Military Expenditure and Economic Growth

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Abstract

This paper proposes to test the relationship between military expenditure and economic growth by including the impact of the share of military and civilian components of government expenditure in an economic growth model with endogenous technology. In this framework, we empirically consider the hypothesis of a nonlinear effect of military expenditure on economic growth. The comparison between costs and benefits of defence sector has traditionally explained the nonlinear relationship. This paper suggests that shocks to insecurity may also be a source of nonlinearity as they determine a re-allocative effect within government expenditure.

While parametric partial correlations are in line with empirical findings, the robustness of estimations is tested by using a nonparametric approach. The negative relationship between military expenditure and growth in countries with high levels of military burden predicted by theory becomes significant only after including a proxy for re-allocative effects in the growth equation.

JEL: H5, O41, O47

KEY WORDS: Economic growth, military burden, cross-section estimations

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1. INTRODUCTION

The endogenuos growth theories suggest that government expenditure has an important impact on long run growth rate. Its influence depends on the size of government intervention and on the different components of public spending. Moreover, different kind of government expenditures have heterogeneous effects on economic growth. For example, public infrastructures, research and development and public education are often considered public goods which have a positive effect on economic growth (Ram, 1986; Aschauer, 1989; Barro 1990, Morrison and Schwartz, 1996). On the other hand, observations that growth in government spending, mainly based on non-productive spending (Glomm and Ravikumar, 1997), is accompanied by a reduction in income growth has given rise to the hypothesis that the greater the size of government intervention the more negative is its impact on. However, while theory assigns productive government expenditure a key role in obtaining a higher steady-state growth rate of the economy, empirical findings do not generally support this link. Devarajan et al. (1996) modelling the relationship between different components of government expenditure conditioning with its initial shares find the existence of a positive relationship between current government expenditure and economic growth, while physical capital components of government expenditure highlight a negative impact.

Governments have also had a prominent role in financing the military sector. The endogenous growth theory provides a foundation for the relationship between the share of military expenditure and long-run economic growth, predicting an inverse hump-shaped link (Shieh et al. 2002). The theoretical arguments stem from the comparison between the direct and indirect costs of military activities and its indirect benefits. When the share of military burden is small with respect to the whole economy, it is possible to have benefits greater than costs and to obtain a positive impact on growth rate (Deger and Sen, 1995).

One important conclusion is that neglecting the characteristics of nonlinearity of military expenditure and growth results in mis-specified models which bias empirical analyses (Stroup and Heckelman, 2001; Cuaresma and Reitschuler, 2003; Aizenman and Glick 2006; Dunne and Perlo-Freeman, 2003; Collier and Hoeffler, 2004). A common reason for the presence of nonlinearities is that military expenditure is the key to keep security, reflecting the hypothesis that the marginal effect of a change in military burden is not constant both across different levels of the variable and across economies and leading in the extreme case to the existence of multiple growth regimes (Cuaresma and Reitschuler, 2006).

To investigate the aforementioned relationship, we model military spending as a separate issue in the production function with respect to other non-military government expenditures. This implies that government decides about the allocation of military expenditure in a complementary way to private inputs which are competitive with each other public service. In the empirical section, this framework enables us to test how the partial effect of military expenditure on growth can vary according to the different initial shares of government expenditure on non-military categories. In fact, while the effect of military expenditure is different whether the threat to security is high or low, economic insecurity might stimulate greater government efficiency. In fact, insecurity can lead the government to substitute inefficient spending with more efficient civilian outlays (Landau, 1996; Stroup and Heckelman, 2001).

This article discusses empirical issues to account for the (nonlinear) relationship between the share of military expenditure and growth by using Aizenman and Glick's (AG) data (2006). In this setting we extend the intertemporal-optimising endogenous growth model proposed by AG. In their framework the impact of military burden on growth is endogenously determined along with the impact of external threats. The extension we propose is to model the allocative influence of civilian and military government expenditure on economic growth, so that a positive correlation between the size of military expenditure and the "efficiency" of civilian expenditure is expected in the military burden and economic growth nexus. To take this effect into account we introduce an interaction term which acts as a conditioning variable into the growth equation and in cross-country analyses its effect may mitigate the original negative relationship. Furthermore, we test the role played by other forms of nonlinearities by considering that the partial effect of military burden varies over different levels of the variable itself (Landau, 1996; Stroup and Heckelman, 2001). The empirical analysis is carried out by including the military burden squared in alternative growth regressions. Moreover, the presence of multiple growth regimes is assessed by grouping (dividing into subgroups) countries according to their military burden. In the latter case, country spillovers that generate a safe environment for domestic and foreign private investments and indirect benefit on growth might determine multiple steady-states in presence of an increase in the demand for military expenditure. Finally, in a complementary way, the robustness of the partial linear regressions between military burden and growth is evaluated by using a non-parametric approach.

2. THEORY

Ideally, our hypothesis regarding the effects of military expenditure on growth should be incorporated into a general growth model. Even though there are a large numbers of contributions of theory concerning the effects of government expenditure components on economic growth, the empirical evidence is mixed. It is difficult therefore to classify government expenditures in *productive* or *unproductive* categories. Their impact on growth is left to empirical results.

We consider a growth model with endogenous technology in which the impact of military expenditure on economic performance does not depend on the choice of supply-side or demand-side models (Sandler and Hartley, 1995). The framework uses a representative household that consumes, accumulates and pays taxes with respect to a single composite commodity. The government provides security by spending on defense and provides public services by investing in consumption and infrastructures (Barro, 1990; Devarajan et al., 1996).

Formally, the aggregate production function is assumed to include private capital stock, *k*, military government expenditure, g_1, and non-military government expenditure, g_2. The production function is Cobb-Douglas, therefore the relationship can be written as:

$$y = Ak^{1-\alpha-\beta} g_1^{\alpha} g_2^{\beta} \qquad 0 < \alpha, \beta < 1 \qquad (1)$$

As a result of (1) the household's budget constraint is given by the motion equation of private capital, taking the government's decisions about expenditure allocation as given:

$$\dot{k} = (1-\tau)Ak^{1-\alpha-\beta} g_1^{\alpha} g_2^{\beta} - c \qquad (2)$$

where $\dot{k}$ denotes the private capital changes with respect to time, τ is the flat rate income tax and c is the consumption level of households. Thus, the representative agent chooses consumption, c, and capital, k, in order to maximize the future instantaneous utilities:

$$U = \int u(c)e^{-\rho t}dt \tag{3}$$

where ρ is the rate of time preference. We assume that this function increases in *c* and is concave; therefore we have that $\partial(c) > 0$ and $\partial^2(c) < 0$. As usual in this literature, we use an isoelastic utility function for the model to be solved analytically. Formally:

$$u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma} \tag{4}$$

in which σ is the intertemporal elasticity of substitution of consumption. Since the elasticity of substitution is assumed to be positive, it is worth noting that the marginal utility of consumption $-\sigma$ must be negative.

By using the flat-rate income tax, τ, the government finances public expenditure dividing them between military and non-military outlays. Thus, the following budget constraint relationship is given:

$$G = g_1 + g_2 = \tau y \tag{5}$$

Let ϕ and $1-\phi$ be respectively the fraction of resources for military and non-military spending. The flows of government spending are allocated by using the following rules:

$$g_1 = \phi\tau y \tag{5a}$$

$$g_2 = (1-\phi)\tau y \tag{5b}$$

In order to obtain a growth rate of consumption, the model for the representative household is solved by putting (4) into (3) and maximizing subject to (1), (2), (5), (5a) and (5b). However, it is well known from Barro's work (1990) that given the utility function (4), the growth rate of consumption is $\frac{\dot{c}}{c} = \frac{1}{\sigma}(y' - \rho)$, so that the steady-state growth rate of consumption can be written as:

$$\frac{\dot{c}}{c} = \gamma = \left[(1-\alpha-\beta)(1-\tau)\phi^{\alpha}(1-\phi)^{\beta} A \left(\frac{G}{k}\right)^{(\alpha+\beta)} - \rho \right] \tag{6}$$

The formulation of the model is a way to assert something about the role of the public sector, namely the military and non-military sector, on the growth rate by using the comparative statistic. To this purpose, we formulate equation (6) in terms of the parameter ϕ, deriving the equation for $\frac{G}{k}$:

$$\frac{G}{k} = \left(\tau A \phi^{\alpha}(1-\phi)^{\beta}\right)^{1-\alpha-\beta} \tag{7}$$

Then, we insert (7) into equation (6) and, differentiating it with respect to ϕ, we obtain the following result:

$$\frac{\partial \gamma}{\partial \phi} = \frac{1}{\theta}\left[B\phi^{\frac{\alpha}{1-\alpha-\beta}}(1-\phi)^{\frac{\beta}{1-\alpha-\beta}}\left[\alpha\phi^{-1} - \beta(1-\phi)^{-1}\right]\right] \tag{8}$$

in which $B = (1-\alpha-\beta)(1-\tau)A^{\frac{1}{1-\alpha-\beta}}\left(\tau\right)^{\frac{\alpha+\beta}{1-\alpha-\beta}}$.

By partially differentiating with respect to the share of military government expenditure, we are now able to impose some restrictions on the expected sign of that variable. In fact, since $0 < \phi < 1$, it follows that:

$$\left\{ \frac{\alpha}{\phi} < \frac{\beta}{1-\phi} \qquad \frac{d\gamma}{d\phi} > 0 \right\} \tag{9}$$

$$\left\{ \frac{\alpha}{\phi} > \frac{\beta}{1-\phi} \qquad \frac{d\gamma}{d\phi} < 0 \right\}$$

It is worth noting that the impact of the military burden on growth depends on the productivity parameters relative to their initial share, ϕ. Thus, if the actual ϕ is higher than its optimal level with respect to the relative output elasticity, α and β, we expect military burden to have a negative impact on growth, as generally predicted in models with endogenous technology.

If we concentrate our attention on high levels of military expenditure, where opportunity costs dominate indirect benefits from military expenditure, there is another channel which may generate nonlinearities. External shocks in threat produce increases in military expenditure's share. This might bring about reallocative effects in response to economic uncertainty: diversion of expenditure toward more efficient civilian activities may be a source of nonlinearity in the growth process. It is worth remarking that the efficiency of government policies does not imply that the share of civilian government expenditure decrease when military expenditure rise, since efficiency might be obtained by more productive re-allocative effects (Landau, 1996). Thus, the steady-state growth rate based on equations (9) may be positively affected by government expenditure reallocation and it is possible to find a less negative impact of the military expenditure on growth.

In the next section we empirically investigate the impact of military expenditure on economic performance and we analyze how the composition of government expenditure and its financing affect the steady-state growth rate. We take into account the nonlinear relationship between military expenditure and growth as well as countries' specificity which make the steady state growth rate conditional.

3. THE EMPIRICAL FRAMEWORK

The theoretical link developed enables to test whether the share of military expenditure and its initial share are associated with higher (or lower) growth. As previously mentioned, the aim of the paper is far from evaluating the impact of specific threats on military burden. However, the need for security is a possible source of nonlinearities in the relationship between military burden and economic growth (Hooker and Knetter, 1997; Aizenman and Glick, 2006; Crespo Cuaresma and Reitschuler, 2004)[1]. Empirical models for military expenditure demand have generally been specified as a function of socio-economic, institutional factors and threats to security. Both internal and external threats have been found having a positive statistical relationship with military expenditure (Dunne and Perlo-Freeman, 2003). Thus, as the theory suggests, a shock to security cause the initial share of military expenditure to rise and, at the same time, it leads to modify the composition of non-military expenditure in the production function. We refer to the latter effect as the re-allocative effect of civilian government expenditure. Landau (1996) finds evidence that the hypothesized reallocation regenerate more efficient government expenditure. In a sample of developing countries he found that higher share of military expenditure is not associated with lower shares of *productive* government expenditures such as education, health and infrastructures. Stroup and Heckelman's (2001) empirical results also confirm the same effect. Referring to a cross-section of Africa and Latin America countries they show that an increase of military expenditure, caused by external threat, is associated to higher current government expenditure, which has a positive impact on economic growth. These results can be rationalized saying that nonlinear behaviour of military burden-growth nexus induces policy-makers to obtain more efficient government policies, especially in developing countries. More precisely, the behavioral hypothesis is that when the inhabitants' perception of an external threat increases, it is likely that policy-makers can draw more taxes and allocate the additional income part to the defense sector and part to more efficient public policies. This does not mean that the efficiency f their economic frontiers can be obtained simply by substituting unproductive government expenditure with productive activities[2]. This is because the productivity of each expenditure category depends on its initial share to GDP and the complementarity among inputs (Devarajan et al., 1996).

To sum up, our key explanatory variables of the growth equation are the shares of military and non-military government expenditure, which we assume to have a negative sign in the empirical estimates. However, we include a variable to account for the interaction between military burden and the share of non-military expenditure *(govms).* This term is considered responsible for the nonlinearity effects. Its impact on growth is expected to be positive and therefore it will mitigate the negative impact of military expenditure on growth in the main equation.

The robustness of model is investigated by takings into account that the share of military expenditure might vary over different levels of the variable itself. To account for this fact, the squared value of military expenditure is introduced into the equation as an alternative proxy for *govms* (Landau, 1996). To support the basic nonlinear effect of military expenditure on economic growth we should expect a positive and significant coefficient for the military burden and a negative and significant coefficient for the military burden squared (Stroup and Heckelman, 2001).

However, the hypothesis that nonlinearities may be generated by high levels of both military and non-military expenditure for different groups of countries represents one of the aims of this paper. In fact, the threshold at which these nonlinearities occur is largely variable and depends on the country specific perception about uncertainty. Thus, if the nonlinearities are not statistically *controlled* for, the negative relationship between military burden and growth might be questionable as the relationship might be locally misspecified.

We propose that a nonparametric approach can check the robustness of the parametric estimations of the model, which can either include or not include the interaction variable, *govms*. The strategy of the analysis is carried out by following the parametric estimations produced by AG (2006) and by replacing the discrete variable of threat with *govms*[3]. The framework is given by:

$$\gamma_h = \beta_{1h} + \beta_{2h} K + \beta_{3h} z + \beta_{4h} X + \varepsilon_h \tag{10}$$

where K is a vector of state variables, z is a vector of country's environmental variables, X represents the set of the shares of military and non-military expenditure with respect to GDP and the interaction term. Thus, $X = \{mil, gov, govms\}$.

Considering the partially linear regression representing the growth equation in (10), the nonparametric counterpart γ_h for countries *h=1,…,N* can be written as:

$$\gamma_h = \lambda_h^T K + \alpha_h^T z + \phi_h(X) + \nu_h \tag{11}$$

in which α_h^T and λ_h^T are transposed vectors of unknown parameters. The *core* function $\phi_h(X)$ can be specified as a univariate function such as $\phi_h(x)$ or as a multivariate function $\phi_h(\vec{x})$ in which the conditioning variables of interest are included. The underlying model is the one specified in (10), in which X may or may not contain the interaction term as explanatory variable. Let for convenience consider the model in which the interest variable is $X = \{mil\}$. We find that $\mathrm{E}(\gamma_h | mil) = \lambda_h^T K + \alpha_h^T z + \phi_h(mil)$ and $V(\gamma_h | mil) = \sigma^2(K, z, mil; gov)$.

The aim is to estimate α_h^T and λ_h^T in presence of the unknown function ϕ_h, with the objective of estimating $\phi_h = mil$, after checking for the effects of non-military government expenditure of the state and environmental variables. The procedure is repeated by including *govms* variable to account for nonlinearity in the growth-military burden nexus. The estimations rely on a simple basic idea. If ϕ_h is linear, the local conditional correlation is calculated as a partial residual from the regression γ_h that contains all variables except military burden. Then, following Robinson (1988), a kernel based estimation is used to obtain the unknown function. The inspection of nonparametric estimations helps to understand whether the interaction term in the growth equation robustly accounts for nonlinearities. To this purpose, two procedures are possible: one can test alternative hypotheses in a nested framework and/or one can use a nonparametric measure of model (11) as a *benchmark* for the evaluation of parametric results. In order to stress this point, the inverse U-shaped relationship between military burden and growth (which scholars have found when controls for nonlinearities are omitted) might suggest the existence of an unknown level-dependent relationship. We follow Hansen's (2000) procedure to endogenously determine the possible threshold of military burden, applied in the defense economics literature by Cuaresma and Reitschuler (2003).

4. RESULTS

Table 1 shows the regression results of the cross-section estimations for the set of countries selected by AG (2006). Firstly, we discuss the estimations based on the full sample of 90 countries in column *1* and *2*. The difference between the specifications of column *1*, *2a* and *2b* concerns the selected choice variable. In the first column, *govms* is included together with military burden (*mil*), while the second column (*2a*) outlines a restricted model the *govms* variable excluded. Column *2b* shows the growth equation results by including the squared of military expenditure (*milsq*).

The parsimonious growth models include non-military expenditure with respect to *GDP* (*gov*), the logarithm of the initial *GDP (lgdp)* and the share of private investments over

GDP (*inv_gdp*) as state variables: these variables reflect each country's endowments of physical capital and natural resources[4]. The environmental variables embodied are measured by the population growth rate (*gpop*) and a dummy variable for African countries (*Africa*). According to AG (2006), the measure of good government (*goodgov*) was directly included in the model since it was found to significantly condition the allocation of government expenditure (Mauro, 1995, 2001).

The parameter of (the logarithm of) initial GDP is interpreted as the conditional rate of convergence[5]. The model in column 1 produces a greater convergence with respect to the restricted model in column 2 (about 2 percent against 1.6). This value is in line with many empirical work in growth economics (see Barro, Sala-I-Martin, 2005) and as well in defence economics. In accordance with AG's (2006) results, we found that military burden has a direct and significant effect on growth only in the case when *govms* is included in the specification. Instead, supporting the finding by Barro (1991) and Knight et al. (1996), the restricted model (column *2a*) shows an insignificant effect of military burden on growth. These outcomes assume relevance in explaining Landau's hypothesis. Since the interaction term *govms* has as expected a positive sign and it is statistically significant, shocks on threat to security causes a higher level of government expenditure in military and non-military categories. The expenditure impact on growth of the share of civilian government expenditure is expected to be negative and represents the potential for governments to use resources for enacting economically unproductive public sector policies. Finally, all the other *control variables* included in the models have the expected signs and they are statistically significant at the usual level.

Diagnostic tests are reported at the bottom of Table 1 in which the heteroskedasticity test is separated from skewness and kurtosis. It is worth noting that the extended growth-military model in column 1, which accounts for heteroschedasticty, rejects the hypothesis at the five percent conventional level. Keeping in mind that the aforementioned hypothesis generally represents a relevant issue in cross-country estimations, by including *govms* we obtain an improvement in the statistical model[6].

As shown by including *govms* in the relationship between military burden and growth, it is likely that a large share of the non-linearities is accounted for. The model in column 2b is estimated by substituting *govms* in model 1 by *milsq*. The results show insignificant coefficients for *mil* and *milsq* rejecting the presence of this form of nonlinearities. For this reason the rest of the paper will focus on the comparison between model 1 and model 2a.

On the other hand, it has to be taken into account that the size, sign and significance of β_4 in equation (10) could depend on state (K) and environmental (*z*) variables, so that correlations can hide part of the nonlinearities in the data. To investigate this problem, we analyse the robustness of the previous results by a nonparametric estimation. This approach potentially allows to consider a great amount of variability, so that the robustness is evaluated by comparing local nonparametric partial correlations between military expenditure and growth with their parametric counterpart. In Figure 1, the solid lines outline the partial relation between growth and military burden, as implied by the linear regression in column 1 and 2a of Table 1. The horizontal axis plots *mil* for the full sample, while the vertical axis shows growth rate γ_h after filtering the conditional variables of the model other than *mil*. For the same variables, the dash lines report the non parametric conditional correlation. Their estimations are obtained by running locally weighted least square regressions and using different bandwidths. Starting from .8, the bandwidth is reduced to .2 to allow for decreasing (amounts of) smoothing. Since we find the nonparametric relationship to be stable between military burden and growth in the neighbourhood of .5, our graphs only report the patterns for this estimation bandwidth.

The assumption that *govms* account for nonlinearities is confirmed by the graphs in Figure 1.

INSERT FIGURE 1

The nonparametric partial correlation in Figure *1(graph a)* shows a slight downward sloping and a little curvature extremely close to the parametric correlation when the control for the interaction term is included. The negative impact of military burden on growth is coherent both with the theoretical view and with recent empirical estimations (Stroup and Heckelman, 2001; Cuaresma and Reitschuler, 2003; Aizenman and Glick, 2006).

The estimation of the nonparametric pattern shows that nonlinear effects in the relationship between military burden and growth often occur in those countries with high military burden. While Israel and Jordan seem to have a *leverage effect* in the linear parametric regression, if we do not include a "correct" control for the presence of nonlinearities, we can suppose that the highest military burden levels could determine changes in the regime of their relationship with economic growth[7]. It is easy to verify that countries with a high level of military burden also allocate more of their budget to non-military government functional category. This explains why the interaction variable aims to explain the positive substitution effect between inefficient and efficient civilian government expenditure. The results show a negative relationship between military burden and economic growth. Furthermore, Figure 1 (*graph b*) shows that the relationship becomes insignificant as *govms* is omitted, which confirms the previous results

A further hypothesis is put forward for a sub-sample of countries. Since the interaction between military burden and government expenditure produces a different threshold which might reverse the military burden-growth relationship, we can have nonlinearity across-country with more than one change of slope.

Before testing the aforementioned hypotheses, the endogenous threshold is estimated to obtain countries' sub-samples in which the positive relationship between military burden and growth may become negative as the military burden increases from positive to negative as the military burden become higher. We adapt Hansen's procedure for cross-country estimations, in which data are sorted by the empirical distribution of military burden. The threshold is estimated by dividing the original sample into two sub-samples, *i.e.* only one change of regime in the military burden-growth nexus.

The estimated parameters for these two sub-samples are obtained through equation (10). Since the variable responsible for the regime switching is unobservable, we include a dummy variable to account for different regimes. The threshold's estimate is obtained by considering each realization of the unobservable variable, starting from 30 percent of the empirical distribution. The estimated parameter is the result of minimizing the sum of squared residuals across all estimated models. The sample is divided into two groups: one includes 39 countries with a lower military burden, while the second group includes 50 countries with a share of military expenditure over the threshold.

The estimates of the growth regressions for each of the two sub-samples are presented in columns (3-4) and (5-6) of Table 1. Columns (4) and (6) show the regressions without controls for nonlinearities, while columns (3) and (5) include the control variables. It is worth noting that military burden has a negative impact on growth in countries with high levels of military burden. Instead, contrary to the expectations, in countries with a lower military burden the estimates are positive but not significant, even when the regression is controlled for *govms*. Only in countries with higher military burden the interaction term positive and statistically significant at the ten percent level, which supports the previous results. The conclusion is that the synergy between high levels of non-military and military expenditures tends to diminish the negative influence that a given share of military expenditure determines on economic growth. It should be noted that diagnostic tests, reported in Table 1, confirm a good fit for the estimated regressions. Finally, Figures 2 and 3 display parametric and nonparametric correlations between military burden and growth, in a restricted sample of countries with lower and higher military burden, respectively.

INSERT FIGURE 2 AND FIGURE 3

In Figure 2, low military burden countries have an almost horizontal growth-military burden curve when *govms* is excluded, indicating that military burden is fairly constant across growth rates. The nonparametric estimation does not add relevant aspects also when the interaction term is included in the estimations; the estimated patterns are close to the parametric ones. The graph in Figure 3 (graph b) points out an interesting feature: in countries with very high level of defense expenditure we observe a nonlinear relation with a negative to positive slope change. Thus, even if we do not provide a formal test to disentangle nonlinearities, the inclusion of the interaction term allows to account for the local (and global) robustness of the relationship between military expenditure and growth.

5. CONCLUDING REMARKS

This paper discuss whether the growth regression method, derived by the endogenous growth model, is appropriated to measure the relationship between military burden and economic growth. Since the share of government spending is believed to explain lower growth rates, we model the steady-state growth rate by including the initial shares of civilian and military components. Moreover, this model enables to include the possible presence of nonlinearities in the previous relationship.

Our empirical tests extend the analysis carried out by Aizenman and Glick (2006). We substitute the nonlinear impact of the external threat by an interaction term to account for the re-allocative influence of government expenditure between civilian and military components. The hypothesis behind this choice is that the share of military expenditure, which incorporates external shocks to countries' security, may generate significant re-allocative effects in government expenditure efficiency.

Our parametric results are in line with previous empirical findings concerning the relationship between the share of military expenditure and economic growth. In contrast, we find an insignificant impact on growth for the square of military expenditure when this variable is used as a proxy for alternative forms of nonlinear relationship.

The robustness of estimations is tested by a nonparametric approach applied to two sub-samples: a group with high military spending level and a second group with low military spending. For the first group we find a weak negative relationship between the share of military expenditure and economic growth when the reallocative term is excluded; a regime change occurs in the last part of this sub-sample. However, the negative relationship becomes significant only if the interaction term is included: this variable mitigates the negative impact of a given military burden on economic growth. By contrast, countries with lower military burden show an insignificant relationship between military burden and growth with the nonparametric estimations close to the parametric analysis.

In conclusion, the results confirm that the relationship between military expenditure and growth might contain nonlinearities other than those hypothesized by traditional growth models in which the appropriate control variables are not included. In this direction, the nonparametric approach seems to be a useful tool for future research to avoid functional misspecifications in the growth equation.

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Table 1 – *Estimations results of the cross-country military expenditure-growth model for the full sample and sub-sample countries with high and low military expenditure based on the endogenous threshold*

	Full Sample			High military exp.		Low military exp.	
Variables	(1)	(2a)	(2b)	(3)	(4)	(5)	(6)
lgdp	-1.952	-1.626	-1.651	-1.126	-1.131	-2.847	-2.831
	(0.000)	*(0.003)*	*(0.003)*	*(0.128)*	*(0.137)*	*(0.000)*	*(0.000)*
mil	-0.880	0.024	-0.159	-1.135	-0.431	0.985	0.046
	(0.010)	*(0.873)*	*(0.719)*	*(0.016)*	*(0.057)*	*(0.624)*	*(0.943)*
govms	0.072			0.056		-0.061	
	(0.004)			*(0.082)*		*(0.621)*	
milsq			0.021				
			(0.664)				
goodgov	0.441	0.416	0.416	0.952	1.035	0.585	0.571
	(0.023)	*(0.041)*	*(0.041)*	*(0.002)*	*(0.001)*	*(0.052)*	*(0.051)*
gov	-0.329	-0.117	-0.124	-0.419	-0.204	-0.175	-0.258
	(0.001)	*(0.083)*	*(0.076)*	*(0.009)*	*(0.038)*	*0.357*	*0.006*
inv_gdp	0.115	0.088	0.092	0.102	0.092	-0.002	0.004
	(0.026)	*(0.100)*	*(0.091)*	*(0.074)*	*(0.114)*	*(0.989)*	*(0.969)*
gpop	-1.335	-1.013	-1.076	0.421	0.722	-2.753	-2.739
	(0.001)	*(0.012)*	*(0.012)*	*(0.485)*	*(0.229)*	*(0.000)*	*(0.000)*
africa	-2.495	-2.645	-2.541	-3.061	-3.341	-2.811	-2.770
	(0.001)	*(0.001)*	*(0.002)*	*(0.004)*	*(0.002)*	*(0.009)*	*(0.009)*
constant	20.651	15.203	15.813	10.498	6.978	29.192	30.303
	(0.000)	*(0.000)*	*(0.000)*	*(0.071)*	*(0.206)*	*(0.000)*	*(0.000)*
Diagnostics							
R^2	0.443	0.372	0.373	0.588	0.551	0.617	0.613
White het. test	χ^2_{42}=57.7	χ^2_{34}=60.4	χ^2_{34}=59.8	χ^2_{42}=44.8	χ^2_{34}=39.9	χ^2_{34}=35.0	χ^2_{33}=34.0
	(0.053)	*(0.003)*	*(0.013)*	*(0.354)*	*(0.221)*	*(0.420)*	*(0.419)*
Skewness	χ^2_{8}=17.45	χ^2_{7}=10.51	χ^2_{7}=12.62	χ^2_{8}=10.2	χ^2_{7}=11.05	χ^2_{8}=10.47	χ^2_{7}=11.80
	(0.025)	*(0.161)*	*(0.115)*	*(0.247)*	*(0.136)*	*(0.233)*	*(0.107)*
Kurtosis	χ^2_{1}=3.41	χ^2_{1}=2.51	χ^2_{1}=2.56	χ^2_{1}=1.71	χ^2_{1}=2.64	χ^2_{1}=1.10	χ^2_{1}=1.42
	(0.064)	*(0.112)*	*(0.107)*	*(0.19)*	*(0.103)*	*(0.293)*	*(0.232)*

*In the brackets are reported p-values. Diagnostic tests are obtained from Cameron and Trivedi's decomposition of IM-test (2006).

Figure 1 – *Partial correlation and non-parametric estimations between military expenditure and growth rate (full sample)*

a) Estimations with the proxy of security b) Estimations without the proxy of security

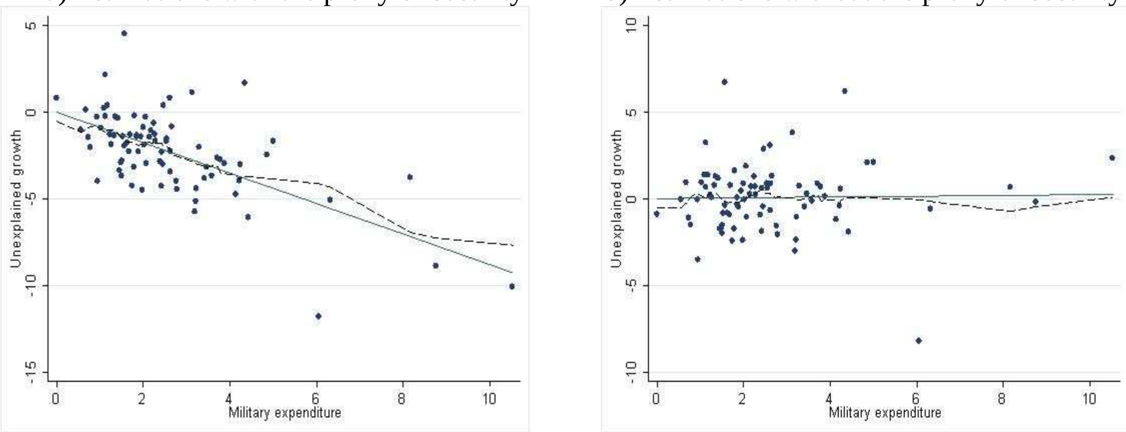


Figure 2 - *Partial correlation and non-parametric estimations between the sub-sample of countries with a lower military expenditure and the growth rate*

a) Estimations with the security proxy b) Estimations without the security proxy

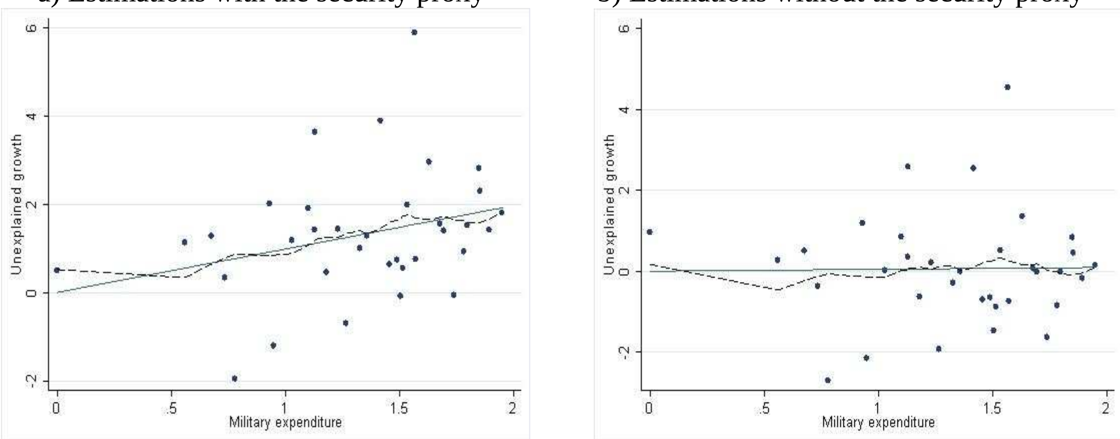
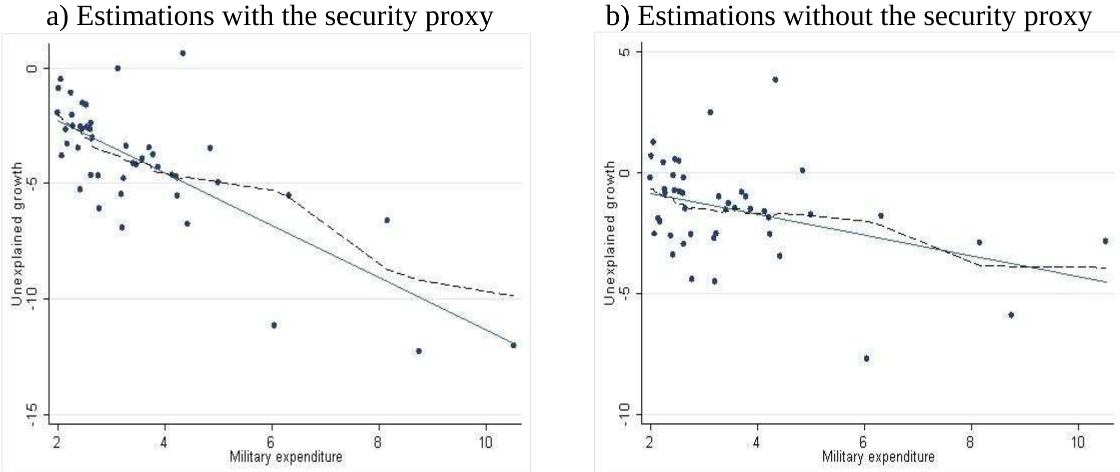


Figure 3 - *Partial correlation and non-parametric estimations between the sub-sample of countries with a higher military expenditure and the growth rate*

a) Estimations with the security proxy b) Estimations without the security proxy



FOOTNOTES

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[1] The endogenous growth framework that includes military expenditure as an imperfect substitute for private capital and external threat is used in Aizenman and Glick (2006).

[2] This point of view is sustained by Landau (1994) and Stroup (2001).

[3] The slight coherence of the categorical indicator of external threat of a country in the theoretical framework used in Aizenman and Glick (2006) and the statistical inconsistence of this variable obtained in estimations makes the use of this indicator to account for nonlinearities questionable.

[4] The measures of human capital in the form of schooling were found to be statistically non-significant and were omitted.

[5] It is known that the economy tends to approach its long-run steady state at the estimated rate if the other explanatory variables of the growth model are held constant.

[6] Fiaschi and Lavezzi (2006) discuss these aspects showing the negative relationship between volatility and growth.

[7] For example, in the growth model context, a nonparametric test of multimodality was used by Bianchi (1997) to test the hypothesis of income convergence for a group of 119 countries between 1970 and 1989.