Military expenditure and economic growth, 1960–2014

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Abstract

This article compares results of our 2015 study of the effect of military expenditure on economic growth, 1988–2010, with results using an additional 28 years of data provided in the newly revised and extended SIPRI dataset, 1960–2014. When the additional data points are added, we find no substantive differences and confirm the statistically significant negative effect of military expenditure on growth reported in our prior research. Using the same estimation process, there is no evidence of a structural break in the time series. Considering nonlinearity and heterogeneity, the estimates using the new data for ninety-seven countries are remarkably consistent with the earlier results and, overall, are very similar in sign and statistical significance, and many of the coefficients are larger (more adverse) than before. The new data provide valuable extra information and support for the original findings.

Military expenditure data provided by the Stockholm International Peace Research Institute (SPIRI) have been an important source for empirical research on the effect, if any, of military spending on economic growth for many years. Some of SIPRI's data were available for as far back as 1950, but *consistent* data across countries was only available from 1988. This limited the coverage of most cross-country studies engaging in the debate. The newly revised, extended, and consistent series now provide researchers with a valuable resource with which to validate previous analyses. The data also allows them to take advantage of new panel data techniques that have become available and which are more reliable with longer time series of data.[1]

The application of new data and new techniques is particularly valuable in this debate. Early studies had found it difficult to identify the impact of military spending on growth. Later studies seemed to be consistently identifying a statistically significant negative effect when post-cold war data points began to become an important part of the sample. Certainly, the end of the cold war saw substantial changes in the geopolitical environment and large worldwide reductions in military expenditure. This reduction, coupled with strong economic performance, provided valuable information in the data and some support for the existence of a peace dividend, recognizing the opportunity cost of military expenditure. Diverting resources to other development purposes, such as education, healthcare, infrastructure, or job creation, has been found to improve economic performance.[2]

This article takes the models in our previous study, estimated on data for 1988–2010, and examines whether the newly available data points have any statistically significant impact on the results. It also considers the robustness of the results to nonlinearity and group heterogeneity across the samples and investigates potential structural breaks in the full dataset of 97 countries for the period 1960–2014. The next section includes a brief review of the literature. The section thereafter provides a discussion of the dataset. This is followed by the presentation of the estimation results. The last section concludes.[3]

Effects of military expenditure on economic growth

Empirical studies on military expenditure and economic growth are comprehensively reviewed in our two recent survey pieces. Earlier surveys, by J. Paul Dunne and Ron Smith, respectively, had suggested little empirical regularity. That said, they did conclude that there exists no evidence of any statistically significant positive effect of military spending on growth. Instead, most studies reported negative coefficients, but often with a statistically insignificant value. There was certainly no theoretical consensus to guide the empirical analysis. Simple Keynesian aggregate demand arguments suggested that the expansion of government spending in a less than full-employment environment would increase investment, income, employment, and hence lead to higher rates of economic growth. There were also suggestions that military spending may lead to higher economic growth through positive spillover effects. Adding an aggregate production function to a Keynesian model made the theoretical predictions less clear. Allowing for the existence of vested interests and the presence of a military industrial complex suggested a negative impact on

growth due to adverse externality effects on the rest of the economy. Only underconsumptionist or effective demand Keynesian theorists saw a clear economy-enhancing role for military spending. In contrast, a neoclassical perspective would see military expenditure, financed by taxes or borrowing, as crowding out private investment and reducing growth. Although there may be security benefits to the economy as a result of military spending, resource diversion away from more productive government activities such as education or health, leads to large opportunity costs. This lack of consensus in the theoretical approaches meant the debate became largely an empirical one.[4]

In our 2013 survey, we found that of 168 studies published since Benoit's seminal work appeared in 1973, military spending had negative effects on economic growth in 44 and 31 percent of cross-country and case studies respectively. Only 20 percent of studies found positive results, while about 40 percent reported unclear results. An earlier suggestion, by Dunne and Uye, that increasing the proportion of post-cold war data might provide more consistent results indeed seemed to have supporting evidence. A comparison of time periods indicated that 53 percent of authors who used predominantly post-cold war data found military spending to have a negative effect on growth, while only 38 percent found such a result when using data before the end of the cold war. In a meta analysis using data covering 1960–1990, Alptekin and Levine found the combined effect of military expenditure on growth to be positive, with no evidence of a negative defense–growth relation for the least developed countries, nor in general. While their choice of studies was not comprehensive this—combined with findings dominated by post-cold war data—does illustrate the possibility that the available data did not consist of time series long enough to identify any particular impact of military spending on growth.[5]

Model, data, and empirical methods

Following Dunne, Smith, and Willenbockel, the military expenditure–economic growth relation is modeled in this article using an augmented Solow growth model with Harrod-neutral technical progress. The full derivation and description of the model can be found in our 2015 study. (The specific growth equation to be estimated is shown in the next section.)[6]

Military expenditure data comes from SIPRI's database. GDP per capita, the change in the capital stock (a proxy for investment) and population data come from the World Bank's *World Development Indicators* (WDI). Conflict-related data are taken from the UCDP/PRIO armed conflict database. The final balanced panel consists of data for 97 countries for

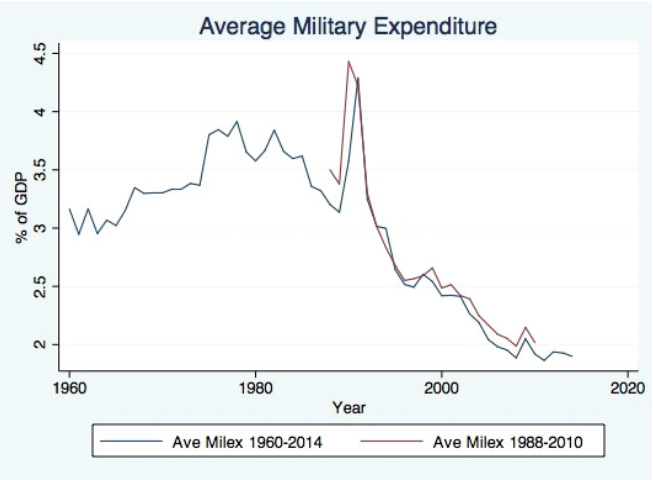

Figure 1: Average military expenditure, 1988–2010 and 1960-2014. *Source*: SIPRI "old" and "new" dataset.

1960–2014. Due to missing data, the number of countries included in the study was narrowed down from an initial group of 170. For example, there are no data for Angola before 1988, Liberia before 2004, or for North Korea (for the entire 55 year period). Indeed, a number of countries did not even exist for some of the relevant time period. Countries such as Botswana, Mozambique, Namibia, and the majority of the current eastern European block could not be included for this reason. Thus, even though SIPRI's new dataset contains an additional 28 years of data, such considerations restricted us to 97 countries, nine less than in our 2015 study. Figure 1 displays the difference in average military expenditure between our 2015 paper and this article.

Table 1 (next page) gives summary statistics for the main empirical variables in our 2015 dataset and compares them to the current study. As mentioned, the main differences are the addition of 28 years of data and the exclusion of 9 countries. Our sample includes 25 developed and 72 developing countries. Regarding major continental regions, we include 33 African countries, 15 from Asia and Oceania, 19 European, and 21 North and South American ones as well as 9 from the Middle East. In the full sample, 44 percent of all countries experienced some form of violent conflict, 67 percent received official development assistance (ODA), and 38 percent are deemed to be natural resource dependent.

Since the new data provides more information for countries during the cold war period, the comparison shows, on average, slightly higher military expenditure as well as lower GDP and population size. The capital stock as a percentage of GDP remained roughly the same. For purposes of comparison, the same indicator variables are used for sample stratification. They include income groups, developed and developing

Table 1: Variables and comparative descriptive statistics

		1960–2014		*Dunne and Tian (2015)*	
Variable	*Description*	*Mean*	*St.Dev.*	*Mean*	*St.Dev.*
m	Military spending % of GDP	2.96	3.59	2.7	3.71
y	GDP per capita	9,355	13,025	11,964	12,658
k	Capital stock % of GDP	21.22	6.84	21.28	6.57
pop	Population in 000's	33,987	95,321	50,408	156,627
Δy	Growth in per capita GDP	1.88	5.62	1.96	4.78
Δm	Growth in military spending	–0.58	7.68	–2.2	20.58
Δk	Growth in capital stock	0.04	16.17	0.13	14.84
Conflict	% of conflict experience	44.3	49.7	36.1	48.3
Aid	% of ODA recipients	67	47	63.2	48.2
Nat	% of resource dependent	38.2	48.6	35.8	47.9

Table 2: Growth effects of military expenditure over varying time periods

	(1)	*(2)*	*(3)*
Sample	*1960–2014*	*1960–1987*	*1988–2014*
Variables	*Δly*	*Δly*	*Δly*
Δlk	0.085** (0.005)	0.110** (0.008)	0.062** (0.006)
Δlm	–0.032** (0.004)	–0.043** (0.006)	–0.020** (0.006)
lngdpop	–0.024** (0.005)	–0.095** (0.020)	–0.043** (0.005)
ly1	–0.033** (0.003)	–0.054** (0.009)	–0.076** (0.007)
lk1	0.030** (0.003)	0.035** (0.006)	0.030** (0.004)
lm1	–0.017** (0.002)	–0.023** (0.004)	–0.012** (0.003)
Constant	–0.289** (0.134)	0.657 (0.484)	–2.117** (0.298)
Trend	Yes	Yes	Yes
LR coefficient	–0.515	–0.426	– 0.158
Observations	3,962	1,608	2,354
R-squared	0.132	0.176	0.151

Note: Dependent variable: Δly; standard errors in parentheses; significance levels: ** p<0.01, * p<0.05, † p<0.1; all standard errors reported are the normal standard errors.

countries, conflict experience, natural resource dependence, ODA receipts, and political institutions. Disaggregation into subsamples takes concerns regarding group heterogeneity and nonlinearity into account.

Classification of countries as developed or developing, and into income groups, is taken from the World Bank's WDI database. Developed countries are coded with a numerical value of one; all remaining countries received a value of zero. To balance the sample sizes of the different income groups, the categories of low and low-middle income countries were combined into a single low-income category. High-middle income countries were defined as middle-income countries. The category of high-income countries remains unchanged. The armed conflict indicator differentiates between civil and interstate wars. Natural resource abundance, measured by mineral exports as a share of total exports, uses data from Haglund and the UNCTADstat database. A combined measure of fuel and nonfuel minerals indicates whether a country is natural resource dependent. A country is considered mineral dependent if its mineral exports constitutes over 25 percent of total exports. ODA data is taken from the WB's WDI.[7]

The full sample of countries was initially divided into net ODA recipients and all others. Net receipts of aid are measured as a share of gross national income (GNI), and countries that received on average less than 0.1 percent of aid as a share of GNI are considered nonaid recipients. Finally, measures of political institutions use the polity variable extracted from the Polity IV database, ranging from –10 (high autocracy) to +10 (high democracy). To create an indicator variable consistent with the others, a country with a polity value of less than –3 is categorized as an autocratic state. Values between –3 and +3 (inclusive) are intermediate cases, and values of greater than +3 are seen as democratic states.[8]

Empirical results

The military expenditure and economic growth relation is estimated with a first-order dynamic model which can be written in the form:

$$\Delta lny_{it} = \gamma lny_{i,t-1} + \sum_{j=1}^{3} \beta_j \Delta lnx_{j,i,t} + \sum_{k=1}^{2} \alpha_k lnx_{k,i,t-1} + \eta_t + \mu_i + \nu_{it}, \text{ for } i = 1, 2, ..., N; t = 1, 2, ..., T,$$

where y is GDP per capita, x_1 is gross fixed capital formation as a share of GDP (to proxy investment), x_2 is military spending as a share of GDP, x_3 is the population growth rate (plus 0.05, or $n+g+\delta$). The reparameterized general first-order dynamic model is then estimated and results are shown in Table 2. All variables are in logs (l). The notation Δ represents the change in a variable, and a "1" following a variable name refers to a one-period lag. The dependent variable in all regressions is Δly, the change in the log of per capita GDP.

Table 3: Growth effects of military expenditure—development stratifications

	1960–2014			*1988–2010*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Sample	*All*	*Dev*	*Non-Dev*	*All*	*Dev*	*Non-Dev*
Variables	*Δly*	*Δly*	*Δly*	*Δly*	*Δly*	*Δly*
Δlk	0.085**	0.175**	0.077**	0.070**	0.213**	0.059**
	(0.005)	(0.011)	(0.057)	(0.006)	(0.014)	(0.007)
Δlm	–0.032**	–0.101**	–0.027**	–0.027**	–0.018**	–0.027**
	(0.004)	(0.089)	(0.005)	(0.005)	(0.006)	(0.006)
lngdpop	0.024**	–0.057**	0.039**	–0.056**	–0.093**	–0.046**
	(0.005)	(0.008)	(0.006)	(0.009)	(0.013)	(0.011)
ly1	–0.033**	–0.021**	–0.034**	–0.089**	–0.044**	–0.091**
	(0.003)	(0.004)	(0.004)	(0.008)	(0.012)	(0.009)
lk1	0.030**	0.029**	0.028**	0.030**	0.023**	0.026**
	(0.003)	(0.005)	(0.003)	(0.005)	(0.009)	(0.006)
lm1	–0.017**	–0.012**	–0.018**	–0.017**	(0.009)	–0.018**
	(0.002)	(0.003)	(0.002)	(0.004)	(0.006)	(0.004)
Cons	–0.289**	0.034**	–0.539**	–3.406**	(0.044)	–4.459**
	(0.134)	(0.226)	(0.165)	(0.398)	(0.587)	(0.497)
Trend	Yes	Yes	Yes	Yes	Yes	Yes
LR coefficient	–0.515	–0.571	–0.529	–0.191	–0.097	–0.198
Observations	3,962	1,166	2,796	2,148	607	1,557
R-squared	0.132	0.352	0.126	0.14	0.375	0.143

Note: Dependent variable: *Δly*; standard errors in parentheses; significance levels: ** p<0.01, * p<0.05, † p<0.1; all standard errors reported are the normal standard errors.

Table 2 shows results for the full sample for the complete period, 1960–2014 in column 1. As in our 2015 study, the new estimations show a well-defined empirical model, with all the traditional growth variables statistically significant and of the expected signs. The change in log capital (*Δlk*) is positive and statistically significant, the log of the population growth rate (+ 0.05) is negative and statistically significant, and the long-run coefficient of military spending is negative, statistically significant, and almost three times larger than that found in our 2015 study.

Our 2015 study was also concerned with possible group heterogeneity and thus divided the sample into developed and developing countries. The results are similar, but while military spending in the long-run was insignificant for the developing country group (Table 3, column 5), this was not the case for the extended time period (column 2). In our new study reported here, military expenditure exerts statistically significant negative effects on per capita GDP growth for both the long and the short-run, and with generally larger coefficients.

Another issue addressed in our previous paper concerned the possibility of heterogeneity across income levels, maybe in the form of a nonlinear relation. Table 4 (next page) shows the estimation results when the countries were stratified into different income groups, low, middle, and high. Once again, the empirical growth model is generally well-specified for the extended sample, with coefficients of the expected sign. For all three income groups, the effect of military expenditure on growth is negative and statistically significant, both in the short and long-run. The main differences between the new and old data periods (i.e., 1960–2014 as compared to 1988–2010) are the size of the coefficients and the significant effect found for middle-income countries. For low-income countries, military expenditure had a larger negative coefficient in the earlier study, but for medium and high-income countries, the new estimates suggest the opposite. As for Table 3, the long-run coefficients for the 1960 to 2014 dataset shows military expenditure to have a substantially larger negative effect on growth than when the data is limited to 1988 to 2010.

Previous studies have found differences in the military spending–growth relation for countries in conflict and those that are not and this led us to stratify by conflict experience in our 2015 study. As with that study, the results in Table 5 do not support this. Irrespective of whether a country has experienced conflict, military expenditure exerts a statistically significant negative effect on economic growth in both the short and long-run and there is no difference when only countries that

Table 4: Growth effects of military expenditure—income stratifications

	1960–2014			*1988–2010*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Sample	*Low*	*Middle*	*High*	*Low*	*Middle*	*High*
Variables	*Δly*	*Δly*	*Δly*	*Δly*	*Δly*	*Δly*
Δlk	0.050**	0.139**	0.144**	0.003	0.163**	0.112**
	(0.007)	(0.010)	(0.010)	(0.010)	(0.011)	(0.013)
Δlm	–0.011*	–0.047**	–0.092**	–0.034**	–0.019**	–0.025**
	(0.005)	(0.007)	(0.009)	(0.009)	(0.008)	(0.007)
lngdpop	0.079**	–0.136**	0.062**	–0.026**	(0.021)	–0.083**
	(0.007)	(0.020)	(0.008)	(0.015)	(0.022)	(0.010)
ly1	–0.030**	–0.037**	–0.018**	–0.093**	–0.092**	–0.082**
	(0.006)	(0.007)	(0.004)	(0.013)	(0.013)	(0.013)
lk1	0.027**	0.034**	0.010*	0.014†	0.043**	0.021*
	(0.004)	(0.007)	(0.005)	(0.008)	(0.009)	(0.010)
lm1	–0.016**	–0.018**	–0.023**	–0.027**	(0.005)	–0.020**
	(0.003)	(0.003)	(0.004)	(0.006)	(0.006)	(0.007)
Cons	–0.968**	0.718**	1.122**	–4.455**	–5.476**	(0.609)
	(0.209)	(0.296)	(0.261)	(0.673)	(0.790)	(0.635)
Trend	Yes	Yes	Yes	Yes	Yes	Yes
LR coefficient	–0.533	–0.486	–0.529	–0.29	–0.054	–0.244
Observations	1,485	1,081	1,396	831	638	695
R-squared	0.178	0.219	0.279	0.128	0.345	0.257

Note: Dependent variable: *Δly*; standard errors in parentheses; significance levels: ** p<0.01, * p<0.05, † p<0.1; all standard errors reported are the normal standard errors.

have experienced civil conflict are selected (columns 3 and 6). While our 2015 study found military spending to be marginally more harmful for countries in conflict as compared to those not in conflict, with the extended data, military spending in nonconflict countries has a higher adverse effect. Warranting further investigation, this is an intriguing result which points to the potential role that security plays in the military expenditure–economic growth relation.[9]

Finally, Table 6 shows the results across countries with differences in natural resource abundance, ODA receipts, and political institutions. Since the coefficients of the general Solow control variables remained consistent throughout these stratifications, only the coefficients of interest—military spending in the short and long-run—are reported. For natural resource dependence, the UNCTADstat data were used to divide the full sample into 37 resource dependent countries and 60 that are not. As in our 2015 study, military expenditure has negative, statistically significant short and long-run effects on growth. Once more, the coefficients are more negative when the extended data series is used. The results also suggest that military expenditure has negative, statistically significant short and long-run effects on per capita GDP growth, irrespective of whether a country receives foreign development aid or not. Finally, in regard to political institutions, use of the new SIPRI data suggests that economic growth is hampered in countries with all types of political institutions, albeit with the largest impact occurring for intermediate or transitional states.

All in all, with more than 20 stratification runs, the empirical result is clear. Irrespective of country subgroups or sample periods, military expenditure consistently exerts an adverse effect on economic growth and adding the new data points to our study only strengthens this conclusion.

Conclusion

Due to the important influence such spending has on security and the potential for violent conflict, the economic impact of military spending on economic growth is a question of great concern to developed and developing countries alike. The launch of the revised and extended SIPRI data provides a valuable means of checking the robustness of prior research findings. This article reestimated the empirical models of our 2015 study, which used data for 1988-2010, with the extended data for 1960–2014. Given the running down of the cold war confrontation in the mid-1980s, this could be considered as adding in cold war-period data points. Our results suggest no evidence of a structural break in the time series and generally

Table 5: Growth effects of military expenditure—conflict stratifications

	1960–2014			*1988–2010*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Sample	*Conflict*	*Nonconflict*	*Civil conflict*	*Conflict*	*Nonconflict*	*Civil conflict*
Variables	*Δly*	*Δly*	*Δly*	*Δly*	*Δly*	*Δly*
Δlk	0.086**	0.083**	0.082**	0.045**	0.087**	0.046**
	(0.008)	(0.006)	(0.008)	(0.010)	(0.008)	(0.010)
Δlm	–0.023*	–0.040**	–0.022**	–0.028**	–0.025**	–0.027**
	(0.006)	(0.005)	(0.006)	(0.007)	(0.007)	(0.008)
lngdpop	0.060**	–0.047**	0.066**	–0.036**	–0.075**	–0.029**
	(0.007)	(0.008)	(0.008)	(0.013)	(0.012)	(0.014)
ly1	–0.040**	–0.029**	–0.038**	–0.118**	–0.067**	–0.107**
	(0.006)	(0.003)	(0.006)	(0.013)	(0.009)	(0.014)
lk1	0.039**	0.023**	0.037**	0.030**	0.029**	0.029*
	(0.005)	(0.003)	(0.005)	(0.008)	(0.006)	(0.009)
lm1	–0.015**	–0.022**	–0.017**	–0.021**	–0.018**	–0.019**
	(0.003)	(0.002)	(0.003)	(0.005)	(0.005)	(0.005)
Cons	–0.766**	0.348**	–0.824**	–5.897**	–1.450**	–5.998**
	(0.216)	(0.189)	(0.231)	(0.606)	(0.550)	(0.678)
Trend	Yes	Yes	Yes	Yes	Yes	Yes
LR coefficient	–0.385	–0.759	–0.447	–0.178	–0.269	–0.178
Observations	1,632	2,330	1,472	775	1,389	695
R-squared	0.159	0.156	0.166	0.193	0.138	0.257

Note: Dependent variable: *Δly*; standard errors in parentheses; significance levels: ** p<0.01, * p<0.05, † p<0.1; all standard errors reported are the normal standard errors.

Table 6: Growth effects of military expenditure—other stratifications

	1960–2014			*1988–2010*		
Sample	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Variables	*Δlm*	*lm1*	*LR coeff.*	*Δlm*	*lm1*	*LR coeff.*
Nat. resource	-0.026**	-0.022*	-0.361	-0.021**	-0.011*	-0.083
No nat. resource	-0.041**	-0.015**	-0.600	-0.028**	-0.021**	-0.328
ODA	-0.024**	-0.017**	-0.548	-0.028**	-0.018**	-0.170
No ODA	-0.092**	-0.024**	-1.412	-0.023**	-0.016*	-0.246
Autocratic	-0.026*	-0.022**	-0.333	-0.027†	-0.008	-0.114
Intermediate	-0.038**	-0.024**	-0.414	-0.052**	-0.041**	-0.318
Democratic	-0.031**	-0.014**	-0.666	-0.012*	-0.008*	-0.113

Note: Dependent variable: *Δly*; standard errors in parentheses; significance levels: ** p<0.01, * p<0.05, † p<0.1.

give consistent findings across the two samples, with military spending exerting clear, strong, and uniformly negative short and long-run effects on growth, and especially so over the longer time period. Consistent across sample stratifications, this provides further evidence of the robustness of the results already found for the more limited time series: In general, military spending has a negative effect on economic growth.

Notes

1. Consistent data: See Perlo-Freeman and Skons (2016). Limited coverage: Dunne and Tian, (2013).

2. Early studies: See, e.g., Ram (1995); Dunne (1996); Smith (2000). Later studies: See, e.g., Dunne and Tian (2013); Alexander (2013); Compton and Paterson (2015). Changes in geopolitical environment: SIPRI (2014). Diverting resources have been found: Gleditsch, *et al*. (1996).

3. Our previous study: Dunne and Tian (2015).

4. Our recent survey pieces: Dunne and Tian (2013; 2015). Earlier surveys: Dunne (1996); Smith (2000). Vested interests: Dunne (1996). Opportunity costs: Dunne, Smith, and Willenbockel (2005).

5. Seminal work: Benoit (1973). Earlier suggestion: Dunne and Uye (2010). Meta analysis: Alptekin and Levine (2012).

6. Dunne, Smith, and Willenbockel (2015); Dunne and Tian (2015).

7. Natural resource-abundance data: Haglund (2011); UNCTADstat database: http://unctadstat.unctad.org/EN/.

8. See Dunne and Tian (2015) for a full description of the various indicator variables.

9. Previous studies: Smaldone (2006).

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