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Military Expenditure, Economic Growth and Heterogeneity

by
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Abstract

This paper examines the impact of military expenditure on economic growth on a large balanced panel, using an exogenous growth model and dynamic panel data methods for 106 countries over the period 1988-2010. A major focus of the paper is to consider the possibility group heterogeneity and non-linearity. Having estimated the model for all of the countries in the panel and finding that military burden has a negative effect on growth in the short and long run, the panel is broken down into various groupings based upon a range of potentially relevant factors and the robustness of the results is evaluated. The factors considered are different levels of income, conflict experience, natural resources abundance, openness and aid. The estimates for the different groups are remarkably consistent with those for the whole panel, providing strong support for the argument that military spending has adverse effects on growth. There are, however, some intriguing results that suggest that for certain types of countries military spending has no significant effect on growth.

Keywords: Military expenditure; economic growth; conflict; development
JEL code: O11; H56

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Introduction

There is an impressively large and growing literature on the effects of military spending on economic growth that reflects a continuing lack of consensus. As more data becomes available that does not reflect the particular geopolitical environment of the Cold War, there is more information in the data, which should help researchers in identifying any relation with economic factors. Certainly, the end of the Cold War saw sizeable reductions in military expenditure internationally and in recent years the declining trend has bottomed out and military expenditure is once again on the increase, across the medium and high income groups. The lowest income group continues to experience declines in military spending and military spending as a share of GDP remains the lowest for the low income countries relative to the other income groups (SIPRI 2012). SPIRI (2011) reported that world military expenditure in 2010 reached $1.6 trillion, representing 2.6 percent of global gross domestic product (GDP) or equivalent to $236 per person. While the end of the Cold War meant fewer major international conflicts, there was an increase in internal conflicts in the developing world and while the number of conflicts has been declining more recently, they remain a major concern for the developing world.

One issue that has received little attention has been the robustness of the parameter estimates of growth models across groups of countries. This paper contributes to the existing literature by continuing this investigation with a particular focus on parameter heterogeneity using a post Cold War balanced panel of 104 countries for 1988-2010. The next section briefly reviews the existing literature for developing countries and provides an exposition of the growth model based on Dunne et al (2005), which includes military spending and overcomes some of the limitations of earlier models. Section 3 provides a discussion of the dataset. Section 4 presents the results of the estimated growth model using the cross country data and considers the variation in results across various subsamples when the sample is stratified by developed, non-developed; income groups (low, medium, high); conflict (conflict or not; civil, interstate); conflict and income groups; net recipients of aid; natural resources; and trade openness. The final section presents some conclusions.

Military Spending and Growth

It is important to have a theoretical model for empirical work, but since most economic theories do not have an explicit role for military spending there is no obvious choice. Indeed, as there is no agreed theory of growth among economists, there is no standard framework to fit military spending into. In most recent empirical work some form of neoclassical growth model has been used, exogenous or endogenous, to provide a consistent and flexible framework for the analysis (Dunne et al, 2005). These will inevitably focus on particular aspects of the growth process and may miss complexities, such as the effect of institutions, natural resources, strategy, conflict etc.

The empirical debate over the relation between military expenditure and growth was started by the contributions of Benoit (1973, 1978) which found positive association. This led to a large amount of research activity and an impressive build-up of literature that has tended not to support Benoit's initial findings. Opinions on the effects of military spending

are divided among two groups; the “pro” group that views military spending as a guarantee of peace, security and welfare, while the “against” group sees such spending as a wasteful enterprise that influences the economy beyond the resources it takes up. Although the effects of military expenditure have been debated for almost forty years, the answer is almost always an empirical one. Irrespective of which perspective one takes the topic of military expenditure is, most definitely, nontrivial; often leading to important economic consequences.
A number of researchers have tried to survey the existing literature, Ram (1995) Dunne (1996) and Smith (2000) finding no empirical regularity, positive or negative, though Smith did indicate that there could be a small negative effect in the long-run, however, more sophisticated techniques are required to find such a relationship. Dunne and Uye (2010) in a survey of 102 studies on the economic effects of military spending show that negative effects of military spending on growth were reported in 39 and 35 percent of cross-country and case studies respectively. Only 20 percent found positive effects for both types, while over 40 percent found unclear results.

What is clear is past research has not been able to provided consensus on the economic effects of military spending, though more recent studies do seem to be providing more consistent support for a negative effect of military spending on growth (Dunne and Tian, 2013). The more recent cross country studies have also should increasing concern over group heterogeneity, endogeneity and non-linearity. These include Smaldone (2006) who suggested that differences in results for Africa reflect countries’ experience of conflict, Tiwari and Shabiz (2012) who considered non-linearities, Looney and McNab (2007) who considered economic freedom and governance and Dunne (2012) who allows for non-linearity and conflict experience in SSA.

Following on from these contributions this paper estimates a growth model for the sample of 104 countries and then stratified into sub-samples to compare the results across income groups, developed and developing countries, conflict experience, civil wars and interstate wars, natural resource abundance, net recipients of aid and trade openness. This sample stratification method is used because firstly, the concern is with investigating the application of the specified theoretical growth model and secondly that many of the factors are invariant over time and so indicators could not be introduced as explanatory variables.

Conflict experience would seem to be an important potential source of heterogeneity. As mentioned Smaldone (2006) argued that military burden within Africa generally corresponds to the security realities and affects the relationship between military spending and growth. Dunne (2012) provides support to this claim. As is common in the literature conflict is defined here as having at least 25 combat-related deaths per year, but a cumulative battle death of over 1,000 throughout the duration of the conflict is also considered.

Natural Resource endowment has been investigated as having an impact on conflict and is a good candidate for a factor that might influence the relation between military spending and growth. Collier and Hoeffler (2004) found that where (rebellions/civil wars are motivated by greed) they primary commodity exports can substantially increases conflict risk. They argue that In the presence of natural resource abundance, opportunities arise through extortion

and looting of profits for those in control of the resource, thus making conflict/rebellion feasible or perhaps even attractive. Other research suggests similar hypotheses, Sarr *et al* (2011) explains that in a resource rich country, an unchecked ruler can use resources as collateral and facilitate acquisition of loans and loot the economy. Looting then leads to political instability and hence diminished growth. It certainly seems a reasonable to suggest that resource abundance countries may differ in their relation between military spending and growth and following conventions in the literature, natural resource dependence is measured as the ratio of mineral exports to total exports and a country is considered mineral dependent if mineral exports constitute more than 25 percent of a country's total exports. This is consistent with the IMF's definition of export dependence.

Another potentially important variable is foreign aid. In the conflict literature Collier and Hoeffler (2004) identify diaspora and their impact on conflict through flows of funds that can support insurrection. In the growth literature recent developments have considered the impact of aid on developing countries, with no consensus. Burnside & Dollar (2000) concluded that aid has a positive impact on growth in developing countries with good policies (fiscal, monetary and trade) and no impact in the presence of poor policies. On the other hand, Easterly, Levine & Roodman (2004) and Hansen & Tarp (2000) rebut Burnside & Dollar (2000)'s claim and find that aid works for countries with poor policies. While there is no consensus regarding the impact of aid on growth, it is recognised that aid fungibility can result in discretionary spending. Thus it is reasonable to suppose that the impact of military spending may differ between countries that are net aid recipients and those that are non-recipients.

A final issue that has been highlighted in the literature is the impact of openness of economies on growth. There is no consensus, with proponents of trade openness having a positive effect on development including Edwards (1997), Frankel and Romer (1999) and Dollar and Kraay (2004) and those finding that find trade openness has a negative effect on growth including Yanikkaya (2002), with Rodriguez and Rodrik (2000) finding little evidence that open trade policies are associated with economic growth. There is also a substantial literature on trade and conflict, suggesting that countries that trade are less likely to fight (Polachek, 2007). In addition, involvement in the arms trade can impact upon economic growth for a given level of military expenditure (Yakovlev, 2007). In 2011, according to SIPRI, the top 7 suppliers or arms in the world (USA, Russia, Germany, France, China, UK, Italy) are also within the top 10 of the world's top military spenders. The majority of the world's economies are arms importers; hence, a more open economy could represent greater net arms imports than the equivalent closed economy. This represents an opportunity cost since the resources used for arms imports could be used for developmental purposes. penness variable is calculated by taking the sum of a country's imports and exports and dividing that by its GDP, with a country considered open if it is above the value for the world average and vice versa for a closed economy.

Modelling Military Spending and Growth

For the empirical analysis the model developed by Dunne *et al* (2005) is used, whereby the effect of military spending on economic growth is based on the augmented Solow growth

model with Harrod-neutral technical progress, similar to Knight *et al* (1996). The key assumption within this exogenous growth model is that military spending share *m*=M/Y affects factor productivity via a level effect on the efficiency parameter, which controls Harrod-neutral technical change. Putting it differently, a permanent change in *m* does not affect the long-run steady-state growth rate, but has the potential to have a permanent effect on per capita income along the steady-state growth path. The share of military spending can also affect the transitory growth rates along the path to the new steady-state equilibrium.

The starting point of the model is an aggregate Neoclassical Cobb-Douglas production function featuring Harrod-neutral technological progress.

1. $$Y(t) = K(t)^{\alpha}[A(t)L(t)]^{1-\alpha}$$

Where *Y* denotes aggregate real income, K is the real capital stock, L is labour and A is the technology parameter evolving according to:

2. $$A(t) = A_0 e^{gt} m(t)^{\theta}$$

where g is the exogenous rate of Harrod-neutral technical progress and *m* is the share of military expenditure in total output (GDP). Together with the standard Solow model assumptions of an exogenous savings rate *s*, constant labour force growth rate *n* and constant rate of depreciation δ; one can display the dynamics of physical capital accumulation by:

3. $$\dot{k}_e(t) = s_K k_e^{\alpha}(t) - [n + g + \delta]\dot{k}_e \Leftrightarrow \frac{\partial lnk_e}{\partial t} = se^{(\alpha-1)lnk_e} - (n + g + \delta)$$

where $k_e = \frac{K}{AL}$ denotes the effective capital-labour ratio and α is the constant capital-output elasticity. The steady-state level of k_e is:

4. $$\tilde{k}_e^* = \left[\frac{s}{n+g+\delta}\right]^{1/(1-\alpha)}$$

where the asterisk denotes the steady-state value of the variable. It is now possible to solve for the steady-state value of output. Linearising (3) via a truncated Taylor series expansion around the steady-state[1] and substituting (4) we get:

5. $$\frac{\partial lnk_e}{\partial t} = (\alpha - 1)(n + g + \delta)[lnk_e(t) - lnk_e^*]$$

and since $lny_e = ln\left[\frac{Y}{AL}\right] = \alpha ln\, k_e$ then:

[1] Re-writing (3) in the form $\frac{du}{dt} = f(u),\ u = lnk_e$, the linearised form is $f(u^*) + f'(u^*)[u(t) - u^*]$

6. $\frac{\partial lny_e}{\partial t} = (\alpha - 1)(n + g + \delta)[lny_e(t) - lny_e^*]$

where the steady-state level of output per effective worker is:

7. $\tilde{y}_e^* = \left[\frac{s}{n+g+\delta}\right]^{\alpha/(1-\alpha)}$

Equation (6) estimates the transitory dynamics of output per effective worker in the neighbourhood of the steady-state. Following Dunne *et al* (2005), (6) is integrated forward from *t-1* to *t* giving:

8. $lny_e(t) = e^z lny(t-1) + (1 - e^z)lny_e^*,\ z = (\alpha - 1)(n + g + \delta)$

Now using equations (2), (7) and (8), y_e is related to observable per capita income *y=Y/L* via:

9. $lny(t) = e^z lny(t-1) + (1 - e^z) * \left\{lnA_0 + \frac{\alpha}{1-\alpha}[lns - \ln(n + g + \delta)]\right\} + \theta lnm(t) - e^z \theta lnm(t-1) + (t - (t-1)e^z)g$

where z is still equivalent to (α-1)(n+g+δ), while θ is the elasticity of steady-state income with respect to the long-run military expenditure share. Equation (9) provides the basis for the empirical analysis Dunne et al (2005) suggest that the dynamic panel model specification can now be written in the form:

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$$lny_{i,t}, = \gamma lny_{i,t-1} + \sum_{j=1}^{3} \beta_j\, lnx_{j,i,t} + \sum_{k=1}^{2} \alpha_k\, lnz_{k,i,t-1} + \eta_t + \mu_i + \upsilon_{i,t} \ \ ; i = 1,2, \dots, N \ ; t = 1,2, \dots, T$$

where $x_1 = s$ = the gross investment/GDP, $x_2 = (n_{i,t} + g + \delta)$ = labour force growth rate plus $(g + \delta)$ which is a constant, assumed to be equal to 0.05[2], $x_3 = m_{\ i,t}$ which is equal to military spending as a share of GDP, $z^1 = m_{i,t-1}$ and $z^2 = s_{i,t-1}$ which is the lagged variable of military spending and gross investment as a share of GDP respectively. The variable $n_t$reflects the time specific effects, μ_t represents group specific effects and $\upsilon_{i,t}$is the error term. We also follow from Knight et al (1993), Islam (1995) and Dunne (2011) in treating *s* and *n* as variant across countries and time; while taking g and δ to be constant and exogenous across time and country.

[2] The assumption that (g+δ)=0.05 follows from Mankiw et al (1992)

Data Description

The balanced panel is composed of annual data for 104 countries covering the period 1988-2010. This includes all countries that had a maximum of three missing observations for the military expenditure variable. Military expenditure as a share of GDP was taken from the Stockholm International Peace Research Institute (SPIRI). Other economic variables, real per capita GDP *(growth)*, gross-fixed capital formation as a share of GDP (used as a measurement of capital) were taken from the World Bank's World Development Indicators database (WDI). Due to difficulties in obtaining reliable data for the average growth rate of the labour force, the working-age population growth is used. Classifications of countries that are either developed or non-developed and income groupings are also taken from the WDI[3]. In order to homogenise the sample size for the different income groupings, the low and low-middle income countries were combined to form low-income countries, while high-middle income countries were defined as middle-income and the high-income definition left unchanged. The conflict indicator was taken from the Uppsala Conflict Data Program and International Peace Research Institute Oslo (UCDP/PRIO) database. A country is given a numerical value of one if it has experienced a conflict between the periods 1988-2010. A civil war and interstate war variable was constructed, dividing countries into those that had experienced either a civil war or interstate war.

Natural resource abundance was measured by mineral exports as share of total exports, using data from Hagland (2011) and UNCTADstat. The focus was on the six types of fuels and non-fuel minerals as defined by the Standard International Trade Classification (SITC) codes shown in Table 1.

Table 1: Types of minerals as classified by SITC codes

SITC code and description	
SITC 27: Crude fertilizers, other than those of division 56, and crude minerals (excluding coal, petroleum and precious metals)	Non-fuel minerals
SITC 28: Metalliferous ores and metal scrap	
SITC 68: Non-ferrous metals	
SITC 667: Pearls and semi-precious stones	
SITC 971: Gold, non-monetary	
SITC 3: Mineral fuels (including natural gas), lubricants and related materials.	Fuel

The natural resource indicator was divided into three variables, with each variable given a value of one or zero. The first variable, *(avenat)*, characterises whether a country is natural

[3] Country classifications for developed/non-developed are taken from the World Bank. Income groups are also taken from the World Bank, the detailed criteria are as follows: the WB divides economies into income groups according to 2010 gross national income (GNI) per capita. The groups are: low-income, $1005 or less; lower-middle income, $1006-3975; upper-middle income, $3976-12275; and high-income, $12276 or more.

resource dependent via a combination of fuel and non-fuel minerals, the second variable, *(fuel)*, indicates whether a country is fuel dependent and the third variable, *(non-fuel)*, records countries that are non-fuel, mineral dependent. The mineral dependence variable (where mineral exports constitute at least 25 percent of total exports) was based only on the year 2010 data, but this seems reasonable given the variable is unlikely to show much variation over time.

Aid was taken from the World Banks WDI, by dividing the sample into countries that are net recipients of aid compared to those that aren't. As the net recipients of aid is measured as a share of GDP any country that on average received less than 0.01 percent of aid as a share of GDP was considered as non-aid recipients. Aid recipients were then divided further into countries that receive low (less than 1% of GDP), medium (between 1% and 3% of GDP) and high amounts of aid (greater than 3% of GDP).

The trade openness variable *(trade)* takes on the value of one for open or zero for closed economies. The imports, export and GDP figures are recorded in constant US dollars; the GDP figures have been deflated using Purchasing Power Parity (PPP). Due to missing observations we were unable to take the sample average of a 23 year period or the initial period (1988). Thus we have chosen two arbitrary years in our time-series data, namely 2000 and 2009 to identify for changes in openness[4].

Table 2 below provides a summary of the final data set containing 104 countries over a twenty-three year period. The sample includes 28 developed countries, 76 developing countries, 29 African countries, 20 Asian and Oceania countries, 26 European countries, 21 North and South American and 10 Middle East countries[5].

[4] The full sample is divided into 79 open and 25 closed countries for the year 2000 and 78 open and 26 closed countries for the year 2009. During the 10 year period countries such as Uganda and China moved from closed to open while others such as France and Greece moved the opposite direction.

[5] A list of countries featured in the sample can be found in table A1 in the appendix.

Table 2: Variable Description and Summary Statistics

Variable Name	Variable Description	Mean	Std. Dev.
y	Real per capita GDP	12157	12718
m	Military expenditure as share of GDP	2.74	3.73
k	Gross fixed capital formation as share of GDP	21.28	6.57
ly	Natural log of real per capita GDP	8.73	1.29
lm	Natural log of military expendidure as share of GDP	0.71	0.75
lk	Natural log of goss fixed capital formation as share of GDP	3.02	0.30
ly1	Lagged natural log of real per capita GDP	8.73	1.30
lm1	Lagged Natural log of military expendidure as share of GDP	0.72	0.75
lk1	Lagged Natural log of goss fixed capital formation as share of GDP	3.02	0.30
cly	Growth rate of real per capital GDP (log)	0.02	0.05
clm	Growth rate of military expenditure as share of GDP (log)	-0.02	0.20
clk	Growth rate of fixed capital formation as share of GDP (log)	0.00	0.15
lngdpop	Population growth rate *(clpop)*+0.05 (assumed value for g+d) used in Solow-style regressions	-2.74	0.18
dev	Development indicator (1=Developed, 0=Non-developed)	0.27	0.44
inc	Income indicator (1=Low income, 2=Middle income, 3=High income)	1.93	0.84
conflict	Conflict indicator (1=Conflict, 0=No conflict)	0.37	0.48
civilwar	Civil war indicator (1=Civil war, 0=No civil war)	0.32	0.47
intwar	Interstate war indicator (1=Interstate war, 0=No interstate war)	0.11	0.31
aid	Aid Indicator (1=Net recipient of aid, 0=Non-net recipient of aid)	0.63	0.48
aid2	Aid Indicator (0=Non-net recipient of aid, 1=Low aid, 2=Medium aid, 3=High aid)	1.39	1.28
fuel	Fuel dependent countries (1=fuel dependent, 0=non-dependent)	0.17	0.38
nonfuel	Non-fuel mineral dependent countries (1=dependent, 0=non-dependent)	0.18	0.39
nat	Aggregate natural resource dependence (inc fuel and non-fuel) (1=dependent, 0=non-dependent)	0.35	0.47
comnat[6]	Combined fuel and non-fuel natural resource dependence. (1=dependent, 0=non-dependent)	0.41	0.49
open00	Openness indicator (1=open, 0=not open) in 2000	0.76	0.43
open09	Openness indicator (1=open, 0=not open) in 2009	0.75	0.43

[6] Refer to footnote 9 and 11 for the difference between the variable *nat* and *comnat.*

Empirical Analysis

In undertaking the empirical analysis of military spending and growth a major problem has been poor data quality and the lack of exogenous variation within the data. However, since the end of the Cold War, data quality and leverage has improved and the developments of panel data techniques has helped overcome limited exogenous variation in the data (Dunne et al (2002); Dunne *et al* (2004)). Panel data methods such as simple fixed effects, random effects and random coefficient estimators have been increasingly used and as longer time-series data becomes available dynamic specifications have been introduced into panel data methods (Smith & Dunne, 2002). This has raised a number of issues, as in the following example of a simple bivariate dynamic model:

11. $y_{it} = \alpha_i + \beta\ x_{jt-1} + \lambda\ y_{jt-1} + \ u_{it}$

a fixed effects estimator would suffer from lagged dependent variable (y_{it-1}) bias, which biases the OLS estimator (coefficient of x_{it-1}) downwards. It is also not consistent as N (number of groups) goes to infinity for fixed T. It is, however, consistent as T goes to infinity and where T is large the bias will be relatively small. There is further heterogeneity bias when the parameters differ over the groups, but this can be dealt with by estimating each equation individually and taking an average of the individual estimates. In the case of positive serial correlation in the independent variables, the resultant heterogeneity bias will bias the estimates of λ upwards.

As the data available is not long enough to use large-N and large-T methods a dynamic model is specified and fixed effects is used to estimate it. For the long-run estimates the overall biases are likely to offset each other due to the estimates of β (downwards) and λ (upwards) working in opposite directions (Dunne et al, 2002). The estimated general first-order dynamic model takes the form of:

12. $lny_{i,t} = \alpha lny_{i,t-1} + \sum_{j=1}^{3} \beta_j lnx_{j,i,t}\ + \eta_t + \mu_i + \upsilon_{i,t}\ ; i = 1,2, \dots, N; t = 1,2, \dots, T$

where *y* is GDP per capita*;* x_1 is gross investment/GDP; x_2 is military spending/GDP; x_3 is the labour force growth rate or *(n+g+δ)*. The re-parameterised general first order dynamic model is then estimated and the results are presented in Table 3, where all variables are in logs, *c* represents the change in the variable and the dependent variable is *(cly),* representing the change in per capita GDP. These results show a very well-defined empirical model; all the variables are statistically significant with signs as expected and a clear negative relationship (short and long-run) between military expenditure and economic growth[7].

Considering possible heterogeneity in the sample, Table 3 also provides estimation results for developed and non-developed countries, giving results which are similar to the full sample. The non-developed country group there is a negative and significant relation between military expenditure and economic growth in the short and long run, while for the

[7] Unit root tests were performed using both the Im et al (2003) and Fisher-Dickey Fuller method; the results suggest no unit root for lm, cly and clm, while, as expected, GDP (y) does exhibit unit root.

developed countries there is a negative and significant short run effect but no long-run effect.

Table 3: The Growth Effects of Military Expenditures in the Solow Growth Model

Sample	(1) All Countries	(2) Developed	(3) Non-developed
Variables	cly	cly	cly
clk	0.0554***	0.213***	0.0431***
	(8.53)	(15.03)	(5.75)
clm	-0.0280***	-0.0181***	-0.0283***
	(-5.69)	(-3.22)	(-4.54)
lngdpop	-0.0542***	-0.0925***	-0.0451***
	(-6.09)	(-7.13)	(-4.17)
ly1	-0.0917***	-0.0443***	-0.0940***
	(-12.16)	(-3.6)	(-10.52)
lk1	0.0273***	0.0233**	0.0230***
	(5.63)	(2.53)	(4.02)
lm1	-0.0170***	-0.00933	-0.0179***
	(-4.81)	(-1.59)	(-4.29)
year	0.00199***	0.0001	0.00252***
	(9.01)	(0.28)	(9.28)
Constant	-3.369***	-0.0441	-4.430***
	(-8.5)	(-0.08)	(-8.97)
Observations	2,148	607	1,541
Number of id	104	28	76
R-squared	0.127	0.375	0.131

Dependent variable: Growth rate of real per capita GDP *(cly)*
t-ratios in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As Dunne (2012) and Pieroni (2006) argue, the effect of military expenditure may well be very different for countries with different income levels, suggesting a non linear relation. To consider such differences, the full sample was stratified into three different income groups, giving the results in Table 4. The empirical growth model is generally well specified across the groups. For all three income groups the effect of military burden on growth is negative and significant in the short-run, but only evident in the low and high-income countries in the long run[8].

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[8] The difference in sample size of 5 countries between the high income and developed countries are due to countries classified as high income in terms of per capita GDP (oil economies) but not developed. The 5 countries are Bahrain, Hungary, Kuwait, Oman and Saudi Arabia.

Table 4: The Growth Effects of Military Expenditure, Stratifying for Income

Sample	(1) Low	(2) Middle	(3) High
Variables	cly	cly	cly
clk	0.00124	0.137***	0.120***
	(0.13)	(11.76)	(9.24)
clm	-0.0326***	-0.0214**	-0.0247***
	(-3.76)	(-2.51)	(-3.77)
lngdpop	-0.0257*	-0.0199	-0.0831***
	(-1.67)	(-0.92)	(-8.09)
ly1	-0.0935***	-0.0953***	-0.0820***
	(-7.39)	(-7.26)	(-6.36)
lk1	0.0140*	0.0384***	0.0210**
	(1.81)	(4.42)	(2.19)
lm1	-0.0265***	-0.00421	-0.0200***
	(-4.56)	(-0.72)	(-3.03)
year	0.00256***	0.00304***	0.000588
	(6.94)	(6.82)	(1.64)
Constant	-4.500***	-5.366***	-0.609
	(-6.6)	(-6.83)	(-0.96)
Observations	821	632	695
Number of id	40	31	33
R-squared	0.127	0.271	0.257

Dependent variable: Growth rate of real per capita GDP *(cly)*
t-ratios in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Previous studies, particularly in Africa, have found differences in the military spending growth relation for countries in conflict and those not (Dunne, 2012), but the results here do not support this. Breaking the full sample into groups of countries that have experienced conflict (38) and those that have not (66) gave the results in Table 5, which show significant negative effects of military expenditure both in the short and long-run irrespective of whether a country has experienced conflict. It is possible that the type of conflict may be more relevant so Table 5 also reports results for countries that experienced civil conflicts and those that experienced interstate conflicts. This gave 33 countries experiencing civil conflict and 11 interstate conflict, with 6 countries experiencing both[9]. The estimation results for countries with civil war experiences (Column 3, Table 5) were consistent with the overall sample, conflict and no-conflict groups, with significant negative short and long-run effects of military burden

[9] Ethiopia, India, Iran, Pakistan, Peru and United Kingdom.

Table 5: The Growth Effects of Military Expenditure, Stratifying for Conflict

Sample	(1) Conflict	(2) No Conflict	(3) Civil War	(4) Interstate
Variables	cly	cly	cly	cly
clk	0.0414***	0.0646***	0.0421***	0.123***
	(4.28)	(7.41)	(4.13)	(5.37)
clm	-0.0331***	-0.0234***	-0.0320***	-0.0180*
	(-4.61)	(-3.5)	(-4.23)	(-1.74)
lngdpop	-0.0354***	-0.0715***	-0.0281**	-0.144***
	(-2.7)	(-5.86)	(-2.02)	(-3.71)
ly1	-0.118***	-0.0710***	-0.106***	-0.126***
	(-9.37)	(-7.5)	(-7.85)	(-5.27)
lk1	0.0314***	0.0227***	0.0299***	0.0765***
	(3.84)	(3.69)	(3.5)	(3.99)
lm1	-0.0208***	-0.0180***	-0.0193***	-0.0138**
	(-4.37)	(-3.33)	(-3.81)	(-2.12)
year	0.00320***	0.00104***	0.00318***	0.00264***
	(9.58)	(3.43)	(8.52)	(4.28)
Constant	-5.607***	-1.677***	-5.644***	-4.758***
	(-9.29)	(-3.06)	(-8.34)	(-4.51)
Observations	773	1,375	674	227
Number of id	38	66	33	11
R-squared	0.195	0.110	0.184	0.327

Dependent variable: Growth rate of real per capita GDP *(cly)*
t-ratios in parentheses
*** p<0.01, ** p<0.05, *
p<0.1

Conflict could have a different effect on countries at different income levels, so to investigate this the 38 countries that have experienced conflict, were grouped into low-income, medium-income; and high-income countries. Due to the lack of observations for the medium and high-income groups the results show be analysed with caution[10]. While column 1 shows negative and significant short and long-run effects, column 2 shows insignificant effects for medium income countries experiencing conflict, but column 3 is consistent with column 1. Interestingly, the coefficient (on *clm*) is more than 3 times larger than that for the conflict affected low-income countries and larger than the overall conflict and civil war sample and the long-run coefficient (on *lm1*) is twice as large as the low-income conflict affected countries and more than 3 times greater than the overall conflict and civil war

[10] The consistency in the sign and statistical significance of the Solow growth variables even when the sample is limited to 98 observations or 5 countries (conflict and high income) provides further evidence towards the well-defined nature of our empirical model.

group. This suggests that military spending can have a particularly damaging impact on growth in high income countries involved in conflict.

Table 6: The Growth Effects of Military Expenditure, Stratifying for Conflict & Income

Sample Variables	(1) Conflict & Low Inc cly	(2) Conflict & Med Inc cly	(3) Conflict & High Inc cly
clk	0.0210*	0.181***	0.0875***
	(1.93)	(6.73)	(3.11)
clm	-0.0343***	-0.0226*	-0.113***
	(-3.78)	(-1.84)	(-3.63)
lngdpop	-0.0302**	-0.00729	-0.0705**
	(-2.06)	(-0.12)	(-2.45)
ly1	-0.106***	-0.146***	-0.450***
	(-7.37)	(-4.61)	(-9.41)
lk1	0.0251***	0.0343*	0.0923***
	(2.68)	(1.7)	(3.37)
lm1	-0.0282***	0.00281	-0.0575***
	(-4.47)	(0.35)	(-3.84)
year	0.00323***	0.00366***	0.00775***
	(7.67)	(4.11)	(6.69)
Constant	-5.793***	-6.120***	-11.23***
	(-7.4)	(-4.09)	(-5.83)
Observations	486	189	98
Number of id	24	9	5
R-squared	0.214	0.356	0.574

Dependent variable: Growth rate of real per capita GDP *(cly)*
Sample
Significance levels: *** p<0.01, ** p<0.05, * p<0.1

To consider the possible impact of natural resource differences, the UNCTADstat database was used to divide the sample into 43 countries that are resource dependent and 61 countries that are not resource dependent. Table 7, shows that military burden has negative and significant short and long-run effects of similar size for both for countries with and without natural resource abundance[11]. In the rationale for stratifying for natural resource

[11] It should be noted that within some natural resource abundant countries (Table 7, column 1) one type of mineral export does not constitute more than 25% of total exports, but, the combination of all mineral exports exceeds the 25% threshold amount.

abundance an indirect hypothesis was that that resource rich countries spend on average more on military than non-resource rich countries[12].

Table 7: The Growth Effects of Military Expenditure, Stratifying for Natural Resource

Sample Variables	(1) Natural Resource cly	(2) No Resource cly	(3) Fuel cly	(4) Non-fuel cly
clk	0.0416***	0.0767***	0.0202	0.0507***
	(4.49)	(8.12)	(1.46)	(3.65)
clm	-0.0247***	-0.0294***	-0.0398***	-0.00612
	(-3.31)	(-4.48)	(-3.27)	(-0.58)
lngdpop	-0.0472***	-0.0750***	-0.0945***	-0.0240*
	(-4.12)	(-5.06)	(-4.46)	(-1.65)
ly1	-0.126***	-0.0673***	-0.117***	-0.149***
	(-9.66)	(-7.27)	(-5.33)	(-7.49)
lk1	0.0309***	0.0244***	0.0274**	0.0327***
	(3.87)	(3.96)	(2.22)	(2.6)
lm1	-0.0156***	-0.0196***	-0.0254**	-0.00783
	(-2.94)	(-4.07)	(-2.52)	(-1.16)
year	0.00310***	0.00100***	0.00246***	0.00365***
	(9.12)	(3.44)	(4.55)	(7.24)
Constant	-5.323***	-1.657***	-4.156***	-6.260***
	(-8.75)	(-3.15)	(-4.36)	(-6.91)
Observations	864	1,284	355	380
Number of id	43	61	18	19
R-squared	0.163	0.122	0.165	0.192

Dependent variable: Growth rate of real per capita GDP *(cly)*
t-ratios in parentheses
Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Estimates of the means showed that resource rich countries allocate on average 3.4 percent of their GDP to military expenditure, while non-resource rich countries spend only 2.3 percent of their GDP on the military. This difference of 1.1 percentage points is statistically significant. Interestingly, the coefficient estimates suggest that even though on average natural resource abundant countries spend more on military then non-natural resource abundant countries, the negative effect is less for the resource abundant countries. This could mean that resources abundance makes military burden more affordable. To consider if there was any difference in the type of resources, the group was broken down into those that are resource rich in fuel and those rich in non-fuel minerals, giving the results in

[12] See page 7, under natural resources.

columns 3 and 4. These show clear differences[13], with the results for the fuel resource rich countries consistent with the general results, but the non fuel results showing military spending to have no effect on growth in the long or short run. This would suggest that the oil economies in the natural resource sample are driving the negative effects of military burden in overall estimates of natural resource abundant countries.

Moving to consider the possible impact of aid, Table 8 shows the results for countries that receive aid and those that do not and the stratifies those that receive aid into low, medium and high aid recipients.

Table 8: The Growth Effects of Military Expenditure, Stratifying for Net Recipients of Aid

	(1)	(2)	(3)	(4)	(5)
Sample	**Aid**	**No Aid**	**Low Aid**	**Medium Aid**	**High Aid**
Variables	**cly**	**cly**	**cly**	**cly**	**cly**
clk	0.0300***	0.165***	0.151***	0.0384*	0.00607
	(3.82)	(13.45)	(10.23)	(1.88)	(0.59)
clm	-0.0305***	-0.0212***	-0.00839	-0.0377***	-0.0376***
	(-4.75)	(-3.02)	(-0.92)	(-2.67)	(-4.01)
lngdpop	-0.0427***	-0.0868***	-0.0908***	0.00642	-0.0326**
	(-3.87)	(-5.69)	(-5.6)	(0.16)	(-2.16)
ly1	-0.108***	-0.0692***	-0.105***	-0.213***	-0.103***
	(-10.43)	(-6.6)	(-5.2)	(-7.41)	(-7.36)
lk1	0.0171***	0.0468***	0.0260***	0.0358**	0.0102
	(2.85)	(5.35)	(2.77)	(2.22)	(1.24)
lm1	-0.0182***	-0.0171**	0.00617	-0.0251**	-0.0254***
	(-4.27)	(-2.51)	(0.97)	(-2.41)	(-4.07)
year	0.00270***	0.000968***	0.00256***	0.00306***	0.00295***
	(9.22)	(2.76)	(4.32)	(5.09)	(6.87)
Constant	-4.676***	-1.607**	-4.500***	-4.412***	-5.212***
	(-8.86)	(-2.52)	(-4.37)	(-4.32)	(-6.55)
Observations	1,325	823	390	239	696
Number of id	65	39	19	12	34
R-squared	0.131	0.245	0.331	0.227	0.142

Dependent variable: Growth rate of real per capita GDP from 1988-2010 (cly)
t-ratios in parentheses
Significance levels: *** p<0.01, ** p<0.05, * p<0.1

[13] Note: the difference in sample size between the sum of the fuel and nonfuel minerals countries and the natural resource abundant countries are the countries that fit into the profile identified in footnote 12 above. The 6 countries are namely, Albania, Brazil, Bulgaria, Canada, India and Norway.

The results show negative significant short and long-run effect of military burden irrespective of whether a country receives foreign aid. This also holds for countries receiving medium and high levels of aid, but not for those receiving low levels of aid. Furthermore, the negative coefficients of the short-run *(clm)* and long-run *(lm1)* military burden increases in size as we move higher up the levels of aid received

Finally, the impact of openness is considered[14]. As the degree of openness could change both the opening and closing value of exports plus imports as a share of GDP was used as a check for consistency, but the results shown in Table 9 were very similar. The results showed negative and significant effects for military spending on growth in both the short and long-run, albeit only at the ten percent level in the short run for closed economies in year 2000. The mean estimates for military burden for the open economies for the years 2000 and 2009 were 2.8 and 3.0 percent respectively, which were about one half a per cent of GDP greater than the closed economies. Despite these differences, both groups showed significant adverse effects of military burden on growth.

[14] Stratification of arms imports and exporters was considered as an alternative to using openness, since one might expect the effect of military spending to be different for a country that is a net exporter compared to a net importer. However, of the 104 country sample only 9 countries were classified as net arms exporters, thus providing insufficient observations for meaningful regression analysis.

Table 9: The Growth Effects of Military Expenditure, Stratifying for Trade Openness

	(1)	(2)	(3)	(4)
Sample	**Open 2000**	**Closed 2000**	**Open 2009**	**Closed 2009**
Variables	**cly**	**cly**	**cly**	**cly**
clk	0.0358***	0.154***	0.0302***	0.162***
	(4.87)	(11.5)	(4.07)	(12.9)
clm	-0.0310***	-0.0146*	-0.0301***	-0.0181**
	(-5.24)	(-1.82)	(-5.15)	(-2.17)
lngdpop	-0.0454***	-0.0632***	-0.0675***	-0.0477***
	(-4.13)	(-4.69)	(-5.84)	(-3.72)
ly1	-0.105***	-0.0653***	-0.0823***	-0.120***
	(-11.26)	(-5.47)	(-9.5)	(-7.3)
lk1	0.0184***	0.0522***	0.0206***	0.0611***
	(3.27)	(5.42)	(3.73)	(5.98)
lm1	-0.0198***	-0.0112**	-0.0189***	-0.0129**
	(-4.48)	(-2.17)	-4.3	(-2.33)
year	0.00198***	0.00207***	0.00156***	0.00265***
	(7.19)	(6.23)	(5.56)	(7.74)
Constant	-3.171***	-3.906***	-2.607***	-4.571***
	(-6.44)	(-6.47)	(-5.16)	(-7.57)
Observations	1,630	518	1,610	538
Number of id	79	25	78	26
R-squared	0.115	0.315	0.103	0.345

Dependent variable: Growth rate of real per capita GDP *(cly)*
t-ratios in parentheses
Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Conclusion

Military spending by governments is indeed important in the influence it has, especially when it leads or facilitates conflict. As a result the economic impact of such spending is of great concern. This paper develops and analyses a comprehensive post-cold war balanced panel dataset for the period 1988-2010, using the modelling framework suggested by Dunne *et al* (2005) and considering possible sample heterogeneities and nonlinearities. The estimation results using the dynamic first order model with fixed effects provided surprisingly strong support for the negative impact of military burden on growth for both the short and long-run.

When countries were grouped as developed and developing only the long-run effect for the developed countries was insignificant. Consistent results were observed when countries were broken into three income groups, with the short-run coefficient estimate negative and significant for all three groups and the long-run coefficient estimate negative and significant for the low income and the high income groups.

While military spending on growth for conflict or non-conflict affected countries was both negative and significant, the expected differences in the effects of military burden on growth in civil and interstate wars was not apparent. When the type of conflict was considered, both
civil and interstate wars groups showed negative and significant effect of military spending on growth, though further stratification by income led to insignificant results for medium income countries that had experienced conflict. Similarly consistent results were found when grouping countries by their natural resource endowments, aid dependence and trade openness.

These results do seem to provide valuable robustness checks and support strongly the view that military spending has an adverse effect on growth. It does seem as though post Cold War it is possible to see this result developing as a consensus view. But while a compelling conclusion can be drawn across countries, care is needed in applying the conclusion to individual countries, as some groupings of countries did differ, for example non-fuel natural resource abundance, low aid recipient countries showed no effect of military spending on growth. There is, however, certainly no evidence of any significant positive effects.

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APPENDIX

Table A1: List of countries in full sample

Africa	N & S. America	Asia & Oceania	Europe	Middle East
Algeria	Argentina	Australia	Albania	Bahrain
Angola	Belize	Bangladesh	Austria	Egypt
Botswana	Bolivia	Brunei	Belgium	Iran
Burkina Faso	Brazil	Cambodia	Bulgaria	Israel
Burundi	Canada	China, P. R.	Cyprus	Jordan
Cameroon	Chile	Fiji	Denmark	Kuwait
Djibouti	Colombia	India	Finland	Lebanon
Ethiopia	Dominican Rep.	Indonesia	France	Oman
Ghana	Ecuador	Japan	Germany	Saudi Arabia
Kenya	El Salvador	S.Korea	Greece	Syria
Lesotho	Guatemala	Malaysia	Hungary	
Madagascar	Jamaica	Mongolia	Ireland	
Malawi	Mexico	Nepal	Italy	
Mali	Nicaragua	New Zealand	Luxembourg	
Mauritania	Panama	Pakistan	Malta	
Mauritius	Paraguay	Papua New Guinea	Netherlands	
Morocco	Peru	Philippines	Norway	
Mozambique	United States	Singapore	Poland	
Namibia	Uruguay	Sri Lanka	Portugal	
Rwanda	Venezuela	Thailand	Romania	
Senegal			Russia	
Seychelles			Spain	
Sierre Leone			Sweden	
South Africa			Switzerland	
Swaziland			Turkey	
Tansania			UK	
Tunisia				
Uganda				

southern africa labour and development research unit

The Southern Africa Labour and Development Research Unit (SALDRU) conducts research directed at improving the well-being of South Africa's poor. It was established in 1975. Over the next two decades the unit's research played a central role in documenting the human costs of apartheid. Key projects from this period included the Farm Labour Conference (1976), the Economics of Health Care Conference (1978), and the Second Carnegie Enquiry into Poverty and Development in South Africa (1983-86). At the urging of the African National Congress, from 1992-1994 SALDRU and the World Bank coordinated the Project for Statistics on Living Standards and Development (PSLSD). This project provide baseline data for the implementation of post-apartheid socio-economic policies through South Africa's first non-racial national sample survey.

In the post-apartheid period, SALDRU has continued to gather data and conduct research directed at informing and assessing anti-poverty policy. In line with its historical contribution, SALDRU's researchers continue to conduct research detailing changing patterns of well-being in South Africa and assessing the impact of government policy on the poor. Current research work falls into the following research themes: post-apartheid poverty; employment and migration dynamics; family support structures in an era of rapid social change; public works and public infrastructure programmes, financial strategies of the poor; common property resources and the poor. Key survey projects include the Langeberg Integrated Family Survey (1999), the Khayelitsha/Mitchell's Plain Survey (2000), the ongoing Cape Area Panel Study (2001-) and the Financial Diaries Project.

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