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Military Burden and Economic Growth: Evidence from a Multivariate Cointegration Analysis

Abdunasser Duella*

Department of Economics, California State University, Fullerton, California, USA

Abstract

The causation relationship between economic growth and military spending in developing countries was subject to intense debate in recent years. This study examines the causal relationship between aggregate government spending and economic growth in Algeria for the period 1980-2010. We also break down the aggregate government spending into military and civilian spending and assess their impact on economic growth. Both bivariate and multivariate co-integration is utilized to determine the type and direction of causality. Using Johansen's co-integration procedure and VECM, the study showed the existence of uni-directional causality between economic growth and military spending. This study also uses the variance decomposition analysis to assess the dynamic effect of one variable on the other two variables in the model beyond the sample period.

Keywords: Economic growth; Co-integration; Variance decomposition; Granger causality

Introduction

The central theme in all of economics revolves around the efficient allocation of scarce resources among alternative uses. "The scarcity of resources leads economists to suggest that large defense expenditures undertaken by governments reduces the resources available for investment in other more productive sectors of the economy, and thus will lead to a slowdown in growth [1]".

The empirical evidence collected for developed countries seem to validate and verify the above statement. However, the studies that were undertaken for many of the developing countries revealed an entirely opposite pattern as noted by Benoit. "This finding was so unexpected and challenging that it made it worthwhile to undertake this empirical study to shed more light on the underlying relationship between military spending and economic growth in developing countries [1]".

The issue of causality between economic growth and military spending in developing countries has been explored by many researchers during the past few decades with no conclusive results. Some studies have shown the causality to be uni-directional while others showed it to be bi-directional, yet other investigations concluded the absence of causality altogether.

The inconclusiveness regarding the direction of causality between the above two variables can be attributed to exogenous, non-economic factors such as military strategies, structural and policy differences, the specification of variables under investigation and the type of causality techniques used [2].

Economic theory has very little to say about the prediction of the direction of causality between growth and defense spending; yet we can use economic theory to shed some light on the type of relationship that exists between economic growth and government (defense) spending.

The relationship between military expenditure and economic growth has frequently been explored empirically in the defense economics literature, since the important research work undertaken by Benoit [1]. The results of Benoit's ad hoc studies are derived from the existence of a series of spill-overs and positive externalities which led to a significant number of empirical studies.

Studies covering this area of research can be divided into three categories based on their findings: The first category of studies found positive effects of defense spending on growth. Military spending according to Knight and Brumm [3,4] promotes economic growth through stimulating aggregate demand and producing positive externalities that boosts foreign direct investment. In this study it was found that defense spending had a positive impact on economic growth in a sample of 44 LDC's (less developed countries) between 1950 and 1965.

"The second category of empirical studies led to opposite conclusions demonstrating that military spending has a negative impact on economic growth. The economic reasoning behind such conclusions is that diverting large government expenditure towards the military sector would leave other productive sectors such as manufacturing, construction and agriculture with less financial resources [5,6]. Others such as Fiani [7], have found that economic growth and defense expenditure are negatively related. Klein [8] using time-series data from Peru found that military spending had a negative relationship with GDP growth. Also, Benoit [1] used the Spearman rank order correlation and regression analysis to show the negative impact on growth indicating the existence of crowding-out effect [9]".

The third category of empirical studies includes all the work that reached inconclusive results on the direction of causality between economic growth and military expenditure. For example, Rothschild, Biswas and Ram [10-15], found no statistical evidence that links economic growth to military spending. Also Dakurah [16] used error correction models to study the causal relationship between economic growth and military spending for 62 countries, and found no common causal relationship between the above two variables for any of the countries under consideration.

***Corresponding author**: Abdunasser Duella, Department of Economics, California State University, Fullerton, California, USA, Tel: + (657) 278-5412; E-mail: aduella@fullerton.edu

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Among the countries that have received little attention in the empirical literature covering the causal relationship between defense spending and economic growth are the countries of the Middle East and North Africa (MENA) [17,18] which are characterized by large macro-economic imbalances.

"Algeria, the country under consideration for this study has been plagued by fiscal imbalances for most of the past three decades. Oil production on the average represented 85 per cent of Algeria's GDP (gross domestic product). Algeria's fiscal imbalances are due mainly to huge government expenditures in public projects, widespread corruption by government officials and the vulnerability of government revenues due to external shocks (the instability of oil prices). Policymakers have attempted to address the fiscal imbalances by introducing economic reforms that are essentially geared toward promoting the private sector at the expense of the public sector [19]".

The rest of this paper is organized as follows: Theoretical Background discusses the theoretical framework in the relationship between government spending and economic growth. The Econometric Methodology and Data examines the data and methodology applied in this study. Estimation Results presents the empirical results and finally Concluding Remarks provides a brief summary and conclusions.

Theoretical Background

What does economic theory say about the effect of government spending on economic growth? This has been the subject of intense debate among economists who adhere to the two different schools of thought, the Classical versus the Keynesians.

The Keynesians are concerned with how the economy performs in the short run as a result of changes in the business cycle. They believe that economic recessions and high rates of unemployment are the direct result of deficient aggregate demand. They advocate the use of expansionary fiscal policy to boost aggregate spending so as to reduce unemployment and enhance the level of economic activity. According to the Keynesians, a one dollar increase in government (military) spending through the expenditure multiplier effect will increase the equilibrium level of real GDP by more than one dollar.

The Classical School on the other hand is very much concerned with how the economy performs over the long run. They believe that if the economy happens to deviate from its long run equilibrium in the short run, there are internal forces within the economy that will ensure its return to the full-employment equilibrium. The adjustment process begins in the labor market, characterized by excess supply of labor (actual rate of unemployment exceeding the natural rate of unemployment). A fall in the real wage will lead to an increase in the demand for labor, thereby resulting in full-employment equilibrium in the labor market, which will ultimately make actual real GDP converge to potential GDP.

Classical and Neoclassical believe that changes in government spending have no effect on the level of GDP in the long run. Increase in government spending will lead to a fall in national saving and an increase in the real interest rate, which in turn will reduce private investment. This process is known as the crowding- out effect i.e., as public spending rises, public goods are substituted for private goods. The increase in government spending is offset by a decline in private investment which will leave the level of GDP unchanged.

Fiscal Policy is also made less effective by the existence of long time lags from the time a specific need is recognized for taking action to the time of the realized outcome of such an action.

New growth theorists suggest that there is both a temporary effect from government spending during the transition to equilibrium and a long run effect on economic growth.

"According to new growth theorists, government spending may affect economic growth through the following channels: (1) the government invests heavily in social infrastructure such as education, hospitals, roads, ports and other institutions that are conducive to growth. (2) The enforcements of rules and regulations pertaining to the protection of property rights that is essential in attracting and preserving foreign direct investment. (3) Reforms in labor laws and retirement policies that have a direct impact on the natural rate of unemployment, and thus growth over the long run. (4) The government is also instrumental in promoting and enhancing knowledge capital through its investment in research and development [20]".

From the discussion that we presented so far we can conclude that there are four possible causal relationships between growth and military spending: unidirectional causality from military expenditure to growth, or vice versa; bi-directional causality between growth and defense spending; and finally a lack of any causal relationship.

In this paper we will attempt to determine the type of causality that exists between growth and defense spending in Algeria by using the appropriate statistical tools of Granger causality [21,22] and the Error Correction Model.

The Econometric Methodology and Data

Most empirical studies of the relationship between government spending and economic growth have been conducted using cross-country data in an attempt to explain observed differences in growth rates across countries.

However, cross-section analysis does not capture the country specific nature of the relationship between the relevant economic variables included in the model. For this reason we have opted for using time-series analysis to investigate not only the type of relationship but also the direction of causality between the variables.

Data and definition of variables

Within a vector auto regression (VAR) [23,24] framework, we proceeded to form two systems of causal relationships:

a) A bivariate system that includes real GDP (RY) and total government expenditure as a ratio of real GDP (RGY).

b) A multivariate system that includes real GDP (RY), real military expenditure as a ratio of real GDP (RDY) and real civilian government expenditure as a ratio of real GDP (RCY).

$$RY=(RGY) \quad (1)$$

$$RY=(RDY, RCY) \quad (2)$$

All variables are expressed in natural logs and are measured in real terms in millions of Algerian Dinars (constant 2005 prices). The data covers the period (1980-2010) and is taken from the International Financial Statistic (IFS) 2011 CD-ROM, the World Development Indicators (WDI) 2011 CD- ROM and the United States Arms Control and Disarmament Agency (ACDA, 2011).

Method

Engle, Granger, Johansen, Johansen and Juselius [25-28] introduced the co-integration and error correction model (ECM) to examine the long-run equilibrium, and the short-run relationship among variables

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in the model. According to Granger [25], if two series are co-integrated, the dynamic relationship between the two variables could be examined within the framework of an ECM. The ECM was first introduced by Sargan [29], and later extended by Engel and Granger [25]. The ECM is derived from the co-integrating equations by including the lagged error correction term to recapture the long-run information lost via the differencing of the variables. It states that if two variables are co-integrated of order one, then they can be modeled by an ECM to determine the long-run relationship between two or more variables. The error correction terms derived from the co-integrating vectors are found through Johansen's multivariate co-integration test procedure.

The co-integration test involves two steps: the unit root test and the likelihood ratio test. The stationary properties of the individual variables in the above two equations are examined by using the unit root tests suggested by Dickey and Fuller [30,31]. Recent developments in the time-series studies have emphasized the importance of testing for unit roots in the series, since the validity of the empirical relationship between times series depends on the requirement that the classical stationary assumptions are satisfied. Granger, Newbold and Phillips [32,33] argue that the regression results are spurious if the time series involved in OLS are non-stationary. If the variables have unit roots, then the likelihood ratio test is used to find out the number of co-integrating vectors. If it is found that there are one or more co-integrating vectors, then this will imply that there exists at least one long-run equilibrium in the system of variables.

Co-integration test

The next step is to test for the existence of long-run equilibrium relationships between government spending and economic growth. If we let Z be a p x 1 vector that contains:

$$Z_t = (RY, RCY, RDY) \quad (3)$$

Where all elements of this vector are first differenced stationary, meaning that they are all integrated of order one denoted by I (1). Following Johansen's procedure, we assume that Z_t has a vector autoregressive (VAR) representation that takes the form:

$$Z_t = \alpha + \prod_1 Z_{t-1} + \prod_2 Z_{t-2} + ... + \prod_k Z_{t-k} + \mu_t \quad (4)$$

Where α is the intercept and μt is a column vector of white noise processes with mean zero. The ∏ matrix contains information about the long run relationships between the variables. Equation (4) can be re-parameterized as:

$$\Delta Z_t = \alpha + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + ... + \Gamma_k \Delta Z_{t-k} + \mu_t \quad (5)$$

Where the rank of the parameter Γ_k represents the number of co-integrating vectors and it contains parameters for a p-order lag process. Δ is the difference operator.

The VECM estimate

The ECM was first introduced by Sargan [29] and later extended by Engle and Granger [25]. The ECM is derived from the co-integrated equations by including the lagged error correction term to recapture the long-run information lost via the differencing of the variables. According to Engle and Granger [25] if n variables are found to be co-integrated, then an error correction model can be formulated such that:

$$\Delta Y_t = \propto + \sum_{i=0}^{s} \delta \Delta Y_{t-i} + \lambda\, ecm_{t-1} + \mu_t$$

Where Yt is the vector of n variables that are co-integrated, Δ is the difference operator, s is the lag length of the model, and *ecm* denotes the residual from the co-integration equation and μ is a vector of uncorrelated white noise residuals (innovations). The coefficient of the error correction term λ captures the short run effects of the long run dynamics. The coefficient of the lagged error correction term is a short run adjustment coefficient representing the proportion by which the long-run disequilibrium in the dependent variable is being corrected for in each period.

"The formulation of the VECM has the merit of allowing for short-run dynamics as well as long-run equilibrium of the model. Moreover, the inclusion of error correction term adds another route through which causality can be identified. The direction of causality can be detected in this model through one or more of the following three channels: (1) the coefficient of the error correction term; (2) the coefficients of the lagged independent variables; and (3) the coefficients of the error correction term and the lagged independent variables [9]".

Estimation Results

Unit root test

To avoid the potential problem of estimating spurious relationships, the time series properties of the variables under investigation were tested for the presence of unit root. The Augmented Dickey Fuller (ADF) and Phillips-Peron (PP) tests were applied to all the variables in the series and the results are presented in Table 1 below.

All the series used in the model appear to contain a unit root in their levels. Both tests, however, indicate that all variables are integrated of order one, and thus, they are difference stationary.

Table 2 below reports the results of the Johansen's co-integration test using both the trace test and the maximum eigenvalue test (λ max). This test is first applied to a bivariate system that includes the ratio of total government spending to GDP (RGY) and real GDP (RY), and then it is applied to a trivariate system where the total government spending is disaggregated to civilian expenditure ratio (RCY) and military spending ratio (RDY).

The co-integration results from Table 2 above indicate that there is at least one co-integrating relationship in the bivariate system and two co-integrating relationships in the trivariate system. The co-integrated equations (6) and (7) are derived directly from the Johansen's test results that are based on the VECM estimates and are presented as follows:

ADF Test Statistic			*Phillips-Peron Test Statistic*		
Variable	Levels	Differences	Variable	Levels	Differences
RY	1.124	-4.870	RY	0.771	-4.990
RDY	0.507	-4.927	RDY	0.507	-4.952
RCY	2.138	-4.382	RCY	1.760	-4.411
RGY	0.188	-4.788	RGY	-0.216	-4.853

Table 1: Tests for integration.

Variable	H_0	H_A	λ_{max} STATISTIC	95% CV	Trace statistics	95% CV
RY, RGY	r=0	r=1	12.63	14.26	21.69	15.49
	r ≤ 1	r=2	9.07	3.84	9.07	3.85
RY, RDY, RCY	r=0	r=1	32.45	21.13	57.91	29.8
	r ≤ 1	r=2	21.66	14.26	25.45	15.49

The VAR structure is based on the AIC and SBC values, which sets the value of lag length to 1; r = number of co-integrating vectors (indicating long-run relationships); λmax is the maximum eigenvalue statistic.

Table 2: Johansen's co-integration tests and results.

Error Correction	Δlog (RY)	Δlog (RDY)	Δlog (RCY)
ECT_{-1}	0.2362 [2.1060]	-0.5066 [-2.9504]	0.466 [4.2157]
$\Delta log(RY_{t-1})$	-0.6605 [-2.8093]	-0.4111 [-1.8480]	0.326 [2.2769]
$\Delta log(RDY_{t-1})$	-0.7785 [-2.1232]	0.0384 [0.2283]	-0.3764 [- 2.3667]
$\Delta log(RCY_{t-1})$	1.1346 [2.77=30]	-1.4807 [-3.0025]	0.4762 1.5500]
R^2	0.64	0.62	0.7
F- statistic	13.65	11.23	15.67
Log likelihood	25.55	19.26	20.87
Akaike AIC	-1.06	-0.44	-0.78
Diagnostic Tests for the VECM Residual			P-Value
Jarque-Bera Test for Normality			0.465
Serial Correlation LM Test			0.693
White Heteroskedasticity Test			0.389

ECT represents the error-correction terms; the values in brackets are absolute values of t-statistics, indicating statistical significance at the 5% level; Δ is the differencing operator; The VAR structure is based on the AIC value which sets the value of lag length to 1.

Table 3: Granger causality test (VEC Estimates).

Period (Years)	ΔRDY	ΔRCY	ΔRY
1	29.89	2.82	67.3
2	23.65	14.38	61.97
3	21	20.29	58.71
4	20.54	21.24	58.22
5	20.06	23.26	56.68
10	19.81	23.07	57.13

The results are based on an unrestricted three-variable VAR system of RY, RDY, and RCY; all variables are first differenced; Cholesky Ordering: ΔRDY, ΔRCY, ΔRY.

Table 4: Variance Decomposition of ΔRY.

Period (Years)	ΔRY	ΔRCY	ΔRDY
1	0.00	0.00	100.00
2	0.01	9.11	90.88
3	5.38	25.56	69.06
4	6.79	25.10	68.11
5	6.68	28.70	64.63
10	6.94	29.06	64.00

The results are based on an unrestricted three-variable VAR system of RY, RDY, and RCY; all variables are first differenced; Cholesky Ordering: ΔRDY, ΔRCY, ΔRY.

Table 5: Variance Decomposition of ΔRDY.

$$Log\ (RY) = -\ 0.032 - 1.745\ log\ (RGY) \quad (6)$$
$$[-2.54]$$

$$Log\ (RY) = -\ 0.065 - 0.95\ log\ (RDY) + 2.98\ log\ (RCY) \quad (7)$$
$$[-6.92] \qquad [3.25]$$

The bivariate co-integration results in equation (6) show that the ratio of real total government expenditure has a negative long-run relationship with economic growth in Algeria. The negative outcome is consistent with earlier empirical studies where government expenditures were found to affect economic growth adversely in many developing countries. The trivariate results represented by equation (7) show that civilian government expenditure affects economic growth positively in the long run and that military spending happens to have a negative impact on economic growth in the long-run. All the independent variables are statistically significant at the 5% level. The numbers in brackets in the above equations are the t-statistics for the relevant coefficients.

Now that co-integration has been determined between economic growth and military spending and government civilian expenditure, we now apply the vector error correction model (VECM) to investigate the direction of causality between the above variables.

The summary results of VECM are presented in Table 3 above. The error correction terms for output, military spending and civilian government spending are all statistically significant at the 5% level. The VECM results demonstrate that output, defense spending and civilian government expenditure adjust to sustain their long-run equilibrium at a speed of 24%, 51% and 47% respectively.

These results also reveal that there is a negative and uni-directional causal relationship between economic growth and defense spending. The direction is from defense spending to economic growth. There is also a bi- directional and positive causal relationship between economic growth and civilian government spending; and also a bi- directional and negative causal relationship between defense spending and civilian government expenditure. "This supports Lebovic and Ishaq [34] findings that military burdens in MENA countries were major causes of slow economic growth. Also, that nonmilitary government spending is not necessarily bad for growth [35]".

Results of variance decompositions and impulse-response functions

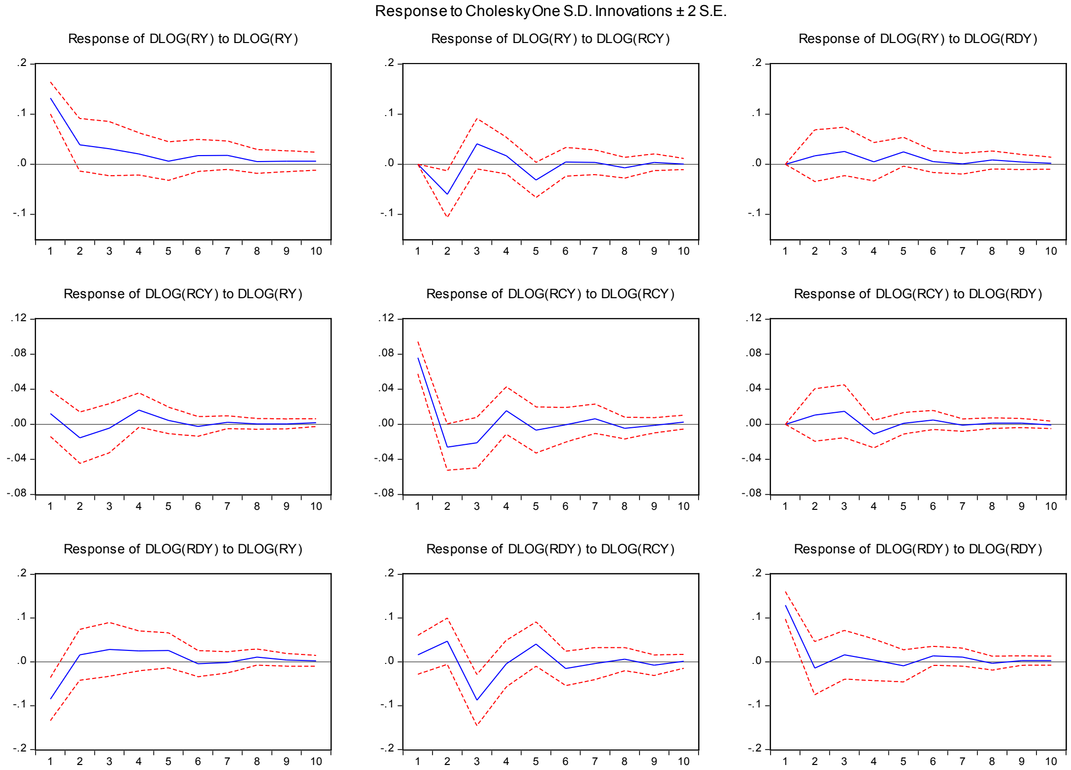
In order to further check the robustness of our results, we used the variance decomposition technique to enable us to further test the relationship between the variables used in our model. This has the merit of assessing the dynamic effect of one variable on the other beyond the sample period. To this end, we proceeded to determine the proportion of forecast error variance for each variable that is due to its own innovations plus those from other variables that are included in the model.

Considering the VEC model in Equation (8), a change in any of the random innovations μ_{it} , i = RY, RDY, RCY will immediately change the value of the dependent variable and also the future values of the other two variables through the dynamic structure of the system. An innovation in each of the three variables produces changes in the future growth of real GDP. Thus it is possible to break down the forecast-error variance of economic growth in each future period and to determine the percentage of variance that each variable explains.

Table 4 below shows the proportion of the forecast error of each variable in the model. Results for six time-period horizons are presented to ensure that the dynamic nature of the system is captured.

Table 4 reveals that economic growth is not completely explained by its own innovation. A large proportion of its variance is explained by military spending and government civilian expenditure, especially in the long run. In the first year both government civilian expenditure and military spending account for 32.71 per cent of the forecast-error variance of economic growth. This is in contrast with 43 per cent in year 10. Military spending is responsible for explaining 30 percent of the variation in economic growth in the first year and 20 percent of the variation over the long run.

Table 5 above summarizes the variance decomposition of military spending. It shows that initially military expenditures are exogenous and independent of economic growth and civilian expenditures in the first two years. However, in the medium and long run both civilian expenditures and economic growth are responsible for explaining at least 30 percent of the variation. What is interesting is that civilian expenditures are more important than economic growth in explaining military spending in Algeria. This is because some of the government civilian expenditures are directly linked to military expenditures.



The solid line (blue) show the estimated effect of a one standard deviation shock in a designated endogenous variable on the other variables in the model. The vertical axis is the estimated effect and the horizontal axis show the number of years. The dotted lines (red) represent the 95 percent confidence intervals based on 2000 replications of the Hall bootstrap.

Figure 1: Impulse response functions.

To understand the dynamic relationship between the different endogenous variables in the model, we used impulse response functions to demonstrate how various endogenous variables respond to a one standard-deviation permanent shock in a given variable. We also use the 95 per cent confidence interval that is based on the 2000 replication of the Hall bootstrap method.

The top panel of Figure 1 shows how a one standard permanent deviation in RY, RDY and RCY affects real GDP. It is interesting to note that defense spending (RDY) has a negative effect on real GDP in both the medium run and the long run. Civilian spending (RCY) on the other hand has a positive effect in the short run and medium run on real GDP.

The middle panel demonstrates the effect of one standard deviation in (RCY) on (RY), (RDY), and (RCY).

The bottom panel shows the effect of a one standard permanent deviation in (RY), (RDY) and (RCY) on defense spending. It shows that real GDP has a positive impact on defense spending in the short run but it turns negative in the medium run and long run.

Concluding Remarks

The purpose of this paper is to investigate the causal relationship between military expenditures and economic growth in Algeria where the government plays a major role in the allocation of the country's resources. The empirical analysis covered the period 1980-2010. We used both a bivariate and trivariate framework of causality analysis. The former used aggregate government spending and economic growth and the latter used economic growth and disaggregated government spending into military and civilian spending.

Our empirical estimates clearly indicate the presence of co-integration in both the bivariate and the trivariate framework of analysis. In the bivariate analysis we found that the long-run relationship between economic growth and aggregate government spending is negative which is consistent with other similar studies that covered countries such as Egypt, Israel and Syria. However, when we disaggregated government spending into military and civilian expenditures we found that economic growth in the long run is positively related to civilian spending and negatively related to military spending. This indicates that the negative effect of military spending on economic growth tends to overwhelm the positive effect of civilian spending on economic growth.

To determine the direction of causality in the above two frameworks we used the vector error correction model and we found that the causality relationship between economic growth and aggregate government spending is uni-directional; from government spending to economic growth. Also, our results show the existence of unidirectional causality between economic growth and military spending (from military spending to economic growth.) However, the causality relationship between economic growth and civilian spending is bi-directional.

To further support our findings beyond the sample period we decomposed the forecast-error variance of each of the three variables and the results obtained confirm our Granger causality findings within the sample period.

The implication of our analysis seem to indicate that Algeria could benefit immensely by reducing its military burden and channeling the freed resources towards developing its social infrastructure particularly health and education. Moreover, expanding the capital stock through increased investment in the productive sectors of the economy may lead to the fostering of economic growth and development in Algeria.

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