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Sustainability of Public Debt and Economic Growth in Cote d'Ivoire: is There a Threshold Effect?

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ARTICLE INFO	ABSTRACT
	The development of Ivorian public debt in recent years has raised concerns. Is its current level capable of boosting the economy or, on the contrary, being at the source of a recession? This paper analyzes the effect of the level of indebtedness on economic growth in Côte d'Ivoire using the Threshold Autoregressive (TAR) model over the period 1970-2018. The results obtained in the short run shed light on the no relationship between public debt and economic growth. In the long run, on the other hand, there is a bi-directional granger causality between public debt and the sustainability of economic growth. The non-linearity between the variables of interest has been studied and the results show the presence of a threshold effect: beyond 48.03 percent of GDP, any increase in public debt by 1% should reduce economic growth by 0.28%. Thus, the study questions the relevance of the criterion set by the WAEMU: public debt <70% of GDP.

1. Introduction

In the past decade, the economic literature on economic growth and public debt has been the subject of numerous papers. Debt is used for spending to create wealth and stimulate the economy. However, Panizza and Presbitero[23] and Kumar and Woo[36] establish a threshold value beyond which any increase in public debt could negatively impact economic growth. For Freeman and Webber (2009) the level of public debt is not essential. Rather, it is the use of this resource that can either positively or negatively impact the economy. Indeed, according to the latter if these resources were used in productive sectors such as nutrition, education and health, its impact on the economy would be positive regardless of its level.

The level of public debt in Côte d'Ivoire has grown drastically since the 1980s. It reached its maximum in 1994. At that date (1994), the level of public debt to GDP was 173.87%, more than double of the community standard set by WAEMU. To understand the evolution of Ivorian debt, one must delve into the past of African countries. after independence, difficulties mainly arose due to a snowball effect of debt; It was in this climate that the first oil shock of 1973 occurred when the price of oil quadrupled. The huge profits made by OPEC countries are placed in private international banks. The latter lend them to developing countries at relatively attractive rates. The World Bank is also following this trend. From 1968 to 1978, it increased its loans to developing countries tenfold[18]. No control is carried out,

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and the beneficiary countries will very often embark on the construction of white elephants.

Meanwhile, the prices of agricultural export products, the main resource, of African countries are sinking, they are reaching the lowest levels ever recorded. This is largely due to continued overproduction (Dutch syndrome) and deteriorating terms of trade. Besides that, it should be remembered that the United States, wanting to revive its economy, raised interest rates in the 1980s. This considerably increased the interest burden on borrowing countries. Consequently, many African countries borrow to repay.

To deal with these financial difficulties, several measures are taken depending on the country. In Côte d'Ivoire, we are witnessing the dismantling of the Agricultural Product Price Stabilization and Support Fund (CAISTAB) in 1990; the privatization of state-owned companies and the devaluation of the FCFA in January 1994. The main purpose is to achieve economic growth of around 6% by 1996, with an increase in exports and a consolidation of public finances (primary balance objective aligned with the Community standard of the around 3%), and by reducing the harmful effects of structural adjustment on the poorest social strata [20]. It is true that contrary to pessimistic forecasts, the devaluation of the devaluation of the FCFA by 50% has had some beneficial effects on economic activity. According to Akiko *et al.* [3], in three years the increase in GDP due to devaluation would be around 4.8%. This is due to the fall in unemployment and the resulting competitiveness.

However, from 1996 onwards it became clear that not all of these measures were large enough to resolve the financial difficulty. The main international financial institutions therefore ended up implementing, in the same year, the so-called Heavily Indebted Poor Countries (HIPC) initiative. This initiative involves significantly reducing the debt burden of poor countries and making them sustainable.

Côte d'Ivoire after decades of effort has seen its external debt reduced by 24% following its eligibility for the HIPC program in 1998. In 2012, when reaching the achievement point, some macroeconomic indicators have greatly improved: external debt stocks on GDP rose from 67% to 18% for a normal ratio which should be less than 40%. The stock of external debt on total revenue, which should be less than 250%, was on the rise from 351% before the HIPC to 99% in 2012. In terms of domestic debt on exports, it went from 148% to 36.1%. When it was enough to be less than 150%. And finally, the public debt ratio, which should not be greater than 70% to GDP, fell from 79% to 36.2% after the HIPC.

However, it is a truism to assert that the level of debt, in particular public debt has been constantly increasing in recent years: from 43% in 2013%, it almost 55% in 2018

and this in less than a five-year term. This raises some questions: Is the level of public debt sustainable? Does it stimulate economic growth or, on the contrary, is it harmful for the Ivorian economy? Is there a threshold effect beyond which public debt negatively impacts economic growth?

This study aims to highlight the empirical relationship between the sustainability of public debt and economic growth with a special focus on threshold models.

The remainder of the paper is organized as follows: Section 2 is dedicated to the literature review. Section 3 describes the data and related econometric methodology. Section 4 reports and discusses the empirical results. Section 5 questions the existence of plausible threshold effects based on a further assessment. Section 6 concludes the paper.

2. Literature Review

2.1 The Theory of Over-indebtedness

Theories on public debt are very varied. Among the most important are that of Barro [31]. Indeed, the latter reveals a total neutrality of the debt on the economy. This theory, however, is attributed to 19th century English economist Ricardo and quoted "Ricardian equivalence". He hypothesizes the rationality of economic agents and shows that a deficit fiscalpolicy, financed by borrowing has no effect on economic activity, insofar as agents are no longer victims of a 'fiscal illusion' today. The agents make perfect anticipations and they will integrate this change into their decision. Consequently, they will perfectly anticipate the increase in future taxes intended to repay the initial loan and, in anticipation of these future withdrawals, they will immediately build up savings equivalent to the public debt, thus compromising the policy of fiscal stimulus.

Krugman [19], he defines over-indebtedness as the negative relationship between external debt and investment. In this sense, over-indebtedness occurs when indebted countries can no longer meet their burdens. Other researchers have also supported this theory, in particular, Chowdhury [8] and Elbadawi *et al.* (1997). In other words, the very high debt level no longer favors investment. Consequently, the rates of return on projects in progress fail to reduce the level of debt to a reasonable level.

According to Krugman [19] the high level of debt suggests an increase in future tax rates. As these rates are highly dependent on the level of investment, these new taxes are likely to create distortions in investment. The immediate consequence is that the expected return from productive investment projects will be insignificant for reviving economy; to the extent that planned debt service spending will weaken foreign and domestic investment. If

economic agents realize rational expectations, this theory of over-indebtedness can be challenged. Irrefutably, the latter anticipating a future increase in taxes may reduce their consumption which could have negative impacts on growth. Furthermore, there is no longer any need to prove the link between savings and investment and high debt with possible tax hikes can erode savings which in turn will negatively affect growth. This theory of over-indebtedness assumes for the aforementioned reasons that it must have a maximum threshold beyond which any increase in debt can have a negative impact on economic growth. What emerges from this analysis is that the level of over-indebtedness is apparent when any increase in the level of debt reduces economic growth through investment.

2.2 Public Debt Sustainability Economic Growth

For some authors, the relationship between public debt and economic growth can be perceived in a non-linear form. Among these authors, we can cite Reinhart and Rogoff [30] and Daud *et al.* [11]; for these authors, beyond a certain value, the public debt is no longer sustainable for the economy and is experiencing economic growth. They assess the optimal value of public debt between 60% and 90% of GDP. But other authors have questioned this value. For example, Minea and Parent [4], using a Panel Smooth Transition Regression (PSTR) reassess this inflection point and set the threshold point around 115%. For them, beyond this value, the debt would become unsustainable for the economies insofar as it will have a negative impact on the economy through the investment channel.

Smyth and Hsing [32] show that the optimal level of debt is 48.9% to GDP by using a quadratic model applied to USA economy. In addition, Clements *et al.* [9] using data from a panel of 55 middle-income countries over the period 1970-1999 also observed the negative effect of the debt but on a level beyond the interval between 20% and 25 % of GDP.

Patillo *et al.* [22] they studied the relationship between public debt and economic growth through a panel of 93 countries covering a period of 30 years (1969-1998) and also highlighted a threshold effect. According to them, the positive effect of debt sustainability comes at values below 35% - 40% of GDP. But if the ratio debt to exports is beyond 160%-170%, public debt becomes unsustainable for the economy and causes distortions. According to them, at this moment, these are the negative effect of debt on growth, the effect of debt on liquidity due to the drain on debt service and finally the effect of public sector spending and deficits.

The aforementioned authors are unanimous that, depending on the state of an economy, there is a maximum value beyond which any increase in public debt seems to erode growth. This maximum value is very much dependent on the economic dynamics of the country. To understand the strong impact of the level of public debt on the economies of developing countries, we must look closely at the structure of the economies of these countries. For a long time, these countries remained dependent on their raw materials, thus constituting very extroverted economies. The debt problem of developing countries is therefore not only due to its level but more to the structure of its economy. For example, the level of public debt, ratio public debt to GDP of the OECD member countries and the USA were respectively 112.2% and 104.17% in 2015. This same year the level of public debt of Japan was largely above 200% in relation to GDP. And during these years it was seen to see growth in these aforementioned countries.

For other authors, this non-linear relationship between public debt and economic growth is not always observable. This is how Adam and Bevan [1] and Aizenman *et al.* [2] demonstrate a negative linear relationship between public debt and the rate of economic growth.

As for Greiner [16], he rather highlights the state of the economy. According to him, if in an economy wages and unemployment are flexible then in this case, any increase in the public debt can positively impact the economy because the debt will be used to finance the productivity of investments.

The issue of public debt continues to be crucial due to the upward trend in public spending. High public spending seems to accelerate economic growth. As consumption exceeds income levels, the size of the budget deficit will increase. The government can increase its borrowing to finance the deficit from local or external sources. Although the financial situation may improve, it is nevertheless very sensitive to changes in the current economic situation and the level of public debt. According to Teles and Mussolini [35], if public expenditure is directed towards unproductive expenditure such as subsidies and pensions, it will thus lead to a drop in economic growth.

The economic literature highlights this ambiguity between the level of public debt likely to generate sustainable growth and does not decide the impact of unsustainable public debt on economic growth.

3. Data and Econometric Methodology

3.1 Data

The study uses annual data covering the period 1970-2018. A log-log model is used in order to derive the elasticities to explain the differences between the coefficients of the

study variables. The variables are the economy growth rate (LGDP), public debt (LDEBT), investments (LINV), general government consumption expenditure (LCONS), the opening rate (LOPEN) and the debt service (LDS).

3.2 Econometric Methodology

The aim of this paper is to analyze the relationship between the sustainability of public debt and economic growth in Côte d'Ivoire over the period 1970-2018. The model used is inspired by the work of Solow [33] and Baumol [6].

In order to study the non-linear relationship between public debt and economic growth, we favor the threshold effect autoregression (TAR) method of Caner and Hansen [7]. The basic model is described as follows:

$$g_t = \begin{cases} a_1 d_t + \varepsilon_{1t}, & if\ d_t > \pi \\ a_2 d_t + \varepsilon_{2t}, & if\ d_t \le \pi \end{cases} \qquad (1)$$

where $d_t = \pi$ is the threshold effect (public debt) and g_t economic growth. The above equation system presents two schemes. According to Chudik *et al.* (2015) the augmented form of the above non-linear model can be rewritten :

$$\Delta lng_t = \alpha_1 I_t \left[d_t > (\pi) \right] + \alpha_2 I_t \left[d_t \le (\pi) \right] + \sum_{i=3}^{n} \alpha_i \Delta lnx_t + \varepsilon_t \qquad (2)$$

In this last equation, the usual dichotomous variables are used. The other variables alongside economic growth, public debt and dichotomous variables are used and represented by x_t: openness rate, government consumer spending, debt service, investments.

3.2.1 Unit Root Tests

As a first step in the modeling exercise, it is first necessary to determine the order of integration of the variables (LGDP, LDEBT, LGFCF, LGGFCE, LOUV, LDS). The stationarity of these variables is tested using two techniques: one without structural break, and another one which take into account the structural breaks in the series.

(1) Unit root tests without structural break - The Augmented Dickey-Fuller Test (DFA) [12,13].

In the majority of empirical studies, due to its power, the DFA test is preferred to detect the presence of unit roots. This test is an augmented version of the Dickey-Fuller (DF) test by adding lagged of the dependent variable.

$$\Delta Y_t = \mu + \alpha Y_{t-1} + \beta t + \sum_{j=1}^{k} c_j \Delta Y_{t-j} + \varepsilon_t \qquad (3)$$

where Δ is the first difference operator, Y_t the variable under investigation, ε_t a white noise process with variance σ^2, ΔY_{t-j} the lagged first differences with correction for possible autocorrelation of errors. The optimal lag (k) is determined based on Akaike (AIC) and Schwarz (SBIC). The null hypothesis of the presence of unit root is tested against the alternative: the series is stationary.

The DFA test involves performing a regression on the first difference of the variable being studied, on a constant, a linear deterministic trend, a lagged prime difference and a lagged k-difference.

The common problem with conventional unit root tests such as the test we have just seen (DFA) and many others (test by Philippe Perron (PP) and Dickey Fuller generalized least square (DF-GLS)) is not taken into account the probable structural breaks in the series. This very often causes bias in the test results. For example, to say that the socio-political crisis of 2010 must have caused structural breaks in the series studied is stating the obvious. This is why Perron [26] and Rappoport and Reichlin [29] emphasize the importance of structural breaks for the implementation and interpretation of unit root tests.

(2) The tests of unit roots with structural rupture by Zivot and Andrew (ZA) [37] and by Clemente, Montañés and Reyes [10].

The importance of these tests with taking into account structural breaks is that they are more robust than ordinary tests: ADP, Perron test and so on.

① The test of unit roots with structural break by Zivot and Andrew (ZA) [37].

This test is an extension of the DFA test. It is written as follows,

$$y_t = \alpha + \beta t + \gamma DU1_t + \omega DT1_t + \mu y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \qquad (4)$$

The null hypothesis establishes that there is presence of unit root in the time series (y_t). The alternative hypothesis is that the series is stationary. DU_{1t} and DT_{1t} are indicator variables which capture the change in the constant and in the trend at the date *Tb* respectively. Explicitly,

$$DU_{1t} = \begin{cases} 1, if\ t > Tb \\ 0, otherwise \end{cases} \quad and \quad DT_{1t} = \begin{cases} t - Tb, if\ t > Tb \\ 0, otherwise \end{cases}$$

② The test of Clemente, Montañés and Reyes [10].

Baum [5] suggests using the technique based on the models of Perron and Vogelsang [27,28] for the unit root test in the presence of structural rupture. The latter propose to use the additive outlier (AO) model when the change is supposed to have an instantaneous effect and the innovative outlier (IO) model for a slow effect. In this study,

we assume that the change created, for example, by the socio-political crisis of 2010 instantly affects all sectors of the economy. Thus, the appropriate model is the Clemente-Montañés-Reyes unit root test based on the AO model. This test is carried out in two stages. First, the deterministic part of the dependent variable is removed from the equation,

$$y_t = \mu + d_1 DU1_t + +d_2 DU2_t + \tilde{y}_t \qquad (5)$$

In the second step, the following model is used to test the presence of unit roots,

$$\tilde{y}_t = \rho \tilde{y}_{t-1} + \sum_{i=0}^{k} \omega_{1i} DTB_{1t-i} + \sum_{i=0}^{k} \omega_{2i} DTB_{2t-i} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t \qquad (6)$$

The IO model will not be presented. We can refer to the important paper by Perron [25].

3.2.2 Cointegration Tests

The cointegration test of Gregory and Hansen [15] is used in this study with the aim of testing the presence of structural breaks in the cointegration relationship between the variables of interest (economic growth and public debt). This test is more robust than the cointegration test of Engle and Granger [14] which tends to reject the null hypothesis of non-cointegration less if there is a cointegration relationship that has changed on a certain date (unknown) in the study period. In reality the Gregory and Hansen test is an extension of the approach of Engle and Granger and it involves testing the null hypothesis of non-cointegration against the alternative of cointegration presence with presence of a structural rupture at an unknown date; based on the extension of the usual tests ADF, Z and Z_t.

The standard cointegration approach as used by Engle and Granger [14] in the absence of structural failure is based on the following model:

$$y_t = \mu + \alpha_1 x_t + \varepsilon_t \qquad (7)$$

where y_t is the dependent variable, x_t a vector of explanatory variables which are all I(1) and the error term ε_t is I(0). Based on this model and to take into account possible structural breaks, Gregory and Hansen [15] define a dichotomous variable such that:

$$\varphi_t = \begin{cases} 0, & \text{if } t \leq [n\tau] \\ 1, & \text{if } t > [n\tau] \end{cases}$$

where $\tau \in (0,1)$ indicates the relative date of structural break and [] the integer part. In order to propose cointe-

gration tests with structural breaks, the authors develop four (04) models:

(1) Model with break in the constant term, C

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \varepsilon_t \qquad (8)$$

where μ_1 represents the constant term before the break and μ_2 the intersection after the structural break.

(2) Model with break in the constant term and trend, C/T

$$y_t = \mu_1 + \mu_2 \varphi_t + \beta t + \alpha_1 x_t + \varepsilon_t \qquad (9)$$

where β is the trend coefficient, t.

(3) Model with break in the constant and the slope, C/S

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \alpha_{11} \varphi_t x_t + \varepsilon_t \qquad (10)$$

α_1 represents the slope coefficients of cointegration of explanatory variables before the structural break and α_{11} the slope coefficients after the break.

(4) Model with break in the constant, the trend and the slope, C/S/T

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \beta t + \alpha_{11} \varphi_t x_t + \varepsilon_t \qquad (11)$$

Model (4) is deduced from models (2) and (3).

3.2.3 Causality Tests

After having established that a cointegration relation is present among the variables, the vector error correction model (VECM) which combines both the short-term properties of the economic relation in the form of first difference and the long relation term (at level) is estimated from the following equation:

$$\begin{bmatrix} GDP_t \\ DEBT_t \end{bmatrix} = \sum_{i=1}^{p} \begin{bmatrix} \beta_{1i} & \gamma_{1i} \\ \beta_{2i} & \gamma_{2i} \end{bmatrix} \times \begin{bmatrix} GDP_{t-i} \\ DEBT_{t-i} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \qquad (12)$$

ECT represents the error correction term lagged by a period. The length of the lag is determined by the Schwarz Information Criterion (SBIC). The null hypothesis that GDP does not cause DEBT in the Granger sense is rejected not only if $\sum \beta$ is significant but also if the coefficient of ECT_{t-1} is significant [21]. However, in the error correction model, causal inference is obtained through the significance of λ. In other words, the null hypothesis that DEBT does not cause GDP in the Granger sense is rejected if λ is statistically significant even if $\sum \gamma$ is not significant. The direction of causation is also tested through the VEC Granger causality tests. The results of the error correction estimate and the VEC Granger causality test are presented in Table8.

4. Econometric Results

4.1 Descriptive Analysis

In this section, the variables used in the study are all analyzed: (LGDP, LDEBT, LINV, LCONS, LOPEN, LDS). The first step in an economic study is to validate the choice of variables in the model. As for Tabachnick and Fidell [34], the independent variables with a correlation between them greater than 0.70 should not be included simultaneously in a regression and this in order to preserve their exogeneity. Thus, the first step of our analysis begins with the Pearson correlation matrix.

Based on Table 1, all the variables in the model should be kept. Definitely, the highest correlation coefficient between the explanatory variables is 0.571 which is that between debt and debt service. In addition, it is noted that the negative correlation between public debt (LDEBT) and economic growth (LGDP) on the one hand and between debt service (LDS) and economic growth (LGDP) on the other hand. This suggests a negative impact of these variables (public debt and debt service) on the Ivorian economy.

Table 1. Pearson Correlation Matrix

	LGDP	LCONS	LINV	LOPEN	LDS	LDEBT
LGDP	1					
LCONS	-0.488	1				
LINV	-0.093	0.263	1			
LOPEN	0.111	-0.438	-0.128	1		
LDS	-0.306	0.394	-0.077	-0.328	1	
LDEBT	-0.027	-0.067	-0.676	-0.223	0.571	1

Source: Author's calculation

Table 2. Main Characteristics of Explanatory Variables

Variable	Obs	Mean	Std Dev.	Min	Max
DEBT	49	77.08481	40.10907	15.53266	173.8719
GDP	49	9.75E+12	3.24E+12	4.65E+12	1.99E+13
CONS	49	14.59935	2.037536	10.45996	18.25428
INV	49	15.35327	5.82431	8.253466	29.66121
OUV	49	74.41731	10.70439	55.34852	95.06973
DS	49	8.472261	5.758578	1.580064	21.91397

Source: Author's calculation

Over the study period, it is noted that on average the level of public debt (LDEBT) represents around 77% of GDP. This value is higher than the WAEMU standard of 70% of GDP. About GDP, over the entire study period its value was almost multiplied by more than four. Furthermore, General government final consumption expenditure (CONS) are volatile: low value in 1996 (10.45996) and the maximum

value in 1989 (18.25428). This fact can be explained by the devaluation of FCFA in 1994. After this date, the WAEMU countries had to reduce the consumption expenditures.

According to Figure 1, the analysis of the evolution of public debt can be done in three phases. From 1970 to 1994, the level of public debt continued to increase, reaching its maximum level (around 174% of GDP) in 1994. The level of debt had become unsustainable for the Ivorian economy this year. This can be explained by the many loans taken out with international banks during the 1st oil shock in 1973, which is one of the reasons for the devaluation of the CFA franc in the same year. In phase 2, from 1994 to 2012, the public debt continues to fall. Several reasons may explain this development. In particular, obtaining the completion point of the Heavily Indebted Poor Countries Initiative (HIPC) in 2012 and the willingness of the Ivorian authorities to comply with the Community standard. Finally, a last phase which begins after 2012. It should be noted that since this date, the Ivorian public debt has been growing. In fact, the years when the debt level is high correspond to the years of low growth. The rate of economic growth in recent years has been remarkable, but it should be noted that it has been continuously declining. At the same time, over the same period, the level of debt only increased.
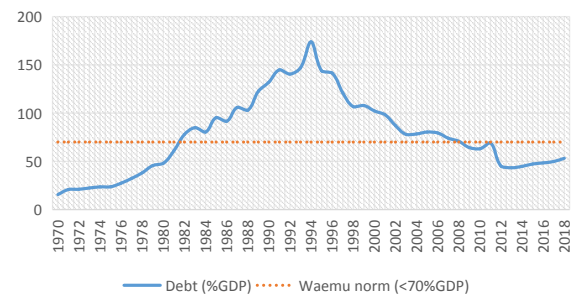

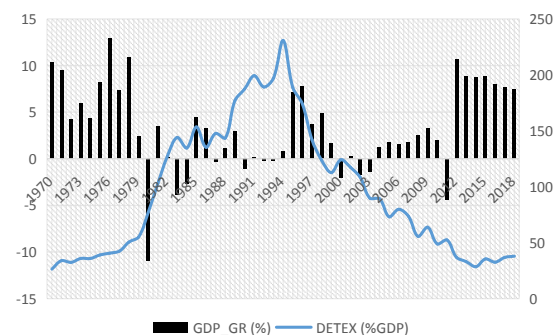**Figure 1.** Evolution of Public Debt

Source: Author

Figure 2. Relationship between GDP growth and Debt

Source: Author

Based on Figure 2, there seems to have a negative relationship between the level of indebtness (in this figure, DETEX denotes external debt) and economic growth.

4.2 Traditional Unit Root Tests

(1) Augmented Dickey-Fuller (ADF) Test

This test is very sensitive to the length of the lag, so before going on to the calculations, it is necessary to determine the optimal delay for each variable using the information criteria of Akaike (AIC) and Schwarz (SBIC). The AIC and SBIC criteria are often written in the form [-2logL + kp]; where L is the likelihood function, p the number of parameters in the model, and k is 2 for the AIC criterion and log (n) for SBIC.

Table 3. Optimal lag series in levels

Series \ Lag		0	1	2	3	4
LGDP	AIC	60.359	56.506	56.342*	56.384	56.396
	SBIC	60.399	56.586	56.463*	56.545	56.597
LDEBT	AIC	1.500	-1.381	-1.379	-1.421*	-1.412
	SBIC	1.5405	-1.300*	-1.259	-1.261	-1.211
LINV	AIC	0.879	-0.936*	-0.933	-0.907	-0.890
	SBIC	0.919	-0.856*	-0.813	-0.747	-0.689
LCONS	AIC	4.343	3.453*	3.476	3.489	3.532
	SBIC	4.384	3.534*	3.596	3.649	3.733
LOPEN	AIC	-1.013	-2.180*	-2.140	-2.110	-2.099
	SBIC	-0.973	-2.100*	-2.019	-1.949	-1.898
LSD	AIC	2.247	0.443	0.452*	0.496	0.540
	SBIC	2.288	0.523	0.572*	0.656	0.741

Notes: * represents the number of optimal lag obtained from the information criterion used.

Source: Author

The variables LGDP and LDS have an optimal lag 2 (Table 3). while the variables LINV, LOPEN and LCONS they have the optimal lag 1. Thus the variable LDEBT, the criteria AIC and SBIC are contradictory. In this type of case, we refer to the SBIC criterion because it is more robust than the AIC criterion for a sufficient population size.

According the ADF tests in Table 4, all the variables are $I(1)$. To confirm this result other tests accounting for structural breaks are performed.

Table 4. Unit Root Tests (ADF)*

Variables	ADF in levels		ADF in first differences		Conclusion
	τ_μ	τ_t	τ_μ	τ_t	
LGDP	0.042	-1.840	-3.219**	-3.225*	*I(1)*
LDEBT	-1.979	-1.380	-5.727***	--6.775***	*I(1)*
LINV	-1.588	-1.117	-5.769***	-5.916***	*I(1)*
LCONS	-2.623	-3.812**	-6.803***	-6.722***	*I(1)*
LOPEN	-1.943	-1.495	-6.714***	-6.894***	*I(1)*
LDS	-1.586	-2.254	-4.377***	-4.485***	*I(1)*

Notes: ***, ** and * indicate statistical significance at 1%, 5% and 10% respectively. τ_μ = statistic with constant ; τ_t = statistic with constant and trend.

(2) Test of Zivot and Andrew (ZA) [37]

As indicated in Table 5, the null hypthesis of the presence of unit roots for all variables is not rejected. The structural break dates are also presented. Based on first differences, the results suggest that we can reject the hypothesis of the presence of unit roots for all variables at 1%. We can conclude that the test of Zivot and Andrew [37] which gives the date of structural breaks leads to the same results as the conventional DFA test.

Table 5. Unit Root Tests Zivot and Andrew

	Model A: Break in the constant			Model C: Break in the constant and trend			Conclusion
	t-statistic	k	T*b*	t-statistic	K	T*b*	
Levels							
LGDP	-2.136	1	2011	-3.450	1	2011	*I*(1)
LDEBT	-3.145	0	1977	-4.019	0	1990	*I*(1)
LINV	-2.879	0	1983	-2.432	0	2004	*I*(1)
LCONS	-5.230**	1	1994	-4.055	1	1979	*I*(1)
LOPEN	-2.536	0	1994	-2.357	0	2011	*I*(1)
LDS	-3.181	0	2001	-3.253	0	1981	*I*(1)
First Differences							
LGDP	-6.185***	0	1979	-5.058***	0	1981	*I*(1)
LDEBT	-8.282***	0	1995	-7.565***	0	2011	*I*(1)
LINV	-6.569***	0	1979	-6.285***	0	1984	*I*(1)
LCONS	-6.689***	1	1997	-6.027***	1	1995	*I*(1)
LOPEN	-8.377***	0	1994	-7.315***	0	2006	*I*(1)
LDS	-6.855***	0	2007	-6.105***	0	2004	*I*(1)

Notes: The critical values obtained from model A (C) are -5.34, -4.80 and 4.11 (-5.57, -5.08 and -4.82) respectively at 1, 5 and 10% levels of significance. ***, ** and * indicate rejection of the null hypothesis at 1%, 5% and 10% levels of significance respectively. Tb is the year of the structural break and k the optimal lag selected to conduct unit root tests ADF. As in the ADF, the SBIC is used to select the optimal lag.

(3) Unit Root Tests Clemente, Montañés and Reyes [10]

In the Table below is presented the results of the unit root test of Clemente, Montañés and Reyes [10] with a structural rupture in the AO model. In Table 6, du1 and rho-1 respectively represent the date of the structural rupture and the unit root. Despite the presence of structural rupture in all the series, we cannot reject the null hypothesis of a unit root in the variables studied at 5%. In other words, as demonstrated by all of the previous unit root tests, all six (06) variables are not stationary at level, although the presence of structural break has been taken into account. Figure 3 shows the dates of structural break.

Table 6. Results of the Model AO

	LGDP	LDEBT	LINV	LCONS	LOPEN	LDS
Niveau						
du1	0.684*** (6.207)	-0.366* (-1.399)	-0.560*** (-6.898)	-0.192*** (-6.22)	0.100** (2.528)	-1.002*** (-6.038)
rho-1	-0.156 (-2.142)	-0.229 (-3.088)	-0.167 (-1.771)	-0.573 (-1.868)	-0.901* (-4.459)	-0.405 (-2.505)
Point optimal of break	2013	2012	1985	1990	1991	2000

Notes: ***, ** and * indicate statistical significance at 1%, 5% et 10% respectively. The number is parentheses is the t statistic.

4.3 Cointegration Tests

Results of the estimation of the cointegration test of Gregory-Hansen [15] with structural break are presented in Table 7. The test is carried out by controlling the variables GFCF, GGFCE, OUV and SD. All the statistics (ADF, Zt and Zα) are obtained for the four (04) models for comparison: the C; C / T; C / S and C / S / T models. The results indicate the rejection of the null hypothesis of non-cointegration at 1% in the C; C / T and C / S / T models and at 5% in the C / S model.
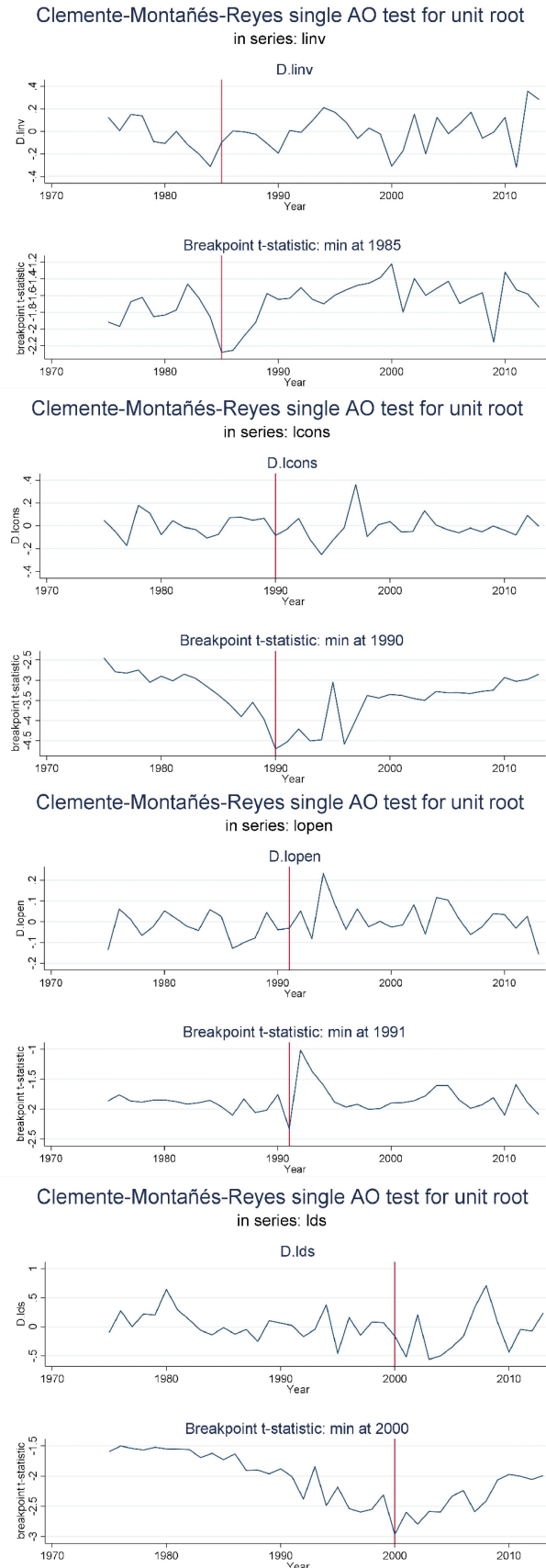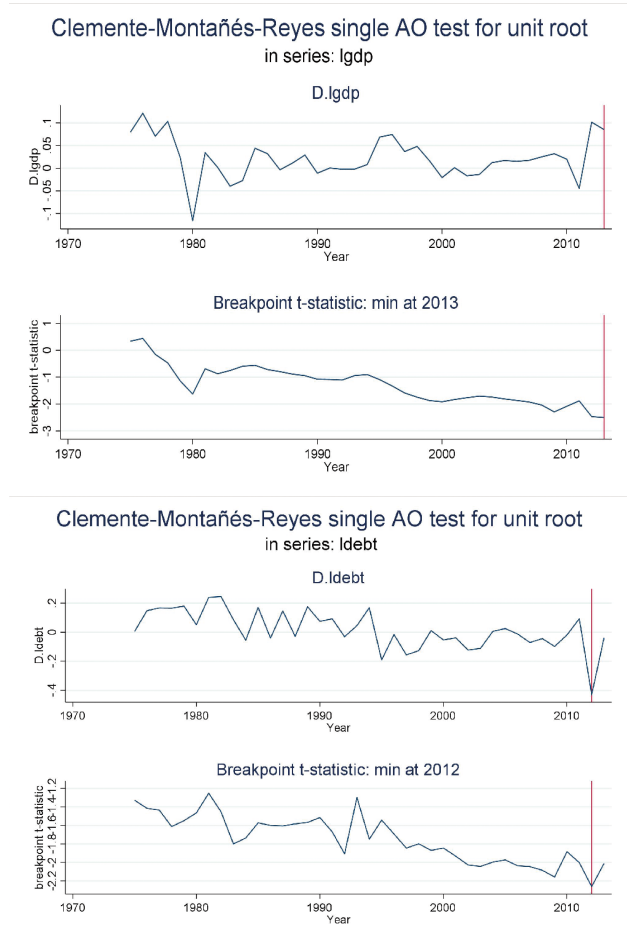
Figure 3. Results of Unit Roots Tests [10], AO Model

The existence of a cointegrating relationship between debt and economic growth indicates that the series evolve together in the presence of a structural break and share common stochastic trends.

Table 7. Cointegration Results of Gregory-Hansen [15] (Growth – Public Debt)

Test statistic	Estimated Value of the test statistic	Break Point	Break Date	Asymptotic Critical Values (CV)		
				CV at 1%	CV at 5%	CV at 10%
(1) Break in the constant term, C						
ADF	-5.32***	41	2010	-5.13	-4.61	-4.34
Z_t	-5.38***	41	2010	-5.13	-4.61	-4.34
Z_α	-36.65	41	2010	-50.07	-40.48	-36.19
(2) Break in the constant and trend terms, C/T						
ADF	-6.12***	30	1999	-5.45	-4.99	-4.72
Z_t	-6.18***	30	1999	-5.45	-4.99	-4.72
Z_α	-43.32	30	1999	-57.28	-47.96	-43.22
(3) Break in the constant term and slope, C/S						
ADF	-5.40**	31	2000	-5.47	-4.95	-4.68
Z_t	-5.46**	31	2000	-5.47	-4.95	-4.68
Z_α	-37.34	31	2000	-57.17	-47.04	-41.85
(4) Break in the constant, trend and slope, C/S/T						
ADF	-6.14***	29	1998	-6.02	-5.5	-5.24
Z_t	-6.69***	28	1997	-6.02	-5.5	-5.24
Z_α	-47.56	28	1997	-69.37	-58.58	-53.31

Notes: Asymptotic critical values are taken from Gregory and Hansen [15]. The length of the lag is chosen based on the AIC criterion with a maximum lag of 5. The asterisks ***, ** and * indicate the rejection of the null hypothesis at significance levels of 1%, 5% and 10% respectively.

Using model C, the structural break date identified is 2010. This date is confirmed by ADF and Zt statistics and corresponds to the start date of the Ivorian socio-political crisis. The dates 1997 and 1998 indicated in the C / S / T model, they correspond to the period of the difficult succession of President Félix Houphouët-Boigny who died in 1993. This period characterized by a deleterious political climate will reach its peak in 1999 and 2000: date corresponding to the first coup d'tat carried out in Cote d'Ivoire. This date is clearly indicated by the C / T and C / S models.

4.4 Causality Tests

In order to analyze the causality between public debt and economic growth we carry out the causation test in the sense of Granger. The results summarized in Table 8

indicate the absence of causality, in the Granger sense, between the variables of interest: economic growth does not cause public debt and public debt does not cause economic growth. The point estimates of the error correction terms show a long-term bidirectional causality between economic growth and the level of debt (DEBT → GDP and GDP → DEBT).

Table 8. Granger Causality Test Results (Growth – Public Debt)

Dependent Variable	Lag	Causal Variable in the Short Run		Causality in the Long Run
		GDP	DEBT	$ECT_{t-1}=0$
GDP	1	---	3.940 (0.268)	-0.011** [0.006]
DEBT	1	1.210 (0.751)	---	-0.031** [0.016]

Notes: Statistics for short-term causation are Chi-square with p-values in parentheses. As for the statistics relating to long-term causality, these are the coefficients of ECTt-1 with the standard errors in brackets. The asterisk ** indicates rejection of the null hypothesis at 5% significance levels.

5. A Further Assessment

To determine the threshold effect of public debt on economic growth; the procedure of Caner and Hansen [7] was followed. According to Table 9, the LM statistic is estimated at 18.00 and significant at 1%. Furthermore, the threshold effect is estimated at 48.03% for a confidence interval of [48%; 53%].

Table 9. Non linearity Tests

Hypothesis Test	LM test	Bootstrap P-Value	Estimating the threshold effect (%)	Confidence Interval at 95%
H_0: Absence of threshold effect	18.00***	0.002	48.03	[48%; 53%]

Notes: The null hypothesis is the absence of the threshold effect against the alternative hypothesis of the presence of threshold effect. *** indicates statistical significance at 1% level.

The existence of the threshold effect is tested and it is confirmed by the F (Gamma) test (see Figure 4). Indeed, the value of the F (Gamma) statistic exceeds the critical value. Thus, the null hypothesis of linear relationship between the variables is rejected in favor of the alternative hypothesis: presence of threshold effect.

The results of the estimates of the economic growth and public debt model of Côte d'Ivoire over the period 1970-2018 are presented in Table 10. In column (2) of this table is presented a regression not taking into account the threshold effect. The last two columns highlight the two regimes of the TAR model.
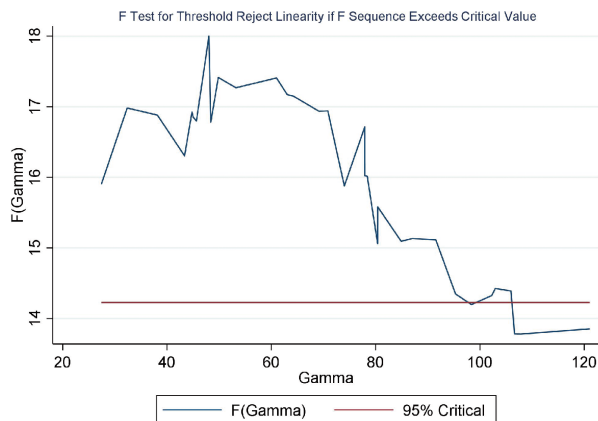
Figure 4. Non linearity Test

Built on the linear model estimated by the Ordinary Least Square (OLS) technique, it is established that public debt (LDEBT) has a positive effect on the economy (LGDP). according to the value of the estimated coefficient of the public debt (= 0.5884) if the latter increases by 1%, the GDP would increase by 0.5884%. The estimated coefficient is significant at 1%. Given that all the previous tests indicate the presence of a threshold effect, the two regimes obtained with the regression of the TAR model will be taken into account. This model updated a threshold effect estimated at 48.03% of GDP. In the low regime (public debt ≤ 48.03%), public debt has a positive effect on the Ivorian economy with an estimated coefficient of 0.9973 significant at 1%. In other words, a 1% increase in public debt under this regime would induce a GDP increase of 0.9973%. In the high regime (public debt> 48.03%), public debt has a negative effect on economic growth with a coefficient of -0.2815 which is significant at 1%. This means that any 1% increase in public debt in this high regime would lead to a drop in GDP of 0.28%. In the low regime, the opening rate has a positive impact on GDP but is not statistically significant. In the high regime, the opening rate has a negative and significant impact on the economy. This suggests that the opening rate contributes to an increase in economic growth if the debt level is contained (low model).

Table 10. Regression economic growth and public debt

Variables (Logarithme)	Linear Model	Model with threshold	
	(OLS without threshold effect)	Regime 1 ≤ 48.03%	Regime 2 > 48.03%
Constant	28.5946*** (1.9180)	26.8471*** (0.9386)	36.6196*** (1.1782)
LDEBT	0.5884*** (0.1339)	0.9973*** (0.0521)	-0.2815*** (0.0933)
LINV	0.5172* (0.1571)	0.1874 (0.1541)	0.2247*** (0.0862)
LCONS	-0.5183* (0.3391)	-0.5123** (0.2222)	-0.6686*** (0.1268)
LOPEN	-0.1342 (0.3085)	0.1654 (0.2048)	-0.8791*** (0.1380)
LDS	-0.3253*** (0.0751)	-0.3332*** (0.0403)	-0.2020*** (0.0329)
Observations	49	15	34
R²	0.49	0.97	0.84

Notes: The dependent variable is the logarithm of GDP over the study period (1970-2018). Standard deviations are listed in parentheses. ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively.

Regardless of the level of debt, investment has a positive impact on economic growth. In the low model, the investment effect is not significant compared to the high model where the coefficient is significant at 1%. The level of debt seems to have no negative effect on economic growth. Despite the negative effect of public debt on economic growth, there is no evidence to support the presence of the phenomenon of public debt sustainability so that any increase in public debt will distort investment when the public debt of the country is in the high regime.

In both regimes, final consumption expenditure by general government (GGFCE) in relation to GDP has a negative and significant impact at 1% on economic growth. But in the high model, this negative impact is greater than in the low model. Debt service (DS) also has a negative impact on economic growth regardless of the regime in which we find ourselves. Unlike government final consumption expenditure, debt service has a much greater negative effect in the high regime than in the low regime. This can be explained by the fact that a highly indebted country benefits from certain favors (rescheduling and / or reduction of public debt).

6. Final Remarks

The purpose of this study was to analyze the effect of public debt sustainability on Ivorian economic growth. The results highlight the short-term non-causality between the variables of interest. On the other hand, in the long term there is a bi-directional causality between public debt and economic growth. This suggests that the level of debt can impact the sustainability of long-term economic growth. This is why it would be wise to borrow within responsible limits so that in the future these loans do not constitute obstacles to development.

The study determines the threshold effect beyond which the authorities must not exceed. Indeed, in the low regime [debt ≤ 48.03%] any increase in GDP of 1% boosted the economy by around 0.99%. In the high regime [debt> 48.03%], any 1% increase in the level of debt reduces growth by 0.28%; This value calls into question the value

of the WAEMU standard set at 70% of GDP. This value should be understood in the context of a panel (eight countries), which may suggest the existence of several threshold effects if we take the specificity of each country; and that it would be the highest threshold effect that would have been chosen as the standard. In addition, it should be pointed out that no matter what the regime in which the Ivorian economy finds itself in, any increase in public debt does not seem to have any negative impact on investments. As the latter have a positive impact on economic growth, following Krugman's [19] definition that there is no effect of over-indebtedness in Côte d'Ivoire and that economic growth is sustainable. These results are partly due to the fact that the Ivorian debt is under control by the authorities and that the investments made are productive.

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