The impact of military spending on economic growth: A threshold regression analysis

Banerjee, Anindya and Karavias, Yiannis and Wang, Lijun

University of Birmingham, Birmingham, Department of Economics and Finance, Brunel University London, Tsinghua University

25 May 2023

Highlights

The Impact of Military Spending on Economic Growth: A Threshold Regression Analysis.

Anindya Banerjee, Yiannis Karavias, Lijun Wang

- The aim of this paper is to estimate the relationship between economic growth and military spending and also to shed light on why most NATO countries are unwilling to increase their military expenditures.
- The contribution of the present paper is that it formally addresses two key issues that plague previous research; nonlinearity and endogeneity.
- The findings of the paper indicate a significant heterogeneity between NATO and non-NATO countries.

The Impact of Military Spending on Economic Growth: A Threshold Regression Analysis.

Anindya Banerjee[a], Yiannis Karavias[b], Lijun Wang[c,*]

[a] *University of Birmingham, Birmingham, B15 2TT, UK*
[b] *Department of Economics and Finance, Brunel University London, London, UB83PH, UK*
[c] *Tsinghua University, Beijing, 100084, China*

Abstract

The question of how military spending affects economic growth has never been more pressing than in the past 30 years, given the rising geopolitical tensions across the globe. Yet the answer to this question has proven elusive, mostly due to two salient characteristics of the data which are present at the same time: endogeneity and nonlinearity. This paper utilises a state of the art panel data threshold regression model that allows for both features, simultaneously. We find that for the full sample of countries the relationship between military spending and economic growth is positive up to the estimated threshold of 2.017% of GDP, and then becomes significantly weaker. For NATO countries however, the relationship is always negative, which explains the reluctance to follow the treaty's minimum military spending requirements.

Keywords: Military spending, economic growth, NATO, panel data, threshold regression, endogeneity.

JEL classification: H56, C23, C24

*Corresponding author. E-mail: lijunwang@mail.tsinghua.edu.cn. Tsinghua University, Beijing, 100084, China

1. Introduction

In July 2018, the former U.S president Donald Trump pressured all North Atlantic Treaty Organization (NATO) countries should increase defence spending to meet their 2% commitment, and suggested that this should ultimately be increased to 4%, (Reuters 2018). Trump's push for an increase in NATO member's spending over the years of his presidency brought the relationship between military spending and economic growth into the spotlight. The question became even more pertinent after Russia's 2022 invasion of Ukraine, the 2023 war in Israel and the tensions in the Red Sea, and large military spending programs such as Zeitenwende, Germany's biggest rearmament since World War II.

The aim of this paper is to estimate the relationship between economic growth and military spending and also to shed light on why most NATO countries are unwilling to increase their military expenditures.

There is a large body of theory examining the effects of military spending. Peace and security are significant factors for sustainable domestic production. Thompson (1974) suggests that poorer countries spend less for their defence and this leads to higher security risks and in turn to a less developed economy. Additionally, military spending can be seen as investment in public infrastructure and human capital which should promote economic growth (Yakovlev (2007)). Finally, Dunne et al. (2005) argue that military spending contributes to the advancement of technology and increase of human capital. On the other hand, military spending can lead to investments in excessive weaponry which can be used in promoting revisionism and conflict, instead of effective national security protection (Kentor and Kick (2008)). Furthermore, military investments can crowd-out the civilian sector, which translates in reductions in the necessary public service inputs (Mylonidis (2008)).

The existence of factors pushing in different directions suggests that the prevailing sign of the relationship is an empirical matter, and that it may vary depending on the level of military spending. Several papers use linear models and find either a positive or a negative relationship, see e.g. Benoit (1978), Brumm (1997), Daddi et al. (2018), d'Agostino et al. (2011), d'Agostino et al. (2019), Ciccone (2011), Antonakis (1997a) and Antonakis (1997b). Stroup and

Heckelman (2001) find an inverse "U"-shaped curve, with the relationship switching sign if military spending is greater than 6.8% or 8.32% of GNP, which as the authors state, is an outlier when compared to the data.

The contribution of the present paper is that it formally addresses two key issues that plague previous research; nonlinearity and endogeneity. In doing so, it improves two key aspects of the estimation methodology. First, the nonlinearity is captured by a threshold regression model, which is more flexible than quadratic models employed previously, because it does not impose a specific form of curvature. As such, it benefits from super-consistent rates of convergence for the threshold parameter estimator. Second, we simultaneously address the issue of endogeneity by exploiting the time structure of the data as in Arellano and Bond (1991). Seo and Shin (2016) derive the asymptotic theory for the panel threshold model with endogenous regressors employed here.

The headline finding is that for the full sample, military spending has a nonlinear relationship with economic growth. The relationship is positive until military spending reaches 2.017% of GDP, and then it remains positive but becomes significantly weaker. For non-NATO countries, the threshold is estimated to be 3.407% which is higher, but which seems reasonable given that these countries are not part of a large-scale military alliance. For NATO countries, the relationship is negative and it becomes even more negative after the threshold of 1.609%. In other words, NATO countries do not benefit from increasing military spending. In the discussion below we offer a possible explanation of the result.

The remainder of the paper is organised as follows. Section 2 presents the threshold regression model and the estimation method. Section 3 contains the regression results, and Section 4 offers a discussion of the results and concludes the article.

2. Model and Estimation Methodology

The panel threshold regression model which we consider is:

$$\Delta y_{i,t} = (\rho - 1) y_{i,t-1} + \beta_1 m_{i,t} I(m_{i,t} \leq \gamma) + \beta_2 m_{i,t} I(m_{i,t} > \gamma) + \delta' x_{i,t} + \mu_i + \nu_t + u_{i,t}$$

where $i = 1, ..., N$, is the number of countries and $t = 1, ..., T$, is the number of time series observations. The scalar dependent variable is $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$ and $m_{i,t}$ is a scalar independent variable whose slope coefficient alternates between β_1 and β_2 according to the indicator function $I(\cdot)$. The parameter ρ signifies growth convergence while γ is the threshold. The remaining controls appear in the $p \times 1$ vector $x_{i,t}$, while δ is a conformable vector of slope coefficients. Finally, μ_i and ν_t are the unobserved individual and time effects and $u_{i,t}$ is the idiosyncratic error term.

In the application below, $y_{i,t}$ is the logarithm of per capita GDP ($logGDPc$) measured in 2010 prices, $m_{i,t}$ is military spending as a percentage of GDP (M/Y), and $x_{i,t}$ includes gross capital formation (GCF), inflation ($INFL$), trade openness ($OPEN$), and the logarithm of population (POP). The model specification follows standard macroeconomics, see e.g. Asimakopoulos and Karavias (2016).

The key characteristics of the above model are as follows. First, it allows current economic growth to be affected by past economic growth and past choices of military spending and the rest of the regressors through $y_{i,t-1}$. Second, it allows for a piecewise linear relationship between military spending and economic growth, and the threshold is based on the level of military spending. Third, it absorbs unobserved country heterogeneity which is not time-varying and aggregate common shocks which affect all countries. The errors $u_{i,t}$ are assumed to be contemporaneously exogenous, homoskedastic and uncorrelated in time. These are standard assumptions for the popular Arellano and Bond (1991) framework.

Despite capturing several omitted variables with the fixed and time effects, the regressors $m_{i,t}$ and $x_{i,t}$ are still endogenous, given that they are formed in equilibrium with economic growth, see e.g. Bazzi and Clemens (2013). We deal with endogeneity by employing lagged values of the regressors as instruments, as it is frequently done in growth regressions. Due to their lag, the instruments are correlated with the regressors at time t, but are also predetermined and not part of the equilibrium.

The "internal" instruments methodology employed here has the drawback that instruments can be weak in the presence of persistent (near-nonstationary) regressors. The solution to this problem is to use an additional set of moments, leading to the so called "System GMM" of Blundell and Bond (1998). However, high persistence is not a problem in our data because we take five-year averages as we explain below. Therefore, we use only the Arellano and Bond (1991) moment conditions. This estimator is frequently called the "difference GMM" in the literature.

The estimation is described in detail in Seo and Shin (2016). Briefly, if γ is known, model (2) is linear in parameters and can be estimated by GMM as in Arellano and Bond (1991) and Blundell and Bond (1998). However, since γ is unknown, we must iterate over every possible value of γ. Military spending takes values $\gamma \in \Gamma$, where Γ has at most NT distinct values (in practice less, given that we trim Γ of its 2.5% first and last observations), and therefore the iteration can happen at most NT times. At every iteration, a value of γ is chosen from a grid made by discretizing the trimmed Γ into 400 points, and for this γ, equation (2) is estimated to get $\hat{\phi}(\gamma) = (\hat{\rho}(\gamma), \hat{\beta}_1(\gamma)', \hat{\beta}_2(\gamma)', \hat{\delta}(\gamma)')'$ and the sum of squared residuals SSR(γ). Then, $\hat{\gamma} = argmin_{\gamma \in \Gamma} SSR(\gamma)$, and based on $\hat{\gamma}$ we recover the rest of the coefficients as $\hat{\phi}(\hat{\gamma}) = (\hat{\rho}(\hat{\gamma}), \hat{\beta}_1(\hat{\gamma})', \hat{\beta}_2(\hat{\gamma})', \hat{\delta}(\hat{\gamma})')'$.

To remove the effect of business cycles we also follow the standard convention in the literature and use five-year averages of the data, see e.g Panizza and Presbitero (2013). This effect reduces T to 6, and additionally helps the GMM estimator with its small sample properties as it reduces the number of instruments (see e.g. Roodman (2009)). Still, the desired number of instruments depends on the number of regressors and the number of countries N, and this leads us to further reduce the instrument count by employing only the first four lagged differences as internal instruments. This again is in line with the literature, see e.g. Levine et al. (2000) who employ only the first three lags. Finally, we also present the Sargan test of overidentifying restrictions which acts as a general specification test.

3. Results

Table 1 presents the estimation results of model (2), and the first column contains the results for the full sample of countries. We find a nonlinear relationship, which is positive in the

Table 1: Dynamic Panel Threshold Regression Estimation Results

Sample	All Countries	Non-NATO	NATO
Threshold	2.017***	3.407***	1.609*
	(0.031)	(0.085)	(0.893)
95% CI	[1.956 , 2.078]	[3.240 , 3.574]	[-0.141 , 3.359]
M/Y β_1	0.067***	0.042***	-0.136**
	(0.004)	(0.007)	(0.064)
M/Y β_2	0.008***	0.008**	-0.208***
	(0.003)	(0.004)	(0.045)
Lag $logGDPc$	-0.173***	-0.170***	-0.435***
	(0.011)	(0.017)	(0.085)
$INFL$	-0.001***	-0.001***	0.0001
	(0.000)	(0.000)	(0.0006)
POP	-0.022	-0.113***	-0.750**
	(0.019)	(0.029)	(0.364)
GCF	0.012***	0.010***	0.010*
	(0.000)	(0.000)	(0.006)
$OPEN$	0.0003***	0.0009***	0.001*
	(0.0001)	(0.0001)	(0.0007)
Sargan Test P-val	0.999	1.000	1.000
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	No
Observations	468	384	84
Number of countries	78	64	14

Notes: The dependent variable is economic growth. $Lag\ logGDPc$ is the logarithm of per capita GDP lagged once, M/Y denotes military spending, GCF is gross capital formation, $INFL$ is inflation, $OPEN$ is trade openness and POP is the logarithm of population.

low regime with $\beta_1 = 0.067$ and almost non-existent in the high regime with $\beta_1 = 0.008$. The interpretation is that if the average annual military spending (because all variables are in five-year averages) increases by 1% of GDP, the average annual economic growth will increase by 0.067 percentage points in the low regime and by 0.008 percentage points in the high regime. The threshold for military spending is estimated at 2.017% of GDP, where incidentally, 2% is the spending requirement for NATO members. Looking at the data, most observations are on the low regime (267 out of 468), while the remaining are in the high regime.

The second column repeats the estimation for the 64 non-NATO countries and it confirms the previous relationship. A key difference is that the threshold is estimated to be higher, at 3.407%. This seems reasonable given that non-NATO countries do not benefit from being members of a large military alliance. In this case, there are 321 observations below the threshold and 64 above.

The third column contains the results for the NATO countries. Because the sample is small with only 14 countries, to reduce the number of instruments we did not include time fixed effects. The results show a piece-wise linear relationship which is negative, characterised by a slope of -0.136 until the threshold, and then it becomes even more negative, with a coefficient of -0.208. The threshold is estimated at 1.609% and there are 30 observations below the threshold and 54 above.

The remaining variables have consistent signs across the three specifications. The coefficient of Lag $logGDPc$ is away from zero, indicating weak persistence in the series and thus strong instruments, and in line with much of the literature GCF and $OPEN$ have a positive effect, while $INFL$ and POP have a negative.

The Sargan tests in all cases are close to 1 which can be due to the number of instruments employed. To examine the behaviour of the Sargan test we estimated the above models with smaller numbers of instruments, as small as 28 when only the set of first lag instruments is used. The Sargan tests in these cases drop below 1 but never reject the specification.[1]

[1] We thank an anonymous referee for this comment.

4. Discussion and Conclusions

Overall, the findings suggest that military spending expenditures affect the economy through the channels of external and internal security. This is evident as military spending is a necessary good only for non-NATO countries and not for NATO countries. Non-NATO countries must spend more on military affairs in order to maintain their external borders and ensure stable growth of national production. Military spending indirectly affects the economy mostly by reducing the risk of conflict, see e.g. Rahman and Siddiqui (2019).

On the other hand, it seems that NATO endows its members with significant political influence and external protection. The article 5 states that if one member is attacked, the whole alliance will come to its defence. Additionally NATO members have high degrees of internal stability because to join the alliance they must already have democracy and tolerate diversity. As such, NATO countries are better off investing elsewhere, than in the military.

References

ANTONAKIS, N. (1997a): "Defence spending and growth in Greece: a comment and further empirical evidence," Applied Economics Letters, 4, 651–655.

——— (1997b): "Military expenditure and economic growth in Greece, 1960-90," Journal of Peace research, 34, 89–100.

ARELLANO, M. AND S. BOND (1991): "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations," The review of economic studies, 58, 277–297.

ASIMAKOPOULOS, S. AND Y. KARAVIAS (2016): "The impact of government size on economic growth: A threshold analysis," Economics Letters, 139, 65–68.

BAZZI, S. AND M. A. CLEMENS (2013): "Blunt Instruments: Avoiding Common Pitfalls in Identifying the Causes of Economic Growth," American Economic Journal: Macroeconomics, 5, 152–186.

BENOIT, E. (1978): "Growth and defense in developing countries," Economic development and cultural change, 26, 271–280.

BLUNDELL, R. AND S. BOND (1998): "Initial conditions and moment restrictions in dynamic panel data models," Journal of econometrics, 87, 115–143.

BRUMM, H. J. (1997): "Military spending, government disarray, and economic growth: a cross-country empirical analysis," Journal of Macroeconomics, 19, 827–838.

CICCONE, A. (2011): "Estimating the effect of transitory economic shocks on civil conflict," .

DADDI, P., G. D'AGOSTINO, AND L. PIERONI (2018): "Does military spending stimulate growth? An empirical investigation in Italy," Defence and peace economics, 29, 440–458.

D'AGOSTINO, G., J. P. DUNNE, AND L. PIERONI (2011): "Optimal military spending in the US: A time series analysis," Economic Modelling, 28, 1068–1077.

DUNNE, J. P., R. P. SMITH, AND D. WILLENBOCKEL (2005): "Models of military expenditure and growth: A critical review," Defence and peace economics, 16, 449–461.

D'AGOSTINO, G., J. P. DUNNE, AND L. PIERONI (2019): "Military expenditure, endogeneity and economic growth," Defence and Peace Economics, 30, 509–524.

KENTOR, J. AND E. KICK (2008): "Bringing the military back in: Military expenditures and economic growth 1990 to 2003," Journal of World-Systems Research, 142–172.

LEVINE, R., N. LOAYZA, AND T. BECK (2000): "Financial intermediation and growth: Causality and causes," Journal of monetary Economics, 46, 31–77.

MYLONIDIS, N. (2008): "Revisiting the nexus between military spending and growth in the European Union," Defence and Peace Economics, 19, 265–272.

PANIZZA, U. AND A. F. PRESBITERO (2013): "Public Debt and Economic Growth in Advanced Economies: A Survey," Mo.Fi.R. Working Papers 78, Money and Finance Research group (Mo.Fi.R.) - Univ. Politecnica Marche - Dept. Economic and Social Sciences.

RAHMAN, T. AND D. A. SIDDIQUI (2019): "The effect of military spending on economic growth in the presence of arms trade: A global analysis," Available at SSRN 3401331.

REUTERS (2018): "Trump tells NATO leaders to increase defense spend to 4 percent," .

ROODMAN, D. (2009): "A Note on the Theme of Too Many Instruments*," Oxford Bulletin of Economics and Statistics, 71, 135–158.

SEO, M. H. AND Y. SHIN (2016): "Dynamic panels with threshold effect and endogeneity," Journal of Econometrics, 195, 169–186.

STROUP, M. D. AND J. C. HECKELMAN (2001): "Size of the military sector and economic growth: A panel data analysis of Africa and Latin America," Journal of Applied Economics, 4, 329–360.

THOMPSON, E. A. (1974): "Taxation and national defense," Journal of political economy, 82, 755–782.

YAKOVLEV, P. (2007): "Arms trade, military spending, and economic growth," Defence and peace economics, 18, 317–338.