Does Defence Expenditure Affect Education and Health expenditures in Saharan Africa?

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Abstract

This study examines the effects of defence expenditure on education and health expenditures, using data from Saharan African countries over the period 2000-2019. It employs the second-generation panel data tools to diagnose cross-sectional dependence and adopt appropriate tests. It then uses a panel vector autoregressive model estimated by the least squares dummy variable method. The study finds two mixed effects of defence expenditure. First, it finds that defense expenditure affects negatively education expenditure in the short run only. Second, it finds evidence of positive effect of defense expenditure on health expenditure in the short, only. Furthermore, this study finds that defence expenditure has no effect on education and health expenditures in the long run. Finally, this study proposes some policy recommendations to the governments of Saharan African countries.

Keywords: Defence expenditure; Education expenditure; Health expenditure; Panel-VAR; Saharan-Africa.

JEL Classification Codes : C23 ; H51 ; H52 ; H56 ; O55.

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1.Introduction

There is renewed interest in analysis of the relationship between defence expenditure and those of education and health in Saharan Africa. One of the most important reasons of this interest is that Saharan African countries experienced, during the last decades, instability related to the terrorism and rebellion. The latter threats the national integrity and public authorities. Consequently, almost all Saharan African countries are forced to undertake large investments in defence in order to ensure their stabilities. According to Stockholm International Peace Research Institute (SIPRI) data, between 2000 and 2020, defence expenditure as a share of gross domestic product (GDP) in Saharan African countries increased from 1.55 to 3.20% respectively. At the same time, these countries also need to simultaneously increase their education and health expenditures in order to achieve sustainable development goals (see figures A2 and A3). Like other developing countries, Saharan African countries budgets is limited and, therefore, government of these countries must be rational when undertaking defence, education and health expenditures. A cursory glimpse at figure A2 shows the evolution of defence, education and health expenditures in the Saharan African countries' budgets.

Theorically, "Guns" versus "Butter" is recognized as one of the most important budgetary trade-offs that countries face (Russet,1969; Caputo,1975; Peroff and Podolak-Warren,1979; Apostolakis,1992). "Guns" are related to defence expenditures, which are regarded as unproductive expenditures. On the other hand, "Butter" is related to education and health expenditures which are considered to be productive expenditures because they satisfy a direct economic need (Fontanel and Smith,1985; Aschauer, 1989). Given the scarceness of resources, Saharan Africa are unable to undertake sufficiently defence, education and health expenditures. This means that Saharan Africa must make a trade-off between these two kinds of public expenditure. The size of this trade-off depends on countries social stability context.

Since studies by Benoit (1978) and Fontanel et Smith (1985), it is known that defence expenditure produces macroeconomic effects. In the short run, the defense expenditure effects on education and health are analyzed by the Keynes (1936) who advocates intervention in the economy in order to boost economic activity in period of recession. Moreover, in the long run, the defence expenditure effects on education and health expenditures is analyzed in the crowding-out theory framework (see Barro,1974; Aschauer,1989). For instance, when countries get into debt to finance their defence expenditure, they rise interest rate which, in turn, reduce productive public investment.

Several empirical studies have examined the defense expenditures effects on education and health expenditures. Results obtained by these studies remain inconclusive. For instance, Apostolakis (1992), Yildirim and Sezgin (2002), Ozsoy (2002), Zhao *et al*, (2017) and Fan *et al*. (2018) find that defense expenditure affects negatively education and health expenditures. Other authors such as Harris *et al*, (1988), Kollias and Paleologou (2011), Lin *et al*, (2015), Zhang *et al*. (2017) find that defense expenditure affects positively education and health expenditures. However, Xu *et al*, (2018), Coutts *et al*, (2019) and Biscione *et al*, (2021) find that defence expenditure has no effect on education and health expenditures.

This study aims to examine the effects of defense expenditures on education and health expenditures in Saharan African countries. This paper makes several contributions to existing

literature. The first contribution is related to the investigation area--there is no study on the Saharan African countries that has attempted to analyze the effects of defence expenditure on education and health expenditures. The second contribution is related to methodological aspects. This study uses a panel vector autoregressive (PVAR) model instead of the static one, commonly used in previous studies. PVAR model has two advantages. Firstly, it exploits the classical VAR advantages which treat all variables as endogenous in the dynamic framework. Secondly, it exploits the panel data advantages that allows controlling for individual heterogeneity and making more information available through combination of time-series and cross-section dimensions (Love and Zicchino, 2006; Canova and Ciccarelli,2013; Abrigo and Love 2016). Also, this study adopts the least squares dummy variable (LSDV) method as estimation technique instead of ordinary least squares one. The LSDV estimator is suitable when the panel data set has moderate time-series and small cross-section dimension (Kiviet,1995; Judson and Owen ,1999; Bun and Kiviet, 2006). Finally, unlike previous studies, this study takes into account cross-sectional dependence issues between countries when choosing unit root, cointegration and Granger non-causality tests (see Hurlin and Mignon,2007; Juodis *et al*.,2021).

The remainder of the study is organized as follows. Section 2 reviews the theorical and empirical studies. Section 3 presents empirical model and estimation strategy. Sections 4 describes data and variables. Section 5 presents and discusses empirical results. Section 6 concludes.

2.Literature Review

Public expenditures are to a large extent directed toward defence, education and health (Devarajan *et al.*,1996; Nubukpo,2007). However, given that budgets are limited, making trade-off between these three components of public expenditure remain key. The nature of this trade-off depends on the opportunity cost that countries face. Thus, countries prefer to carry out defence expenditures when the opportunity cost in term of education and health expenditures is small. According to Peroff and Podolak-Warren (1979), the consequences of this trade-off are lower in the case of budgetary expansion than in budgetary contraction one. Theoretically, the Guns versus Butter model is widely used to illustrate the trade-off that countries face (See Samuelson, 1954; Peroff and Podolak-Warren, 1979). In this model Guns are related to defence expenditure and Butter to social expenditures such as education and health expenditures.

Studies by Benoît (1978) and Fontanel *et al* (1985) point out that defence expenditures produce micro- and macroeconomic effects on countries. The macroeconomic effect of defence expenditure is analysed via keynesian and crowding-out theory. According to Keynes (1936), public authorities must intervene in economy to boost (or to slack) economic activity in recession (or expansion) period. Since defence expenditure is a component of public expenditure, countries can use it as fiscal policy instrument, if its part in aggregate demand is not neglected. In this case, we expect that countries attempt to increase their defence expenditure to the detriment of education and health expenditures. Also, the crowding-out theory shows that defence expenditure affects education and health expenditures via interest rate. For instance, when countries go into debt to finance their defence expenditure, interest rate increases in financial markets (see Barro,1974). In fact, the prevailing high interest rate can inhibit the further government debt.

Several empirical studies have examined the effects of defence expenditures on education and health expenditures. Results obtained by these studies are not conclusive largely because different methodological approaches, data, and samples of countries. A fringe part of these studies finds

that defence expenditure negatively influences education and health expenditures (Verner, 1983; Apostolakis, 1992; Ozsoy, 2002; Yildirim and Sezgin, 2002; Zhao *et al.*, 2017; Zhang *et al.*, 2017; Fan *et al.*, 2018). For example, Apostolakis (1992) examines the effects of defence expenditure on education and health expenditures in Latin American countries over the period 1953-1987 and finds that defence expenditure negatively affects education and health expenditures. Ozsoy (2002), examines the linkage between defence expenditure and education and health expenditures in Turkey from 1925 to 1998 period and finds a negative relationship between those variables. Yildirim and Sezgin (2002) find a negative link between defence expenditure and health expenditures in Turkey over the period 1924-1996., Zhang *et al.* (2017 use a VAR model and find that defence expenditure has a negative effect on education and health expenditures in BRICS countries, only. Fan *et al.* (2018) examine the relationship between defence and health expenditures in 197 countries over the period 2000-2013. Using a simultaneous equation model, they show that defence expenditure exerts a crowding-out effect on health expenditures for all countries, in particular this effect is greater in low-income countries than in high-income ones.

However, some empirical studies find a positive association between defence and education and health expenditures (Harris *et al.*, 1988; Yildirim and Sezgin, 2002; Kollias and Paleologou, 2011; Lin *et al*. 2015; Zhang *et al.*, 2017). Harris *et al.* (1988) analyse the link between defence expenditure, and education and health expenditures in twelve Asian countries. Using time-series model with data covering the period 1972-1982, they find that defence expenditure has a crowding-in effect on education and health expenditures for six and for three countries, respectively. Yildirim and Sezgin (2002) explore the connection between the defence expenditure and education and health expenditures in Turkey over the period 1924-1996, using a simultaneous equation model and find a positive link between defence and education expenditures. Lin *et al.* (2015) examine the relationship between defence expenditure and welfare expenditures in 29 developed countries over the period 1988-2005. Using a simultaneous equation model, they show that defence expenditure has a positive effect on education and health expenditures. Zhang *et al*. (2017) examine the effects of defence expenditures on social expenditures in the G7 and BRICS countries over the sub-periods 1998-2011 and 1993-2007, using a VAR model and show that defence expenditure has a positive effect on education and health expenditures in G7 countries, only.

Contrary to previous studies, other empirical studies find that defence expenditure does not affect education and health expenditures (Davies and Chan, 1990; Xu *et al.*, 2018; Coutts *et al.*,2019; Biscione and Caruso, 2021). For instance, Davies and Chan (1990) study the relationship between security expenditures and welfare expenditures in Taiwan over the period 1961-1985. Using a simultaneous equation model, they show that security expenditures do not influence the education expenditures. Xu *et al.* (2018) investigate the effects of defence expenditure on education expenditure in China from 1972 to 2014. Using a VAR model, they find that defence expenditures have no effect on education expenditures. Coutts *et al*. (2019), examine the effects of increasing in military expenditures on health expenditures in MENA countries over the period 1995-2011. Using a multivariate panel model, they show that increasing in military expenditures do not decrease health expenditures in these countries. Finally, Biscione and Caruso (2021) find that military expenditure does not influence the education and health expenditures in transition economies over the 1990-2015 period, by using a panel data model.

In view of the above reviewed literature, it is obvious that empirical findings on the relationship between defence expenditures versus health and education expenditures remain mixed. This study contributes in literature by assessing the education and health expenditures effects of defence expenditure in saharan Africa.

3. Empirical model and estimation strategy

To specify our empirical panel vector autoregressive (PVAR), we follow Love and Zicchino (2006), and Zhang *et al*. (2017). Controlling for other factors, we write this specified empirical model of order p in compact set as follows:

$$Y_{it} = \mu_i + \phi_{1i}.Y_{it-1} + \phi_{2i}.Y_{it-2} + ... + \phi_{pi}Y_{it-p} + v_{it} \quad (1)$$

Where *i* and *t* are countries and time period respectively; Y_{it} is (6×1) vector of variables including defense expenditure $(defexp_{it})$,education expenditure$(eduexp_{it})$,health expenditure$(hexp_{it})$, public debt $(pdebt_{it})$, population (pop_{it}),and economic growth $(ecgro_{it})$; $Y_{it-1}, Y_{it-2}, ..., Y_{it-p}$ are (6×1) vector of lagged variables; μ_i is a vector of country specific effects; $\phi_{1i}, \phi_{2i,.....,}\phi_{pi}$ are vectors of parameters to be estimated ; v_{it} is (6×1) vector of error terms that assumed to be independent and identically distributed.

The multivariate dynamic panel model (e.g. PVAR) with unobserved individual fixed effect provides biased and inconsistent estimators when it is directly estimated by ordinary least squares method (Nickell, 1981; Bundell and Bond, 1998; Bun and Kiviet, 2006). This would have repercussions on the impulse response function (IRF) and forecast error variance decomposition (FEVD)computations. Indeed, the inclusion of vector of endogenous lagged variables as regressors must lead to correlation between the latter and vector of error terms, and likely the vector of individual fixed effect. The existent literature proposes two estimation methods to overcome this problem: the GMM estimator (Holtz-Eakin *et al*., 1988; Love and Zicchino, 2006; Abrigo and Love, 2016) and the LSDV estimator (Kiviet,1995; Bun and Kiviet, 2006; Cagala and Glogowski,2015). The GMM estimator is only applicable in the micro-panel context where the individual dimension is large and the time dimension short (Anderson and Hsiao, 1982; Arellano and Bond, 1991; Bundell and Bond, 1998). Since our panel data set that we use in this study has a moderate time dimension (T = 20) and a small individual dimension (N = 5), the LSDV estimator is appropriate methodology. Indeed, the LSDV-PVAR method is consistent than the GMM-PVAR method in macro-panel (Kiviet,1995; Judson and Owen ,1999; Hansen,2001; Behr,2003; Bun and Kiviet, 2006; Buddelmeyer *et al*.,2008)[‡].

We apply LSDV-PVAR method to estimate our empirical model (1) above by following some econometric procedures. First, we implement Pesaran (2021) cross sectional dependence (CD) tests in order to discriminate between the first-generation panel unit root tests and those of the second generation. Indeed, the latter takes into account cross-sectional dependence while the former do not (Hurlin and Mignon, 2005). In the presence of cross-sectional dependence, it is

[‡] See Cagala and Glogowski (2015) for LSDV-PVAR empirical application.

appropriate to implement the unit root test by Pesaran (2007). Otherwise, the Levin *et al*. (2002), and Im *et al*. (2003) unit root tests are suitable by diagnosing, respectively, the presence of common and individual unit roots in data. Secondly, we employ the cointegration test. Econometric literature proposes many cointegration tests such as those of Pedroni (2004), Westerlund (2007), and Maddala and Wu (1999). These tests perform differently well depending on variables order of integration and existence of cross-sectional dependence. The Pedroni (2004) test is suitable to implement, when our variables have the same integration order and do not exhibit cross-sectional dependence. However, cointegration test by Westerlund (2007) test performs well than Pedroni (2004), when variables exhibit cross-sectional dependence and are cointegrated at order one (Westerlund, 2007; Persyn and Westerlund,2008). The violation of these two conditions in variables, must direct us to consider the Johansen-Fisher type panel cointegration test developed by Maddala and Wu (1999). This test is a combination of the non-parametric Fisher (1932) test and Johansen (1991) classical cointegration test. If cointegration test confirms the long run relationship between variables, we estimate the PVECM instead of the unrestricted PVAR model, and vice versa. We use Schwarz (1978) and Akaike (1979) information criteria to derive the optimal lag order (**P**) of model to be estimated. Moreover, we perform the Juodis *et al*. (2021) Granger non-causality tests in order to rank variables from the most exogenous to the most endogenous as recommended by Sims (1980). Indeed, the Juodis *et al*. (2021) Granger non causality test outperforms Holtz-Eakin *et al*. (1988) and Dumitrescu and Hurlin (2012) Granger non causality tests, by allowing for homogenous and heterogenous slopes and by accounting for Nickell bias, even if time dimension is moderate (Xiao *et al*.,2021; Juodis *et al*.,2021). Finally, we check robustness of our results by performing the global stability, serial correlation and heteroskedasticity tests.

4.Data and variable definitions

This study uses annual data from Saharan African countries, covering the period 2000-2019.The choice of the period and countries is dictated by the availability of data. However, there are some missing data, and therefore we use linear interpolation method to generate the missing data. This method is accepted in econometric literature (Imtiaz and Shah, 2008; Gygli *and al*.,2019). The Table 1 below displays data sources and variables definition. Table 2 below provides the descriptive statistics of variables.

Table 1. variables definition and data sources

Variables	Definitions	Sources
defexp	Defense expenditure	Stockholm International Peace Research Institute
hexp	Health expenditure	World Development Indicators (WDI)
eduexp	Education expenditure	WDI; UNESCO Institute for Statistics, Morocco's Ministry of finance
pdebt	Public debt	Global Debt database
pop	Population	WDI
ecgro	Economic Growth	WDI

Source: Author

Interest variables: defense, education and health expenditures

Defense expenditure (***defexp***) is proxied by the military expenditures to gross domestic product (GDP) ratio. According to Stockholm International Peace Research Institute (SIPRI) military

expenditure is government spending relating to personnel in the defense sector (such as salaries, pensions, social services, etc.), the acquisition of military equipments and their maintenance operations (such as weapons, tanks, planes, software, etc.), military infrastructures (such as military bases, military hospitals, etc.), foreign military operations, military research and development as well as donations of military equipments received. We follow Zhang *et al*. (2017), Coutts *et al.* (2019) and Biscione et Caruso (2021) to use this measure that presents the burden of defense expenditures in national income.

Education expenditure (***eduexp***) and health expenditure(***hexp***) are respectively proxied by their respective share in GDP. These measures have been employed by Lin *et al* (2015), Zhang *et al*. (2017), and Fan *et al*. (2018). Like these authors, we consider the burden of defense, education and health expenditures in national income, to investigate the trade-off relationship between these public expenditure components, controlling others factors.

Table 2. Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
defexp	100	2.27	1.261	.832	7.956
eduexp	100	4.26	1.901	1.471	9.509
hexp	100	1.877	.955	.414	4.221
debt	100	44.974	17.729	14.135	90.522
pop	100	2.498	1.176	.747	3.907
ecgro	100	2.147	4.309	-9.157	28.676

Source: Author

Control variables

We use public debt, population and economic growth as control variables. We follow Dunne *et al*. (2004), and Khan *et al*. (2021) to measure public debt(***pdebt***) by the central government debt to GDP ratio. According to these authors, the level of countries public debt influences their public expenditure. Indeed, countries with high level of public debt will tend to worry more about its sustainability by reducing their defence expenditures, especially in peace period. When countries reduce their defence expenditure, they generate further resource devoting to education and health sectors. Population (***pop***) is proxied by the population growth rate. We use it in our model, following Deger and Sen (1995) and Yildrim and Sezgin (2002). These authors postulate that the level of defence expenditure is influenced by population growth. Indeed, the population growth is associated with security challenges due to increasing acts of crime, theft and vandalism. In this case, we expect that countries increase defense expenditure to secure their population at the expense of education and health expenditures. Economic Growth(***ecgro***) is measured by the real GDP per capita growth rate. It is also interpreted as a proxy for the level of economic development. We follow Ozsoy (2002) and Biscione and Caruso (2021) in using this variable in our model. Like these authors, we postulate that the level of economic development influences countries defence, education and health expenditures. Indeed, we expect that countries with high level of economic development are able to mobilize direct and indirect tax revenues and contract easily debt from financial markets to finance its public expenditure than countries with low economic development.

5.Results and discussions

First, we present and discuss pre-and post-tests. Table A.1 reports the Pesaran (2021) cross-sectional dependence test results. The latter fails to reject the hypothesis of presence of cross-sectional dependence in defexp, hexp, eduexp, ecgro and pdebt variables at conventional significance levels of 1%, 5% and 10%. However, test outcomes suggest to reject the presence of cross-sectional dependence in pop variable at 10% significance level. Based on CD-test results, we perform the Pesaran (2007) unit root test on all variables, except pop variable for which we perform the Lin *et al*. (2002) and Im *et al*. (2003) unit root tests. Tests results are reported in Table A.2 (see Appendix). Results reveal that variables defexp, hexp, eduexp and pdebt are stationary at first difference at 1% significance level, but ecgro and pop variables are stationary in level at 1% significance level. Based on CD and unit root test results we implement Maddala and Wu (1999) cointegration test. The latter outcomes reported in Table A3 (see Appendix) fail to reject the null of no cointegration between variables because all p-value associated with trace and max-eigen tests are greater than 5%. These results recommend to estimate unrestricted PVAR in lieu of PVECM. Moreover, Schwarz (1978) results reported in Table A5 (see Appendix) indicate to retain one (1) lag as optimal, by applying the parsimony principle. Regarding Juodis *et al*. (2021) Granger causality test outcomes reported in Table A4 (see Appendix), it indicates to rank variables in model as follows: defexp-hexp-eduexp-ecgro-pop-pdebt.

Finally, we implement robustness tests to check the validity of our results. These tests show that errors are homoscedastic at 1% significance level (see Table A6) and are not autocorrelated after 2 lags at 5% significance level (see TableA7). The model is globally stable because all of its roots are inside the unit circle (see Figure A1).

5.1. Defence expenditure effects on education expenditure

Figure 1 displays the effects of defence expenditure on education expenditure. It shows that a positive defence expenditure shock does not affect immediately education expenditure and its effect is null at the end of first period. However, at the second period, the effect of defence expenditure on education expenditure is negative while it becomes slightly positive at the third period. For the remainder periods defence expenditure has no effect on education expenditure. These results are corroborated by those of FEVD presented in Table 3. The FEDV indicates that the education expenditure error variance is due at 5% to defence expenditure innovations. In other words, increasing in defence expenditure is associated with decreasing in education expenditure during the two first period following by a slightly increasing at the third period, only. Our results support the view that defence expenditure has a negative effect on education expenditure in the short run. Also, our results are in line with those of Zhao *et al*. (2017), and Fan *et al*. (2018) who find a negative effect of defence expenditure on education expenditure in BRICS countries and other world countries respectively. We explain our results by the fact that in presence of security challenges, countries make trade-off between defence expenditure and education expenditure, with predilection for the former. One would explain this result by arguing that the non-attendance of education (in some regions) due to insecurity generates further resources which are automatically allowed to defence sector to establish peace.

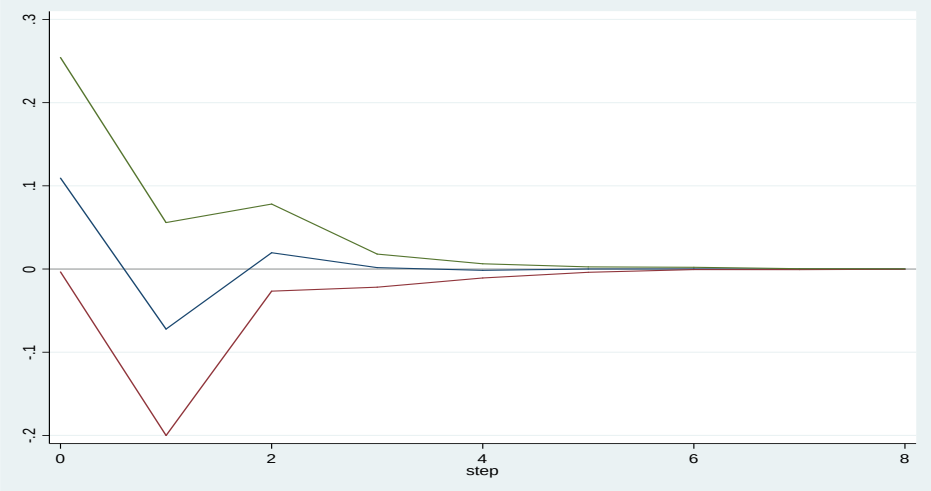

Figure1.Response of education expenditure to defence expenditure shock
Source: Author

Table 3. Forecast error variance decomposition of education expenditure

Period	S.E.	D(DEF)	D(EDU)	D(HEA)	ECGRO	POP	D(DEBT)
1	0.557662	3.650805	96.34920	0.000000	0.000000	0.000000	0.000000
2	0.588300	4.737675	89.44342	5.308425	0.017375	0.006318	0.486791
3	0.589450	4.801291	89.29890	5.345375	0.060482	0.007122	0.486829
4	0.589663	4.800018	89.25826	5.382864	0.063493	0.007757	0.487604
5	0.589672	4.800717	89.25674	5.383159	0.063562	0.008179	0.487647
6	0.589674	4.800687	89.25625	5.383209	0.063562	0.008599	0.487690
7	0.589675	4.800691	89.25575	5.383245	0.063563	0.009016	0.487733
8	0.589677	4.800675	89.25532	5.383251	0.063563	0.009420	0.487768

Source: Author

5.2. Defence expenditure effects on health expenditure

Figure 1 displays the defence expenditure effects on health expenditure. It shows that defence expenditure does not affect, immediately, health expenditure, but its effect is null at the end of first period. Nevertheless, a positive defence expenditure shock has a positive effect on health expenditures during the second and third period. For the remainder periods, the defence expenditure effect is null. In addition, the FEDV results presented in Table 4 support our previous results. They indicate that the health expenditure error variance is due at 1% to defence expenditure innovations. These results mean that increasing in defence expenditure leads to increasing in health expenditure during the two first periods. These results support the view that defence expenditure have a positive effect on health expenditure in short run. Our results are in line with those of Lin *et al*. (2015) and Zhang *et al*. (2017) who find that defence expenditure affects positively health expenditure in OECD and G7 countries respectively. We explain our results by the fact that in presence of security challenges, countries increase their defence expenditure to establish peace meanwhile their health expenditure increases in order to purchase medical care tools using to treat victims.

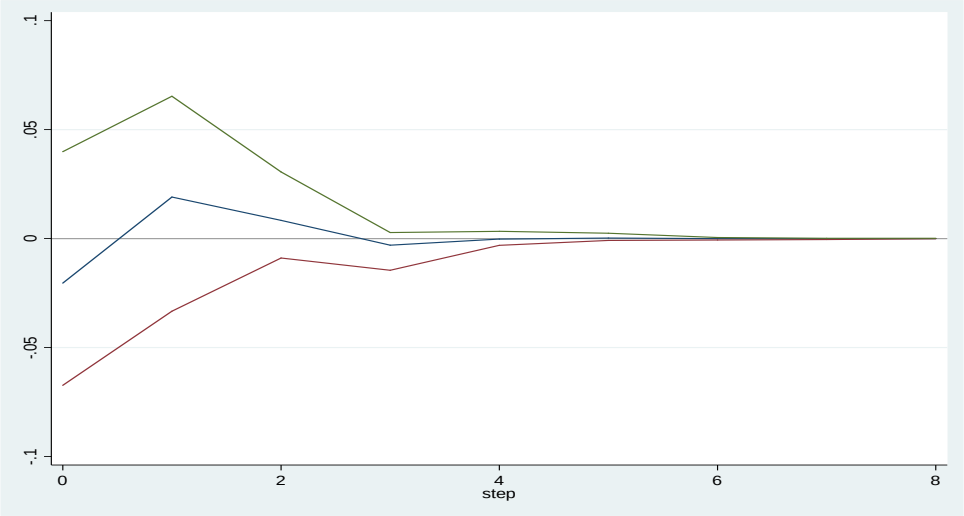

Figure 2. Response of health expenditure to defence expenditure shock
Source: Author

Table 4. Forecast error variance decomposition of health expenditure

Period	S.E.	D(DEF)	D(EDU)	D(HEA)	ECGRO	POP	D(DEBT)
1	0.250581	0.518737	2.463350	97.01791	0.000000	0.000000	0.000000
2	0.261795	1.091445	7.728141	89.08199	2.092629	0.005439	0.000359
3	0.263919	1.125233	7.878334	88.61869	2.312851	0.014256	0.050632
4	0.264018	1.139860	7.917981	88.55178	2.314892	0.019007	0.056481
5	0.264031	1.140045	7.917762	88.54555	2.315486	0.023136	0.058019
6	0.264039	1.140266	7.917284	88.54075	2.315753	0.027093	0.058852
7	0.264046	1.140290	7.917186	88.53667	2.315657	0.030864	0.059329
8	0.264052	1.140298	7.916994	88.53295	2.315557	0.034519	0.059679

Source: Author

6.Conclusion and recommendation

The study examined the effects of defense expenditure on education and health expenditure for 5 Saharan African countries, using annual data covering the period 2000-2019. The defence, education and health expenditures variables are measured as share of GDP. We performed cross-sectional dependence test on all variables in order to choose the appropriate unit root, cointegration and Granger-causality tests. We then specified a panel vector autoregressive model estimated by least squares dummy variable method since it is more suitable when time period is moderate and greater than cross-sectional dimension. We found two mixed effects of defense expenditure. First, we found that defense expenditure affected negatively education expenditure in the short run only. Second, we found that defense expenditure affected positively health expenditure in the short run. Furthermore, we found that defence expenditure had no effect on education and health expenditures in the long run.

We draw lessons from these empirical outcomes to propose some policy recommendations to governments. If governments want to invest more in education sector, they must reduce their defence burden, by adopting pro-peace policies. Also, the reduction in defence expenditure involves decreasing in health expenditure. So, governments will generate further resources to allow to education sector. Meanwhile, governments will contribute to reduce the competitive degree between education and health expenditure. These recommendations will help governments to reduce defence burden and to generate additional resources to devote equitably to education and health sectors decisive for human capital accumulation.

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Appendices

Appendix A: Cross-dependence, unit root, cointegration Granger non-causality and lags choice tests

Table A1. Cross-dependence tests

Variables	CD-stat.	P-value
defexp	1.983	0.058*
eduexp	2.194	0.028**
hexp	-1.885	0.059*
pdebt	9.775	0.000***
pop	-1.322	0.186
ecgro	2.071	0.038**

Notes*:* ****, **, and * denotes significance at 1%, 5% and 10% respectively

TableA2. Unit root tests

Tests	**CIPS**		**IPS**	**LLC**
	Level	**First Dif.**	**Level**	**Level**
Variables	*t-stat*	*t-stat*	*P-Value*	*P-Value*
defexp	-2.52	-4.306***		
eduexp	-2.562	-4.619***		
hexp	-1.523	-3.437***		
pdebt	-2.588	-3.013**		
ecgro	-5.296***			
pop			0.000***	0.000***

Notes: *** and ** denotes significance at 1% and 5% respectively; Critical Value at 1% (CV 1%) = -3.15; CV(5%) = -2.88 ;

Table A3. Maddala and Wu (1999) cointegration tests

Null	***Alternative***	***Trace test(F-stat)***	***P-value***	***Max-eigen test(F-stat)***	***P-value***
r=0	***r=1***	***6.931***	***0.731***	***6.931***	***0.731***
r≤ 1	r=2	58.03	0.000***	58.03	0.000***
r≤ 2	r=3	227.2	0.000***	385.7	0.000***
r≤3	r=4	136.1	0.000***	73.69	0.000***
r≤ 4	r=5	85.35	0.000***	46.87	0.000***
r≤ 5	r=6	41.10	0.000***	41.10	0.000***

Notes: *** and ** denotes significance at 1% and 5% respectively; r denotes number of cointegration rank.

Table A4. Granger non-Causality Test by Judios et al. (2021)

Null Hypothesis	**P-value (HPJ)**
defexp does not Granger pdebt	0.000***
pop does not Granger-cause defexp	0.000***
defexp does not Granger-cause pop	0.000***
ecgro does not Granger-cause defexp	0.000***
defexp does not Granger-cause ecgro	0.000***
pdebt does not Granger-cause eduexp	0.000***
eduexp does not Granger-cause pdebt	0.000***
eduexp does not Granger-cause pop	0.000***
eduexp does not Granger-cause ecgro	0.000***
pdebt does not Granger-cause hexp	0.019**
hexp does not Granger-cause pdebt	0.000***
hexp does not Granger-cause pop	0.001**
hexp does not Granger-cause ecgro	0.000***
pop does not Granger-cause pdebt	0.000***
pdebt does not Granger-cause pop	0.000***
ecgro does not Granger-cause pdebt	0.000***
pdebt does not Granger-cause ecgro	0.000***
ecgro does not Granger-cause pop	0.000***
pop does not Granger-cause ecgro	0.000***
causal ordering**:**	**Defexp-eduexp-hexp-ecgro-pop-pdebt**

Notes: **** and ** denote significance at 1% and 5% respectively

Table A5. Optimal lags tests

Lag	AIC	SC	HQ
0	17.01207	17.21279	17.09127
1	10.28193	**11.68691***	10.83628
2	9.383746	11.99301	10.41327
3	7.987018	11.80056	9.491705*
4	8.129446	13.14726	10.10930
5	8.031600	14.25369	10.48661
6	7.326557*	14.75293	10.25674

Notes: * indicates lag order selected by the criterion

Appendix B: Robustness check tests

Table A6: Autocorrelation Test

Lags	Prob
1	0.0000***
2	0.0957**
3	0.305

Notes: *** and ** denote significance at 1% and 5% level respectively

Table A7. Heteroskedasticity test

Chi-sq	Df.	Prob
345.99	252	0.0001**

Note: ** denote significance at 5% level

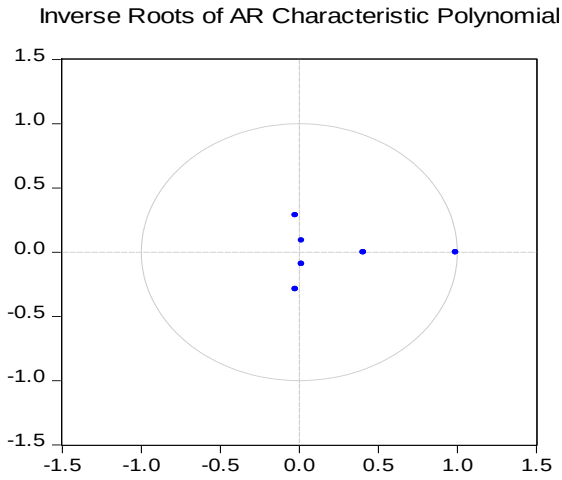

Figure A1. Global stability test

Appendix C: Trends of defence, education and health expenditures and country list

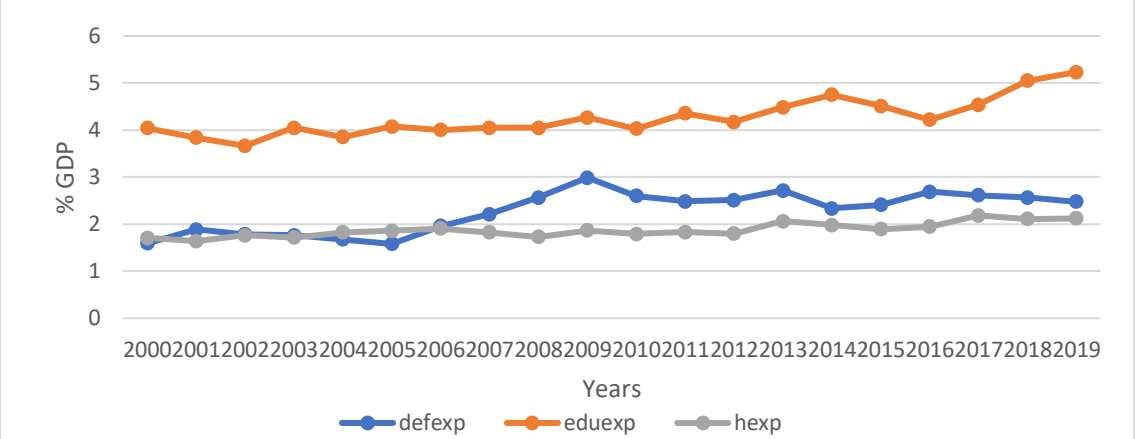

Figure A2. Trends of defence, education and health expenditures as part of GDP
Source: Author, construction based on WDI and UNESCO data

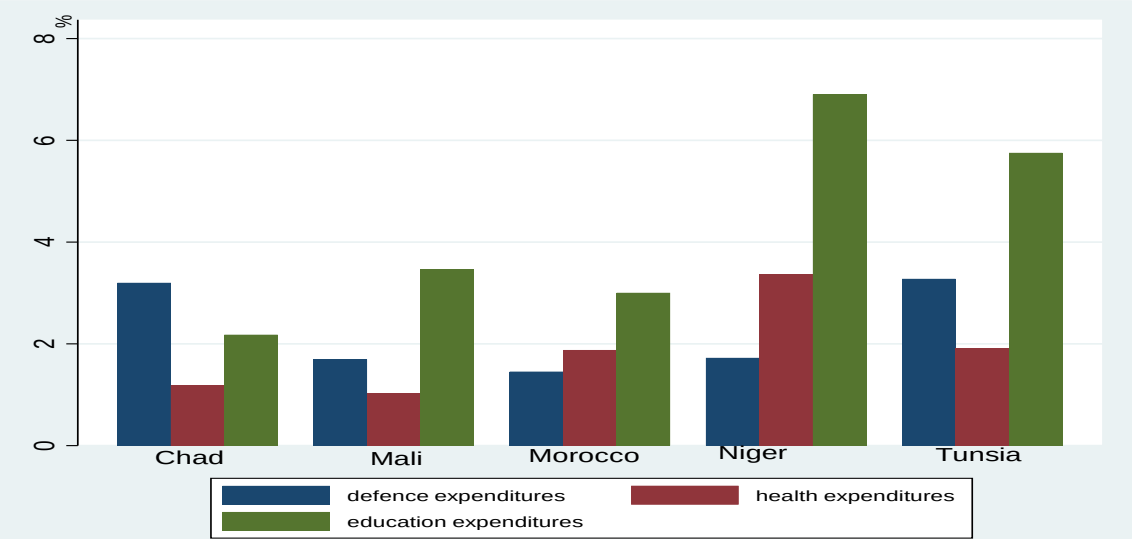

Figure A3. Averages of defence, education and health expenditures as part of GDP between 2000-2019
Source: Author, construction based on WDI and UNESCO data

Table A8. Country list (used as sample)

Country
Chad
Mali
Morocco
Niger
Tunisia