite general processes. More general conditions are possible and will be used in subsequent theoretical derivations.

Instead of considering the alternative hypothesis that y_t is a stationary series around a deterministic linear trend with time invariant parameters, he analyzed the following three possible alternative models:
Alternative hypotheses:

Model (A) $$y_t = \mu_t + \beta t + (\mu_2 - \mu_1)DU_t + e_t, \text{ ..... (5)}$$

Model (B) $$y_t = \mu + \beta_1 t + (\beta_2 - \beta_1)DT_t^* + e_t, \quad \text{..... (6)}$$

Model (C) $$y_t = \mu + \beta_1 t + (\mu_2 - \mu_1)DU_t + (\beta_2 - \beta_1)DT_t + e_t, \quad \text{.....(7)}$$

Where

$DT_t^* = t - T_B$, *and* $DU_t = 1$, if $t>T_B$ and 0 otherwise.

Here, T_B refers to the time of break i.e., the period at which the change in the parameters of the trend function occurs. Model (A) describes what we shall refer to as the crash model. The null hypothesis of a unit root is characterized by a dummy variable which takes the value one at the time of break. Under the alternative hypothesis of a "trend-stationary" system, Model (A) allows for a one-time change in the intercept of the trend function. For the empirical cases, T_B was the year 1929 and $\mu_2 > \mu_1$. Model (B) is referred to as the "changing growth" model. Under the alternative hypothesis, a change in the slope of the trend function without any sudden change in the level at the time of the break is allowed. Under the null hypothesis, the model specifies that the drift parameter μ change from μ_2 *to* μ_1 at time T_B. Model (C) allows for both effects to take place simultaneously, i.e. a sudden change in the level followed by a different growth path.

This study adopted Model C which allows for both effects to take place simultaneously, i.e. a sudden change in the level followed by a different growth path. Equation 8 below is the Perron's equation for unit-root test.

$$y = \mu + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} c\Delta y_{t-1} + \ell_t \quad \text{.....(8)}$$

However, when a policy shift variable and a variable to examine possible change in intercept are included, the equation becomes,

$$y = \mu + \beta t + \theta DU1_t + \gamma DT1 + \alpha\, y_{t-1} + \sum_{i=1}^{k} c\Delta y_{t-1} + \ell_t$$

..... (9)

Where γ = coefficient for growth change variable DT, the dummy for structural break (SAP in this case). Model (C) above allows for both effects to take place simultaneously, i.e. a sudden change in the level followed by a different growth path. Where, TB is the date of implementation of SAP policy in the selected ECOWAS countries. The summation sign contains the relevant number of lagged difference terms (which will be determined for each of the series to be considered by using the Schwarz Information Criterion (SIC)).

The estimation and interpretation of this equation for each of the series will be a means of evaluating the effect of SAP Policy on the coffee series of selected ECOWAS countries. The significance of α and γ terms are of particular importance. A significant γ coefficient indicate the presence of a structural break (which implies that SAP policy significantly affect the variable in question). A α significantly close to one indicates the presence of a unit root. That is the series is the series is differenced-stationary rather than trend stationary. The hypothesis is that many series may have α close to one in a normal ADF test with an intercept and time trend, but that when a shift parameter is included and is significant, the α term may no longer be significantly close to one.

RESULTS AND DISCUSSION

Perron's Structural break test Results with `Growth Change and intercept shift` dummy of West African Coffee

This study applied the test statistics described by Perron (1989) on coffee series from Cote d'Ivoire, Ghana, Nigeria and Togo to examine the effect of structural breaks- namely the SAP – policy of the 1980s adopted by many of the Sub-Saharan African countries. The data contained annual series which have starting date of 1961 and ending date of 2007. Although the date of break for each of the countries differs, the respective date for each of the countries is taken into consideration during the tests.

In this section, the results of the estimation of equation (9) assuming a one-time `crash` and then a slope change for each of the variables in the export crops series for each country considered are presented in tables 1 and 2. Under the hypothesis of a unit root process $\mu \neq 0$ (in general), $\beta=0$, $\gamma=0$, $\alpha=1$. Under the alternative hypothesis of stationary fluctuations around a deterministic breaking trend: $\mu \neq 0$, $\theta \neq 0$, $\beta \neq 0$, $\gamma \neq 0$ and $\alpha<1$. It is important to note that although the various break dummies and intercepts` t-statistics are distributed normally, the critical test statistic that is produced in Perron (1989) must be used for α.

Perron structural break test Results for Ghana

Tables 1 and 2 below, show the Perron's structural break test for coffee series in Ghana. Table 1 is the Perron's unit root test for the coffee series while table 2 is the model estimates for the Perron unit root test but with broken trend and intercept included. From table 1, all the series could not reject the null hypothesis of unit root. However, after the introduction of SAP (which is the growth change variable with time of break at 1983) and trend shift variables, some remarkable differences were observed in the table and are as explained below.

Coffee Acreage

Coffee acreage has a α coefficient that is significantly different from 1 for the unit root test. After the introduction of the SAP and intercept shift variable, there was a significant but slight drop in the value of α from 0.879 to

0.602. This shows that coffee acreage (LA_{ce}) in Ghana is stationary around a deterministic trend rather than being differenced stationary. The growth in the acreage of coffee cultivated as represented by the SAP – trend shift variable was not significant even though it was positive. This result suggests that although SAP has a positive coefficient on coffee production in Ghana, the effect is not too pronounced when compared with cocoa. This will be so if we consider the fact that cocoa is the mainstay of the economy of Ghana.

Coffee yield

The α coefficient for coffee yield (LY_{ce}) in the Perron unit root test for coffee series in Ghana is 0.567. However, after the introduction of the broken trend and intercept variables in the Perron unit root equation, an insignificant coefficient was observed for the SAP variable (γ). The coefficient of 0.059 for γ which is a not significant, show that there was a slight increase in the trend of coffee yield in Ghana after the introduction of SAP in that country but it is not a remarkable one. Although SAP has a positive contribution to the growth of coffee yield in Ghana; the contribution is not significant however.

Coffee producer price

The Perron unit- root test for coffee producer price (LP_{ce}) in Ghana as shown in table 1 reveals that the coefficient of α is significantly different from 1 (α = 0.660 and it is significant at 1%). However, after the inclusion of the SAP variable i.e. growth change and the intercept variable, the coefficient of α is still 0.623 and it is significant at 1%. This suggests that coffee producer price is stationary around a linear deterministic trend. The coefficient of the structural break (SAP) is 0.011 although it is not significant statistically. Coffee is one of the important export crops in Ghana but attention is not on it as it is given to cocoa which is about the main source of foreign exchange and so the result suggests that SAP has a positive impact on coffee producer price in Ghana although it is not significant.

Perron structural break test Results for Nigeria

Tables 1 and 2, show the Perron's structural break test coffee series in Nigeria. Table 1 is the Perron's unit root test for the crop's series while table 2 is the model estimates for the Perron unit root test but with broken trend and intercept included. From table 1, all the series with the coffee in Nigeria could not reject the null hypothesis of unit root. The α for coffee yield have coefficient that is significantly different from 1. This shows that this variable as the Perron unit root test as shown it is trend stationary rather that differenced stationary. However, after the introduction of SAP (which is the growth change variable with time of break at 1986) and trend shift variables, some remarkable differences were observed in the table and are as explained below.

Coffee Acreage

Coffee acreage has a α coefficient that is significantly different from 1 for the unit root test. After the introduction of the SAP and intercept shift variable, there was a significant but slight drop in the value of α from 0.713 to 0.600. This shows that coffee acreage (LA_{ce}) in Nigeria is stationary around a deterministic trend rather than being differenced stationary. The growth in the acreage of coffee cultivated as represented by the SAP – trend shift variable was not significant and negative. This result suggests that SAP has a negative effect on coffee production in Nigeria, the effect is not too pronounced when compared with cocoa. Although Nigeria is one of the major producers of coffee in Nigeria, it is not an important crop in Nigeria as compared to cocoa.

Coffee yield

The α coefficient for coffee yield (LY_{ce}) in the Perron unit root test for export series in Nigeria is 0.397. However, after the introduction of the broken trend and intercept variables in the Perron unit root equation, a significant coefficient was observed for the SAP variable (γ). The coefficient of 0.023 for γ which significant at 5%, show that there was an increase in the trend of coffee yield in Nigeria after the introduction of SAP in that country .SAP has a positive contribution to the growth of coffee yield in Nigeria, and the effect is significant and this could be due to intensification of inputs rather than increase in acreage cultivated.

Coffee producer price

The Perron unit- root test for coffee producer price (LP_{ce}) in Nigeria as shown in tables 1 and 2 reveals that the coefficient of α is significantly different from 1 (α = 0.658 and it is significant at 1%). However, after the inclusion of the SAP variable i.e. growth change and the intercept variable, the coefficient of α is still 0.610 and it

is significant at 1%. This suggests that coffee producer price is stationary around a linear deterministic trend. The coefficient of the structural break (SAP) is 0.015 although it is not significant statistically. Coffee is one of the major export crops in Nigeria and so the result suggests that SAP has a positive impact on coffee producer price in Nigeria although it is not significant.

Perron structural break test Results for Cote d'Ivoire

Tables 1 and 2 below, show the Perron's structural break test for coffee series in Cote d'Ivoire. Table 1 is the Perron's unit root test for the crops series while table 2 is the model estimates for the Perron unit root test but with broken trend and intercept included. From table 1, all the series with the exception of coffee producer price (LP_{ce}) could not reject the null hypothesis of unit root. While all other variables have significant α values that are close to 1, the coefficient of α for the variable listed above have coefficient that are significantly different from 1. This shows that this variable as the Perron unit root test has shown are trend stationary rather that differenced stationary. However, after the introduction of SAP (which is the growth change variable with time of break at 1994) and trend shift variables, some remarkable differences were observed in the table and are as explained below.

Coffee Acreage

Coffee acreage in Cote d'Ivoire has a α coefficient that is not significantly different from 1 show that coffee acreage has a unit root. After the introduction of the SAP and intercept shift variables, there was a significant but slight drop in the value of α from 0.877 to 0.617. This shows that coffee acreage (LA_{ce}) in Cote d'Ivoire is differenced stationary rather than being trend stationary. The growth in the acreage of coffee cultivated as represented by the SAP – trend shift variable was significant and negative. This result suggests that SAP has a negative effect on coffee acreage cultivated in Cote d'Ivoire; it could be as a result of increase in the acreage of cocoa cultivated which could have significantly affected the acreage of land allocated to coffee. Cocoa is is about Cote d'Ivoire's most important export crop. Hence, farmers could afford to trade coffee acreage for cocoa.

Coffee yield

The α coefficient for coffee yield (LY_{ce}) in the Perron unit root test for export series in Cote d'Ivoire is 0.315. However, after the introduction of the broken trend and intercept variables in the Perron unit root equation, a significant coefficient was observed for the SAP variable (γ). The coefficient of 0.052 for γ which is significant at 5%, show that there was an increase in the trend of coffee yield in Cote d'Ivoire after the introduction of SAP in that country. SAP has a positive contribution to the growth of coffee yield in Cote d'Ivoire, and the effect is significant and this could be due to intensification of inputs rather than increase in acreage cultivated.

Coffee producer price

The Perron unit- root test for coffee producer price (LP_{ce}) in Cote d'Ivoire as shown in tables 1 and 2 reveals that the coefficient of α is significantly different from 1 (α = 0.661 and it is significant at 1%). However, after the inclusion of the SAP variable i.e. growth change variable, the coefficient of α is still 0.610 and it is significant at 1%. This suggests that coffee producer price is stationary around a linear deterministic trend. The coefficient of the structural break (SAP) is 0.003 although it is not significant statistically. Coffee is one of the major export crops in Cote d'Ivoire and so the result suggests that SAP has a positive but not significant impact on coffee producer price in Cote d'Ivoire.

Perron structural break test Results for Togo

Tables 1 and 2 below, show the Perron's structural break test for coffee series in Togo. Table 1 is the Perron's unit root test for the crops series while table 2 is the model estimates for the Perron unit root test but with broken trend and intercept included. From table 1, all the series with the exception of coffee yield (LY_{ce}), could not reject the null hypothesis of unit root. While all other variables coefficients that are not significantly different from 1, the coefficient of α for coffee yield (LY_{ce}) is 0.811 and it is significant at 5%. However, after the introduction of SAP (which is the growth change variable with time of break at 1994) and trend shift variables, some remarkable differences were observed in the table and are as explained below.

Table 1. Perron's Structural Break Test for Coffee in Selected ECOWAS Countries.
(Broken trend and intercept not included)

$$Y_t = \mu + \beta t + \alpha Y_{t-1} + \sum_{t=1}^{k} C\Delta Y_{t-1} + e_t$$

Nigeria

Variables	μ	β	α	K
LY	5.426	0.004	0.397	0
	(8.726)	(1.464)	(3.973)**	
LA	1.263	0.005	0.713	0
	(1.503)	(1.384)	(11.434)***	
$L\rho_{ce}$	2.036	-0.021	0.658	0
	(2.771)	(-3.985)**	(5.388)***	

Ghana

Variables	μ	β	α	k
LA	1.677	0.0006	0.879	0
	(1.679)	(-0.039)	(12.488)***	
LY	5.034	0.005	0.567	0
	(7.050)	(2.378)**	(3.804)	
$L\rho_{ce}$	2.100	-0.021	0.610	0
	(2.781)	(-2.676)**	(3.990)**	

Cote d'Ivoire

Variables	μ	β	α	k
LA	5.968	-0.0001	0.877	0
	(4.369)	(-0.043)	(2.129)	
LY	9.194	0.015	0.315	1
	(7.605)	(6.951)**	(0.807)	
$L\rho_{ee}$	2.174	-0.021	0.658	0
	(2.772)	(-2.661)**	(5.565)***	

Togo

Variables	μ	β	α	k
LA	2.436	0.004	0.754	0
	(2.430)	(1.430)	(1.371)	
LY	7.524	-0.011	0.811	0
	(7.913)	(-2.900)**	(3.940)**	
$L\rho_{ee}$	2.364	-0.021	0.692	0
	(2.791)	(-2.675)**	(1.560)	

Source: Data analysis, 2009.
NB t – values in parenthesis
Critical t – values α for taken from Perron's (1989) table.
Critical t-values: 1% = 4.24 5%= 3.95 : λ = 0.59

Table 2. Perron's Structural Break Test for Coffee in Selected ECOWAS Countries.
(Broken trend and intercept included)

$$Y_t = \mu + \beta t + QDU1 + \delta DT1 + \alpha Y_{t-1} + \sum_{t=1}^{k} c\Delta Y_{t-1} + \varepsilon_t$$

Variables	μ	β	θ	δ	α	k
Nigeria						
LY	6.566 (9.326)	-0.020 (-3.626)***	0.214 (2.328)**	0.023 (4.012)***	0.208 (2.361)	0
LA	1.751 (3.328)	0.01 (1.167)	-0.324 (-2.053)**	-0.026 (-1.621)	0.600 (4.855)**	1
$L\rho_{ee}$	2.360 (3.081)	-0.030 (-2.750)**	-0.106 (0.803)	0.015 (1.538)	0.610 (4.866)**	0
Ghana						
LA	5.753 (2.944)	-0.012 (-2.022)**	-0.171 (-1.436)	0.026 (2.542)	0.602 (4.448)***	0
LY	5.192 (7.946)	-0.011 (-2.118)**	0.143 (1.666)	0.023 (2.081)	0.358 (4.204)	0
$L\rho_{ee}$	2.514 (2.980)	-0.021 (-2.660)**	-0.180 (-0.730)	0.011 (1.128)	0.623 (4.891)***	0
Cote D'Ivoire						
Variables	**μ**	**β**	**θ**	**δ**	**α**	**k**
LA	8.694 (5.792)	0.04 (2.339)**	-0.663) (-3.190)***	0.024 (2.315)	0.617 (3.900)**	0
LY	10.232 (8.818)	0.014 (-1.700)*	0.013 (0.293)	0.052 (3.382)**	-0.240 (-1.700)	1
$L\rho_{ee}$	2.859 (3.625)	-0.035 (4.897)***	0.281 (2.066)**	0.003 (0.221)	0.610 (4.897)***	0
Togo						
Variables	**μ**	**β**	**θ**	**δ**	**α**	**K**
LA	3.986 (2.867)	0.002 (0.596)	0.319 (1.976)*	-0.016 (-1.233)	0.601 (4.353)***	0
LY	7.668 (7.777)	-0.008 (-1.220)	-0.176 (-0.773)	0.008 (0.326)	0.096 (0.803)	0
$L\rho_{ee}$	3.072 (3.638)	-0.035 (-3.795)***	0.282 (2.078)**	0.003 (0.205)	0.573 (4.894)***	0

Source: Data analysis, 2009.
NB t – values in parenthesis
Critical t – values α for taken from Perron's (1989) table.
Critical t-values: 1% = 4.24 5%= 3.95 : λ = 0.59

Coffee Acreage

Coffee acreage has a α coefficient that is not significantly different from 1 for the unit root test. After the introduction of the SAP and intercept shift variable, there was a significant but slight drop in the value of α from 0.754 to 0.601. This shows that coffee acreage (LA_{ce}) in Togo is differenced stationary rather than being trend stationary. The growth in the acreage of coffee cultivated as represented by the SAP – trend shift variable was not significant even though it was also positive. This result suggests that although SAP has a positive effect on coffee acreage cultivated in Togo, the effect is not pronounced.

Coffee yield

The α coefficient for coffee yield (LY_{ce}) in the Perron unit root test for export series in Togo is 0.811 and it is significantly different from 1. However, after the introduction of the broken trend and intercept variables in the Perron unit root equation, a positive but insignificant coefficient was observed for the SAP variable (γ). The coefficient of 0.008 for γ suggests that that there was an increase in the trend of coffee yield in Togo after the introduction of SAP in that country. Although SAP has a positive contribution to the growth of coffee yield in Togo, the contribution is not significant.

Coffee producer price

The Perron unit- root test for coffee producer price (LP_{ce}) in Togo as shown in table 1 reveals that the coefficient of α is insignificantly different from 1 (α = 0.692). However, after the inclusion of the SAP variable i.e. growth change and the intercept variable, the coefficient of α stood at 0.573 and it is significant at 1%. This suggests that coffee producer price is differenced stationary rather than stationary around a linear deterministic trend. The coefficient of the structural break (SAP) is 0.003 although it is not significant statistically. Coffee is an important export crop in Togo and so the result suggests that SAP has a positive impact on coffee producer price in Togo although it is not significant.

CONCLUSION AND POLICY RECOMMENDATIONS

This study examined the time series properties of coffee series among selected West Africa countries and the effect of SAP on those series. The study concludes that despite about three decades of operating SAP and economic liberalization in ECOWAS, the SAP policy is not achieving its intended purpose especially for the West African coffee agriculture. Results suggests that exchange rate and price reforms under structural adjustment could not stimulate the desired increased yield and favourable prices to the producers.

However, if the coffees Agriculture in West Africa will indeed develop; there must be a set of deliberate actions taken by the ECOWAS regional governments and other stakeholders in the regional coffee sector. Apart from deliberate complementary interventions to improve structural factors such as infrastructure, marketing, access to inputs and credit, improved production technology and better market information which can be expected to make producers even more responsive, a very good attention must also be given to the coffee chains in West Africa.

Production volumes which are mostly low with attendant poor productivity must be addressed with improved mechanisation of production units. Treatment and processing operations must be put in place to ensure good quality of coffee. Good information about marketing opportunities, good cooperation among producers in the sharing of information on prices and suppliers and trade promotion with international buyers which will ensure familiarity with the global coffee market players will go a long way to boost the income generating power of coffee producing ECOWAS countries given the great potential of the crop in the region.

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