Original Paper

Evaluation of the Non-Linear Effects of the Public Debt on the Economic Growth of the WAEMU

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Abstract

The aim of this article is to analyse the nature of the relationship between public debt and economic growth in the WAEMU. A standard growth model was specified and then estimated in quadratic form from the GMM (GMM). The results show a non-linear relationship between public debt and economic growth. Thus, public debt stimulates economic growth when it does not exceed the threshold of 15% of GDP. Robustness tests show that public debt is boosting the economic conditions of countries with sound macroeconomic policies and good institutional quality.

Keywords

public debt, non-linear effects, economic growth, WAEMU

1. Introduction

The countries of the West African Economic and Monetary Union (WAEMU) (Note 1), since their independence, have embarked on an unprecedented debt process. This debt had strong repercussions on economic activity on the one hand with a slowdown in growth, and on monetary policy on the other hand with an increase in the rate of inflation. From the 1980s to the 1990s, we thus noted an aggravation of fiscal deficits and external balances, timid growth as well as a deterioration in the terms of trade due mainly to the fall in the prices of raw materials on which countries of the Union are very dependent. The rapid growth of public debt has drawn the attention of policy makers and economists regarding the paramount effects of such a large public debt on economic development.

In developed economies, public debt levels have reached unprecedented rates and this in the absence of a major war before the global health crisis of 2020. It is therefore important to know to what extent public

debt affects the economic growth of the Union. The Maastricht Treaty establishes a debt target of 60% of GDP; the public debt must therefore not exceed it.

However, and following the financial crisis of 2007-2008 the countries of the euro zone recorded an economic slowdown that caused serious repercussions on public finances. According to the World Bank World Development Indicators (2019), the debt ratio went from 66.2% in 2007 to 87.7% in 2011. This more or less significant increase differs from country to country. In Ireland we saw the largest increase in the level of its debt by 90% of GDP. As for Greece, the increase in debt exceeded 50% of GDP. Likewise, Spain and Portugal are experiencing an increase in their debt ratios of more than 30% of GDP. In most euro zone countries, public debt exceeds the limit imposed by the Maastricht Treaty. The sharp rise in public debt is not just exclusive for the euro area countries. This increase was recorded in other regions and over the same period. In the United Kingdom, the relatively low public debt ratios in 2007 thus increased from more than 40% of GDP to almost 85% of GDP at the end of 2011. In addition, in the United States the public debt ratio increased from more than 60% of GDP to around 100% of GDP at the end of 2011. Still in Japan, the debt ratio that was already high in 2007, 50% of GDP soared to 240% of GDP in 2015.

It is obvious that this sharp increase in the debt ratio observed in recent times is directly linked, on the one hand, to the support programs granted at the time of the crisis and, on the other hand, to the drop in revenues caused by the economic recession following the crisis. It should therefore be noted that the growth of budget deficits effectively forms the major determinant of the increase in the public debt ratio. Indeed, this development has led economists and political decision-makers to scrutinize the effects of public debt on economic growth. In this context, an abundant literature has dealt with the economic impacts of public debt. Thus, Barro (1974), Elmendorf and Mankiw (1999) and many others, have provided good literature reviews by developing theoretical support for studying the relationship between public debt and economic growth. Later, Singh (2006) and Cohen (2011) presented a broad and relatively exhaustive review of the nature of the relationship between public debt and economic growth.

Furthermore, most empirical work on the subject try to find out an optimal threshold for the public debt to GDP ratio, in the absence of a clear theoretical model showing the interactions between public debt levels and the dynamics of growth (Reinhart & Rogoff, 2010; Ferreira, 2009; Kumar & Woo, 2010; Checcherita & Rother, 2010; Panizza & Presbitero, 2012, etc.). Only, should it be emphasized that despite the criticisms addressed to the Reinhart and Rogoff case and the error revealed in their work, the alarming threshold of 90% seems very important because it fills a gap in the literature on the subject. It should be noted that this work mainly concerns panels from developed and emerging countries from Europe, Asia or America.

Concerning the WAEMU developing countries, the convergence of budgetary policies has proved necessary and the establishment of a multilateral surveillance process has made it possible to highlight a certain number of budgetary criteria, of which we can mainly note: the ratio of outstanding domestic and external debt to nominal GDP should not exceed 70%. The main objective of this article is to assess the

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effects of the expansion of public debt and good governance on the performance of the WAEMU economy. Specifically, it is first, about researching the nature of the relationship between public debt and economic growth and deciding on the existence of a possible threshold beyond which such a relationship will change shape. Secondly, it is an analysis of the effect of good governance on the economy of the Union.

2. Some Elements of Literature

Economic literature has learned, in the case of large external debt servicing, about the channels through which increasing public debt could hinder long-term growth prospects in developing countries. Theoretically, a country is said to be over-indebted when the servicing of its external debt is so heavy that a large part of current production will be granted to foreign lenders. According to Krugman (1988), the over-indebtedness hypothesis suggests that if there is a future probability that the external public debt will be greater than the country's repayment capacity, the expected costs of servicing the debt further discourage domestic and foreign investment and hamper economic growth. In this context, the debt repayment capacity of the country concerned is weakened by a high level of debt; therefore, the future costs of debt service discourage national investment. This principle is known as the virtual debt burden or "debt overhang". This theory is perceptible through the Laffer curve according to which the increase in debt lowers the probability of its repayment.

Singh (2006) admits that a high level of public debt has a negative impact on growth and other indicators of economic development, and therefore on macroeconomic stability. Moreover, the work of Cerra et al. (2008) has revealed the existence of a relationship between increased debt and capital flight. Thus, countries with weak institutions tend to accumulate debt and therefore, discourage capital inflows while promoting capital flight. In the eighties, economists highlighted the harmful role that debt exerts on the expectations of economic agents, and subsequently on investment: this is indeed the theory of the virtual burden of debt. According to this theory, when a country can no longer meet its debt service, there would be less motivation to invest, taking into account the expected costs of this service. This has a depressive effect on investment by directly affecting capital movements. Hanson (2007) has shown that for countries with a large share of domestic debt, private investment is limited which causes a decrease in net national savings and an increase in interest rates, and therefore, we are witnessing a moderation in credit. The credit rationing is due to the transfer of risks to the banks in the event of a long maturity given the fixed rate of internal borrowing and therefore a reduction in yields.

In sum, these studies have shown the negative impact of a high level of public debt on economic growth without questioning the nature of such a relationship. Indeed, public debt has a positive impact on growth up to a certain level; beyond this threshold, the effect of the debt becomes negative. In addition, excess public debt can affect economic growth through several transmission channels.

2.1 Nature of the Relationship between Public Debt and Economic Growth

In the economic literature, several empirical studies have focused on the nature of the relationship between public debt and economic growth. On this subject, Aschauer (2000) proposed a growth model showing the nonlinear effect of public capital on economic growth. For him, public debt is a means of financing public capital. He thus shows that an increase in public debt can have positive effects, but by exceeding a certain threshold these effects become negative. Along the same lines, Reinhart and Rogoff (2010a), analysed the relationship between total public debt and economic growth based on a data set comprising more than 3,700 observations from a sample of 44 countries, including 20 industrialized and 24 developing ones. These analyses show that public debt is not linked to economic growth as long as its threshold does not exceed 90% of GDP. In fact, beyond a rate of 90%, the growth rate of highly indebted countries is significantly lower than that of countries whose public debt/GDP ratio is less than 90%. This non-linear effect is present in both advanced and emerging economies. The hypothesis of non-linearity is essentially based on the idea that the effect of debt on economic growth is not always negative. Indeed, moderate debt can have a positive effect, but beyond a certain level, it becomes harmful to investment and therefore, to economic growth. According to these authors, the non-linear relationship can be explained by the notion of debt intolerance. When the economy reaches the expected debt tolerance limits, there is an increase in market interest rates. This rate hike leads to a rise in taxes, which then leads to severe budgetary adjustments. In order to better present this relationship, Reinhart and Rogoff (2010b), using a sample of 20 developed countries over the 1790-2009 period, show that advanced countries with public debt greater than 90% of GDP have average growth two percentage points lower than that of countries with debt less than 30% of GDP. Thus, the growth rate of countries exceeding the 90% threshold is 1.7 %, while that of countries with a public debt to GDP ratio of less than 30% is 3.7%. The difference is two percentage points, which argues in favour of a public debt—stronger growth relationship in emerging economies. Caner et al. (2010) obtained these results. The latter estimated, in the case of developed countries, an optimal threshold of public debt of 77% of GDP. Beyond this threshold, an additional percentage point of the debt ratio costs 1.7% of annual real growth. For developing countries, the threshold is 64% of GDP. By exceeding this limit, the growth rate drops by around 2% of GDP. Indeed, the nonlinearity of the link between debt and economic growth shows that a moderate level of debt, the increase of public debt to GDP ratio favours the development of investments in order to catch more rapid growth, but it should be mentioned that an increase in debt above the thresholds already reached, reduces economic growth.

On a sample of OECD countries, Panizza and Presbitero (2012) effectively support the existence of a correlation between debt and growth. For them, the link between these two variables is explained simply by the fact that weak economic growth leads to high levels of public debt. Indeed, a high level of public debt affects economic growth via a specific channel. A government with a high level of debt opts for a restrictive policy in order to consolidate its finances, yet such measures will overwhelm economic

activity. In addition, the implementation of severe measures during a recession increases its depressive effects and ultimately increases the burden of public debt.

In sum, several empirical studies have made it possible to identify the "optimal" level of public debt in order to avoid the negative effects on economic growth. The results confirm the existence of a negative and non-linear causal relationship between public debt and growth. Indeed, a low level of public debt has no impact on economic growth, while from a certain level, public debt negatively affects growth. Previous studies have determined a critical debt threshold between 90% and 100% of GDP. However, in certain cases, several observed facts invalidate this threshold. This is the case of Japan where the debt exceeds 200% of the GDP. Therefore, there is no well-defined magic threshold from which growth declines appreciably. It is therefore, essential when analysing the critical debt threshold to take into account the economic, budgetary and institutional characteristics of each country apart.

2.2 Public Debt and Economic Growth

In the empirical literature, while some have been interested in the existence of a critical debt threshold, others have shown that a certain level of institutional quality is necessary in order to encourage investment, stimulate growth and therefore benefit from the debt relief policy.

Indeed, Cordella et al. (2010) show that for developing countries the link between public debt and economic growth depends not only on the scale of debt but on the quality of policies and institutions as well. The authors have proven the existence of over-indebtedness in countries with good institutional quality, and this when the net present value of the debt rises above 20 to 25% of the GDP, but beyond a rate of 70 to 80% of GDP debt has no effect. In countries with poor institutional quality, the rates are lower than in other countries but without overlooking the importance of the debt burden. In an article on the relationship between debt relief and institutional quality, Asiedu (2003) shows that poor, heavily indebted countries have weak institutions and must reach a certain level of quality institutions to take advantage of debt relief. In addition, Dessy and Vencatachellum (2007), shows that the relief granted to 14 African countries between 1989 and 2003 positively affected the share of resources of countries that have reformed their institutions.

All in all, previous studies suggest that public debt affects the economic conditions of countries with sound macroeconomic policies and good institutional quality.

3. Methodological Approach

3.1 Specification of the Empirical Model

In this article, the selected empirical model follows the above-mentioned empirical literature. The basic model can take the following form:

$$y_{it} = \alpha y_{it-1} + \beta DP_{it} + \delta X_{it} + \gamma_t + \mu_{it} + \varepsilon_{it} \qquad (1)$$

The transformation e the equation (1) can write equation (2) below:

$$y_{it} - y_{it-1} = (\alpha - 1)y_{it-1} + \beta DP_{it} + \delta X_{it} + \gamma_t + \mu_{it} + \varepsilon_{it} \qquad (2)$$

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In equation (2), y_{it} represents the GDP growth rate for the country i at time. y_{it-1} is the endogenous explanatory variable. It measures GDP growth for the country i right now $t-1$. DP_{it} is the public debt of the country i at the moment t. X_{it} is a vector of control variables, μ_{it} the country specific effect and γ_t the temporal effect? Finally, ε_{it} the term error.

The non-linear approach is based on the idea of introducing the square of the variable "public debt" into the group of exogenous variables and generally takes the following form:

$$y_{it} = \alpha y_{it-1} + \beta_1 DP_{it} + \beta_2 DP_{it}^2 + \delta X_{it} + \gamma_t + \mu_{it} + \varepsilon_{it} \qquad (3)$$

The basic hypothesis of our work is to verify the effect of a very high debt on economic activity. The conditional convergence hypothesis implies a negative and significant value of the coefficient of the delayed value of GDP per capita. In this case, the control variables and the individual specific effect increase the level of income per capita over the long term towards which each country converges. On the contrary, a positive value of this coefficient signifies the rejection of the convergence hypothesis, defined as a catch-up process. The sample consists of eight WAEMU countries for the period 2000-2019.

3.2 Variables and Data Sources

The endogenous variable being the annual growth of GDP per capita. The explanatory variables are presented in Appendix 2. As an indicator of the performance of economic activity, we use the annual growth rate of GDP per capita. This measurement being the most appropriate allowing the verification of the conditional convergence hypothesis. This variable was explicitly used in the empirical literature (Patillo et al., 2004; Schclarek, 2004; Ferreira, 2009; Checherita & Rother, 2010; Kumar & Woo, 2010; Presbitero, 2010; Baum et al., 2013). Regarding the explanatory variables of the model, the variable of interest, gross public debt, measures the degree of debt and helps to interpret the debt situation. Indeed, the ability to pay or the solvency of an economy is linked to its wealth; public debt can therefore, be considered as an indicator of the financial situation of countries. The prevailing view is that public debt can stimulate growth in the short term, but seems harmful to growth in the long term. In addition, economic theory suggests that debt can promote economic growth, but within limits to be determined. As a result, the link between these two variables is not clear and is still tainted with imprecision. The variable of interest has been used in almost all recent studies on the importance of the relationship between public debt and economic growth (Reinhart & Rogoff, 2009-2010; Kumar & Woo, 2010; Panizza & Presbitero, 2012). The model also contains a vector of control variables from the theoretical literature and usually introduced in this kind of estimation (Table 2).

Table 1. Definition of Variables and Data Sources

Variables	Definition of variables	Scoring
Growth rate of GDP per capita (%annual)	Annual percentage growth rate of GDP per capita based on constant local currencies.	gdp _cap_growth _rate
Gross public debt (% GDP)	Gross public debt as a percentage of GDP.	Public _debt
Population growth (% annual)	Annual percentage growth rate of the population is defined as the average annual change in the size of a population during a given period.	popgrowth
GDP per capita (constant 2000 US $)	GDP per capita represents gross domestic product divided by population.	gdp_percapita
Inflation, consumer prices (% annual)	Inflation as measured by the growth in the consumer price index reflects changes in the cost of a basket of goods and services purchased by the average consumer.	Inflation
Gross capital formation (% of GDP)	Gross capital formation	invest
Trade openness (% GDP)	This variable measures the degree of trade openness of countries to the outside (X + M) on GDP.	openess
Gross enrollment rate (% gross)	Gross enrollment ratio.	
	Primary is the total number Enrollment in primary education, whatever their age, expressed as a percentage of the population of official primary education age.	scola
Total unemployment (% of population)	The share of the labor force that is unemployed but available for and looking for work	unempl_rate

Source: construction of of authors.

Regarding the data, they come from WDI of the World Bank (2019).

3.3 Estimation Method

The estimation method adopted is the Generalized Moment Method (GMM). The generalized moments estimator proposed by Arellano and Bond (1991) is based on the conditions of orthogonality between the delayed endogenous variable and the error term. It provides solutions to the problems of simultaneity bias, reverse causation and omitted variables. It also makes it possible to correct the indigeneity of all the explanatory variables of the model. The proposed estimator refers to the GMM method in first difference in order to eliminate specific individual effects and the use of delayed values of the dependent variable as instruments. Later, Blundell and Bond (1998) proposed the GMM estimator as a system. They combined the equations in prime differences with the equations in level in which the variables are instrumented by their prime differences. Through Monte Carlo simulations, Blundell and Bond (1998) proved that the GMM system estimator is more efficient than that in primary differences. Indeed, when the instruments are weak, the GMM estimator in first differences gives us biased results in finite samples. Thus, we use the two-step estimation procedure. The recourse to this procedure is explained by the fact that the estimator obtained is more effective and more efficient than that in one stage (Sevestre, 2002; Roodman, 2009). Indeed, the estimation in two stages is more precise than that in one stage since it takes into consideration the structure of the matrix of the variance covariance of the errors.

4. Results and Interpretations

4.1 Unit Root Test Results in Panels

Two stationarity tests on panel data are conducted. The Levin Lin and Chu LLC test (2002) and the Im Pesaran and Shin IPS test (2003). The Table 2 summarizes the results of these tests. These two tests are based on the null hypothesis of unit root. The table shows that the LLC test (2002) leads to the rejection of the null unit root hypothesis. Almost all of the variables are stationary in level. Taking into account the heterogeneity of the autoregressive root by means of the I PS test (2003) significantly modifies the results obtained by LLC (2002). Only the institutional variables are non-stationary when applying the IPS test (2003).

Table 2. **Root Test Results**

Variables	LLC	IPS
gdp _cap_growth_rate	-5.179 (0.0000) *	-5.920 (0.0000) *
	-5.492 (0.0000) *	-7.103 (0.0000) *
Public _debt	-2.528 (0.0057) *	-1.364 (0.0862) ***
	-3.973 (0.0000) *	-0.339 (0.3670)
gdp _percapita	-2.020 (0.0217) **	-0.313 (1.0000)
	-2.425 (0.9923)	-4.374 (1.0000)
Inflation	-3.598 (0.0002) *	-2.071 (0.0191) **
	-4.525 (0.0000) *	-8.088 (0.0000) *
invest	-3.437 (0.0003) *	-1.477 (0.0698) ***
	-3.067 (0.0011) *	-2.988 (0.0014) *
unempl _rate	-1.988 (0.0234) **	-0.938 (0.1739)
	-1.461 (0.0719) ***	-1.886 (0.0296) **
scola	-0.483 (0.3142)	1.145 (0.8741)
	-2.107 (0.0175) **	1.157 (0.8766)
popgrowth	-4.265 (0.0000) *	-8.358 (0.0000) *
	-2.431 (0.0071) *	-5.351 (0.0000) *
openess	-7.555 (0.0000) *	-4.808 (0.0000) *
	-5.054 (0.0000) *	-3.587 (0.0002) *

The unit root hypothesis is rejected at * 1%, ** 5%, *** 10%. LLC and IPS correspond respectively to the test results of Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003).

Source: construction of authors.

4.2 The Results of the Estimates by the Generalized Moments Method

Tables 3 and 4 summarize the results of the dynamic panel estimates of the chosen model using the Generalized Moments Method (GMM) in first differences of Arellano and Bond (1991). Table 3 summarizes all the linear and non-linear (quadratic) regressions regarding the three institutional variables, the debt indicator and the control variables taken from the different specifications. Table 4 presents the different estimates after the introduction of new control variables. Finally, Table 5 summarizes the different thresholds determined.

The estimation results of the first specification of our model are presented in the following Table 3:

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Table 3. Results of the Estimations

gdp _cap_growth_rate (-1)	Linear specifications				Non-linear specifications			
	(1)	(2)	(3)	(4)	(1) '	(2) '	(3) '	(4) '
	-0.444*	-0.380**	-0.478**	0.000	-0.342**	-0.560**	-0.301	-0.497**
	(0.009)	(0.058)	(0.041)	(0.995)	*	(0.023)	(0.232)	*
					(0.066)			(0.078)
lag _log_gdp_percapita	-0.317*	-0.267*	-0.321*	-0.201*	-0.406 *	-0.320*	-0.353*	-0.273**
	(0.003)	(0.000) *	(0.000)	(0.000)	(0.002)	(0.002)	(0.003)	(0.020)
log _invest	0.036*	0.023*	0.027*	0.027**	0.034*	0.027**	0.026**	0.027***
	(0.004)	(0.008)	(0.007)	(0.036)	(0.001)	(0.035)	(0.049)	(0.054)
loginflation	-0.000	0.001	0.003	-0.003	0.000	0.001	0.002	-0,000
	(0.977)	(0.605)	(0.235)	(0.138)	(0.985)	(0.431)	(0.100)	(0.852)
log _openess	0.313	0.021	0.021	0.058*	0.044*	0.016	0.042*	0.042*
	(0.101)	(0.153)	(0.102)	(0.000)	(0.000)	(0.380)	(0.002)	(0.002)
log _scola	0.094	-0.115	-0.086	0.009	0.116	-0.026	0.011	0.083
	(0.291)	(0.137)	(0.492)	(0.930)	(0.191)	(0.745)	(0.898)	(0.415)
log _public_debt	-0.018***	-0.024*	-0.017*	-0.014**	0.096*	0.087**	0.143*	0.135*
	(0.075)	(0.003)	(0.002)	*	(0.002)	(0.028)	(0,000)	(0,000)
				(0.087)				
log _pub_debt_carr					-0.018*	-0.018*	-0.026*	-0.025*
					(0.003)	(0.000)	(0,000)	(0,000)
account		0.044***				0.050***		
		(0.059)				(0.054)		
regl _quality			0.035**				0.013	
			(0.041)				(0.200)	
corrupt				-0.028**				-0.019
				(0.020)				(0.228)
Number of observations	137	81	81	81	137	81	81	81
Sargan test	4.834*	3.663*	3.171*	10.358*	2.303*	2.391*	5.29*	6.502*
	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
AR (1)	-0.556*	-0.033*	0.627*	-1.396*	-0.628*	0.569*	-0.698*	-0.078*
	(0.577)	(0.973)	(0.53)	(0.162)	(0.529)	(0.569)	(0.484)	(0.937)
AR (2)	0.534*	0.469*	-0.069*	1.276*	0.765*	-0.127*	0.584*	-0.105*
	(0.593)	(0.638)	(0.944)	(0.100)	(0.443)	(0.898)	(0.558)	(0.916)

*; ** and *** significant respectively at 1%, 5 and 10%.%. The figures in brackets are p-values.

Source: construction of authors.

The results of the table show that the coefficients associated with the variable GDP by delayed head are all negative and significant. The conditional convergence hypothesis is therefore, accepted in all cases at the 1% threshold. This result therefore confirms the conditional convergence hypothesis implemented both in the work of Barro and Sala-i-Martin (1995) and of Mankiw et al. (1992). The negative coefficient per capita income is thus interpreted by catching up with the level of long-term income towards which each country converges. The investment rate (log_invest) on the other hand admits positive and significant coefficients. These results prove that investment is an engine of growth and thus corroborate the majority of empirical work highlighting the importance of this variable as a determinant of growth. Similarly, economic openness (log_openess) contributes positively to economic growth. This result could be explained by the fact that the more the economy is closed, the more it suffers more from the consequences of macroeconomic imbalances. The insignificance of this variable (log_openess) depends on the other variables introduced into the model. This brings together a fringe of the literature which claims that openness is only favourable to growth when the economy reaches a well-defined level of economic development allowing it to face competition on foreign markets (Verner, 2015).

Regarding the inflation (log inflation), it is not statistically significant and not stable. The signs associated with this variable are changing: the results of the estimates show that the effect of inflation is generally marginal; it is negative and not significant in specifications (1), (4) and (4) ', while it is positive in other specifications. These results are not surprising despite the fact that they contradict certain theoretical works, which predict a negative and significant relationship between the rate of inflation and economic growth.

With regard to schooling (log_scola), the results indicate that the coefficients related to this variable are of expected sign but not significant. This is not in line with the results of Barro and Sala-i-Martin (1995) on the determinants of growth, which demonstrate the existence of a positive and statistically significant link between the level of education and economic growth. This result can be explained first, essentially, that the quality of education in the Union is too low to allow the school to better contribute to the growth of the economy. In addition, a persisting fragile interaction between educational results and economic growth could also be linked to the high levels of employment in the public sector and the reduced number of dynamic and internationally competitive economic sectors. These explanations are echoed in the work of the World Bank (2007).

In the specifications (2) to (4) were introduced successively and respectively the following institutional variables: Be attentive and account (account), regulatory quality (regl_quality) and fight against corruption (corrup). These variables are taken into account in the regressions for both linear and non-linear specifications. The results specification (2) and (2)', display, first, a positive and significant effect of the variable account on economic growth. Indeed, an environment that provides a certain degree of freedom of human as well as political rights is an environment, which, is beneficial for economic growth. Subsequently, we notice that the coefficient of the quality of regulation index is positive and significant at the 5% threshold in the linear specification (3).

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As for the nonlinear specification, we can note that the variable (regl_quality) loses its significance but its effect is always positive. The implementation of policies and regulations in a country contributes to not only the development of the private sector but also to economic development, and this, by gaining confidence and reducing uncertainty among investors and, therefore, encourage them to invest more. Finally, specification (4) attests to a negative and significant relationship at the 5% threshold between corruption and economic growth. In the nonlinear specification (4) ', the coefficient of the variable (corrupt) keeps the negative sign but becomes insignificant. We can notice here that even a low level of corruption seems to have a negative effect on economic growth. This seems to corroborate the results of Mauro (1997) and Collier (2000) who highlighted the fact that corruption slows the rate of growth of the country's production. In addition, Wei (1997) has shown that corruption generally overwhelms investment. Finally, Johnson et al. (1998) emphasized the consideration that corruption reduces tax revenue, which pushes the country into debt to deal with shortcomings in the state budget.

Regarding the variable interest public debt, applying a linear specification shows that there is a negative and significant relationship between the level of public debt (log_public_debt) and the annual growth rate of GDP per capita at constant price. These results corroborate those found in an extensive empirical literature (Kumar and Woo (2010), Panizza and Presbitero (2012), etc.). Furthermore, the results demonstrate that even by introducing the institutional variables, public debt continues to dampen economic growth.

However, both theoretical and empirical literature on the issue attests that linear specification may be inappropriate for properly identifying the impact of a high level of debt on economic growth, since the relationship may be non-linear. Testing the hypothesis of non-linearity of public debt amounts to introducing the square of the indebtedness indicator in specifications (1) ', (2) ', (3) 'and (4) ' of the model. The transition to the non-linear form did not change the results obtained for the different variables used in the linear specification. The results found show that the effect of the variable (log_public_debt) on economic growth becomes positive and significant at the 1% and 5% thresholds, while the effect of its square (log_pub_debt_carr) is negative and significant. We therefore note the existence of a non-linear relationship between public debt and economic growth. Indeed, public debt positively affects economic growth up to a certain threshold. Beyond this threshold, its effect becomes negative. This phenomenon is because debt within reasonable limits can allow the countries of the region to consolidate their growth. However, from a certain level, the debt can exceed the repayment capacity and therefore disadvantage growth by the high cost of its service, which, in turn, will discourage investment.

Finally, according to the results of Sargan/Hansen's over-identification tests, we accept the hypothesis of validity of the instruments. The statistics from this test indicate that the instruments used are also valid. Similarly, the results of the autocorrelation tests lead us to accept the hypothesis of absence of autocorrelation of the errors of order 1 and 2: *AR* (1) *et AR* (2). This was the case for all of the specifications.

4.3 Robustness Tests

We test the robustness of the results already obtained by adding other control variables, namely, the population growth rate (log_*popgrowth*) and the unemployment rate (log_*unempl_rate*). The results for this specification are presented in Table 4.

Table 4. Results of Estimates

gdp _cap_growth_rate (-1)	Linear specifications					Non-linear specifications				
	(1)	(2)	(3)	(4)	(5)	(1) '	(2) '	(3) '	(4) '	(5) '
	-0.588**	-0.358***	-1.792***	-0.406***	-0.940	-0.666**	-0.351*	-3.818	-0.578***	-1.341
	(0.032)	(0.051)	(0.089)	(0.083)	(0.142)	(0.044)	(0.009)	(0.139)	(0.066)	(0.464)
lag _log_gdp_percapita	-0.075	-0.280**	0.196	-0.270**	-0.098	-0.154	-0.406*	0.846	-0.310**	0.035
	(0.665)	(0.030)	(0.581)	(0.015)	(0.609)	(0.468)	(0.005)	(0.302)	(0.033)	(0.951)
log _invest	0.072*	0.026**	0.053*	0.034*	0.040*	-0.006	0.027**	0.061*	0.028**	0.031
	(0.002)	(0.013)	(0,000)	(0.001)	(0,000)	(0.945)	(0.010)	(0.005)	(0.043)	(0.261)
loginflation	-0.006**	0.005*	0.0007	0.010*	0.008	-0.008	0.002	-0.006	0.005**	0.001
	*	(0,000)	(0.912)	(0.001)	(0.172)	(0.160)	(0.344)	(0.379)	(0.020)	(0.824)
	(0.077)									
log _openess	0.060**	0.045**	-0.011	0.027	0.012	0.169	0.035**	-0.047	0.027**	0.011
	(0.049)	(0.017)	(0.714)	(0.104)	(0.676)	(0.331)	(0.036)	(0.527)	(0.018)	(0.821)
log _scola	-0.680	0.153*	1.031	-0.081	0.669	0.174	0.135**	2,265	0.120	1.237
	(0.438)	(0.008)	(0.147)	(0.415)	(0.349)	(0.879)	(0.014)	(0.234)	(0.252)	(0.213)
log _unempl_rate	-0.023		-0.069**		-0.072	0.077		-0.046		-0.036
	(0.420)		(0.045)		**	(0.598)		(0.162)		(0.241)
					(0.041)					
log _popgrowth		-0.025**		-0.032*	-0.044		-0.030*		-0.034*	-0.033
		(0.043)		(0,000)	(0.156)		(0.007)		(0,000)	(0.521)
log _public_debt	-0.021	-0.022**	-0.019**	-0.015***	-0.024	1,694	0.080*	0.443	0.129*	0.208
	(0.192)	(0.023)	(0.032)	(0.083)	*	(0.487)	(0.001)	(0.109)	(0,000)	(0.228)
					(0.004)					
log _pub_debt_carr						-0.241	-0.016*	-0.068***	-0.025*	-0.035
						(0.479)	(0.001)	(0.086)	(0,000)	(0.151)
regl _quality			0.092***	0.026***	0.041			0.146***	0.015	0.043
			(0.056)	(0.061)	(0.296)			(0.083)	(0.244)	(0.618
O bservations	107	137	64	81	64	107	137	64	81	64
Sargan test	1.076*	0.076*	0.175*	5.333*	1,327*	0.462*	3.930*	0.616*	2.923*	3.81*

	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)
AR (1)	1,136	-1.021	0.422	-0.522	0.475	0.603	-0.877	-0.821	-0.203	-0.254
	(0.255)	(0.307)	(0.672)	(0.601)	(0.634)	(0.546)	(0.380)	(0.411)	(0.839)	(0.798)
AR (2)	0.048	0.048	-0.442	-0.222	-0.484	0.466	0.823	0.797	-0.545	-0.115
	(0.961)	(0.961)	(0.658)	(0.823)	(0.627)	(0.640)	(0.410)	(0.425)	(0.585)	(0.908)

*, ** and *** significant respectively at 1%, 5% and 10%. The figures in brackets are p-values.

Source: author's construction.

The results obtained do not diverge much from those obtained previously. With regard to the investment variable (log_invest), it should be underlined that the results are, for the most part, significant and consistent with the various theoretical works. Thus, and as theories suggest, the rate of investment has a beneficial effect on growth. However, by introducing the unemployment rate variable in the non-linear specification (1) ', the effect of the investment rate on growth becomes negative and not significant. This result can be justified by the reduction in foreign direct investment in the Union linked, on the one hand, to the global economic recession, and on the other, to the growing uncertainty stemming from the political and security crises transitions in which the countries affected have higher premium risks.

From the results presented above, we can notice that the addition of the control variables influences the significance and the expected signs of the coefficients of the variables of interest. With regard to the unemployment rate, the results of the majority of the estimates show a negative but not significant effect on economic growth. Similarly, we note that all the coefficients of the variable population growth rate (log_popgrowth) are expected signs for all the regressions. Consistent with theoretical growth models, we observe that economic growth is negatively influenced by the rate of population growth.

As for the debt indicator, the results obtained are the same as those obtained in the previous specifications. Public debt in its linear form has a negative impact on economic growth. Moreover, the results of the quadratic form in Table 2 shows that up to a limit value, the public debt promotes economic growth. Exceeding this value, public debt becomes detrimental to growth, which proves the existence of a non-linear relationship between these two variables. However, it must be emphasized that the coefficients on public debt are not significant, and this, in the presence of the unemployment rate as a control variable. This can be explained by the high level of unemployment in the WAEMU area. The effect on economic growth of the public debt is absorbed by that of the unemployment rate.

4.4 Identification of the Threshold Effect

In the section, it is about determining the optimal level of public debt by the quadratic method. The derivation of equation (3) with respect to DP_{it} gives:

$$\frac{\partial y_{it}}{\partial DP_{it}} = \beta_1 + 2\beta_2 DP_{it}$$

At the point of optimal indebtedness, $\frac{\partial y_{it}}{\partial DP_{it}} = 0$. This makes it possible to derive the optimal threshold for public debt:

$$\frac{\partial y_{it}}{\partial DP_{it}} = 0 \Leftrightarrow \beta_1 + 2\beta_2 DP_{it} = 0 \Leftrightarrow DP_{it} = -\frac{\beta_1}{2\beta_2}$$

The public debt variable in the basic model is expressed in logarithms, so the determination of the optimal debt threshold is done by taking the exponential:

$$DP_{it}^* = \exp(-\frac{\beta_1}{2\beta_2}).$$

Table 5. Threshold of Public Debt in% of GDP

Specification (1)' from Table 3	Specification (3)' from Table 3	Specification (4)'from Table 4
14.037%	15.095%	12.194%

Source: author's calculation.

Table 3 shows the point of debt diversion beyond which the effect of public debt becomes negative. We note that the debt threshold for the entire sample varies between 12 and 15% of GDP. Indeed, the thresholds obtained are appropriate for our case, and this, generally, by the consistency of the results with the various works dealing with the link between public debt and growth. The level of public debt of the WAEMU countries is relatively lower compared to that of the developed countries, which explains, although partially, the thresholds obtained. This seems important to us because of the absence of theoretical or empirical work that has explained the public debt-growth relationship in the region as a whole.

5. Conclusion

The purpose of this article was to investigate the nature of the relationship between public debt and economic growth and to decide whether there is a threshold beyond which such a relationship will change for countries of WAEMU.

The econometric results obtained reveal that, overall, public debt has an effect on economic growth. However, two kinds of specifications were adopted. Linearly, public debt positively and significantly affects economic growth. According to a quadratic specification, public debt has a positive impact to a certain threshold beyond which its effect becomes negative. This threshold is around 12% to 15% confirming the hypothesis of non-linearity of the debt. Robustness tests consist of introducing new control variables, namely, the population growth rate and the unemployment rate. The results are, for the most part, significant and consistent with the various theoretical works.

In addition, the threshold at which the public debt—growth relationship changes sign is around 15%. This threshold is not surprising due to the low debt ratios of several countries of the Union relative to developed ones.

These results have implications for economic policies. Indeed, governments can stimulate economic growth by reducing the weight of their debt. In fact, public debt is a question of sustainability before being a need for liquidity. Thus, significant levels of public debt raise sustainability problems in terms of public finances as well as solvency risks, and this, through the increase in the premium risk, which in turn, leads to an increase in the cost of borrowing for countries. In addition, the accumulation of public debts generates a sharp increase in interest rates that can harm economic growth through a decline in private investment.

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Note

Note 1. Eight (08) countries make up the WAEMU, namely Benin, Burkina Faso, Côte d'Ivoire, Guinea Bissau, Mali.