THRESHOLD COINTEGRATION AND ASYMMETRIC ADJUSTMENT BETWEEN GOVERNMENT SPENDING AND REVENUE IN CÔTE D'IVOIRE

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ABSTRACT

This paper re-examines the inter-temporal relationship between government expenditures and revenues in Côte d'Ivoire while relaxing the common assumption of a symmetric adjustment process underlying the standard cointegration tests. Our empirical methodology makes use of recent developments on threshold cointegration that considers the possibility of non-linear and asymmetric adjustment. The empirical results show the evidence of cointegration and asymmetric adjustment to budgetary disequilibria. Further, we find that the short-run adjustment process to correct budgetary disequilibria is faster when the budget is improving than when it is worsening. When the budget is worsening spending rather than revenues, carry the burden of restoring the long-run relationship. This indicates that government expenditures play a significant role in reducing budget deficits.

Key Words: Government expenditure, Revenue, Threshold cointegration, Asymmetric adjustment

INTRODUCTION

The control of budget deficits has become a major challenge for most African countries since 1980s. Today, the international community attaches great importance to a country's fiscal deficit and deficits have become one of the important indicators of public finance health. Public deficits control in Cote d'Ivoire has become an important objective of economic policy after the signing in 1994 of the stability and growth pact within the West African Economic and Monetary Union (WAEMU). Further, it is believed that chronic deficits adversely affect economic growth. Accordingly, various measures have been proposed in an attempt to restrict the size of budget deficits. While some of these measures focus on spending, others target revenues, and still others target both tools. The question that which of these tools is the most effective strategy has received considerable academic attention in macroeconomics and is still an unresolved issue. Raising taxes has adverse effects on the private sector and on economic growth in general. Reducing expenditures is also a difficult task because it involves long-run commitments. In either case

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however, the problem is that raising revenues may induce higher spending or reducing spending may induce lower revenues, without necessarily affecting the deficit. In such a context, an accurate knowledge of the causal relationship between government spending and revenues provides helpful information in affecting government deficit. It is therefore the aim of this paper to gain better insight of budgetary variables behaviours and offer policy actions that can be implemented to eliminate budget deficits in Cote d'Ivoire.

In the public finance literature, four hypotheses have been advanced to characterise the inter-temporal relationship between government expenditures and revenues. First, the *tax-and-spend* hypothesis advanced by Friedman (1978) contends that changes in government revenues induce changes in expenditures. Friedman, (1978) infers that raising taxes will only lead to more government spending, and hence to fiscal imbalances, Buchanan and Wagner (1978) argue for the opposite relationship in that decreased revenues lead to increased spending as consumers demand more programs. Their remedy for budget deficits is therefore an increase in revenues. Empirically, this hypothesis is characterized by unidirectional causality running from government revenues to government expenditures. Second, the spend-and-tax hypothesis relies on the reverse causal relation, suggesting that spending may lead revenues in the sense that governments spend first and then increase tax revenues as necessary to finance expenditures (Peacock and Wiseman, 1979). This hypothesis suggests spending cuts as the desired solution to reducing budget deficits. Third, under the fiscal synchronization hypothesis suggested by Musgrave (1966) as well as Meltzer and Richard (1981), revenues and expenditures decisions are made simultaneously. Empirically, this hypothesis is characterized by contemporaneous feedback or bidirectional causality between the two variables. A fourth hypothesis relates to the institutional separation of the expenditure and taxation decisions of government (Buchanan and Wagner, 1978; Baghestani and McNown, 1994). This perspective suggests that revenues and expenditures are independent of each other.

A growing body of empirical literature of public finance has tested the validity of the four theoretical hypotheses. Most of the empirical studies are carried out for Latin America, USA, Europe and Asia, and very limited attention has been devoted to Sub-Saharan African countries. The findings from these empirical studies are controversial, ranging from bi-directional or unidirectional causality to no causality. Traditionally, the empirical investigation used two conventional econometric techniques. The first one are based on the classical Granger causality tests within a vector autoregressive (VAR) framework (see Anderson *et al.*, 1986; Manage and Marlow, 1986; Blackley, 1986; Ram, 1988). Another set of recent studies has employed the technique of cointegration and error-correction models. An incomplete list of such studies includes Miller and Russek (1990), Bohn (1991), Jones and Joulfaian (1991), Owoye (1995), Hondroyiannis and Papapetrou (1996), Vamvoukas (1997), Koren and Stiassny (1998), Li (2001), and Chang *et al.*

(2002)[1]. Payne, (2003) attributed these mixed results to the model specifications and econometric methodologies as well as the sample periods examined. In addition, the present study points out that a common limitation of all of the above studies using cointegration tests is that they assume linear adjustment towards long-run equilibrium relationship, and the adjustment process to maintain the equilibrium occurs in every time period. That is if revenue increase leads to expenditure increase, then revenue reductions lead to expenditure reductions and likewise if causality is from expenditures to revenues. Furthermore, they assume quantitative impacts of equal magnitude for both positive and negative shocks in the leading variable irrespective of whether the budget deficit is worsening or improving. If inappropriate, these assumptions may result in specification errors which may lead to inappropriate fiscal policy decisions. In the recent literature, some news arguments suggest that fiscal variables may display asymmetric adjustment paths. First, it is widely acknowledged that the budget position is highly sensitive to the business cycle through automatic stabilizers. The economy may behave in different manner during times of crisis and during "normal" times (Sichel, 1993; Perrotti, 1999). To the extent that the business cycle is asymmetric, one cannot rule out the possibility that public revenues and expenditures may also exhibit asymmetries. Second, asymmetry in the relationship between government spending and tax revenues may arise if the fiscal authorities react differently to deviations of the government expenditure from its equilibrium level. For instance, the authorities may be more willing to raise taxes rapidly when the government expenditure is above its equilibrium rather than lowering taxes rapidly when government spending falls below its long-run level. Balke and Fomby, (1997) and Enders and Granger, (1998) have shown that standard cointegration tests have low power in the presence of asymmetric adjustment.

As an extension of our previous study (Keho, 2009), and different from past research studies, this paper exploits recent advances in nonlinear cointegration modeling to obtain further insights into the Ivorian budgetary process. More precisely, it applies the threshold cointegration approach proposed by Enders and Granger, (1998) and Enders and Siklos, (2001) to test for a threshold cointegrating relationship between spending and revenue. Moreover, by estimating the threshold error correction model including positive and negative changes in expenditure and revenue, the short-term adjustments of both fiscal variables to budgetary equilibrium also are examined. In the empirical literature, even though this econometric approach is used in certain studies, its application for analyzing the relationship between government expenditures and revenues has not been previously widely considered. Blackley (1990), Ewing *et al*. (2006), Gil-Alana (2009) and Zapf and Payne (2009) are the only studies that have attempted to examine asymmetry in the government revenues-spending relation. The present study is the first work of its kind for a Sub-Saharan African country.

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[1] For a comprehensive survey of the empirical evidence on the tax-spend debate for both developed and developing countries, see Payne (2003). See also Narayan (2005).

ECONOMETRIC METHODOLOGY

This paper applies the methodology of the threshold cointegration test of Enders and Granger (1998) to test for temporal asymmetric relationship between government expenditure (E_t) and revenue (R_t). Assuming both variables are I (1) process, we first estimate the cointegration relation as follows:

$$E_t = \beta_0 + \beta_1 R_t + e_t \tag{1}$$

Where β_i are parameters to be estimated? Note that the residuals e_t represent the budgetary disequilibrium. The existence of long-run relationship involves stationary e_t. The augmented Dickey-Fuller (ADF) statistic is used to ascertain whether the residuals e_t are stationary. To test for stationarity of e_t, we have to obtain $-2 < \rho < 0$ in the regression given by:

$$\Delta e_t = \rho e_{t-1} + v_t \tag{2}$$

Where v_t is a white-noise process? If the two fiscal series are cointegrated, the bivariate representation of their short-run dynamics takes the form:

$$\Delta E_t = \mu_1 + \sum_{i=1}^{p} \beta_{1i} \Delta E_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta R_{t-i} + \gamma_1 e_{t-1} + \eta_{1t} \tag{3}$$

$$\Delta R_t = \mu_2 + \sum_{i=1}^{p} \varphi_{1i} \Delta E_{t-i} + \sum_{i=1}^{q} \varphi_{2i} \Delta R_{t-i} + \gamma_2 e_{t-1} + \eta_{2t} \tag{4}$$

However, a crucial limitation of equations (3) and (4) is that they do not capture the asymmetric nature of the responses of E_t and R_t to each other. They assume the short-run adjustment towards long run equilibrium to be always present and time invariant: the parameters γ_1 and γ_2, which measure the speed of adjustment are considered as fixed. Nevertheless, according to Balke and Fomby (1997), the movements towards equilibrium value do not always appear or at least do not have the same intensity. Equations (3) and (4) are particularly inappropriate if spending behave differently when the revenue is increasing than when it is decreasing. In addition, Pippenger and Goering (1993), Balke and Fomby (1997), Enders and Granger (1998) and Enders and Siklos (2001) showed that traditional tests for unit root and cointegration all have low power in the presence of non-linear adjustment towards long run equilibrium. In our case, this is important since the linear relationship in equation (2) is misspecified if the adjustment in expenditures towards the budgetary disequilibrium is asymmetric. The key point of our study is that if we presume the presence of asymmetric behavior in expenditures, then the standard tests for unit root and cointegration must be modified to account for such asymmetric behavior. Therefore as to capture the short-run asymmetric effects of increases and decreases in each fiscal variable, we decompose ΔE_t and ΔR_t into positive (increases) and negative (decreases) changes as follows, and incorporate these changes as separate variables into equations 3 and 4.

$$\Delta E_t^+ = \begin{cases} \Delta E_t & if & \Delta E_t \geq 0 \\ 0 & if & \Delta E_t < 0 \end{cases} \qquad \Delta E_t^- = \begin{cases} \Delta E_t & if & \Delta E_t \leq 0 \\ 0 & if & \Delta E_t > 0 \end{cases} \qquad (5)$$

$$\Delta R_t^+ = \begin{cases} \Delta R_t & if & \Delta R_t \geq 0 \\ 0 & if & \Delta R_t < 0 \end{cases} \qquad \Delta R_t^- = \begin{cases} \Delta R_t & if & \Delta R_t \leq 0 \\ 0 & if & \Delta R_t > 0 \end{cases} \qquad (6)$$

As in Enders and Granger (1998) and Enders and Siklos (2001), we account for asymmetric adjustments in the model by letting the deviation from the long-run equilibrium behave as a two regimes Threshold Autoregressive (TAR) process. Thus, we replace (2) with:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t) \rho_2 e_{t-1} + \mu_t \qquad (7)$$

where I_t is the indicator function such that:

$$I_t = \begin{cases} 1 & if & e_{t-1} \geq \tau \\ 0 & if & e_{t-1} < \tau \end{cases} \qquad (8)$$

and τ the threshold value. In the TAR process, the indicator variable I_t depends on the previous period's budgetary disequilibrium (e_{t-1}). As such, Equations (7) captures the response of the budgetary disequilibrium to positive and negative discrepancies from the threshold. In applying the TAR model, it is possible to examine whether the positive phase of the budgetary disequilibrium (e.g. deficits) has different effects on the behavior of expenditures and revenues than does the negative phase of budgetary disequilibrium (e.g. surpluses). For any value of τ, Petrucelli and Woolford (1984) showed that the sufficient and necessary conditions for e_t to be stationary are: $\rho_1 < 0$, $\rho_2 < 0$ and $(1 + \rho_1)(1 + \rho_2) < 1$. Since the exact nature of the non-linearity may not be known, it is also possible to allow the adjustment to depend on the previous period's change in e_{t-1} (i.e. Δe_{t-1}) instead of the level of e_{t-1}. In this case, the indicator in Equation (8) becomes:

$$I_t = \begin{cases} 1 & if & \Delta e_{t-1} \geq \tau \\ 0 & if & \Delta e_{t-1} < \tau \end{cases} \qquad (9)$$

The resulting model is called Momentum Threshold Autoregressive (MTAR) model. The M-TAR specification allows us to examine whether the positive phase of the changes in budgetary disequilibrium has a different effect on the behavior of expenditures and revenues than does the negative phase. If the errors in equation (7) are serially correlated, it is possible to use an augmented model with lagged changes of e_t. In this circumstance, equation (7) is replaced by:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t) \rho_2 e_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta e_{t-i} + \mu_t \qquad (10)$$

If the threshold parameter enters the model unrestrictedly, the problem of how to consistently estimate it along with the values of ρ_1 and ρ_2 emerges here[2]. To obtain a consistent estimate of the threshold, we follow the grid search procedure suggested by Chan, (1993). Specifically, the residual series e_{t-1} and Δe_{t-1} are sorted into an increasing order and the central 70% of observations are then considered as potential thresholds. For each possible threshold, the underlying model is estimated, and the consistent threshold value $\hat{\tau}$ is found by selecting the value that minimizes the sum of squared residuals. Once $\hat{\tau}$ is obtained and the TAR and MTAR models are estimated, the next step is to perform testing for threshold cointegration. In both specifications, the null hypothesis of no cointegration is given by the restriction $\rho_1 = \rho_2 = 0$, while the null hypothesis of symmetry is $\rho_1 = \rho_2$. To test for threshold cointegration, Enders and Siklos (2001) proposed two types of tests, called the Φ and t_{Max} statistics. The t_{Max} statistic is given by the larger t-statistic of ρ_1 and ρ_2. A significantly negative t_{Max} statistic would imply that ρ_1 and ρ_2 are both negative. The Φ-statistic is the F-statistic of the null hypothesis $\rho_1 = \rho_2 = 0$ of no cointegration. As the distributions of Φ and t_{Max} are not standard, appropriate critical values are tabulated by Enders and Siklos, (2001). If the null hypothesis of no cointegration is rejected, it is worthwhile to further test for symmetric adjustment using a standard F-test. Rejecting both the null hypotheses of $\rho_1 = \rho_2 = 0$ and $\rho_1 = \rho_2$ implies the existence of threshold cointegration with asymmetric adjustment. This justifies estimation of the following asymmetric error-correction models:

$$\Delta E_t = \delta_1 + \sum_{j=1}^{p_1} \phi_{1j} \Delta E_{t-j} + \sum_{j=0}^{q_1} \theta_j^+ \Delta R_{t-j}^+ + \sum_{j=0}^{m_1} \theta_j^- \Delta R_{t-j}^- + \gamma_1^+ I_t e_{t-1} + \gamma_1^- (1 - I_t) e_{t-1} + \zeta_{1t} \quad (11)$$

$$\Delta R_t = \delta_2 + \sum_{j=0}^{p_2} \varphi_j^+ \Delta E_{t-j}^+ + \sum_{j=0}^{q_2} \varphi_j^- \Delta E_{t-j}^- + \sum_{j=1}^{m_2} \phi_{2j} \Delta R_{t-j} + \gamma_2^+ I_t e_{t-1} + \gamma_2^- (1 - I_t) e_{t-1} + \zeta_{2t} \quad (12)$$

The main feature of the model is that it allows the long-run adjustment parameters γ_i^+ and γ_i^- to behave in different manners depending on the value of the threshold. These parameters determine the rate at which positive and negative deviations adjust to long-run relationship. The Granger causality tests are performed by testing for the existence of asymmetry using a series of coefficients tests as in the following hypotheses:

$$H_1: \quad \theta_j^+ = 0 \quad \forall j, \ H_2: \ \theta_1^- = 0 \quad \forall j, \ H_3: \ \theta_j^+ = \theta_j^- = 0 \ \forall j \quad (13)$$

Hypotheses H_1 and H_2 test whether or not positive change in revenue ΔR_t^+ or negative change in revenue ΔR_t^- has any effect on ΔE_t. H_3 is the null hypothesis that both positive and negative changes in revenue does not affect government expenditure. These hypotheses are tested using F-tests. Similar hypotheses can be formulated for revenue equation (12) to test for causality in the reverse direction.

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[2] Some studies use a threshold value of zero. However there is no a priori reason to expect the threshold to be zero.

DATA AND EMPIRICAL RESULTS

Data and unit root tests

The present study uses annual data covering the period 1960 to 2007. The main variables are total government expenditures and government revenues expressed as GDP ratios. This transformation alleviates the question of whether data should be considered in nominal or real terms. While controlling for GDP, this treatment decreases the dependency of fiscal variables upon nominal income dynamics. Many studies have used this transformation (see Bohn, 1991; Hondroyiannis and Papapetrou, 1996; Baghestani and AbuAl-Foul, 2004; Narayan, 2005). Nominal data on the overall government revenues and expenditures are from the National Institute of Statistic and the statistics yearbook 2006 published by the Central Bank of West African States (BCEAO, 2006). Data for nominal GDP are obtained from *World Development Indicators* of the World Bank (2008). The empirical analysis involves three steps: (i) testing for stationarity of the series; (ii) under the assumption of I(1) series, testing for threshold cointegration; (iii) estimating the bivariate threshold error-correction model and performing the Granger causality tests.

Table 1: Unit root test results

	Level			First Difference		
Series	ADF	PP	DF-GLS	ADF	PP	DF-GLS
E_t	-0.477	-0.276	-1.504	-4.658[*]	-4.552[*]	-4.636[*]
	(-1.948)	(-1.948)	(-1.948)	(-1.948)	(-1.948)	(-1.948)
R_t	-0.372	-0.378	-1.619	-6.737[*]	-6.739[*]	-6.471[*]
	(-1.948)	(-1.948)	(-1.948)	(-1.948)	(-1.948)	(-1.948)

Notes: The lag length of the ADF and DF-GLS tests is determined using the MAIC criterion of Ng and Perron (2001) following initial consideration of a maximum lag length equal to $k_{max}=int(12(T/100)^{0.25}$), where T is the sample size. The numbers in parenthesis are 5% critical values. [*] indicates the rejection of the null hypothesis at the 5% level of significance.

To assess the orders of integration of the two series, we apply the unit root tests of Dickey-Fuller (1979), Phillips-Perron (1988) and Elliott *et al*. (1996). These tests are denoted as ADF, PP and DF-GLS respectively. The results obtained from application of these tests show that both government expenditure and revenue exhibit behaviour consistent with unit root non-stationarity (see Table 1).

Testing for threshold cointegration

Given the unit root tests results, we further test for cointegration between the two variables. We use the Engle-Granger, (1987) two-step procedure which involves estimating the equation (1) by OLS. Although the estimates of the coefficients are super consistent, formal hypothesis testing in regard to the value of the cointegrating parameters cannot be directly carried out because the nonstationarity of the individual series implies that the estimated standard errors are not consistent. Hence, we perform the Dynamic OLS (DOLS) regression proposed by Stock and Watson, (1993) which involves adding leads and lags of the first differenced regressors in the regression (1). This procedure corrects for potential endogeneity problems and provides estimates of the cointegrating

vector which are asymptotically efficient. The cointegrating slope is significant and positive, indicating that expenditure and revenue are positively linked (see Table 2 Panel B). Moreover, the Stock and Watson test indicates that this coefficient is greater than one, indicating the significant and persistence of budget deficits over the period.

The residuals $\hat{e}_t$ from the cointegrating relationship are used to examine whether the adjustment process towards the long-run equilibrium relationship is linear or exhibits threshold nonlinearities. This issue was analysed using the econometric model described in section 2. As can be seen from results reported in Table 2 Panel A, the estimates of ρ_1 and ρ_2 satisfy the stationary conditions. More importantly, the null of no cointegration ($\rho_1 = \rho_2 = 0$) can be rejected for both the TAR and the MTAR models, indicating that expenditure and revenue are cointegrated. Given this findings, the null hypothesis of symmetric adjustments can be tested using a standard F-test. The F-statistics allows us to soundly reject the null hypothesis of symmetric adjustment ($\rho_1 = \rho_2$). Hence, we can conclude that the two fiscal variables are cointegrated and that the adjustment mechanism towards equilibrium is asymmetric. This implies asymmetries in expenditure changes to revenue shocks or revenue changes to spending shocks. As measured by the AIC and the SC, both TAR and M-TAR adjustment exhibit similar goodness of fit, and, therefore, the one modeling framework is not significantly superior over the other. The point estimates of ρ_1 and ρ_2 suggests substantially faster convergence for negative deviations (below threshold) from the long-run relationship than for positive deviations (above threshold). Negative deviations from long-term equilibrium resulting from decreases in government spending or increases in government revenues (such as $\hat{e}_{t-1} < -3.978$) are eliminated much faster than positive deviations resulting from increases in expenditures or decreases in revenues. Therefore, the short-run adjustment towards the budgetary equilibrium tends to persist more when the budget is worsening and reverts more quickly when the budget is improving.

Table 2: Results of threshold Cointegration tests

Panel A: Threshold cointegration tests		
Coefficients	TAR	MTAR
ρ_1 [a]	-0.174[***] (-1.712)	-0.193[***] (-1.893)
ρ_2 [a]	-1.109[*] (-5.760)	-1.120[*] (-5.516)
Estimated threshold $\hat{\tau}$	-3.978	-3.624
Φ [b]	17.361[*]	16.204[*]
F-test[c] (Sig.)	19.806[*] (0.000)	17.937[*] (0.000)
AIC	4.936	4.966
SC	5.055	5.085
Q(4)[d]	2.764 (0.598)	4.063 (0.397)
Panel B: Cointegrating relationship $E_t = \beta_0 + \beta_1 R_t + e_t$		
	β_0	β_1
OLS[e]	0.476	1.153

	(0.152)	(8.623)
DOLS[e]	-7.318[*] (-3.064)	1.506[*] (14.827)

Notes: [a] Coefficients and t-statistics for ρ_1 and ρ_2.

[b] Φ denotes the F-test for the null hypothesis $\rho_1=\rho_2=0$. Critical values for Φ for a TAR two-variable case and one lagged change are 7.31 and 10 for 5% and 1%, respectively; corresponding values for MTAR are 7.14 and 9.93 (see Enders and Siklos (2001), Table 5, p. 172).

[c] F shows the sample F-statistic for the null hypothesis tests for symmetry $\rho_1=\rho_2$. p-values are in parenthesis below.

[d] Ljung-Box statistic for the hypothesis that the first 4 of the residual autocorrelations are jointly equal to zero. p-values are in parenthesis below.

[e] The numbers in parenthesis are t-statistics.

*, **, and *** denote significance at the 1%, 5% and 10% levels, respectively.

Short-run dynamics and causality testing

Having established threshold co integration between expenditure and revenue, we next examine their short-run dynamics by estimating the asymmetric version of the error correction model. As TAR and MTAR models give similar results, we focus on the TAR-ECM, which yield the results reported in Table 3. The estimated coefficients on the error correction terms determine the rate at which expenditure and revenue adjust to positive and negative deviations from the long-run equilibrium. The results show that expenditure and revenue respond much faster to an improving in the budget than to a worsening budget. However, revenue apparently does not adjust to disequilibrium when the budget is worsening. Note that the response of revenue to an improving in the budget is much larger (in absolute terms) than the response of expenditure. When government expenditure is above its long-term level, fiscal authorities react by lowering spending rather than rising revenues. Formal testing of coefficient equality shows that the null hypothesis $\gamma^+ = \gamma^-$ can be strongly rejected at the 5% level of significance in the revenue equation as the relevant F-statistic has a p-value of 0.001. The hypothesis cannot be rejected in the expenditure equation, the F-statistic having a p-value of 0.113. However, the test of symmetry within asymmetric error correction models has long been recognised to suffer from exceptionally low power (see Cook *et al.*, 1999; Holly *et al.*, 2003). In light of the difference in the values of the coefficients and the low power of the symmetry test, it is reasonable to conclude that the results from the asymmetric ECM confirm the findings of the TAR model on the speed of adjustment and therefore asymmetric adjustment is really present.

Table 3: Causality testing under asymmetry

Variable	γ^+	γ^-	θ_0^+	θ_0^-	$H_1:\theta_j^+ = 0 \ \ \forall j$	$H_2:\theta_j^- = 0 \ \ \forall j$	$H_3:\theta_j^+ = \theta_j^-$
ΔE_i	-0.490[*] (0.000)	-0.806[*] 0.000)	0.436[*] (0.014)	0.502[**] (0.068)	6.594[*] (0.014)	4.903[*] (0.003)	5.094[*] (0.001)
ΔR_i	0.087 (0.444)	1.023[*] (0.000)	0.768[*] (0.001)	0.176 (0.536)	6.566[*] (0.003)	0.388 (0.536)	4.640[*] (0.007)

Notes: Results are based on the following asymmetric error-correction model:

$$\Delta y_t = \delta + \sum_{j=1}^{p}\phi_{1j}\Delta y_{t-j} + \sum_{j=0}^{q}\theta_j^+\Delta x_{t-j}^+ + \sum_{j=0}^{m}\theta_j^-\Delta x_{t-j}^- + \gamma^+ I_t e_{t-1} + \gamma^-\left(1-I_t\right)e_{t-1} + \zeta_t$$, where the

dependent variable Δy is ΔE when Δx is ΔR, and ΔR when Δx is ΔE. Δx_t^+ and Δx_t^- are defined as Δx_t^+

=max(Δx_t ,0) and Δx_t^- =min(Δx_t ,0), respectively. Lag values for *p*, *q* and *m* are selected on the basis of AIC criterion. * and ** indicate significance at the 5% and 10% levels, respectively.

Of secondary interest is the short-run causality testing results. As shown by the F-statistics for the joint restrictions hypotheses tests for H_1, H_2 and H_3, the short-run dynamics are characterized by bidirectional causality between expenditure and revenue. The temporal causal relationship between depends upon the overall direction of budget change. Considering the individual coefficients on the contemporaneous changes variables, the coefficient of the positive change in revenue is significantly positive in expenditure equation. This implies that increase in revenue would lead to an increase in government expenditure. The coefficient of the negative revenue change is also positive, indicating that lower revenue is associated with declining public spending. This result lends support to the *tax-and-spend* hypothesis in the view of Friedman, (1978). With respect to the revenue equation, positive changes in expenditure lead to revenue increases, while negative changes have no significant effect on revenue growth.

CONCLUSION AND FUTURE RESEARCH

This article relaxes the implicit assumption of a symmetric adjustment process underlying the conventional cointegration models when examining the relationship between revenues and expenditures. It has explored the possibility of threshold effects in the relation between the two variables of the budgetary process in Côte d'Ivoire. The empirical methodology used threshold cointegration approach for estimation and inference. Using annual data over the period 1960 to 2007, the following results were found. First, results of threshold cointegration indicate that government expenditures and revenues are cointegrated with an asymmetric adjustment process. Adjustment towards the long-run equilibrium is faster when the budget is improving than when it is worsening. The results obtained from the asymmetric error-correction model indicate that when the budget is worsening the short-run adjustment to correct the budgetary disequilibria is mainly done by changes in government expenditures rather than changes in revenue. Second, the short-run dynamics suggest that the tax-and-spend hypothesis holds between expenditure and revenue while the spend-and-tax hypothesis holds during some periods and not in others. This implies that the fiscal authorities can pursue fiscal synchronization policies during certain periods and not during others. The main policy implication of these findings is that to reduce the size of fiscal imbalances policymakers should focus mainly on spending cuts rather than raising taxes. In periods of surplus, fiscal policies should control revenues and expenditures simultaneously.

The results presented in this paper provided the first evidence of asymmetric relationship between government expenditures and revenues for an African country. It has added to the literature a study on public finance and calls for the need to revise the traditional linear specification on dynamics. This is certainly an important issue in macroeconomics policy since the short-run dynamics is crucial to policy-makers in determining the timing and extent of intervention. Bearing in mind that

the class of non-linear models is infinite, we view the empirical results discussed in this paper as a promising step towards investigating the role of nonlinearities in the area of public finance. It would be interesting to formally introduce and estimate a two-regime threshold model where the transition mechanism between regimes is smooth. Another interesting topic of research would be to test for threshold cointegration in a multivariate framework rather than using univariate residual-based procedures. As multivariate threshold models utilise the full structure of the model, they should have higher power than univariate methods. Moreover, the TAR model assumes that only the adjustments to equilibrium change with regimes, while the autoregressive parameters remain constant. An additional promising direction would be to relax this assumption, allowing the speed of the adjustment as well as the short-run impacts of the regressors to vary across regimes. We intend to address these issues in future research.

REFERENCES

Anderson, W., M. S. Wallace and J. T. Warner (1986). Government Spending and Taxation: What Causes What? *Southern Economic Journal*, Vol. 52, No. 3, pp. 630-639.

Baghestani, H. and R. McNown (1994). Do Revenues or Expenditures Respond to Budgetary Disequilibria? *Southern Economic Journal,* Vol. 61, No. 2, pp. 311-322.

Baghestani, H. and B. AbuAl-Foul (2004). The Causal Relation between Government Revenue and Spending: Evidence from Egypt and Jordan, *Journal of Economics and Finance*, Vol. 28, No. 2, pp. 260-269.

Balke, N. S. and T. B. Fomby (1997). Threshold Cointegration, *International Economic Review*, Vol. 38, pp. 627–645.

BCEAO, (2006). Statistics Yearbook 2006, Central Bank of West African States.

Blackley, P. R. (1986). Causality between Revenues and Expenditures and the Size of the Federal Budget, *Public Finance Quarterly,* Vol. 14, pp. 139-156.

Blackley, P. R. (1990). Asymmetric Causality between Federal Spending and Tax Changes: Avoiding a Fiscal Loss, *Public Choice,* Vol. 66, pp. 1-13.

Bohn, H. (1991). Budget Balance through Revenue or Spending Adjustments? Some Historical Evidence for the United States, *Journal of Monetary Economics*, Vol. 27, pp. 333-59.

Buchanan, J. M. and R. W. Wagner (1978). Dialogues Concerning Fiscal Religion, *Journal of Monetary Economics*, Vol. 4, pp. 627-636.

Chan, K. S. (1993). Consistency and Limiting Distribution the Least Squares Estimator of a Threshold Autoregressive Model, *The Annals of Statistics,* Vol. 21, No. 1, pp. 520–533.

Chang, T., W. R. Liu and S. B. Caudill. (2002). Tax-and-Spend, Spend-and-Tax, or Fiscal Synchronization: New Evidence for Ten Countries, *Applied Economics*, Vol. 34, pp. 1553-61.

Cook, S., S. Holly and P. Turner. (1999). The Power of Tests for Non-linearity: The Case of Granger-Lee Asymmetry, *Economics Letters*, Vol. 62, pp. 155-159.

Dickey, D. A. and W. A. Fuller. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, Vol. 74, pp. 427-431.

Elliott, G., T. J. Rothenberg. and J. H. Stock. (1996). Efficient Tests for an Autoregressive Unit Root, *Econometrica*, Vol. 64, No. 4, pp. 813-836.

Enders, W. and C. W. C. Granger. (1998). Unit-Root Tests and Asymmetric Adjustment with an Example Using the Term Structure of Interest Rates, *Journal of Business and Economic Statistics*, Vol. 16, No. 3, pp. 304-311.

Enders, W. and P. L. Siklos (2001). Cointegration and Threshold Adjustment, *Journal of Business and Economic Statistics*, Vol. 19, pp. 166-76.

Engle, R. and C. W. J. Granger. (1987). Co-integration and Error Correction: Representation, Estimation and Testing, *Econometrica*, Vol. 55, No. 2, pp. 251-276.

Ewing, B. T., J. E. Payne, Thompson. M. A. and O. M. Al-Zoubi. (2006). Government Expenditures and Revenues: Evidence from Asymmetric Modeling, *Southern Economic Journal*, Vol. 73, No. 1, pp. 190-200.

Friedman, M. (1978). The Limitations of tax Limitation, *Policy Review*, pp. 7-14.

Gil-Alana, L. A. (2009). Government Expenditures and Revenues: Evidence of Fractional Cointegration in an Asymmetric Modelling, *International Advances in Economic Research*, Vol. 15, No. 2, pp. 143-155.

Holly, S., P. Turner and M. Weeks. (2003). Asymmetric Adjustment and Bias in Estimation of Estimation of an Equilibrium Relationship from a Cointegrating Regression, *Computational Economics*, Vol. 21, pp. 195-203.

Hondroyiannis, G. and E. Papapetrou. (1996). An Examination of the Causal Relationship between Government Spending and Revenue: A Cointegration Analysis, *Public Choice*, Vol. 89, No. 3-4, pp. 363-374.

Jones, J. D. and D. Joulfaian. (1991). Federal Government Expenditures and Revenues in the Early Years of the American Republic: Evidence from 1792-1860, *Journal of Macroeconomics*, Vol. 13, No. 1, pp. 133-155.

Keho, Y. (2009). Budget Balance through Revenue or Spending Adjustments? An Econometric Analysis of the Ivorian Budgetary Process, 1960-2005, *Journal of Economics and International Finance*, forthcoming (December).

Koren, S. and A. Stiassny. (1998). Tax and Spend or Spend and Tax? An International Study, *Journal of Policy Modeling,* Vol. 20, No. 2 pp. 163-191.

Li X, (2001). Government Revenue, Government Expenditure, and Temporal Causality: Evidence from China, *Applied Economics,* Vol. 33, pp. 485-497.

Manage, N. and M. L. Marlow. (1986). The Causal Relation between Federal Expenditures and Receipts, *Southern Economic Journal,* Vol. 52, No. 3, pp. 617-629.

Miller, S. M. and F. S. Russek. (1990). Co-integration and Error-Correction Models: Temporal Causality between Government Taxes and Spending, *Southern Economic Journal*, Vol. 57, No. 1, pp. 221-229.

Meltzer, A. H. and S. F. Richard. (1981). A Rational Theory of the Size of Government, *Journal of Political Economy*, Vol. 89, No. 5, pp. 914-927.

Musgrave, R. (1966). Principles of Budget Determination In *Public Finance: Selected Readings,* H. Cameron E. T. W. Henderson (Eds.). Now York: Random House.

Narayan, P. K. (2005). The Government Revenue and Government Expenditure Nexus: Empirical Evidence from Nine Asian Countries, *Journal of Asian Economics*, Vol. 15, pp. 1203-1216.

Newey, W. and K. West. (1994). Automatic Lag Selection in Covariance Matrix Estimation, *Review of Economic Studies*, Vol. 61, pp. 631-653.

Ng S. and P. Perron (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power, *Econometrica*, Vol. 69, pp. 1519-1554.

Owoye, O. (1995). The Causal Relationship between Taxes and Expenditures in the G7 Countries: Cointegration and Error Correcting Models, *Applied Economic Letters*, Vol. 2, pp. 19-22.

Payne, J. E. (2003). A Survey of the International Empirical Evidence on the Tax-Spend Debate, *Public Finance Review*, Vol. 31, pp. 302-24.

Peacock, A. and J. Wiseman. (1979). Approaches to the Analysis of Government Expenditures Growth, *Public Finance Review*, Vol. 7, pp. 3-23.

Perotti, R. (1999). Fiscal Policy in Good Times and Bad, *Quarterly Journal of Economics,* Vol. 114, No. 4, pp. 1399-1436.

Petrucelli, J. and S. Woolford (1984). A Threshold AR (1) Model, *Journal of Applied Probability*, Vol. 21, pp. 270-286.

Phillips, P. C. B. and P. Perron. (1988). Testing for a Unit Root in a Time Series Regression, *Biometrika*, Vol. 75, No. 2, pp. 335-346.

Pippenger, M. K. and G. E. Goering. (1993). A Note on the Empirical Power of Unit Root Tests Under Threshold Processes, *Oxford Bulletin of Economics and Statistics*, Vol. 55, pp. 473-81.

Ram, R. (1988). Additional Evidence on Causality Between Government Revenue and Government Expenditure *Southern Economic Journal,* Vol. 54, No. 3, pp. 763-769.

Stock, J. and M. W. Watson. (1993). A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems, *Econometrica*, Vol. 61, pp. 783-820.

Sichel, D. (1993). Business Cycle Asymmetry: A Deeper Look, *Economic Inquiry*, Vol. 31, pp. 224-36.

Vamvoukas, G. (1997). Budget expenditures and Revenues: An Application of the Error Correction Modeling, *Public Finance*, Vol. 52, No. 1, pp. 139-143.

Zapf, M. and J. E. Payne. (2009). Asymmetric Modelling of the Revenue-Expenditure Nexus: Evidence from Aggregate State and Local Government in the US, *Applied Economics Letters*, Vol. 16, No. 9, pp. 871-876.