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NON-LINEAR EFFECT OF MILITARY SPENDING ON ECONOMIC GROWTH IN AFRICA: A COMPARATIVE STUDY BETWEEN STABLE AND UNSTABLE COUNTRIES

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The objective this paper is to make a comparative analysis of the non-linear effect of military spending on economic growth in stable and unstable African countries. The methodology used refers, on one hand, to the threshold panel technique, and on the other hand to the Generalised Method of Moments (GMM) using data from 1990 to 2017. The results reveal that military spending negatively and significantly affects economic growth in both groups of countries. The positive sign associated with the variable "military spending squared" confirms the existence of a non-linear relationship with military spending thresholds, respectively, of about $ 2.13 billion and $ 3.63 billion for the stable and unstable group of countries, ceteris paribus. In terms of recommendations, (i) States must engage in the resolution of internal and cross-border conflicts that fuel increase military expenditures; (ii) guarantee the expression of civil liberties that condition the exercise of economic activities.

Keywords: Military Spending, Economic Growth, Threshold Panel, Generalised Moment Method.

Classification JEL - C23, H56, O47

Introduction

For a few decades now, states have been devoting a large and growing share of their budget to military spending (Arzellier and Nicolini, 2000; Masoud and Zaleha, 2015; Kollias et al. 2004; Korkmaz 2015). In 2018, global military spending stood at $ 1739 billion, an increase of 2.6% from 2017. The top five spenders in 2018 are the United States, China, Saudi Arabia, India and France, which alone account for 60% of world military spending.

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In this overall situation, Africa's share represents $ 38.22 billion in 2017, or 2.19% of world military spending (SIPRI, 2019). In Africa, military spending has increased from $12.48 billion in 2000 to about $ 30 billion in 2010; and then 38.22 billion dollars in 2017. However, the countries of North Africa (Algeria, Morocco, Libya and Egypt) show a salted bill with 22.2 billion dollars in 2017, or 58.08% of the continent's total military expenses. In some countries, military expenditure is rather down due to the difficult economic situation (Liberia, Sierra Leone, and Central African Republic), while in others (Burkina Faso, Nigeria, Sudan) these are rising due to armed conflicts they face (WDI, 2017).

In this context of changing military spending, economic growth[1] rates are falling gradually since 2010, droping from 3.69% to 2.07% in 2013; then 1.13% in 2015; 1.09% in 2016 and 1.63% in 2017 (World Bank, 2017). These economic growth rates are heavily dependent on the primary sector, most notably the oil sector. However, we observe the decline in the share of oil revenue in the Gross Domestic Product (GDP) of the area from 2013 (oil revenues are at 5.42% in 2012, 4.56% in 2013; 74% in 2014, 1.53% in 2016, and a slight increase to 2.82% in 2017). The above inventory shows that this increase in military spending could be detrimental to economic growth, which is highly volatile in Africa.

These different stylised facts fuel controversy in relation to works in the literature. Since the work of Benoit (1973), the relationship between military spending and economic growth has been the subject of much empirical work. Some authors conclude that military spending has a positive impact on economic growth (Arzellier and Nicolini 2000; Malizard, 2013; Martin, 2013; Saroja and Eliyathamby, 2014; Masoud and Zaleha 2015); while for others, the effect is negative (Berthelemy et al. 1994; Dune and Mohammed, 1995; Korkmaz, 2015; Njamen and Kouladoum 2018). No consensus emerges from this literature, so it seems difficult to put the superiority of one approach over another. To overcome this controversy, Landau (1994) shows that a non-linear approach might be better suited to analyse this relationship. Thus, the works of Cuaresma and Reitschuler (2004 and 2006), Lee and Chen (2007), Malizard (2014) adopt this non-linear approach by defining thresholds beyond which the effect of military expenditure on growth becomes negative.

The rise in military spending in Africa is occurring in a context of social and political instability in some countries due to post-election violence and the proliferation of terrorist groups (Njamen and Kouladoum, 2018). This is why it is imperative to group African countries into two broad categories (stable and unstable) in order to take into account this disparity in the analysis. Moreover, to explain the link between military spending and economic growth in Africa, we hypothesise that these expenditures would create a business climate conducive to economic expansion (Arzellier and Nicolini, 2000; Malizard 2013).

This study provides at least two contributions to the literature on the economic impact of military spending. Firstly, on a theoretical level, most of the work is concerned with the study of the relation between military expenditure and economic growth in a linear form.

[1]. Economic growth is measured by per capita GDP growth rate.

In this paper, we consider a non-linear form that highlights the existence of a reversal threshold beyond which any increase in military spending would degrade the rate of economic growth. Secondly, on an empirical level, this paper to the best of our knowledge, is first to focus on the study of the non-linearity of military expenditure in Africa. The study carries out a comparative analysis based on stable and unstable countries. Stylised facts show that in unstable countries, prey to armed conflict, military expenditures are made for the purpose of combating insecurity; while in stable countries, the latter rather obey the phenomenon of arms race (Berthelemy et al. 1994). As a consequence, the effects on economic growth could be differentiated according to the group of countries. Also, taking into account specific control variables such as the Global Civil Liberties Index, the number of armed forces personnel, would provide more information to explain the evolution of military spending in stable and unstable African countries and its impact on economic growth. Thus, the purpose of this paper is to make a comparative analysis of the non-linear effect of military spending on economic growth in stable and unstable countries in Africa.

This paper is organised in six sections. After the introduction, section 2 is devoted to stylised facts in relation to military expenditure and the economic environment in Africa. Section 3 provides a summary review of the literature. Section 4 presents the methodology; which leads to the results in section 5. Finally, section 6 deals with the conclusion and the economic implications.

Stylised Facts

SIPRI database (2017) on military-related expenditure indicates that Africa on average is spending more than the global average as a percentage of total government expenditure on its military. After the end of the cold war, the world spending on military has been reducing, but that is not the case for Africa. This trend of military spending in Africa has been very disproportionate, with North African countries at the frontline on average. Africa two biggest spenders, Algeria and Angola continued with their rapid military spending increases financed by high oil revenues, with Algeria increasing by 12% since 2005 to reach 11.9 billion dollars in 2014 and Angola increasing by 6.7% to reach 6.8 billion dollars within the same period. Both countries now spend more than 5% of their GDP on military. The trend in military spending in Africa has changed mostly linked to the volatility of world oil prices and constant armed conflicts across the continent. The exact nature of this spending as well as its possible correlated macroeconomic variables is thus worth examination.

Figure 1 demonstrates the evolution of military expenditure in Africa. In the 80s and 90s, military spending in Africa generally slightly decreased or remained stagnant. This corresponds to the period when most African countries especially Sub-Saharan Africa countries adopted the structural adjustment program of the IMF following the economic crisis of the 80s. Military expenditures have been on the rise since the early 2000s. This trend has been on both the stable and unstable African countries. This increase trend witnessed a peak in 2014 with a record spending of about 43 billion US dollars. A corresponding peak

was witnessed in the same year in the stable groups of countries, recording a slightly above 15 billion US dollars. This trend indicates the stable group of countries accounted only about 34% of the military spending that year. They however witnessed their highest peak only a year later to a value of about 28 billion US dollars. This period of increase spending corresponds to a period when African countries witnessed an increase though unstable economic growth. Following a fall in oil prices in 2014, military spending decreased in Africa. This value stood at about 37.5 billion US dollars in 2016 corresponding to about 12% drop compared to the 2014 peak. This was evident in both groups of countries. It is thus imperative to put into evidence the behavior of growth rate within the same period. Figure 2 shows the evolution of growth rate in Africa from 1990 to 2017.

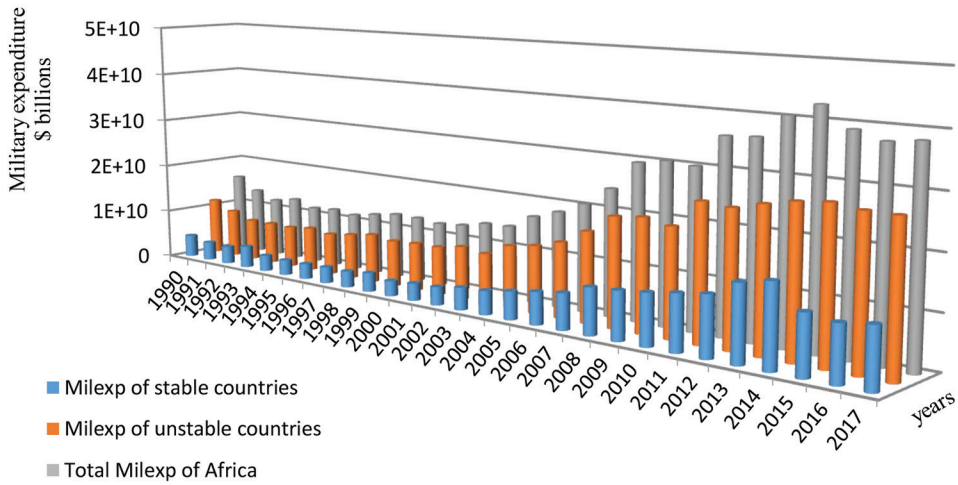

Figure 1: Comparative evolution of military expenditures in Africa

Source: *authors, using the World Bank database (2015)*

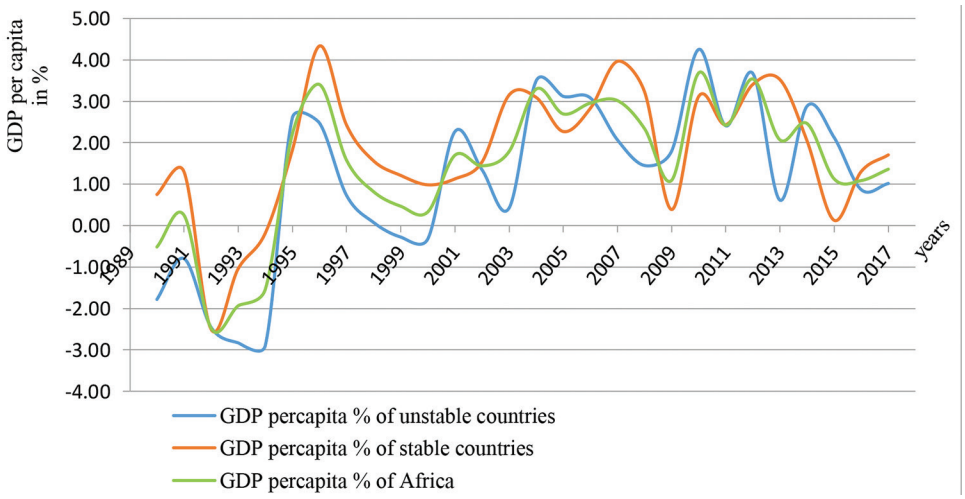

Figure 2: Comparative evolution of economic growth in Africa

Source: *authors, using the World Bank database (2015)*

Unlike military spending which had a stable or just slight fluctuations, Per capita growth has been very unstable all over Africa. Between 1991 and 1994, Africa had a negative per capita GDP on average. The lowest trend stood at –2.5% in 1992. This trend was similar in both the stable and unstable groups of countries. The unstable group however registered the lowest trough of -2.9% in 94 slightly less than the continents lowest of 1992. This negative trend was witnessed soon after the economic crisis of the late 80s, which propagated into Africa. This saw a slowdown in the continent's growth rate. In order to boast economic growth, many African countries adopted the structural adjustment program of the IMF in the late 80s and early 90s. One of the conditions of this program was a cut down in public expenditure (hence military expenditure). By 1994, the trend of per capita GDP had regained a positive growth path, this saw the stable group of countries growing faster than the rest of the continent, recording its highest peak of 4.3% in 1996 just 4 years after it recorded its lowest trough. This did not last as by 1997, the continent was hit by the debt and global economic crisis of 1997/1998/1999. This put the growth rate once more on a decrease in Africa, the continents average falling almost to zero by 2000.

The GDP per capita of the unstable countries decreased faster than that of the stable group of countries falling below zero this same year (2000). By 2003, the growth rate had taken a promising though unstable trend in Africa until it started decreasing again in 2008 just after the economic crisis of 2007-2008 which saw Africa registered a growth rate of about 1% in 2009 against more than 3% that was registered just 2 years before. In this same year, the stable group of countries registered a growth rate very closed to zero far below those of the unstable groups of countries (1.8%). It is worth mentioning that by 2008, the number of armed conflicts had greatly reduced in the region compared to the 90s. Growth rate then picked an increasing path after 2009 with the unstable groups of countries growing faster than the stable group of countries. This positive unstable growth continued in Africa until 2015 when it dropped to about 1% as opposed to more than 3.5% recorded in 2012. In the same year (2015), the stable group of countries registered their lowest growth in GDP per capita in two decades (0.1%) while the unstable group registered 2.1%. This was after the petroleum price shock of 2014 that also saw a drop in military spending within the same period.

Literature Review

We will hereby analyse the theoretical and empirical works between military spending and economic growth.

Review of theoretical work

Theoretical link between military spending and economic growth is summarised in the discussions between public spending and economic performance. The debate is divided between two schools of thought. The first line of thought considers that public expenditure has a beneficial effect on economic growth. This assertion is part of the Keynesian logic and considers that the regulation of economic activity by the public authorities involves

counter-cyclical actions. This perspective leads governments to support economic activities when it can no longer be self-regulated. So, in the short term, public spending can be used to stimulate aggregate demand and boost economic growth (Keynes, 1936). For the Keynesians, a policy of sustainable spending would help bring the national economy closer to full employment; and fiscal policy would be a powerful level of economic dynamism. By reviving the activity, the budget generates positive spill-over effects on the economy as a whole: we talk about the multiplier effect of public expenditure (Samuelson, 1992). Therefore, in connection with our problem, the argument in favour of public spending is that the latter, in particular public investments in armaments but also in road networks, electricity, transport, telecommunications, education and health generate externalities which improve the productivity of private factors and thus support economic growth (Malizard, 2013; Martin, 2013).

However, the second school of thought, the neoclassical disputes the positive effect of the Keynesian multiplier and argues on the contrary that an expansionary fiscal policy does not have a favourable effect on economic activity. Negative effects arise from the fact that economic agents anticipate the future consequences of fiscal policy and adjust their consumption and savings behaviour accordingly (Barro, 1990; Feldstein, 1982). In fact, the effect of public spending on growth depends on the sources of financing used by the government. If this expenditure is financed by a rise in direct taxation, the net impact on growth may be negative despite a positive effect on the marginal productivity of private capital. If expenditures are financed by borrowing, then economic agents understand that today's non-taxation is a tax deferral in the future. As a result, instead of increasing their level of consumption, they save the surplus income due to today's non-taxation, to pay future taxes. This tends to reduce demand and the surplus of public expenditures is offset by the fall in private demand. In response, fiscal policy is weakened; which reduces the effects of the traditional Keynesian multiplier: this is the theory of Ricardian equivalence (Yapo, 2002).

The macroeconomic analysis of military spending has not attracted the enthusiasm of economists. In this respect, Aben (1992), shows that if the impact of military expenditures on economic activities is feasible, they do not have a decisive contribution and hence, do not appear to be a good vector of economic policy. According to Aben (op. Cit.), the problem of the efficiency of military expenditures on the economy stems from the multiplicity of channels by which these expenditures affect economic activity. Thus, according to Dunne et al. (2005), three channels can be considered.

Firstly, the demand channel, based on the Keynesian theory, highlighting the positive effect of military spending on the macroeconomic environment through the multiplier effect illustrates the negative effect of military spending on private investment; which raises the interest rate.

Secondly, the supplies channel. Here, the factors of production are in competition between civil and defense uses: it is the "butter-canon" dilemma illustrated by this quote of Dwight Einsenhower[2]: "*Every gun that is made, every warship launched, every rocket fired*

2. *The chance for peace speech*, 1953

signifies, in the final sense, a theft from those who hunger and are not fed, those who are cold and are not clothed". Nevertheless, we note positive spill-over effects such as the effects of technological spill-over (indirect spill-over effects) in the nuclear or aeronautical sectors, which are beneficial for the economic sphere (nuclear power plant, more efficient airliners).

Finally, we have the security channel. It is widely accepted that military expenditures satisfy a need for security, a condition for a stable business climate. By analogy, an increase in military spending may be perceived as a sign of an imminent threat, delaying the process of growth.

In short, there are two contradictory effects for each of the channels. From the Laffer curve (2004), announced by Say (1803) and popularised in the 1970s by Wanninski (1978), we put forward a "Laffer curve of military expenditure" in the logic of theoretical reasoning according to which an exaggerated increase in military spending, if it does not support economic activity according to the Keynesian view, would rather crowd out investments to other sectors of the economy (health, education, infrastructure, etc.); which would help lower the rate of economic growth, ceteris paribus. Graphically, the "Laffer Curve of Military Spending" may be in the form of a bell curve linking military spending to economic growth rates. It is shown in Figure 3.

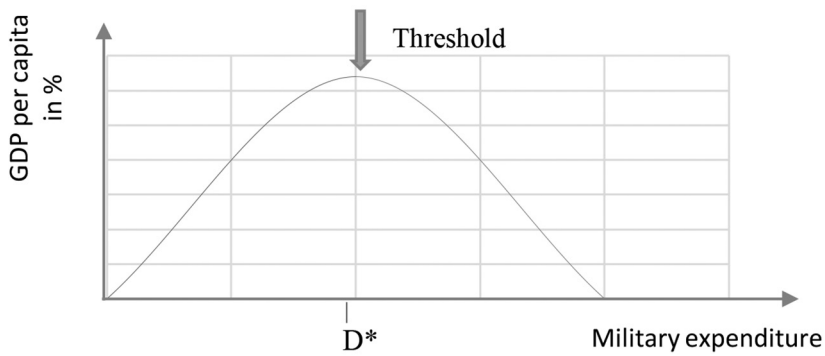

Figure 3: Laffer Curve of Military Spending

Source: *authors, from the Laffer Tax Curve*

According to figure 3, the increase in military spending also leads to increase in economic growth rate. However, for a level of military expenditure higher than D *, the effect on the economic growth rate becomes rather negative, because the bearable threshold is exceeded. The interest of governments is then to keep the level of military expenditure below the bearable threshold (D *), all things being equal. In the next subsection, we review some empirical work related to our problematic.

Review of empirical works

Several empirical studies have highlighted the linear effect of military spending on economic growth. This work can be grouped into three categories: in the first category, the authors show the positive effect of military spending on growth; in the second category, the effect is rather negative; while in the third category, the effect is non-linear.

Regarding the first category, Benoit (1973, 1978) earlier argued that military spending positively influence growth through several channels: the presence of externalities which emanate from military training and research-and-development (R&D) and raise productivity in the private sector; the provision of collective works similar to infrastructure; the stimulation of demand by the multiplier effect, allowing to move towards full employment, or an improved security, favourable to the decisions of private investment. Benoit's argumentations were supported by a series of empirical estimations both in panel (with 44 countries, from 1950 to 1965) and on longitudinal data (for a sample of developing countries). In these regressions, the GDP growth rate is regressed on military spending, whose parameter is found systematically positive. Following the seminal work of Benoit (1973, 1978), Arzellier and Nicolini (2000) analysed the effects of military eviction on the civilian sector. They specified cases where spill-over effects from the military sector are sources of economic growth and have shown that the growth of a region is more driven by inter-sectoral and inter-regional spill-over effects. Saroja and Eliyathamby (2014) specify the existence of a positive causal relationship between military spending and growth in Sri Lanka over the period 1975-2013. Indeed, the country has faced more than thirty years of civil war until 2009. According to the authors, investment in armaments in this framework was a way to redress the political situation of the country, in order to attract new foreign investors. Masoud and Zaleha (2015), in an analysis of a sample of 67 developed countries over the period 2002-2010, conclude that there is a positive and significant relationship between military spending and economic growth. In this context, investment in armaments appears as a strong signal that reinforces the position of investors.

As regards the second category of works, Dune and Mohammed (1995) show that, in a sample of 13 Sub-Saharan African countries over the period 1967-1985, military spending negatively and significantly affects the economy due to the decline in productive investment and the balance of payments deficit. On a study of 15 European Union countries and on the basis of Granger causality test, Kollias et al. (2004) show that sustainable economic growth leads to an increase in military spending, but the opposite is not verified, thus, the effect of military spending on growth turns out to be negative. Going further, Jiang and Zhonghou (2014) on a study on China, show that the impact of military spending on growth is mixed and depends on the study period. Over the period 1952-1978, the increase in military spending positively and significantly affects growth. By contrast, over the period 1978-2009, the effect of these expenditures on growth is rather negative and significant. But for a long-term study (1952-2009), this effect is not significant. In the same light, but this time on a sample of 10 countries in the Mediterranean over the period 2005-2012, Korkmaz (2015) shows that military spending negatively affects economic growth and increases unemployment. Recently, Njamen and Kouladoum (2018), using VAR modeling over the 1985-2015 period, show that military spending negatively and significantly affects economic growth in Chad.

The third category of work completes the previous two categories because the search for non-linearity appears as a promising avenue of research. The first author to use non-linear modeling on this subject is Landau (1994), who introduces the military squared variable

for a set of developing countries into his specification. His result shows that for military spending levels below 6%, the relationship is positive and becomes negative for levels above this threshold. The work of Cuaresma and Reitschuler (2004 and 2006), Lee and Chen (2007), Malizard (2014) also adopt this approach using nonlinear threshold models. Given the multiplicity of channels through which military spending affects growth, non-linearity is often cited as a methodological framework potentially suitable for modeling this relationship (Malizard 2014).

The lack of consensus in the empirical literature suggests that a linear approach is probably not appropriate for analysing the relationship between military spending and economic growth, thus the necessity of the use of a non-linear modeling. In this case, the threshold-effect models constitute an econometric framework to take into account this non-linearity.

Methodology Of Analysis

The objective of this paper is to analyse the effect of military spending on growth in Africa. Our empirical approach is based on a panel threshold model. We present successively the estimation strategy, the empirical model and the data used.

Estimation Method

The analytical approach highlights the existence of a threshold beyond which any increase in military spending would have a negative effect on economic growth.

The analysis of threshold effects is performed using the Panel Smooth Transition Regression Modeling (PSTR). The choice of this technique is not fortuitous. Indeed, there are two main types of threshold modeling: the Hansen (1999) model which assumes that the transition between two regimes is abrupt and the modeling of Gonzalez et al. (2005) for which the transition is rather smooth or is done gradually. In this study, the smooth transition model is more appropriate for describing the change in economic growth induced by regime variables for two reasons (Gonzalez et al. 2005; Cho, 2015; Delatte et al. 2017): on one hand, the smooth-transition model makes it possible to take into account the heterogeneity of the relationship between the explained variable and the independent variables, and on the other hand, the Gonzalez et al. (Op.cit.) is a generalisation of Hansen's model (op.cit.). In addition, the formulation of the model to be estimated suggests three potential sources of endogeneity related to the simultaneity between the explained variable and the variable of interest, the presence of unobserved heterogeneity, and measurement errors. The most appropriate methodology to take into account this possible presence of endogeneity and the non-linearity of the relationship seems to be the PSTR technique.

The PSTR model is defined by the following relation (Gonzalez et al., 2017):

$$Y_{it} = \mu_i + \lambda_t + \beta_0^{'} X_{it} + \beta_1^{'} X_{it} g\left(q_{it}; \gamma, c\right) + e_{it} \tag{1}$$

With $i = 1, \ldots, N$ and $t = 1, \ldots, T$

Where i is the individual dimension and t is the temporal dimension of the panel. Y_{it} is the dependent variable and $X_{it} = \left(X_{it}^{1},\ldots,X_{it}^{k}\right)$ is the matrix of k-explanatory variables that do not contain delayed endogenous variables. $g(q_{it}; \gamma, c)$ designates the transition function associated with a transition variable q_{it}, a threshold parameter c and a smoothing parameter γ. μ_i and λ_t represent the individual fixed effect and the temporal effect respectively, e_{it} the error term.

The transition function $g(q_{it}; \gamma, c)$ of equation 1 is a continuous function of the transition variable q_{it} and lies between zero and one. According to the work of Teräsvirta (1994, 1998), Jansen and Teräsvirta (1996), Teräsvirta et al. (2010), the m-order transition function can be written in the following manner.

$$g(q_{it};\gamma,c) = \left[1 + \exp(-\gamma \prod (q_{it} - c_j)\right] \tag{2}$$

With $\gamma > 0$ $etc_1 < c_2 < \cdots < c_m$

Where $c = (c_1, \cdots, c_m)$ is a vector of dimension, $(1, m)$, grouping the threshold parameters and γ represents the positive smoothing parameter or the slope associated with the function g. The smoothing parameter γ determines the speed of the transition between the two regimes. The larger this parameter, the more brutal is the transition. When γ is zero, the transition function becomes constant and the PSTR model is reduced to a linear auto-regressive model.

In practice, Gonsalez et al. (2017) indicate that it is usually sufficient to consider $m = 1$ or $m = 2$ to capture non-linearity or the existence of threshold

For $m = 1$, the model implies that the two regimes are associated with the "much higher" and "significantly lower" values of the transition variable, q_{it} with a monotonic transition. On the other hand, for $m = 2$, the transition function is at its minimum at the point $(c_1 + c_2)/2$ and reaches its maximum for "much higher" and "much lower" values of the transition variable, q_{it}. Here, c_1 and c_2 are the thresholds that give the location of the transition function according to the values of m.

Two tests are used to address the inference issue in PSTR modeling: the non-linearity test and the test of number of regimes (Fouquau, 2008).

Linearity test or homogeneity test: this test is an essential step in the analysis. It aims to verify that the threshold effect is statistically significant and reciprocally, to show that the relationship between the explanatory variables and the explained variable can be represented using a regime change model. To do this, we construct a null hypothesis test of linearity against the alternative hypothesis of a smooth transition model with threshold. There are two sets of possible hypotheses: $H_0 : \beta_1 = 0$ versus $H_1 : \beta_1 \neq 0$ or $H_0 : \gamma = 0$ versus $H_1 : \gamma \neq 0$. The null hypothesis can be tested using a Lagrange multiplier statistic with a usual distribution:

$$LM = \frac{TN(SCR_0 - SCR_1)}{SCR_0} \tag{3}$$

Where SCR_0 is the sum of the squares of the residuals of a linear model with individual effects and SCR_1 the sum of the squares of the residuals of the auxiliary equation. Under

H_0, the LM statistic is distributed according to a Chi-square law with *mk* degree of freedom, where *k* is the number of explanatory variables. According to Gonzalez et al. (2005), the optimal transition variable is the one that minimises the p-value of the linearity test.

Test of the number of regimes: the remaining heterogeneity test makes it possible to test the number of regimes or the number of transition functions necessary to capture all the heterogeneity and non-linearity of the data. The logic of this test is similar to that of the linearity test. More specifically, the null hypothesis of a PSTR model with a single transition function is confronted with the alternative hypothesis of a PSTR model with at least two transition functions. The principle of the test is based on the following assumptions: $H_0 : \gamma_2 = 0$ versus $H_1 : \gamma_2 \neq 0$. As before, it is possible to use the statistical value of the Lagrange multiplier to perform this test. In case of rejection of H_0, the model used is poorly specified. It must contain at least a second transition function to successfully capture all the heterogeneity. The test procedure must then continue, the PSTR model containing two transition functions must be confronted with a model containing three transition functions, and so on. This test sequence continues until the rejection of H_0.

4.2. Econometric Specification

The empirical model chosen draws on Benoit (1978) and Benedict et al. (2005), taken up by Njamen and Kouladoum (2018). The dependent variable is economic growth, which is captured by GDP per capita (Tcrois). The independent variable of interest is military expenditures (Milexp) in US dollars. These expenditures include all current and capital expenditures for the armed forces, including expenditures for civilian and military personnel, social services and military personnel pensions, operations and maintenance, procurement, research and development and military aid (in the military expenditure of the donor country) (WDI, 2017).

We use the most commonly used control variables in the literature. This is the annual percentage investment rate (Tinv), oil revenues as a percentage of GDP (Oilrent), an institutional variable namely the Global Civil Liberties Index (IGLC), the growth rate of the population (Txpop), the number of armed forces personnel (Forcearmé), the human capital captured by the primary school enrollment rate (out of school) and the external debt as a percentage of GDP (Dext). The empirical model in the form PSTR is inspired by the works of Malizard (2014):

$$Tcrois_{it} = \mu_i + \lambda_t + \beta_1 milexp_{it} + \beta_2 milexp_{it} g(q_{it};\gamma,c) + \beta_3 Var_{it} + e_{it} \quad (4)$$

Where *Var* represents the vector of the control variables. The expected signs of model variables, as well as the work supporting these predictions, are presented in Table 1.

Table 1: Expected Signs of Different Variables

Variables	Expected Signs	Justifications
Milexp	+	Arzellier et Nicolini (2000)
Tinv	+	Masoud et Zaleha (2015)
Oilrent	+	Omrani et Toumache (2016)
IGLC	–	Azam et al. (1996)
Txpop	+/–	Benedict et al. (2005)
Forcearmé	+/–	Rudner (1987)
Txscolarisation	+	Benedict et al. (op.cit.)
Dext	+	Pattillo et al. (2002)

Source: *authors inspired by a review of literature*

PSTR robustness test

Inspired by Landau (1994), we estimate a dynamic quadratic form of the empirical model in order to evaluate the robustness of the PSTR model. The equationis represented as:

$$Tcrois_{it} = a_0 + a_1 Tcrois_{it-1} + a_2 Milexp_{it} + a_3 Milexp_{it}^2 + a_4 Tinv_{it} + a_5 Dext_{it} + a_6 Var_{it} + E_{it} \quad (5)$$

Where, $Tcrois_{it\text{-}1}$ represents the economic growth lagged by a period. This variable is introduced into the model to account for the endogeneity in the growth equation. $Milexp^2$ is military expenditures as a percentage of GDP squared, *Var* the vector of control variables, *E* the error term, a_i the coefficients of the explanatory variables. The presence of the variable $Milexp^2$ in this specification makes it possible to highlight and determine the maximum threshold beyond which any increase in military expenditure is detrimental to economic growth. This threshold is highlighted by the Generalized Method of Moment (GMM) in the Blundel and Bond system (1998), considered as a robustness test of the results obtained by the PSTR (SuDinh, 2015; Mondjeli and Tsopmo, 2017). The validity of the results produced is based on two main tests: the lack of 2nd order auto-correlation and the conformity of Sargan's (1958) overidentification test.

Data

The sample is made up of 41 African countries whose annual data are collected over the period 1990-2017. The choice of study period and number of countries depends exclusively on the availability of data. These data come from the World Development Indicators database (WDI, 2018) and *Perspective Monde* (2019) of the University of Sherbrooke.

African countries are grouped into two categories, divided into 21 unstable countries and 20 stable countries. This classification is based on the Global Peace Index (2018) from the University of Sydney's *Centre for Peace and Conflict Studies* (Appendix). Within the groups, stable countries are ranked in descending order of stability (from the most stable to moderately stable countries); while unstable countries are ranked in ascending order of instability (from unstable to highly unstable countries). Descriptive statistics of model variables are presented in Tables 2 and 3.

Table 2 : Descriptive statistics for the unstable country group

Variable	Obs	Mean	Std. Dev.	Min	Max
Tcrois	588	1.123295	5.670428	-47.50332	37.53553
Milexp	588	7.41e+08	1.47e+09	1817811	1.04e+10
Tinv	588	20.55712	10.17027	0	60.01827
Oilrent	588	5.028348	9.980279	0	56.28454
IGLC	588	4.993197	1.164475	2	7
txpop	588	2.482065	1.063738	-6.77	8.11
Forcearmé	588	92913.44	162326.9	2000	866000
Txscolarisation	588	85.15584	25.75461	21.62279	148.1242
Dext	588	72.82784	65.24172	0	470.0238

Source: *Authors, from the collected data*

Table 3 : Descriptive statistics for the stable country group

Variable	Obs	Mean	Std. Dev.	Min	Max
Tcrois	560	1.771506	4.276421	-26.41177	23.05313
Milexp	560	3.19e+08	7.58e+08	1931395	6.84e+09
Tinv	560	22.07111	7.22768	-2.424358	52.41832
Oilrent	560	3.173725	9.405734	0	56.1387
IGLC	560	3.794643	1.192841	1	7
Txpop	560	2.374536	0.9170797	-0.61	4.62
Forcearmé	560	30255.43	54035.6	800	251000
Txscolarisation	560	96.69877	25.10869	32.5255	152.2163
Dext	560	64.29657	46.6018	3.601596	254.4376

Source: *Authors, from the collected data*

The statistics related to the variables of the model are expressed in numerals (Tcrois, Milexp, Forcearmé) or in annual rates (Tinv, Oilrent, Txpop, Txscolarisation, Dext), with the exception of The Global Civil Liberties Index whose values require a clarification.

The Global Civil Liberties Index (IGLC) allows assessing the liberties of individuals in a political regime, essential condition for the exercise of economic activities. The index varies from 1 to 7 (1 = liberties and 7 = no liberties or repression). The lowest scores (1 and 2) in the civil liberties scale are awarded to countries that guarantee the expression of citizens freedom, while the highest scores (6 and 7) are given to states offering little freedoms to their citizens who live in fear of repression.

Estimation by the PSTR technique requires the use of a balanced panel. That's why we keep 41 of the 54 countries on the African continent. And even for the 41 selected countries, there are some missing data, despite the restriction of the study period. Management of missing data is performed using the multiple imputation method (Rubin, 1987; Njamen and Kwatcho, 2016).

First of all, it is necessary to determine the properties of each of the variables. For this, we apply the Im-Pesaran-Shin panel stationarity test. The results of this test are shown in Table 4.

Table 4 : Im-Pesaran-Shin (IPS) Unit root test

Variables	Stables countries		order	Unstables countries		order
	Statistic	Prob		Statistic	Prob	
Tcrois	-11.559	0.0000	I(1)	-7.62448	0.0000	I(1)
milexp	-1.36118	0.0867	I(0)	-2.07228	0.0191	I(0)
tinv	-2.39871	0.0082	I(0)	-2.34759	0.0094	I(0)
oilrent	-1.80263	0.0357	I(0)	-2.33641	0.0097	I(0)
IGLC	-3.64387	0.0001	I(0)	-4.26483	0.0000	I(0)
Txpop	-21.5211	0.0000	I(0)	-3.48966	0.0002	I(0)
Forcearmé	-5.09012	0.0000	I(0)	-2.83324	0.0023	I(0)
Txscolarisation	-1.29437	0.0978	I(0)	-1.62806	0.0518	I(0)
Dext	-9.04120	0.0000	I(1)	-10.5156	0.0000	I(1)

Note: *The values presented in the table are the statistic and the p-value*

Table 4 shows that the variables of the model are stationary at level in the two groups of countries, with the exception of Tcrois and Dext. This justifies the introduction of the Tcrois variable lagged by a period in Equation 5. The results of the estimates are presented in the next section.

Results

In this section, we present the results of our econometric analysis based on the different steps given in the previous section. The results of the homogeneity test (non-linearity) and test of number of regimes are presented in Tables 5 and 6. Table 5 shows that the hypothesis of linearity of the model is rejected for stable and unstable country groups. The PSTR model is therefore suitable for estimates. The results of the test of number of regimes (Table 6) indicate the non-rejection of the null hypothesis, which indicates that a threshold captures the heterogeneity (non-linearity) in the different models.

Table 5 : Linearity test

Threshold variable		Fisher test ((LMF)	LRT test (LRT)
Milexp	Stable countries	187.74***	178.42***
	Unstable countries	69.83***	104.29***

Note: *Ho : linear model ; H1 : PSTR model with at least one threshold. Significance level: (***) 1%*

Table 6 : Test of the number of regimes

	Threshold	RSS	MSE	Fstat	Prob	Number of transition functions
Stable countries	2.1346e+09	24.55	0.0462	12.77	0.0267	1
Unstable countries	3.6389e+09	24.55	0.0807	12.57	0.1367	1

Note: *Ho: PSTR with one transition function; H1: PSTR with at least transition functions*

The results of the PSTR model estimation are reported in Table 7. These results show that the effect of military spending on economic growth in stable countries depends on the rate

of population growth, the number of armed forces and external debt; while in unstable countries, this effect depends on the investment rate, oil revenues, the global index of civil liberty, the primary school enrollment ratio and the external debt.

Table 7 : Estimated coefficient of the PSTR model

Variables	Stable Countries	Unstable Countries
milexp	0.426*** (0.0223)	0.317*** (0.0229)
$milexp_{it}\, g(q_{it}; \gamma, c)$	0.00146*** (0.000437)	0.0385*** (0.00968)
Tinv	-0.00271 (0.00191)	-0.00372** (0.00169)
Oilrent	0.000297 (0.00287)	0.00525** (0.00264)
IGLC	-0.0711*** (0.0145)	-0.0365** (0.0184)
txpop	-0.0966*** (0.0186)	0.0174 (0.0140)
Forcearme	0.156*** (0.0392)	0.00835 (0.0389)
Txscolarisation	0.000267 (0.000800)	0.00210** (0.000940)
Dext	-0.00542*** (0.000326)	-0.00405*** (0.000324)
γ	0.48	0.001192
Observations	560	588
Number of i	20	21

Note: Standard errors in parentheses. Significance levels: (***) 1%, (**) 5%, (*) 10%

Table 7 shows that the direct effect of military spending on growth is positive and significant in both stable and unstable countries. This result is in line with the Keynesian logic of the works of Benoit (1978), Arzellier and Nicolini (2000), Masoud and Zaleha (2015). The coefficients of interaction between military expenditures and the transition function are also positive and significant in both groups of countries. However, the estimation of threshold effects suggests a threshold beyond which any increase in military spending would have a negative influence on economic growth. This threshold is about $ 2.13 billion for the group of stable countries and $ 3.63 billion for the group of unstable countries, all things being equal.

In order to test the robustness of the results of the threshold effect model of equation 4, we estimate equation 5 by the GMM. The results are reported in Table 8.

Table 8 : Estimated coefficient of the GMM model

Variables	Stable countries	Unstable countries
$Tcrois_{it-1}$	0.706*** (0.128)	0.931*** (0.0172)
Milexp	-4.447* (2.695)	-0.239** (0.0999)
milexp2	0.123* (0.0713)	0.00639** (0.00268)
Tinv	-0.00301 (0.0142)	7.54e-05 (0.000848)
Oilrent	0.0202*** (0.00672)	0.00329*** (0.000801)
IGLC	-0.318*** (0.0757)	-0.0125* (0.00677)
Txpop	-0.0579 (0.262)	-0.00258 (0.00677)
Forcearme	0.398** (0.192)	0.00285 (0.0134)
Txscolarisation	-0.00870** (0.00401)	0.000187 (0.000314)
Dext	-0.00223 (0.00148)	-0.000962*** (0.000170)
Wald chi2	3096.26***	16642.55***
Prob (AR_2)	0.056	0.253
Prob (Sargan test)	0.431	0.212
Observations	540	567
Number of i	20	21

Note: Standard errors in parentheses. Significance levels: (***) 1%, (**) 5%, (*) 10%

The results in Tables 7 and 8 are similar (similarity in sign and significance of estimated coefficients) with the exception of the population growth rate in unstable countries and school enrollment rate in stable countries. The Wald test is significant at 1%, which illustrates the good specification of the model. In addition, we observe the absence of 2nd order auto- correlation at the 5% threshold and the validity of the test of identification of instruments. Moreover, the variables *milexp* and *$milexp^2$* have opposite signs for the two groups of countries, which confirm the hypothesis of non-linearity of the estimation of threshold-effect panels. The following comments are made about the model variables estimated by the GMM.

Per-capita GDP lagged by one period has a positive and significant influence at 1% on GDP per capita in both groups of countries. This result corroborates Barro's theory of convergence of growth models (1990), which states that the economic growth levels of different economies tend to be closer together over time.

Military spending (*milexp*) has a negative and significant effect at 1% in both groups of countries. This negative effect on growth is greater in the group of stable countries because

military spending is, by nature, unproductive (military operating expenditure). Thus, an increase in military spending in the stable group of countries reduces per capita GDP by 4.4 units. This result corroborates those of Korkmaz (2015), Njamen and Kouladoum (2018), and can be explained by the fact that the tolerable threshold of military expenditure is exceeded. On the other hand, the effect of the variable $milexp^2$ is rather positive and significant in the two regressions. This result means that for military expenditures below the respective thresholds, the effect on growth could be positive in both groups of countries, which is consistent with the non-linearity highlighted by Landau (1994), Malizard (2014).

Concerning control variables, oil revenues have a positive and significant effect, respectively, in both groups of countries. This result corroborates what was expected (Omrani and Toumache, 2016). The Global Civil Liberties Index (*IGLC*) has a negative and significant effect in both groups of countries, which is what was expected and can be explained, on one hand, by the fact that there is an obstacle to the freedoms of individuals in two groups of countries, which prevents the exercise of economic activities (Azam et al. 1996). On the other hand, the average values of the *IGLC* are 3.72 and 5.34, respectively, in stable and unstable country groups, which is higher than the low values of the index (1 and 2).

For other control variables, the effect is differentiated and varies by country group. Thus, the number of armed forces personnel (Forcearmé) has a positive and significant effect on growth in the group of stable countries, while the effect is rather insignificant in the group of unstable countries. Regarding the school enrollment rate (txsccolarisation), the effect is negative and significant in the group of stable countries and not significant in unstable countries. Foreign debt (Dext) has a negative and significant impact on growth in unstable countries, but not significant in stable countries.

Conclusion

This study allowed us to conduct a comparative study of the non-linear effect of military spending on economic growth in stable and unstable countries in Africa. The methodology used is that of the threshold panels and the GMM using data from 1990 to 2017. This paper then contributes to the debate by offering new empirical evidence for the case of Africa. The results reveal that military spending negatively and significantly affects economic growth in both groups of countries. The positive sign associated with the military spending squared variable ($Milexp^2$) confirms the existence of a non-linear relationship between military spending and economic growth in Africa. The estimations point to the existence of military spending thresholds of about $ 2.13 billion for the stable country group and $ 3.63 billion for the unstable group of countries. This shows that for military spending levels above the defined thresholds, the effect on economic growth becomes negative, respectively in the two groups of countries. The results also show that oil revenues have a positive effect on economic growth, while the Global Civil Liberties Index has a negative effect in both groups of countries. Regarding the other control variables, the effect on growth is positive and significant for the number of armed forces personnel, and negative for the primary school enrollment rate in stable countries. For external debt, the effect is significant only in unstable countries.

The recommendations lie on the reduction of the budget for the defense sector. But given the current outlook for growth (a priori weak) and the strategic orientations likely leading to an increase in defense spending, there is reason to fear a decrease in the effectiveness of the effect of military spending on growth. However, since the defense sector is one of the largest in terms of overall public spending in Africa, it would be better if the potential reductions in spending were on the operating budget of the Ministries of Defense rather than on the budget allocated for the purchase of military equipment. It is essential to place special emphasis on the hazards that could jeopardise growth efforts: (i) the security situation remain a concern in some countries. If the situation were to increase, it would have a significant impact on trade and investment decisions. (ii) There is a need for greater diversification of economies to reduce their high dependent on oil revenues, given the fall in the price of oil on the international market. Finally, (iii) States should guanratee the expression of civil liberties that condition the exercise of economic activities.

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Appendix: Ranking of countries according to the global peace index in Africa

Stable countries	Classification	Unstable countries	Classification
Mauritius	Peaceful	Algeria	Unstable
Botswana	Peaceful	Niger	Unstable
Madagascar	Peaceful	congo	Unstable
Zambia	Peaceful	Guinea Bissau	Unstable
Sierra Leone	Peaceful	Ivory Coast	Unstable
Ghana	Peaceful	Ethiopia	Unstable
Malawi	Peaceful	Djibouti	Unstable
Tanzania	Peaceful	Mauritania	Unstable
Lesotho	Moderately peaceful	South Africa	Unstable
Tunisia	Moderately peaceful	Zimbabwe	Unstable
Togo	Moderately peaceful	Rwanda	Unstable
Mozambique	Moderately peaceful	Cameroon	Unstable
Senegal	Moderately peaceful	Kenya	Unstable
Benign	Moderately peaceful	Mali	Unstable
Gabon	Moderately peaceful	Chad	Unstable
Burkina Faso	Moderately peaceful	Burundi	Unstable
Morocco	Moderately peaceful	Egypt	Unstable
Gambia	Moderately peaceful	Nigeria	Unstable
Angola	Moderately peaceful	Democratic Republic of Congo	Highly unstable
Guinea	Moderately peaceful	Sudan	Highly unstable
		Central African Republic	Highly unstable

Source: *Global Peace Index (2018), Centre for Peace and Conflict Studies*