

# A Nonlinear Growth Effect of Fiscal Policy? The Special Case of US Defense Policy

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## Abstract

The impact of US defense policy (proxied by the expenditures in the defense sector) is investigated empirically using longitudinal data for the US and allowing the effect of defense spending on growth to be nonlinear. Using recently developed econometric methods involving threshold regressions, evidence of a level-dependent effect of military expenditure on GDP growth is found: the positive externality effect of defense spending prevails for relatively lower levels of defense spending (with respect to the history of defense spending in the US) and reverts for higher levels.

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# 1 Introduction

The terrorist attacks against the US in September 2001 have once more intensified the discussion about whether higher defense expenditure is necessary to provide a greater degree of security, thereby inducing confidence and stimulating economic growth. As Deger and Sen (1995) note, the fact that from a purely economic point of view the military burden is seen as the quintessential unproductive expenditure (except as insurance against war) would suggest that its impact on output growth is negative. Until the influential work of Benoit (1973), practically all economic theorists had assumed the macroeconomic impact of defense expenditure to be nonpositive, although no empirical evidence was presented in this respect. However, even if defense spending<sup>1</sup> had an adverse effect on current economic growth, this does not necessarily imply that such expenditure is harmful or too high because defense spending does entail the confidence effect mentioned above. The impact of defense expenditure on GDP growth is thus not clear-cut and deserves detailed empirical analysis in order to discern which (if any) of the effects prevails: Does defense expenditure have an externality effect for an economy, especially in regard to infrastructure, technological progress and human capital formation or does it crowd out resources for consumption and investment, thereby hampering growth?

The question is of extreme relevance in the context of the US economy, as defense expenditure constitutes the major “piece of the cake” of discretionary government expenditure. According to the Center for Defense Information (2002), the “National Defense” category of the federal budget for the financial year 2003 accounts for over half (51.6 percent or USD 396 billion out of USD 767 billion) of all discretionary spending as compared to 6.7 percent for education or 5.3 percent for health. Since one goal of the government is to promote the general living standard and thus stimulate growth, it is only legitimate to ask why defense expenditure is much higher than education or health spending – or, in other words, whether defense expenditure has an externality effect that can make up for the hypothesized crowding out of resources in the health and education sector.

However, the political argument that defense expenditure may stimulate growth and, vice versa, that defense spending cutbacks may have negative economic implications has been particularly popular in the US and may be partly explained by the strong influence of the military-industrial complex in political decisions. One claim of advocates of an extensive military policy is that reduced defense spending drives up unemployment (see Smith 1977).<sup>2</sup> For example,

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<sup>1</sup>The terms *defense expenditure*, *defense spending*, *military expenditure* and *military spending* will be used as synonyms throughout the paper.

<sup>2</sup>For an extensive investigation of the employment effect of defense expenditure see Dunne and Smith (1990). Using data for eleven OECD countries, they found that the share of defense expenditure had no significant influence on the unemployment rate and concluded that the fear that reductions in the share of military expenditure would be associated with

Adams and Gold (1987) quote former US Secretary of Defense Caspar Weinberger as having argued that reductions in defense expenditure would create substantial unemployment because military spending is labor intensive. Other advocates of high defense expenditure stressed the fact that military expenditure serves as a (Keynesian) device to shorten the demand-supply gap (as in World War II), a phraseology Nixon and Reagan repeatedly used (see Galbraith 1994).

Econometric investigations of the effect of defense spending on economic growth in the US have mostly been based on supply-side specifications such as, *inter alia*, those of Atesoglu and Muller (1990), Huang and Mintz (1990, 1991), Mintz and Huang (1990), Muller and Atesoglu (1993) or Ward and Davis (1992). More recently, Atesoglu (2002) used cointegration methods to assess the defense-growth nexus in the US, concluding that a positive relationship existed between military expenditure and GDP growth. What these studies have in common is that they (a) do not comprise the World War II period, even though this was the period with the highest level of defense expenditure in the twentieth century and (b) neglected the possibility that the impact of defense expenditure on growth could be nonlinear.

The aim of this paper is to contribute to the discussion on the impact of defense spending on GDP growth in the US by estimating two fairly general models relating both variables in the spirit of, e.g., Deger (1986) and Biswas and Ram (1986). The possibility that the relationship between defense expenditure and growth could be nonlinear is also explicitly considered and modeled in each of the alternative settings. The results indicate that a level-dependent (and therefore nonlinear) relationship exists between defense expenditure and GDP growth, with the partial correlation between the growth rate of defense spending and GDP growth significantly positive only for levels of defense spending under an estimated threshold. Such a significant relationship disappears, however, for higher levels of defense spending. When the pure externality effect is identified using a theoretically based empirical specification, it is significantly negative for relatively high values of military spending and significantly positive for low levels.

The remainder of the paper is organized as follows: Section two presents a simple growth model which, in due course, is empirically estimated. In a next step, the straightforward nonlinear generalization of the model is presented and estimated. Section three approaches the relationship between growth and defense spending with an alternative modeling strategy based on Biswas and Ram (1987) in order to isolate the externality effect of military spending. Section four concludes.

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higher average unemployment levels is misplaced. The results of Dunne and Smith (1990) are contrary to those of Hooker and Knetter (1997) who found that changes in procurement spending significantly affect unemployment in those U.S. states which are heavily dependent on the military sector.

## 2 Growth and Defense Spending in the US

### 2.1 A Linear Growth Equation

A simple theoretical representation of the relationship between defense spending and GDP growth can be obtained using a generalization of the neoclassical growth equation (see, e.g. Solow, 1956). Growth in GDP will be hypothesized to depend on the growth rate of savings, labor force, exports and military spending. While the growth-savings and growth-labor dependence stems from conventional growth theory,<sup>3</sup> export growth is included in order to assess the effect of the external market on domestic production (see e.g. Balassa, 1978, and Feder, 1982). As suggested by Benoit (1973) and subsequent research, it is hypothesized that growth could be influenced by defense expenditure. The linear baseline model to be estimated is thus,

$$y_t = \beta_0 + \beta_1 s_t + \beta_2 l_t + \beta_3 x_t + \beta_4 d_t + \epsilon_t, \quad (1)$$

where  $y_t$  refers to the growth rate of GDP,  $s_t$  is the growth rate of savings,  $l_t$  is the growth rate of the labor force,  $x_t$  is the growth rate of exports,  $d_t$  is the growth rate of defense expenditure and  $\epsilon_t$  is assumed to be a Gaussian white noise error process with constant variance  $\sigma^2$ .<sup>4</sup>

Equation (1) is estimated using annual U.S. data ranging from 1929 to 1999.<sup>5</sup> The first column in Table 1 presents the estimated parameters in (1) using OLS. Almost 88% of the variation in GDP growth is explained by the independent variables. A positive, highly significant partial correlation is found between all explanatory variables and GDP growth. The Durbin Watson test statistic (DW) does not present strong evidence of deviations of uncorrelation in the residuals, and the Jarque-Bera test statistic -  $\chi^2$  - distributed under the null of normality - takes a value of 5.934, so we cannot reject the null that the residuals are normally distributed at a 5% significance level. White's heteroskedasticity test does not show any significant deviation from homoskedasticity in the residuals. Although this result may give a first indication of a positive nexus between economic growth and defense spending, the potential endogeneity of the explanatory variables in (1) would render the OLS estimates inconsistent. The

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<sup>3</sup>In order for our model to provide a parsimonious and simple framework to test for non-linearity, we will drift away from endogenous growth theory and thus we will abstract from such issues as modelling technological progress.

<sup>4</sup>The augmented Dickey-Fuller test cannot reject the null hypothesis of unit root non-stationarity at any reasonable significance level for the US data on all right-hand side variables in (1), so the first difference specification appears to be the appropriate one in this case. The results of the unit root test are available from the authors upon request.

<sup>5</sup>Data in constant 1998 prices from the Business Statistics Database, Bureau of Economic Analysis, U.S. Department of Commerce. The data are available from the authors upon request.

Table 1: Growth equation: linear specification

Variable	OLS: Estimated parameter (s.e.)	IV: Estimated parameter (s.e.)
Constant	0.007*** (0.003)	0.009*** (0.003)
$s_t$	0.062*** (0.016)	0.035* (0.018)
$l_t$	1.015*** (0.091)	1.047*** (0.118)
$x_t$	0.058*** (0.014)	0.058*** (0.015)
$d_t$	0.016*** (0.005)	0.022*** (0.006)
$\sigma$	0.020	0.018
$\bar{R}^2$	0.879	0.864
DW	1.712	2.072

\*\*\*(\*\*)[\*] stands for 1% (5%) [10%] significant, DW is the Durbin-Watson test statistic.

second column in Table 1 shows the estimated parameters if instrumental variable (IV) estimation is used. Lags of the explanatory variables and GDP growth are used as instruments. The IV estimates do not differ substantially from the OLS estimates, and indicate a positive partial correlation between GDP growth and growth in defense expenditure. The endogeneity problem, thus, does not seem to distort the estimates strongly.

## 2.2 The Nonlinear Counterpart

Practically all models applied to establish the effect of defense expenditure on growth in the U.S. have assumed a linear relationship between both variables. There is no piece of research, to the knowledge of the authors, which tests for the possibility of a nonlinear relationship. Some suggestions of a nonlinear defense-growth nexus can be found in Kinsella (1990) and Hooker and Knetter (1997). While Kinsella (1990) comments briefly on the possibility of a nonlinear effect of military spending on growth (of the type that is actually studied in this piece of research), Hooker and Knetter (1997) suggest that their results, namely that the unemployment multiplier of procurement is larger in states with higher levels of spending, could be due to a nonlinear effect of defense expenditure: as the size of the shock increases, the multiplier effect of the shock becomes larger. They also state that if the true relationship between defense and other variables such as growth is nonlinear, then models that assume a linear relationship may underestimate the response of these variables to large changes in defense spending.

The relationship defined by (1) does not allow for a nonlinear effect of defense spending on growth rate in the form of, for instance, a level-dependent parameter for the defense expenditure variable. A straightforward generalization that easily allows for a nonlinear growth-defense expenditure link and provides a convenient framework for testing for linearity is given by

$$y_t = \beta_0^i + \beta_1^i s_t + \beta_2^i l_t + \beta_3^i x_t + \beta_4^i d_t + \epsilon_t^i, \quad (2)$$

where  $\epsilon_t^i$  is assumed to be Gaussian white noise with constant variance  $\sigma^2$ , with  $\epsilon_t^i$  independent  $\epsilon_t^j$  of for  $i \neq j$ . The specification is, thus, piecewise-linear, and the level of total defense spending,  $D_t$ , is the variable which is responsible for the regime which is active. That is,

$$i = \left\{ \begin{array}{l} 1 \text{ if } D_t \leq \gamma \\ 2 \text{ if } D_t > \gamma \end{array} \right\} \quad (3)$$

The threshold parameter,  $\gamma$ , needs to be estimated as well. If  $\gamma$  were known, the estimation of  $\beta_k^i, k = 0, \dots, 4, i = 1, 2$  would be straightforward: the sample is divided into two subsamples, which are assigned label 1 and 2 according to (3), and the  $\beta$ -parameters are estimated for each subsample. The estimation of  $\gamma$  is done as follows (see Hansen 2000): a grid search is conducted on  $D_t$ , and (2) is estimated for every realized value of  $D_t$  after trimming some percentage on the tails of the distribution of  $D_t$ . The value of  $D_t$  corresponding to the model that minimizes the sum of squared residuals across all estimated models is the estimator of the threshold parameter.<sup>6</sup>

The grid search for the estimate of the threshold parameter was done after trimming 25% from the extremes of the empirical distribution of  $D_t$ . The estimated threshold is  $\hat{\gamma} = 384.77$  billion 1998 US Dollars, and it divides the sample into two groups: the data below the threshold comprises 44 observations, and the 26 remaining observations are over the threshold. The upper regime includes World War II, the Vietnam War and a substantial part of the Cold War period around 1980.

The threshold model provides an intuitive and simple setting for testing for linearity. In principle, the idea would be to test for  $\beta_k^1 = \beta_k^2 \forall k$ . However, this simple testing problem presents an extra difficulty given the fact that the threshold parameter,  $\gamma$ , is only identified under the alternative hypothesis of nonlinearity. The lack of identification of under the null hypothesis distorts the distribution of the otherwise standard F-statistic used in the testing problem. In the spirit of Andrews and Ploberger (1994), Hansen (1996, 2000) overcomes the problem by using a bootstrap procedure: using the estimated linear relationship, artificial data on the dependent variable is simulated and both a linear and a piecewise linear model with the estimated threshold are estimated using the simulated sample. The corresponding F-test statistic is computed and the procedure is repeated a large number of times, leading to an approximate distribution of the test statistic under the null of linearity. The percentage of replicated F-test statistics that exceed the original value of the test statistic computed with real data is thus the p-value of the linearity test.

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<sup>6</sup> See Hansen (1996, 2000) for the properties of this estimator.

Table 2: Growth equation: Nonlinear specification

Variable	Lower regime ( $D_t \leq \gamma$ )	Upper regime ( $D_t > \gamma$ )
	Estimated parameter (s.e.)	Estimated parameter (s.e.)
Constant	0.010*** (0.003)	-0.006 (0.005)
$s_t$	0.068*** (0.016)	0.037 (0.018)
$l_t$	0.890*** (0.104)	1.485*** (0.212)
$x_t$	0.094*** (0.027)	0.060*** (0.020)
$d_t$	0.019*** (0.005)	0.007 (0.012)
$\gamma$		384.77
$\sigma$		0.018
$\bar{R}^2$		0.879
DW		1.800
Linearity test	11.991 (p-value=0.070)	

\*\*\*(\*\*)[\*] stands for 1% (5%) [10%] significant, DW is the Durbin-Watson test statistic. 100,000 replications were used in the bootstrap for the linearity test.

Table 2 presents the estimated parameters from equation (2)–(3), together with the test statistic for linearity and the p-value resulting from the bootstrap method described above. The results indicate evidence of nonlinearity at the 7% significance level, and the adjusted  $R^2$  increases by more than 1 percentage point when the nonlinearity is taken into account. The significant partial correlation found between GDP growth and defense spending when estimating the linear model disappears for levels of defense expenditure above the estimated threshold in the case of the nonlinear specification. For values of defense spending below the threshold, the relationship does not appear to be significantly different from the one found in the linear model. The results of the estimation of the nonlinear model give a deeper insight into the trade-off between the potentially positive externality effect attributed to military spending and its widely hypothesized negative crowding-out effect. While positive externalities seem to prevail for moderate levels of defense expenditure, the positive effect of military spending on GDP disappears when the level of defense spending is relatively high.

### 3 A Production Function Based Model

While the results presented in the previous section give indications of a nonlinear relationship between defense spending and GDP growth, the specification used to test the effect of defense spending on growth and the hypothesis of linearity is relatively ad hoc. This section estimates a more theory-driven model based on the work of Feder (1982) and Biswas and Ram (1986). The model is

a simple two-sector neoclassical growth model with an economy composed of a civilian and a defense sector, which allows for an externality of defense output in the civilian sector. The model will be presented and the theoretical relationship between GDP growth and defense spending will then be estimated, allowing for level dependence in the effects of military spending on growth.

### 3.1 Growth and Defense Spending: a Factor Productivity Approach

Assume that the economy is composed of two sectors, the defense and the civilian sector. Let real output in the defense sector at time  $t$  be  $D(t)$ , and that in the civilian sector be  $C(t)$ . Furthermore, let us assume that labor ( $L(t)$ ) and capital ( $K(t)$ ) are the only inputs in each sector, that the relative marginal products of labor and capital may differ across the two sectors and that the size of the defense sector output ( $D(t)$ ) may act as an externality factor for the civilian sector

Consider the production functions of the two sectors,

$$C(t) = C(L_c(t), K_c(t), D(t))$$

and

$$D(t) = D(L_d(t), K_d(t))$$

where the lower case subscripts  $c$  and  $d$  denote sectoral inputs ( $L(t) = L_c(t) + L_d(t)$  and  $K(t) = K_c(t) + K_d(t)$ ), and total output in the economy ( $Y(t)$ ) is the sum of output in both sectors. The marginal productivities of the factors of production – labor and capital – in the defense sector may not be the same as in the civilian sector.<sup>7</sup> Allowance is made for this by assuming that the marginal productivity of factors used in the defense sector is equal to  $(1 + \delta)$  times the corresponding marginal factor productivity in the civilian sector, i.e.,

$$\frac{D_l}{C_l} = \frac{D_k}{C_k} = (1 + \delta)$$

where the subscripted letters refer to marginal products (assumed constant). If  $\delta$  is positive, factors of production have a larger marginal productivity in the defense sector and vice versa if  $\delta$  is negative. If  $\delta$  is zero, marginal productivities are equal across the two sectors.

Differentiating total output with respect to time and substituting  $dK(t)/dt$  by investment,  $I(t)$ , yields

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<sup>7</sup>Defense production is not completely physically separate from civilian production because a large portion of defense supplies and equipment is used for defense purposes. The distinction between defense and civilian sectors is a theoretical difference. Empirically, civilian output or spending is just the difference between real output and defense spending,  $C(t) = Y(t) - D(t)$ .

Table 3: Production function approach: linear specification

Variable	OLS: Estimated parameter (s.e.)	IV: Estimated parameter (s.e.)
Constant	-0.047*** (0.017)	-0.042* (0.024)
$\frac{I(t)}{Y(t)}$	0.358*** (0.093)	0.316** (0.133)
$\frac{dL(t)/dt/L(t)}{L(t)/Y(t)}$	0.035*** (0.003)	0.045*** (0.008)
$\frac{dD(t)/dt/D(t)}{D(t)/Y(t)}$	-0.052 (0.093)	0.253 (0.200)
$\frac{dL(t)/dt/L(t)}{L(t)/Y(t)}$	0.019 (0.017)	-0.051 (0.042)
$\sigma$	0.023	0.029
$\bar{R}^2$	0.828	0.717
DW	1.730	1.538

\*\*\*(\*\*)[\*] stands for 1% (5%) [10%] significant, DW is the Durbin-Watson test statistic.

$$\frac{dY(t)/dt}{Y(t)} = \alpha \frac{I(t)}{Y(t)} + \phi \frac{dL(t)/dt}{L(t)} \frac{L(t)}{Y(t)} + \varphi \frac{dD(t)/dt}{D(t)} \frac{D(t)}{Y(t)} \quad (4)$$

where  $\alpha = C_K$ ,  $\phi = C_L$  and  $\varphi = (\delta/(1+\delta) + C_d)$ . However, this specification only allows to test empirically whether both  $C_d$  and  $\delta$  are zero at the same time. In order to be able to test independently the significance of each parameter, the further assumption that the effect of defense expenditure on the civil sector has constant elasticity needs to be made. The resulting specification in this case is

$$\frac{dY(t)/dt}{Y(t)} = \alpha \frac{I(t)}{Y(t)} + \phi \frac{dL(t)/dt}{L(t)} \frac{L(t)}{Y(t)} + \varpi \frac{dD(t)/dt}{D(t)} \frac{D(t)}{Y(t)} + \theta \frac{dD(t)/dt}{D(t)} \quad (5)$$

where  $\varpi = \delta/(1+\delta) - \theta$ , that is the productivity differential across sectors (also referred to as the size effect of military spending) and  $\theta$  is the intersectoral externality parameter. Specification (5) allows the identification of the purely externality-driven effect of defense spending. Table 3 presents the estimation of the parameters of (5) using U.S. data.

The quality of the results does not vary if the instrumental variables estimation method is used. Although the estimated parameters corresponding to both defense variables in (5) change signs when the estimation method changes, they are in both cases insignificantly different from zero. The estimation, however, presents some evidence of first order autocorrelation in the residuals and deviation from normality (the Jarque-Bera statistic is 8.825). Although it could be argued that the lack of significance of the parameters corresponding to both defense variables is related to multicollinearity (see e.g. Huang and Mintz 1990), the estimation of specification (4), where such multicollinearity should not be present, also renders an insignificant estimate of  $\psi$ .

Table 4: Production function approach: Nonlinear specification

Variable	Lower regime ( $D_t \leq \gamma$ )	Upper regime ( $D_t > \gamma$ )
	Estimated parameter (s.e.)	Estimated parameter (s.e.)
Constant	-0.053*** (0.018)	-0.064* (0.034)
$\frac{I(t)}{Y(t)}$	0.371*** (0.115)	0.422** (0.189)
$\frac{dL(t)/dt/L(t)}{L(t)/Y(t)}$	0.033*** (0.002)	0.057*** (0.008)
$\frac{dD(t)/dt/D(t)}{D(t)/Y(t)}$	-0.823* (0.455)	0.136 (0.153)
$\frac{dL(t)/dt/L(t)}{L(t)/Y(t)}$	0.110** (0.049)	-0.111** (0.045)
$\gamma$	216.24	
$\sigma$	0.021	
$\bar{R}^2$	0.857	
DW	2.030	
Linearity test	14.545 (p-value=0.008)	

\*\*\*(\*\*)[\*] stands for 1% (5%) [10%] significant, DW is the Durbin-Watson test statistic. 100,000 replications were used in the bootstrap for the linearity test.

### 3.2 The Nonlinear Generalization

While based on the results of the estimation of the model given by (5) one could conclude that military expenditure seems to have no significant effect on economic growth, the conclusion changes radically if we allow for a nonlinear, level-dependent effect of defense spending on GDP growth. Table 4 presents the results of the estimation of the following generalization of (5),

$$\frac{dY(t)/dt}{Y(t)} = \alpha^i \frac{I(t)}{Y(t)} + \phi^i \frac{dL(t)/dt}{L(t)} \frac{L(t)}{Y(t)} + \varpi^i \frac{dD(t)/dt}{D(t)} \frac{D(t)}{Y(t)} + \theta^i \frac{dD(t)/dt}{D(t)} \quad (6)$$

where  $i = 1, 2$  stands for the regime that is active, and depends on the absolute value of real military spending as in (3).

The linearity test rejects the null of no threshold strongly (p-value = 0.008), and now the externality effect appears significant and positive for the regime below the threshold and negative and significant for the regime corresponding to defense expenditure over the threshold. The threshold parameter,  $\gamma$ , is estimated to be 216.24 billion 1998 U.S. Dollars, and the 95% confidence interval for  $\gamma$  includes the value of  $\gamma$  estimated for specification (2)–(3) above.<sup>8</sup> The nonlinear specification does not present significant deviations from whiteness in

<sup>8</sup>The 95% confidence interval is defined to be the values to the right and left of  $\gamma$  that reject the null of linearity at 5% significance level (see Hansen, 1996). That implies that the confidence interval could be asymmetric around  $\gamma$ . For the specification given above, the corresponding 95% confidence level is [135.82, 384.77].

the residuals (the Jarque-Bera statistic is 2.001), and increases the percentage of explained variance by approximately 3 percentage points with respect to the OLS alternative. While there is some weak evidence of a productivity differential between the civil and military sector for relatively lower values of defense spending, the evidence disappears in the upper regime. The externality effect appears positive and significant in the “low defense spending” regime and negative and significant in the “high defense spending” regime. Furthermore, the partial correlation is not significantly different in absolute value across regimes. The crowding-out effect thus seems to be relevant for higher (with respect to the estimated threshold) levels of defense spending, and it is overcome by a positive, growth-promoting effect in lower levels.

The results showing a negative size effect of defense spending on GDP growth in the lower regime, together with a positive externality effect, correspond to the findings of e.g. Ward and Davis (1992). However, the (significant) nonlinear specification gives a more general characterization of the relationship, as it allows in a relatively simple manner to account for level-dependent size and externality effects. Our results indicate that the size effect disappears in the regime with high defense expenditure and the externality effect reverts its sign, thus resulting in a growth-hampering effect of subsequent increases of military spending.

The question arises why defense spending is empirically found to have a positive growth effect under a certain threshold (in both models) and no significant or even a negative impact over that threshold (notwithstanding the negative and significant “size effect” of defense under the threshold in the sectoral model). One possible explanation is that up to a certain amount of defense spending, basic externalities such as infrastructural investment, new technologies or human capital formation overcome the potential crowding-out effect. When these needs are satisfied, the defense sector may carry out investment which is rather unproductive and at best will have no effect on the production of the civilian sector or, as our estimations show, could even hamper growth.<sup>9</sup>

Our results of a nonlinear relationship between defense and growth in the sense of a positive relationship up to a certain level which then reverts is confirmed by the theoretical papers such as Barro (1990) and Slemrod (1995). This strand of literature deals with growth effects of fiscal policy (which can be understood, amongst others, as defense expenditures) and postulates that an economy’s growth rate initially rises with the ratio of government expenditures, but the rate eventually reaches a peak and subsequently declines.

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<sup>9</sup>An interesting example of a potentially unproductive military investment which has received some treatment in recent times is the 60 billion USD B-2 Stealth Bomber (see Spinney 1996).

## 4 Conclusions and Further Paths of Research

The study performed considered the possibility of a nonlinear effect of military spending on growth. Using longitudinal data for the U.S. economy, the paper presents evidence of a level-dependent effect of defense expenditure on economic growth. Allowing for a nonlinear effect of defense spending on growth sheds a new light on the explanation of the characteristics of the defense-growth link, as well as on the quantification and nature of the externality effect of military expenditure. The results based on the nonlinear generalization indicate that while there is a positive externality effect and a negative size effect for low levels (relative to the estimated threshold) of defense spending, for high levels the externality effect reverts its sign and the size effect disappears. The political discussion on the effect of defense expenditure cutting may also benefit from taking into account for such nonlinearities such as the ones modeled in this study.

The quantitative results obtained using linear methods tend to show exclusively one distorted “side of the coin” of the defense-growth nexus. Given that the data strongly reject the linear specification, taking into account the nonuniform effect of defense spending on GDP growth and approaching the problem using nonlinear methods seems to be a generalized piece of advice for future research on the topic.

Further paths of research include testing for nonlinearity in the defense spending-growth link using a cross-country panel data setting to assess the universality of the nonlinear effects of defense expenditure on growth, and accounting for such departures of the linearity hypothesis in research on micro-founded models that assess the effect of defense spending on the civil economy. While this study has only considered aggregated levels of military spending, the nature of the potential nonlinearity could be better understood if disaggregated data on the final use of military expenditure were employed.

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