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MILITARY SPENDING AND INEQUALITY IN SOUTH AFRICA: AN ARDL BOUNDS TESTING APPROACH TO COINTEGRATION

Biyase[*], Eita[†], Udimal[‡], Zwane[§]

Abstract

There has been an increasing interest in understanding the relationship between inequality and military spending. However, given the multifaceted nature of the relationship between these variables, studies have yielded inconsistent results. While some studies in this field considers military spending to be unfavorable to inequality, some studies have found evidence to suggest that it reduces inequality. In South Africa there is comparatively no empirical work investigating the issue. Thus, this paper is the first to investigate this relationship in South Africa and helps to shed some light on the empirical puzzle, by using autoregressive distributed (ARDL) and bounds test for cointegration method. The empirical result established a long run relationship between military expenditures and income inequality in South Africa. An increase in the military expenditures result in high rate of inequality. Based on these findings, it is appropriate for the government's expenditure to be directed at the sectors that have direct impact on the large segment of the population. Military expenditure by its nature is very restrictive and the gains do not trickle down to those who are "trapped" in the quagmire of poverty. It is therefore recommended for more expenditures be directed at "pro-poor" sectors that have direct link with the masses. Government expenditures in the "pro-poor" sectors would help in lifting out those who are experiencing "poverty trapped" and requires the assistance for liberation.

KEYWORDS: inequality; military spending; error correction; ARDL bounds testing

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Introduction

There exists a complex relationship between government spending and economic growth. Whereas some government expenditures impact on economic growth directly, other expenditures only influence economic growth through indirect means. Different expenditure by government have different impact on the economic growth and inequality. Government's spending through transfers and subsidies have direct impact on poverty reduction as it raises the disposal income of households. Indirectly, it improves nutrition, health and education status of poor households. Government's spending's in education, health and infrastructure increases productivity and earnings of poor households (Heltberg, Simler, & Tarp, 2004). As a result, these are often referred to as pro- poor spending. There are other government expenditures, which are not pro-poor spending but have influence on the economic growth and by extension inequality. Military spending falls in this category but the exact impact of military spending on inequality is inconclusive.

Military spending comes in two forms, thus either labour-intensive or capital-intensive expenditures (Kentor, Jorgenson, & Kick, 2012). It is argued that a shift from labour-intensive expenditure to capital-intensive expenditure will have impact on the economic performance of emerging economies such as South Africa. From the Keynesian's perspective, military spending is expected to boost demand and employment, which will invariably translate into economic growth (Chester, 1978; Stevenson, 1974). Military spending as part of government consumption is expected to stimulate economic growth through increases in demand for goods and services (Faini, Annez, & Taylor, 1984). Increase in military spending is expected to boost aggregate demand through employment and output increases. In addition, military spending has the potential of improving human capital, stable political and social conditions of a country. Increase in military spending is also expected to boost technological innovations and spin-offs.

However, those who argue from the political economy and dependency theories perspectives are of the view that military expenditures impede economic growth. There is an opportunity cost associated with military spending as it competes with other sectors of the economy for funding and withdraws skilled workers from other sectors of the economy (Mylonidis, 2008; Russett, 1982). Military spending leads to stifling of funds, as they are diverted from other sectors of the economy that have the potential to spur growth. Military spending pushes the government to either increases taxes or obtain capital from the foreign financial market,

which later harms economic prosperity through increases in tax rates, decrease investment and a decrease in consumer demand (Borch & Wallace, 2010). Military spending diverts resources from their most efficient allocations. Crowding out of private investors is one of the negative impacts associated with unguided military spending (Lipow & Antinori, 1995).

Already, South Africa is classified as a country with high unemployment rates, inequality and high poverty rates. Even though statistics have shown that some gains have been made in reducing poverty in South Africa, with the rate of 18.8% in 2015 down from an initial rate of 33.8% in 1996, South Africa is still classified under middle income country and with a high rate of inequality (World Bank, 2018).

The issue of inequality in South African has engaged the attention of stakeholders and has received and continues to receive government's attention in finding a lasting solution to it. Inequality and unemployment are the major challenges confronting South Africa's development (Roberts, 2014). Inequality has become a political issue and featured prominently in the ruling ANC Party's manifesto for the 2009. Inequalities in South Africa are often attributed to the inability of the economy to generate jobs and lack of pro-poor initiatives to alleviate the suffering of the ordinary people (Ndlovu-Gatsheni, 2012; Roberts, 2014). By international standards, South Africa's New Growth Path (NGP) indicated that that inequality, unemployment, and poverty are still high (SA, 2017, SA, 2014). The same revelation was made by the National Development Plan (NDP). The parliament and cabinet of South Africa in 2013 adopted the NDP as a working document to help the country eradicate poverty and inequality by 2030.

Despite the attention given to inequality and unemployment in South Africa, sectoral investment's impact on inequality has not received attention in South Africa. With the current reduction in its military expenditure as shown in figure 1, there is the need to analyse the relationship between military expenditures and inequality. It is against this backdrop that the study is singling out military expenditure to see how the development is impacting on inequality.

Military expenditures include all current and capital expenditures on the armed forces, which includes peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces, thus if they are trained and equipped for military operations; and military space activities (South Africa World Development Indicators, 2020).

In as much as extant literature has dealt with this topic, there is no conclusive evidence concerning the impact of military spending on inequality. There is no single study that has assessed South Africa peculiar situation with regards to the relationship between military expenditure and inequality. Been regarded as one of the most unequal countries in the world, a study of this nature will guide policy makers to direct public sector expenditures to areas that have a potential to stimulate rapid growth and reduce inequality gap.

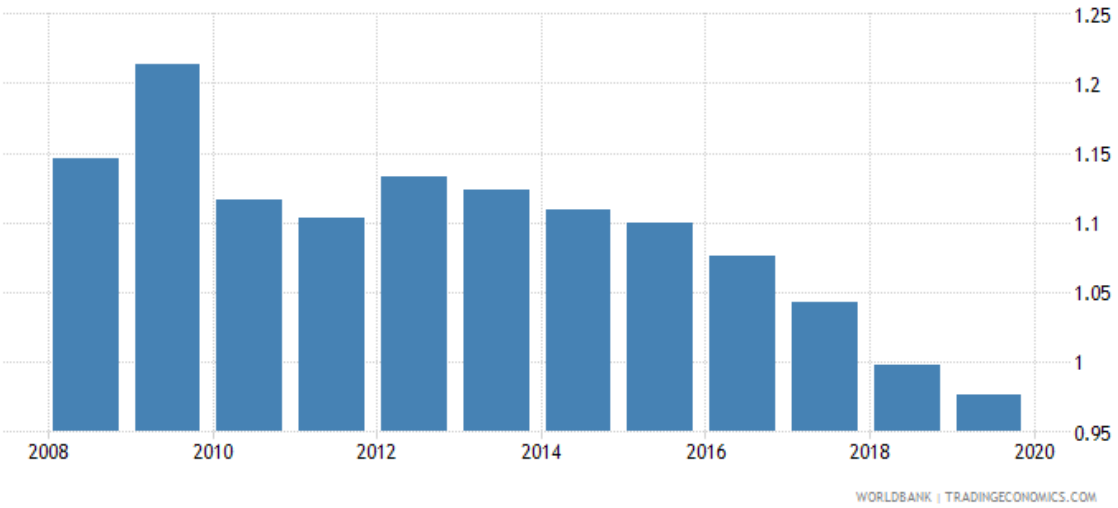


Figure 1 Military expenditure: source: South Africa world development indicators.

2. Brief literature review

Despite a worldwide concerns over the increasing levels in income inequality in both developed and developing nations (see for example, Dunne & Vougas, 1999; Jaumotte et al., 2008; Ali, 2011; Milanovic, 2011; Ekong & Effiong, 2015; Meng et al., 2013), the interactive causal nexus between military spending and income inequality has receive limited attention both at a theoretical and at an empirical level. Studies such as those of Elveren (2012) cite lack of time series data on income distribution as the main factor for the dearth of literature. Nevertheless, even the few conducted studies thus far do not reveal any consensus with respect to the nature of the relationship between these two variables. The lack of consensus among scholars may be due to the econometric technique used, since none of these studies has provided an exclusive model to describe the absolute association between both variables (Meng et al., 2013).

There are no theories that adequately describes the interactive relationship between military spending and income inequality. However, the plausible mechanisms through which military spending can affect inequality are discussed in the existing literature. For instance, based on the Keynesian point of view, increased budget distribution on military expenditure improves economic prospects in military-related industries, which boosts the aggregate demand and job opportunities in the military industries (Lin & Ali, 2009; Meng et al., 2013 Hirnissa et al., 2009; Elveren 2012). The accessibilities of job opportunities in these industries play an important role in lowering income inequality (Meng et al., 2015).

Second, the aforementioned channel might differ in different scenarios since the composition of military expenditure is often complex (Töngür & Elveren, 2015). Hence, if increased military budget is used to create job opportunities for unskilled labour force, then income inequality may be lowered (Wolde-Rufael, 2016a). Nevertheless, if increased military budget is used to create job opportunities for skilled labour force, then income inequality may be worsened (Raza et al., 2017). Based on this complexity, scholars such as Ali (2007) concluded that the genuine impact depends on the precise composition and nature of the military expenditure. Third, according to the microeconomic theory, when military spending increase, it has a crowding-out effect (Meng et al., 2013). This suggest that higher military spending can be at the expense of public spending on social programmes ─ health and education, producing an equalising effect (Lin & Ali, 2009a; Meng et al., 2013). In this way, military spending reduce the resources dedicated to those social programs (Ali, 2004).

Based on the above discussion, it is clear that the possible causality mechanisms that military spending may affect inequality is quite complex. Therefore, studies investigating this relationship can be grouped into three. There are studies that have found evidence supporting a positive military spending ─ income inequality nexus (Wolde-Rufael, 2016a; Wolde-Rufael, 2016b; Elveren, 2012; Meng et al., 2015; Raza et al., 2017; Töngür & Elveren, 2015) and studies that have established a negative causal association between the two variables (Ali, 2012; Comton, 2005; Shahbaz et al., 2016). Again, there are some studies that have found no link between the variables (Lin & Ali (2009b). Table 1 below presents the empirical literature parallel to our work.

Table 1: Studies on the impact of military/defense spending on income inequality

No	Author(s)	Where (country)	Methodology	Data-type	Results	Sign +/-
1	Raza, Shahbaz and Paramati (2017)	Pakistan	ARDL bounds test; Toda and Yamamoto Modified Wald causality test.	Time series	Military spending ⟶ inequality	+
2	Elveren (2012)	Turkey	Engle-Granger's (1987) two-step procedure	Time series	Military spending ⟶ inequality	+
3	Wolde-Rufael (2016a)	Taiwan	ARDL bounds test; Toda and Yamamoto (1995) Granger causality.	Time series	Military spending ⟶ inequality	+
4	Wolde-Rufael (2016b)	South Korea	ARDL bonds test; Granger causality test	Time series	Military spending ⟶ inequality	+
5	Lin and Ali (2009)	58 Selected countries	Panel Granger causality	Time series	Military spending⟶ inequality	+
6	Shahbazi, Sherafatian-Jahromi, Malik, Shabbir and Jam (2016)	Iran	ARDL bounds test; VECM Granger causality approach.	Time series	Military spending ⟶ inequality	-
7	Ali (2012)	MENA countries	Panel regression	Panel data	Military spending ⟷ inequality	-
8	Ali (2007)	USA	Panel regression	Panel data	Military spending ⟶ inequality	+
9	Meng, Lucyshyn and Li (2014).	China	Granger causality	Time series	Military spending ⟶ inequality	+
10	Meng, Lucyhyn and Li (2015).	China	Granger causality and cointegration.	Time series	Military spending ⟶ inequality	+
10	Abell (1994)	USA	Ordinary Least Square (OLS) Regression	Time series	Military spending ⟶ inequality	+

11	Tongur and Elveren (2015).	37 countries across the world	Panel data analysis	Panel data	Military spending ⟶ inequality	+
12	Hirnissa, Habibullar and Baharon (2009).	Selected Asian countries	ARDL bounds tests		Military spending ⟶ inequality	+
13	Biscione and Caruso (2021).	Transition economies	Panel regression	Panel data	Military spending ⟶ inequality	+
14	Raza and Shanbaz (2014).	Pakistan	ARDL bounds test and Granger	Time Series	Military spending ⟶ inequality	+

Table 1 presents previous empirical studies conducted on the impact of military expenditure on income inequality. In support of studies that have established a positive causal association between military spending and income inequality, Wolde-Rufael (2016a) examined this relationship in Taiwan. The authors used ARDL bounds test approach to cointegration and four long-run estimators for the period from 1976–2011. Applying time series data, Wolde-Rufael (2016a) found a long-run association between different measures of inequality and military expenditure, where military spending exerts a positive and significant effect on income inequality in Taiwan. The results of the lag-augmented causality test procedure showed a unidirectional causality running from military spending to income inequality (Wolde-Rufael, 2016a).

The results obtained by Wolde-Rufael (2016a) for Taiwan concurs with those of Wolde-Rufael (2016b) for South Korea. In their work, Wolde-Rufael (2016b) examined a long-run and the causal association between defense spending and income distribution in South Korea fusing time series data spanning from 1965–2011. Applying the bounds test approach to cointegration, Wolde-Rufael (2016b) found a long-run causal association between defense spending and the Gini coefficient with defense spending showing a positive and a statistically significant effect on income inequality. Similar to previous studies, the results of the lag-augmented causality test revealed a unidirectional causality running from defense spending to income inequality in South Korea.

Similar to the study of Wolde-Rufael (2016b), Elveren (2012) analysed the case of Turkey. In this study, the author examined the association between military spending and income inequality applying data for the period of 1963 to 2007. After finding cointegration, the results of VECM Granger causality observed a unidirectional causality running from military spending to income inequality (Elveren (2012). In an unrelated study, Meng et al. (2014) used a pairwise Granger causality to ascertain the causal nexus between income inequality and military expenditure applying data spanning from 1989 to 2012. The results validated the conclusion of previous studies ─ military expenditure Ganger causes income inequality in the Chinese economy. In the same vein, Meng et al. (2015) investigated the long run cointegration and causal association between military spending and income inequality for the in Chinese economy. Using Engle and

Granger (1987) cointegration and VECM Granger causality tests on time series data, the authors found that military expenditure and income inequality are cointegrated and a unidirectional causality ran from military spending to income inequality.

In their recent work, Raza et al. (2017) examined the effect of military spending on income inequality in Pakistan using time series data over the period of 1972 to 2012. Applying the ARDL bounds testing cointegration approach, the results revealed a long run equilibrium association between the two variables. The results of Granger causality, Toda-Yamamoto Modified Wald test and variance decomposition approaches found a unidirectional causality running from military spending to income inequality (Raza et al., 2017). Töngür and Elveren (2015) applied the generalized method of moment to assess the impact of military expenditure on pay and income inequality with respect to the welfare regime. In this comprehensive study of a panel data of 37 countries from 1988 to 2003, the result revealed a positive and significant impact of military expenditure on income inequality. Moreover, Lin and Ali (2009a) who included 58 countries for the 1987–1999 period conducted another comprehensive study. Using the panel non-Granger test, the authors reported a positive association between income inequality and military expenditure.

Likewise, Vadlamannati (2008) assessed the effect of defense spending and income inequality in South Asian countries ─ Pakistan, India, Sri Lanka and Bangladesh from the period of 1975 to 2004. The authors established that defense spending has a positive and significant effect on income equality by controlling the main institutional and macroeconomic variable (Vadlamannati, 2008). The most cited paper in the literature is a study by Abell (1994). In his seminal work, Abell (1994) assessed the relations between military expenditure and income inequality utilising the standard OLS regression applying time series data from 1972 to 1991. The findings showed that military spending increases income inequality as a result of the differences in paying wages to military versus civilian (Abell, 1994).

In multiple country-specific case studies, there is empirical work that have found causality running from military spending to income inequality to some countries, while other countries have established a bidirectional causality between the two variables. For example, Hirnissa et al.

(2009) applied the ARDL method to examine the causality between military expenditure and income inequality for a cluster of countries ─ Malaysia, Indonesia, Singapore, the Philippines, South Korea and India. In addition, they applied innovative accounting approach to test the direction of causal association by utilizing time series data spanning from 1970 to 2005. They documented a one-way causality running from military spending to income inequality for Malaysia, a feedback effect was observed between both series for Singapore and neutral relationship for the remaining countries.

Similar to the study of Hirnissa et al. (2009), Sharif and Afshan (2018) investigated the impact of military spending on income inequality in their comparative study between Pakistan and India using annual time series data from 1980 to 2014. The ARDL bound testing cointegration method, Johansen and Juselius cointegration technique, Gregory and Hansen structural break cointegration methodology, overall endorsed the validity of a long-run causal association between military spending and income inequality in both countries (Sharif & Afshan, 2018). The findings of long-run inquiry likewise, showed a positive effect of military expenditure on income inequality in both India and Pakistan (Shari & Afshan, 2018). Their study established a bidirectional causal association between military spending and income inequality in case of India, while a unidirectional causality was observed for Pakistan, running from military spending to income inequality.

Very few publicly available empirical studies have established a negative causal association between military spending and income inequality. In their influential paper, Ali (2012) investigated the military spending and inequality in the Middle East and North African countries applying panel data covering period 1987 to 2005. Using panel regression, the empirical results showed that that military expenditure had an important negative impact on inequality in the Middle East and North African countries. They pinned down the negative relationship to be an indicative of an effort by states to consolidate their power by providing added subsidies and social programs while on the other hand, they are offering the stick by boosting military spending (Ali, 2012). Shahbaz et al. (2016) assessed the effect of defense expenditure on income inequality in Iran using time series data spanning from 1969 to 2011. The results from ARDL bounds test approach and VECM Granger causality approach found a valid long-run association

confirm a strong negative association between defense expenditure and income inequality. In the case of United States, Comton (2005) observed a negative association between military expenditure and income inequality in United States. The author revealed that an increase in military expenditure creates more employment for unskilled labour force and boost income distribution.

In contrast to the above studies, there are few studies that have found no substantial evidence to support the causal association in either direction between the defense expenditure. In their study, Lin and Ali (2009b) investigated the causal association between defense expenditure and inequality applying BVC and SIPRI data across 58 countries from 1987 to 1999. Applying the recently developed panel Granger non-causality tests, the results showed no substantial evidence to support the causal association in either direction between the defense expenditure and the change in economic inequality (Lin & Ali, 2009b).

In South Africa, a number of studies have been done on military spending ─ economic growth nexus (see for example, Dunne & Vougas, 1999; Batchelor et al., 2000; Dunne et al., 2000; Mosikari & Matlwa, 2014). However, no empirical research on military spending ─ income inequality relationship is publicly available for now, despite the country being seen as one of the most unequal countries in the world. One reason can perhaps be due to the limited time series data on income inequality to interrogate such analysis. Contrary to previous studies that have analyzed the interactive relationship between defense expenditure and economic growth, this paper contribute to the South African literature by investigating the relationship between military spending and income inequality. To the best of our knowledge, this is the first study to apply autoregressive distributed (ARDL) and bounds test for cointegration method to explore this relationship in South Africa.

Empirical model, data and estimation methodology

3.1 Empirical model

Following an extensive review of the literature, empirical model for testing the relationship between military spending and inequality is specified as follows:

$$lnINE_t = \alpha_0 + \alpha_1 lnME_t + \alpha_2 lnEMP_t + \alpha_3 lnPOP_t + \alpha_4 lnGE_t + \alpha_5 lnGDPCAP_t + \varepsilon_t \quad (1)$$

Where $lnINE_t$, $lnME_t$, $lnEMP_t$, $lnPOP_t$, $lnGE_t$, and $lnGDPCAP_t$ are inequality, military expenditure or spending, employment, population, government expenditure and GDP per capita which is a proxy for economic growth. The effect of military expenditure on inequality can be positive, negative or non-existent. That means the effect of military expenditure on inequality is an empirical question. The effect of population, government expenditure, and economic growth proxied by GDP per capita is an empirical question. The variables can have a positive or negative impact on inequality. However, employment is expected to impact positively on inequality.

3.2. Data

The study employs annual data on variables that are regarded as important in explaining inequality: the ratio of military spending to GDP (ME), employment (EMP), population (POP), general government spending (GE) and GDP per capita (GDPCAP). The period of our analysis runs from 1990 to 2017 and the data are annual. The data for our dependent variable of interest (inequality variable) is obtained from Standardized World Income Inequality Database, population, GDP per capita, the ratio of military expenditure to GDP and general government spending are sourced from World Development Indicators, while employment comes from Penn World Table (version 9.1). Table 1A in the appendix provides a summary of the descriptive statistics of income inequality, the ratio of military spending to GDP, the ratio of general government expenditure to GDP, GDP per capita, population, dummy variable and employment. The Table shows that annual mean of all the variables is positive.

3.3 Estimation technique

This study applies autoregressive distributed (ARDL) and bounds test for cointegration developed by Pesaran, Shin and Smith (2001) in order to estimate Equation (1). Equation (1) is estimated in ARDL form as follows:

$$\begin{aligned}\Delta lnINE_t = \beta_0 &+ \sum_{i=1}^{n} \mu_{1i}\, \Delta lnINE_{t-i} + \sum_{i=1}^{n} \mu_{2i} \Delta lnME_{t-i} + \sum_{i=1}^{n} \mu_{3i} \Delta lnEMP_{t-i} \\ &+ \sum_{i=1}^{n} \mu_{4i} \Delta lnPOP_{t-i} + \sum_{i=1}^{n} \mu_{5i} \Delta lnGE_{t-i} + \sum_{i=1}^{n} \mu_{6i} \Delta lnGDPCAP_{t-i} \\ &+ \delta_1 lnINE_{t-1} + \delta_2 lnME_{t-1} + \delta_3 lnEMP_{t-1} + \delta_4 lnPOP_{t-1} + \delta_5 lnGE_{t-1} \\ &+ \delta_6 lnGDPCAP_{t-1} + v_t \end{aligned} \tag{2}$$

Where β_0 is the intercept, and short run parameters are represented by μ_i. The long run parameters or coefficients are represented by γ_i, while Δ indicates that the variables are in first difference form. Testing the null hypothesis of no cointergration is the most important part of equation (2). This is expressed as follows:

$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0$
$H_a: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq 0$

If the null hypothesis is rejected, it means that there is cointegration. The ADRL cointegration technique identifies the long run relationship among the variables in the models. The technique uses the Wald or F-statistics to test for joint significance of $\delta_1, \delta_2, \delta_3, \delta_4, \delta_5$, and δ_6. After establishing the long run relationship between the variables, the next step is to estimate the coefficients of the long run. It also become appropriate to proceed to the error correction model (ECM). The ECM is illustrated as follows:

$$\Delta lnINE_t = \beta_0 + \sum_{i=1}^{n} \mu_{1i}\, \Delta lnINE_{t-i} + \sum_{i=1}^{n} \mu_{2i} \Delta lnME_{t-i} + \sum_{i=1}^{n} \mu_{3i} \Delta lnEMP_{t-i} + \sum_{i=1}^{n} \mu_{4i} \Delta lnPOP_{t-i} + \sum_{i=1}^{n} \mu_{5i} \Delta lnGE_{t-i} + \sum_{i=1}^{n} \mu_{6i} \Delta lnGDPCAP_{t-i} + \delta_1 lnINE_{t-1} + \delta_2 lnME_{t-1} + \delta_3 lnEMP_{t-1} + \delta_4 lnPOP_{t-1} + \delta_5 lnGE_{t-1} + \delta_6 lnGDPCAP_{t-1} + ECT_{t-1} + v_t \quad (3)$$

The coefficient of the ECT is expected to be negative and statistically significant. This indicate that there is adjustment to equilibrium. It also indicate that there a long run equilibrium relationship between variables in equation 1.

4. Empirical results

4.1 Unit root test results

Initial steps in cointegration analysis involves checking the time series properties of all the variables to be used in the analysis. The standard unit root test such as Augmented Dickey–Fuller (ADF) and Kwiatkowski, Phillips, Schmidt, Shin (KPSS, 1992) were performed in this study. Table 2 shows that according to the ADF test statistic, all variables have unit root in levels (nonstationary in levels). With the exception of inequality, all variables become stationary on first difference. This means that they are integrated of order one or I(1). The KSS test statistics indicates that the null hypothesis of stationarity in levels for all variables (except employment) is rejected. This indicates that variables nonstationary in levels. However, the null hypothesis of stationarity is not rejected for all the variables in first difference. That means the variables are I(1). This is in line with the results of the ADF test statistic. The results of the unit root test shows that there is no I(2) variable. This indicates that since there is no I(2) variable, it is now appropriate to proceed the estimation using ARDL.

Table 2. Unit Root Results

Variables	ADF unit root test (level)	KPSS unit test (level)
	Test statistic	Test statistic
LNINE	-0.3113	0.1524#
LNME	-2.1791	0.1534#
LNEMP	-2.8229	0.1130
LNPOP	-2.0959	0.1767#
LNGGE	-2.5017	0.1620#
LNGDPCAP	-2.3799	0.5980#
ADF unit root test (1st difference)		KPSS unit test (1st difference)
LNINE	-1.8544	0.4601
LNME	-3.8516**	0.1310
LNEMP	-4.1008**	0.0870
LNPOP	-3.2469*	0.1360
LNGGE	-4.9369***	0.2115
LNGDPCAP	-2.9144*	0.2351

Notes: */**/*** indicates rejection of the null hypothesis of unit root at 10%/5%/1% significance level.
# indicates rejection of the null hypothesis of stationary at 5% significance level.

4.2 Preliminary analysis

Figure 2 plots the evolution of the dependent variable of interest (inequality). It indicate that the inequality have generally shown marked upward increase for the period 1990–2017 period with peaks in during the global financial crisis 2008/2009. Figure 3 and 4 use Zivot and Andrew's unit root test to accounts for a structural break in the data series and shows that there was one time structural break for the variables inequality which occurred in 2008—during the financial crisis. Figure 3 reveals a structural break for military spending, occurring in 1998—during the Asian crisis.

Figure 2: inequality in SA, 1990–2017

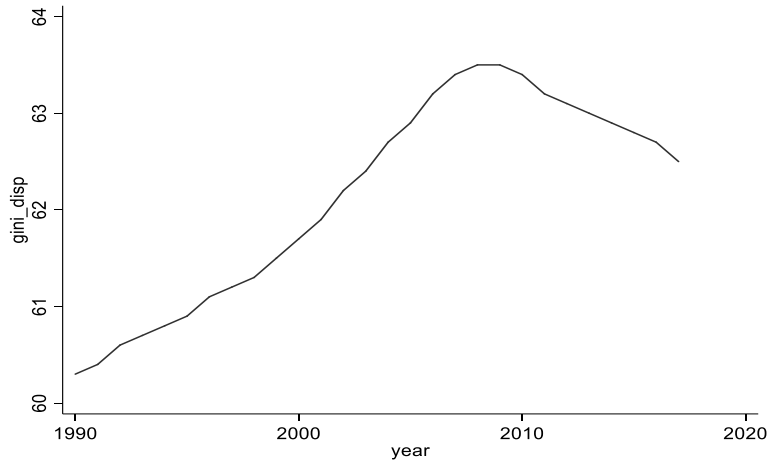


Figure 3: inequality in SA, 1990–2017

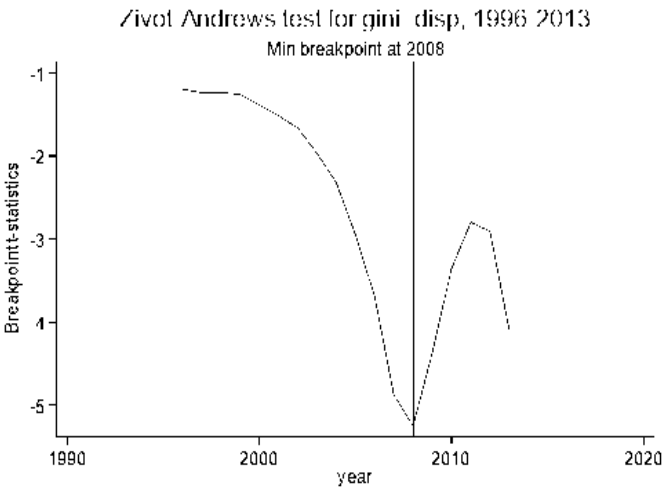
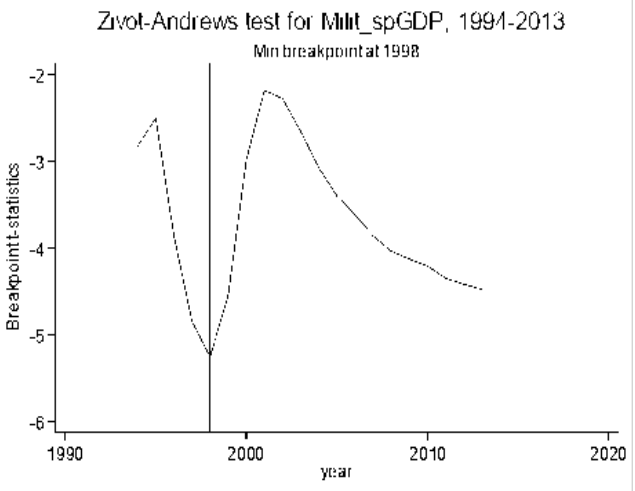


Figure 4: Military spending SA, 1990–2017



4.3 ARDL bounds test of cointegration estimate

Having established the order of the integration of the variables, we performed a bounds test for cointegration to find out whether there is the long run association between inequality and military spending and the control variables. Table 3 presents the estimates of bound F-test for cointegration. The F-statistic of 9.027069 surpasses the upper bound at 5% level of significance. Thus we reject the null hypothesis of no cointegration – there is a long run association between inequality and independent variables in South Africa. The study thus concludes that there is evidence of a long run relationship between the variables.

Table 3. Bounds F-test for Co-integration.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	**9.027069**	10%	1.75	2.87
k	6	5%	2.04	3.24
		2.50%	2.32	3.59
		1%	2.66	4.05

4.4 Long-run estimates

Table 4 presents the long-run estimates. The ratio of military spending to GDP coefficient of 0.09326 is positive and significant at one percent level of significance, implying that a one percentage rise in the ratio of military spending to GDP should bring about 0.09 percent increase in inequality. This result is in line with Wolde-Rufael (2016a) and who found a long-run causal association between defense spending and the Gini coefficient, with defense spending showing a positive and a statistically significant effect on income inequality. Likewise, our results resemble those of Töngür and Elveren (2015) who also reported a positive and significant impact of military expenditure on income inequality in a cross-country study.

Similarly, population is positively associated with income inequality with its coefficient being statistically significant, suggesting that a one percent increase in population would increase income inequality by 1.2 percent. Perhaps unsurprisingly, the general government expenditure presents a negative and significant estimate on income inequality. What this means is that in the long run, general government expenditure has a negative and significant impact on the inequality in South Africa – one percentage increase in the general government expenditure will bring about − 0.28 percent decrease in income inequality. The GDP per capita, also has a negative but less significant association with income inequality in the long run. The estimated coefficient value of − 0.072 suggest that one percent increase in the GDP per capita ought to reduce income inequality by 0.072 in South Africa. Surprisingly, the employment variable with coefficient of 0.145644 present a positive (though insignificant) influence on income inequality, indicating that one percent increase in employment growth would increase income inequality 0.15 percent.

Table 4. Long-run ARDL estimates.
Dependent variable: LNINE

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNME	0.09326***	0.027245	3.423013	0.0035
LNGE	-0.280069***	0.125349	-2.23431	0.0401
LNPOP	1.248067***	0.426984	2.922984	0.01
LNGDPCAP	-0.071654	0.173323	-0.413414	0.6848
LNEMP	0.145644	0.145921	0.998102	0.3331
DUM98	-0.019504	0.013274	-1.469315	0.1611

*Notes:; ***, **, *signify statistical significance at the 1%, 5% and 10% level, respectively*

4.5 Short-run estimates

Table 5 presents the short-run impact of the ratio of military spending to GDP, population, GDP per capita and employment, as well the error correction terms (ECT). The estimated coefficient of the ECT (which specifies the speed of adjustment from short-run towards long-run equilibrium) confirms the long-run relationship between the ratio of military spending to GDP, including control variables and income inequality. The estimated ECT coefficient with a value of -0.10 suggests that a deviation from the equilibrium in the present year will be adjusted by 10 percent in the following year.

Table 5. Short-run ARDL estimates.
Dependent variable: ΔLNINE

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔLNGGE	-0.011768***	0.004693	-2.507835	0.023
ΔLNPOP	0.541481***	0.03292	16.44838	0.000
DUM98	0.000193	0.000808	0.238442	0.815
ECT*	-0.102104***	0.010954	-9.321241	0.000

*Notes: ***, **, *signify statistical significance at the 1%, 5% and 10% level, respectively*

4.6 Diagnostic tests

Whether or not the conclusions drawn from the ARDL estimates are to be taken seriously depends very much on the statistically fitness of the model in question. The statistical fitness of the model is judged based the extent to which errors are well-behaved and the stability of the coefficients over time. The specification test for the relevant errors: heteroscedasticity, normality and serial correlation were performed and reassuringly in favour of 'well-behaved errors' in that we fail to detect serial correlation and non-normality--these diagnostic statistics are not reported

here but can be obtained from the authors on request. An attempt was also made to assess the stability of both the error correction model parameters, employing the cumulative sum of recursive residuals CUSUM (see graph 2) and squared version of CUSUM (i.e. CUSUMSQ) (see graph 3) approaches suggested by Brown and his associates (1975). The parameters are said to be stable if and only the CUSUM statistics are inside the 5% significance level. As can be seen in Figure 2 and 3 that the plots of the CUSUM and CUSUM of squares are not crossing critical bounds (i.e. within the 5% significance bounds), thereby confirming the stability of the parameters and appropriateness of the ARDL models employed in this study.

Figure 2. Plot of CUSUM Test

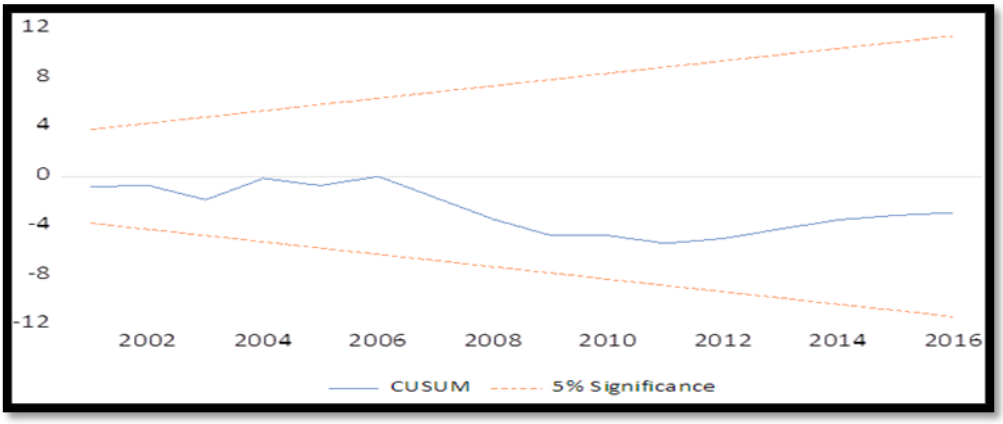
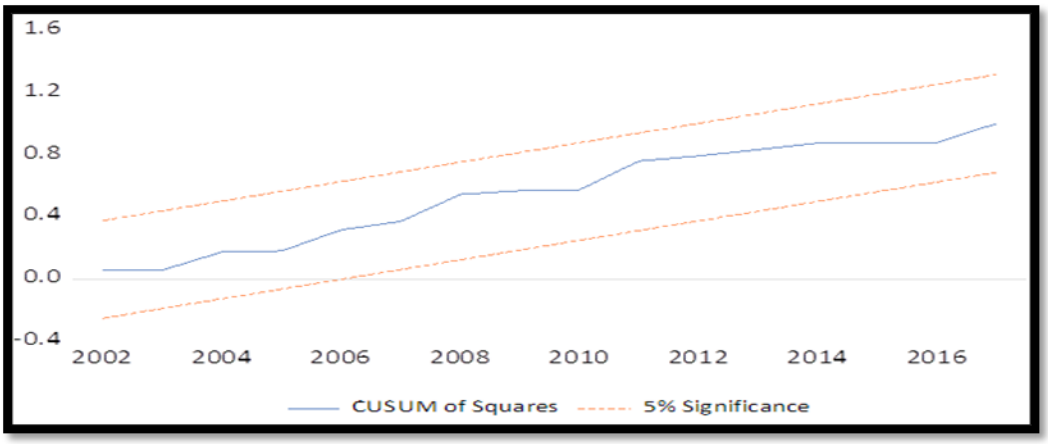


Figure 3. Plot of CUSUMSQ test



Conclusion

The study through ADRL approach looks at the long run and short run effect of military expenditures on inequality in South Africa. The dataset spanned from 1990-to- 2017. The empirical result established a long run relationship between military expenditures and income inequality in South Africa. An increase in the military expenditures result in high rate of inequality. For population growth, the result established a long run positive relationship with income inequality. Population increase without a corresponding increase in opportunities results in high income inequality as it put immense pressure on the already existing meager resources thereby resulting in "the survival of the fittest" phenomenon. On the general government expenditures, the study showed a negative long run relationship with the income inequality. General expenditures by government affects diverse groups of people unlike military expenditure, which is more restrictive in nature hence its negative influence on income inequality in South Africa.

Based on these findings, it is appropriate for the central government's expenditure to be directed at the sectors that have direct impact on the large segment of the population. Military expenditure by its nature is very restrictive and the gains do not trickle down to those who are "trapped" in the quagmire of poverty. It is therefore recommended for more expenditures be directed at "pro-poor" sectors that have direct link with the masses. Government expenditures in the "pro-poor" sectors would help in lifting out those who are experiencing "poverty trapped" and requires the assistance for liberation. By so doing, income inequality will be decreased significantly.

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Appendix

Table A1. Descriptive stats

Variable	Obs	Mean	Std. Dev.	Min	Max
gini_disp	28	62.13571	1.066741	60.3	63.5
Milit_spGDP	28	1.619428	0.729614	1.043302	3.896351
RGDP_PC	28	48039.48	5833.112	40394.93	55516.27
Pop	28	62.35737	3.474859	55.91291	65.67944
General_go~P	28	19.33395	0.888001	17.81401	20.799
Employment	27	39.67852	1.275409	36.8	43.1
Dum	28	0.714286	0.460044	0	1