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Military spending and economic growth in China: a regime-switching analysis

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This article investigates the impact of military spending changes on economic growth in China over the period 1953 to 2010. Using two-state Markov-switching specifications, the results suggest that the relationship between military spending changes and economic growth is state dependent. Specifically, the results show that military spending changes affect the economic growth negatively during a slower growth–higher variance state, while positively within a faster growth–lower variance one. It is also demonstrated that military spending changes contain information about the growth transition probabilities. As a policy tool, the results indicate that increases in military spending can be detrimental to growth during slower growth–higher growth volatility periods.

Keywords: China; economic growth; Markov switching; military spending

JEL Classification: C22; H30; O40

I. Introduction

Over the last few decades there has been a considerable attention on the macroeconomic effects of military spending from both policy makers and academics alike. The general argument is that any potential change in the defence spending will affect economic growth in an economy (see Barro and Sala-i-Martin, 1995; Dunne, 1996, for a detailed analysis). More specifically, the linkages between military spending and economic growth can be summarized by two main theoretical views. The Keynesian income multiplier effect posits that military spending affects economic growth positively, whereas crowding-out hypothesis favours a negative growth impact of military spending.

In this study, we contribute to the existing literature by examining regime switching in the relationship between military spending changes and economic growth in China over the period 1953 to 2010. Given the rise of China as global economic and military major power, the linkage between its military spending and economic growth has drawn much attention over the recent years (see Dimitraki and Menla Ali, 2013, for a comprehensive review).[1] Most of the existing empirical studies have assumed linear dependence and constant parameters (e.g. Chen, 1993; Masih *et al.*, 1997; Wolde-Rufael, 2001, among others),

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[1] Dimitraki and Menla Ali (2013) found that military spending is driven by the economic development in the long run in China. In this article, we examine whether military spending changes have any short-run dynamic impact on growth or not. This is also in line with what is known as the fiscal multiplier effect of military spending (see Hall, 2009, for a thorough theoretical and empirical discussion).

which is not the case since the Chinese economic system underwent structural changes in the light of the policy reforms undertaken since 1978. Indeed, China has observed unprecedented episodes of economic growth over the last few years. The Chinese economy has been growing at an annual rate of 9.7% over the period 1978 to 2010 as opposed to 6.4% during 1953–1977.[2]

Although a number of studies have provided evidence for the nonlinear relationship between military spending and growth (e.g. Stroup and Heckelman, 2001; Aizenman and Glick, 2006; Kalaitzidakis and Tzouvelekas, 2011, among others), the nonlinear dependence between these two variables with reference to China has drawn less attention. The only exception is the study by Lai *et al.* (2005), who examined the arms race between China and Taiwan, and using a multivariate threshold regression they found that defence spending leads the Chinese economic growth only in one regime (when Taiwan's spending growth is less than 5%).

Considering the recent evidence of Lai *et al.* (2005) on nonlinear dependence, this article uses the Markov regime-switching model as an alternative way to examine the nonlinear relation between military spending changes and economic growth in China. To the best of our knowledge, the regime-switching relationship between the two variables has not been explored in the literature yet. The existence of multiple growth regimes and parameter heterogeneity has been widely known by now. The multiple steady states and growth regimes have been attributed mainly to the dynamics of business cycles (e.g. Hamilton, 1989) and also to the presence of what is known as sizable spillovers (e.g. Azariadis and Drazen, 1990).

The chosen econometric model will enable us to examine the impact of military spending changes on economic growth in two states of growth by allowing the data themselves to identify these states. That is, when the economic growth is fast/slow and when the growth exhibits high/low volatility. Intuitively, military spending budgets may not be the same during expansionary and recessionary periods and also when the growth is highly volatile and less volatile. In fact, there is now evidence that military spending changes with the dynamics of economic growth. All major economic powers, including the United States, the United Kingdom, the European Union and China, have set public investment programmes in order to counter the global recession of 2007–2008 (Custers, 2010). Furthermore, Wood (2010) reports that the economic basis of the military spending fluctuation in China is mainly due to the dynamics of GDP. Also, the Chinese decisions related to the allocation of resources on defence were based, among other factors, on its economic performance (e.g. improved economic performance allows the expansion of the military spending) and the timing of its various 5-year economic plans (e.g. 1953–1957, 1958–1962, 1966–1970, 1971–1975, 1976–1980, 1981–1985 and so on) (Cusack and Ward, 1981). In particular, during the period of the economic plans, China was trading off the defence spending by boosting investment or consumption to promote economic growth. The military spending was increasing mainly at the beginning of the economic plans, whilst the economic resources were directed to socio-economic purposes afterwards (which were promoted by the developmental plans) (Cusack and Ward, 1981).

The adopted model will also provide us with inference regarding the impact of military spending changes on the transition probabilities associated with switching of growth states. Knowledge of the regime-switching relation between military spending changes and economic growth may provide important policy implications. Policy makers can set appropriate policies with regard to military and nonmilitary budgets, depending on the state of the economy. For example, if military spending has adverse effects on economic growth in a state of recession or if military spending keeps growth in the recessionary state, expansionary policies to boost the economy could then be unsuccessful if military spending is large. In addition, an economic boost may be deemed by military spending cutbacks or spending with due consideration.

The remainder of this article is organized as follows. Section II provides an overview of China's growth and defence policies. Section III reviews the theoretical and empirical work on the linear and nonlinear relationship between military spending and economic growth. Section IV outlines the econometric methodology conducted in the study. Section V describes the data and discusses the empirical results, and finally Section VI concludes.

II. An Overview of China's Growth and Defence Policies

The current renewed interest in China's defence spending and its military modernization requires shedding further light on the relationship between military spending policies and strategies and economic growth in China. Even though there were considerable changes in industry, infrastructure and telecommunications, China did not commence into a fast-rising economic growth before 1949 as a result of fiscal weaknesses and a low rate of government spending (approximately 9% in relation to national income). However, the year 1949 was China's actual turning point in the growth process due to a socio-economic

[2] Growth figures, sourced from China's Statistical Yearbooks, are calculated by the authors.

uprising.[3] In addition, economic growth is a long-term process that is based on the accumulation of capital (both physical and human), along with the development of institutions to support any sociopolitical and economic changes (Richardson, 1999).

As far as China's growth effects of military spending are concerned, they were, in comparison to other nations, not restricted to the production of weapons. Since 1949, the People's Liberation Army played a rather developmental role in promoting economic growth via investment in the military technology (and as an extent in the Chinese military industry). Furthermore, since Mao's developmental and military technology programmes, China's fundamental policies were concentrated on both national security and economic prosperity via what is known as technological infusion (Feigenbaum, 1999).[4] In particular, China's defence spending was mostly an assurance to preserve national security and uphold the world peace.[5]

It follows that the Chinese military expenditures, especially the national investment policies towards the military industry and the R&D, link the defence sector with the Chinese developmental strategies (Feigenbaum, 1999). For example, Marshal Nie Rongzhen (a Chinese defence technical leader) argued that China should rely on the defence industry (as part of the Chinese modernization policy) not only due to security issues but explicitly the military technology diffusion will boost China's overall economic growth (especially by fostering industrial innovations and setting the basis for advanced technological diligences) (Feigenbaum, 1999). Undoubtedly, the Chinese economic development also depends on financial and trade ties with other countries, and China is likely not to jeopardize such ties (Roy, 1994).

III. A Review of the Literature

The relationship between defence expenditure and economic growth has become widely debated both theoretically and empirically. On the one hand, the transfer of resources from the civilian to the military sector creates the crowding-out effect, and on the other, the defence sector provides positive externalities (especially in less developed countries) through channels such as infrastructure, human capital formation (e.g. education and training) and technological advancements (Ram, 1995). Another channel for the positive impact of military spending stems from the fact that military spending provides a country with security (both internally and externally), which in turn attracts foreign investors, especially those of long-term investment plans (Sandler and Hartley, 1995).

The empirical findings are also inconclusive. More specifically, since Benoit's (1978) seminal paper, who found the existence of a positive relationship between military expenditure and economic growth in developing countries, there sparked a bulk of empirical research to challenge his findings. The literature approached the issue from different theoretical and methodological perspectives, different periods and different applications in various geographical areas and commonalities (e.g. high–low growth or nonconflict and conflict states).

While the impact of military expenditures on economic growth in developing countries is found to be insignificant (Deger and Sen, 1995), such an impact turns out to be relatively stronger and negative in developed countries (Kollias *et al.*, 2007). All in all, the empirical studies suggest that military expenditure is either positively (e.g. Kusi, 1994, among others) or negatively related to growth (e.g. Knight *et al.*, 1996; Shieh *et al.*, 2002, among others), while others conclude that there is no discernible relationship between the prolonged variables (e.g. Majeski, 1992; Mintz and Stevenson, 1995, among others). The findings with reference to China are also mixed as demonstrated in a recent survey by Dimitraki and Menla Ali (2013) and Table 1 which reports the existing empirical studies for China.

Since these aforementioned studies have mainly adopted linear methods in analysing the linkage between military spending and economic growth, the ambiguity of the findings of these studies may be due to the use of different models (i.e. causality is a model-dependent set-up, see Hendry and Ericsson, 1991), and the models may be sensitive to the samples selected and nonlinearity may also be important. Indeed, several empirical studies concluded that nonlinearities are highly associated with fiscal policy variables such as government expenditure, taxes, the overall size of deficit, etc. (see Barro, 1990; Giavazzi *et al.*, 2000). Furthermore, Pieroni (2009) argued that if the nonlinearities are not statistically controlled for, any relationship between military burden and economic growth might be questionable as the correlation between them might be wrongly specified, and thence erroneous conclusions might be drawn.

[3] According to Naughton (2007), the increased strain on the living standards as a result of the increase in the population growth, the absence of technological innovations, the danger of famine and diseases and mainly the uneven distribution of income were some of the reasons that were lunging the existing socio-economic system.

[4] Those policies are known as 'techno-nationalism' which identify further a direct link between military spending policies and a country's economic development mainly via the channel of investment (Feigenbaum, 1999).

[5] Naughton (2007) argued that China's fundamental principle is to safeguard national security and harmony and guarantee progress of building a developed society (e.g. to attract new investors as part of their development policies).

Table 1. Review of the empirical literature of China's defence spending-economic growth nexus

Author(s)	Period	Methodology	Main finding(s)
Chen (1993)	1950–1991	(1) Engle and Granger (1987) two-step cointegration (2) Granger causality tests	(1) EG and Milex are not cointegrated (2) No Granger causality between the two variables is found in the short run
Masih *et al.* (1997)	1950–1991	(1) Johansen (1995) cointegration (2) Granger causality tests	(1) EG and Milex are cointegrated (2) Causality runs from Milex to EG
Sun and Yu (1999)	1965–1993	OLS regression	(1) China's GNP affects Milex (2) The results are robust irrespective of using official Chinese or Arms Control and Disarmament Agency data
Chang *et al.* (2001)	1952–1995	(1) Johansen (1995) cointegration (2) Granger causality tests	(1) China's national income and Milex are not cointegrated (2) Causality from EG to Milex changes is found in the short run
Wolde-Rufael (2001)	1950–1991	(1) A series of unit root tests (2) Granger causality tests	(1) EG and Milex are not integrated of the same order (2) Causality runs from Milex changes to EG
Lai *et al.* (2005)	1953–2000	Multivariate threshold regression	(1) Arms race is found between Taiwan and China (2) China's Milex changes lead EG in only one regime (when Taiwan's spending growth is less than 5%)
Bing-Fu and Liming (2006)	1960–1999	OLS regression	(1) Lagged Milex, GDP and changes in the strategic environment are major determinants of China's Milex (2) Economic factors, the national security environment and lagged Milex are the primary determining factors of Milex prior to 1981 (3) Lagged Milex affects Milex after 1981
Pradhan (2010)	1988–2007	(1) Johansen (1995) cointegration (2) Granger causality tests	(1) GDP, Milex and public debt are cointegrated (2) Causality from Milex changes to EG was detected in the short run
Bo and Xing (2011)	1953–2007	Granger causality tests	(1) No causality is found between Milex changes and EG (2) Causality from Milex changes to EG is only found for the period 1989 to 2007 using China's official data, but not for Stockholm International Peace Research Institute data
Chang *et al.* (2013)	1988–2010	Bootstrap panel causality approach	Causality from real GDP to Milex is found for China
Meng *et al.* (2013)	1989–2012	(1) Engle and Granger (1987) two-step cointegration (2) Granger causality tests	(1) Milex and income inequality are cointegrated (2) Causality from Milex changes to those of income inequality is found in the short run
Dimitraki and Menla Ali (2013)	1952–2010	(1) Bartlett corrected trace test for cointegration (2) Long-run weak exogeneity tests	(1) Cointegration is found between Milex and real GDP along with some control variables (2) It is the economic development that drives increases in Milex

Note: EG and Milex denote economic growth and military spending, respectively.

Empirical studies on the nonlinear relationship between military spending and economic growth include Stroup and Heckelman (2001), Lai *et al.* (2005), Aizenman and Glick (2006), Cuaresma and Reitschuler (2006) and Yang *et al.* (2011), among others. To the best of our knowledge, the only empirical study of the nonlinear relationship between military spending and economic growth with reference to China is the study by Lai *et al.* (2005) (see Table 1). This article, by contrast, aims to provide a further nonlinear evidence between the two variables in China using the Markov-switching specifications.

IV. The Markov-Switching Model

In this study, we examine the nonlinear impact of military spending changes on economic growth in China over the period 1953 to 2010. The Markov regime-switching model developed by Hamilton (1989, 1990) is particularly appropriate to examine the economic growth in different regimes. More specifically, economic growth is allowed to be shifted in the mean and the variance, that is, for periods of expansion and contraction and high volatility and low volatility.[6] The model is specified as follows:

$$y_t = \mu_{s_t} + \sum_{i=1}^{2} \phi_i y_{t-i} + \beta_{s_t} x_{t-1} + \lambda' z_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim N(0,\sigma^2_{s_t}) \tag{1}$$

where y_t and x_t denote respectively the economic growth and changes in military spending and ε_t is a white noise term. z_{t-1} is a vector of control variables proposed in the growth literature[7] (e.g. Barro, 1990), namely nondefence spending changes,[8] government investment changes,[9] population growth and human capital changes with coefficients λ_1, λ_2, λ_3 and λ_4, respectively.[10] Autoregressive terms (up to two lags)[11] are also considered in case there is persistence, if any, in the conditional mean of economic growth.

Since y_t is being modelled as conditional normal, the mean, μ_{s_t}, the variance, σ^2_{st}, and the slope of military spending changes, β_{s_t}, depend on the state s_t, $s_t \in \{1, 2\}$, which is in operation. The nonobservable state variable s_t is assumed to follow a first-order Markov process with constant transition probabilities specified as follows:

$$p_{ij} = \Pr(s_t = j \mid s_{t-1} = i) \tag{2}$$

where the probability of being in state j based on the information on the whole series will be referred to as the smoothed probability, $\Pr(s_t = j \mid y_1, \ldots, y_T)$. In order to check the sensitivity of the identified regimes to the exogenous variables (e.g. military spending changes and control variables), we also estimate Equation 1 without any exogenous variables.

Furthermore, to examine whether military spending changes provide any inference about the transition probabilities associated with switching between growth states, we also allow these transition probabilities to be time varying (see Filardo, 1994). In particular, rather than examining the impact of military spending changes, x_{t-1}, on economic growth directly, as specified in Equation 1, we allow these transition probabilities to depend on x_{t-1} instead.[12] That is, the growth transition probabilities are specified as follows:

$$P_t^{11} = \frac{\exp\{\gamma_0 + \gamma_1 x_{t-1}\}}{1 + \exp\{\gamma_0 + \gamma_1 x_{t-1}\}}, \quad P_t^{22} = \frac{\exp\{\eta_0 + \eta_1 x_{t-1}\}}{1 + \exp\{\eta_0 + \eta_1 x_{t-1}\}}. \tag{3}$$

Note that if an increase in military spending leads to an increase in the probability of staying in state 1, one would anticipate $\gamma_1 > 0$. On the other hand, $\eta_1 < 0$ indicates that an increase in military spending results in a decrease in the probability of staying in state 2.

The model estimation is conducted by maximum likelihood using the expectation maximization algorithm described by Hamilton (1989, 1990). Furthermore, for comparison purposes, several constant parameter models are also estimated using OLS. Such models have been frequently estimated in the literature and may take the following forms:

A model without exogenous variables:

$$y_t = \mu + \sum_{i=1}^{2} \phi_i y_{t-i} + \varepsilon_t, \qquad \varepsilon_t \sim \mathrm{N}(0,\sigma^2) \tag{4}$$

A model with military spending changes only:

$$y_t = \mu + \sum_{i=1}^{2} \phi_i y_{t-i} + \beta x_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim \mathrm{N}(0,\sigma^2) \tag{5}$$

A model with military spending changes and control variables:

$$y_t = \mu + \sum_{i=1}^{2} \phi_i y_{t-i} + \beta x_{t-1} + \lambda' z_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim \mathrm{N}(0,\sigma^2) \tag{6}$$

[6] Hamilton (1989) and Arin and Spagnolo (2011), among many others, have shown that the Markov regime-switching model is particularly appropriate for modelling the growth states, while similar findings were found by Smith *et al.* (2000) for military expenditures.

[7] There are a number of variables affecting economic growth (see Levine and Renelt, 1992, for a thorough discussion). This article follows recommendations made by Levine and Renelt (1992) and Sala-i-Martin (1997) for the most common variables that affect economic growth and widely used in the growth literature.

[8] Defence plus nondefence spending constitute government consumption.

[9] Government investment is the variable 'ci' from PWT 7.1 and is defined (in PWT 7.1) as 'Investment Share of PPP Converted GDP Per Capita at current prices %'.

[10] By doing so, our underlying theoretical model follows the Barro style growth model derived from Barro (1990) and adjusted by Devarajan *et al.* (1996) to take into account military and nonmilitary spending.

[11] Following the London School of Economics approach to econometrics, we check autocorrelations up to 2 years dynamics, hence two observations in our case.

[12] Note that the impact of military spending changes on the growth transition probabilities is estimated by keeping the growth-control variables in Equation 1.

More details on the estimation process of the models described above and the data are given in the Section V.

V. Data Description and Empirical Results

The data used to estimate the model are annual observations for China over the period 1953 to 2010 and were retrieved from the following sources. Economic growth of real GDP, population (in millions), nondefence spending and military expenditures are from China's Statistical Yearbooks, while the data for government investment and human capital are from the Penn World Tables.[13] For robustness purposes, the results are also estimated using real GDP growth from Penn World Tables (version 8.0).[14]

Table 2 reports a summary of descriptive statistics of the relevant variables: military spending changes and economic growth. The annual mean of economic growth in China is positive (8%), whilst the corresponding mean for military spending changes is negative (−3%). With regard to volatility, economic growth exhibits lower volatility (by two and a half times) than military spending changes. Furthermore, the two variables exhibit strong excess kurtosis and skewness. The Jarque–Bera (JB) test statistics show that normality is rejected at the 1% level for both variables.

In order to examine the time-series properties of the relevant variables, we run the more powerful unit root test of Elliott et al. (1996) which modifies the Dickey-Fuller test using generalized least squares (DF-GLS). Also, the minimum Lagrange multiplier (LM) unit root test of Lee and Strazicich (2004) with one structural break in the intercept and the trend is reported. The latter is likely to be instructive as the time series under examination involve the Chinese policy reforms in the early 1980s. Unlike the Zivot and Andrews (1992) unit root test with a single endogenous structural break, the LM test is known to have no size distortion and spurious rejections in the presence of a break under the null hypothesis.[15] The results, as displayed in Table 3, show that both military

Table 3. Unit root test results

	Military spending changes	Economic growth
Panel A: DF-GLS tests		
Without trend	−2.432(4)**	−2.243(4)**
With trend	−2.881(4)	−4.844(4)***
Panel B: One-break LM tests		
Statistic	−10.510 (0)****	−8.278 (2)***
T_B	[1973]^s	[1970]^s
λ	$\lambda = 0.4$	$\lambda = 0.5$

Notes: The 1% and 5% critical values for the DF-GLS test are respectively −2.608 and −1.946 (without trend) and −3.754 and −3.177 (with the trend). The lag length, represented in parentheses, is selected on the basis of the modified Akaike information criterion for the DF-GLS tests and the general-to-specific approach for the LM tests with a single break. The estimated breakpoints T_B for the single-break LM tests are in square brackets, with s indicating that the identified breakpoint is significant at the 5% level. Critical values for the minimum one-break LM unit root test allowing for a shift in intercept and change in trend slope (Model C) for a sample of $T = 100$ are displayed below, which depend (to some extent) on the location of the breakpoint ($\lambda = (T_B/T)$ where T is the sample size) and are symmetric around λ and $(1 - \lambda)$.
***indicates significance at 1% and ** at 5%.

Break point location	Critical values	
$\lambda = (T_B/T)$	1%	5%
0.1	–5.11	–4.50
0.2	–5.07	–4.47
0.3	–5.15	–4.45
0.4	–5.05	–4.50
0.5	–5.11	–4.51

Table 2. Summary of descriptive statistics

	Mean	SD	Skewness	Excess kurtosis	JB
Economic growth	0.083	0.071	−2.152	11.372	210.47***
Military spending changes	−0.031	0.186	0.260	10.200	123.79***

Notes: JB is the Jarque–Bera test for normality.
***denotes significance at 1%.

[13] Version 7.1 of Penn World Tables is used to obtain government investment, whereas human capital is retrieved from version 8.0.

[14] See Waller (1997), Wang (1999) and Orlik (2012) for a thorough discussion related to the reliability and reasons for variances of the Chinese data; Bing-Fu and Liming (2006) for a discussion about overestimates of the Chinese data from Western mainstream and issues with exchange rates; Sun and Yu (1999) who state that differences in sources might be systematic but are still qualitatively the same; Bo and Xing (2011) for a discussion of the differences in statistical methodology and the institution of the defence system between China and Western mainstream and Dunne (1996) for a thorough explanation that there should be no concern for the source of origin for data used in time-series analysis as long as their definitions do not change significantly.

[15] The endogenous breakpoint in the Zivot and Andrews (1992) test is chosen where a one-sided test statistic on the coefficient in the ADF test is minimized (i.e. the most negative). Hence, such test favours to reject the null hypothesis of unit root for a trend stationary process with a break.

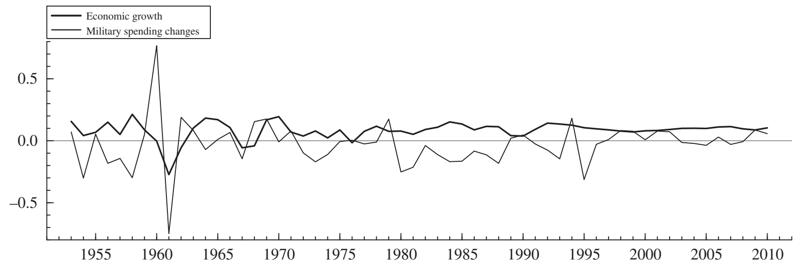

Fig. 1. Economic growth and military spending changes in China over the period 1953 to 2010

spending changes and economic growth are $I(0)$ processes. Figure 1 displays the annual time-series pattern of economic growth and military spending changes over the period 1953 to 2010. It is also evident from this figure that the two series are covariance stationary.

The OLS as well as the maximum likelihood estimates are reported in Table 4. Columns 1 and 4 report the estimates of the two competing (linear and nonlinear) models without the presence of any exogenous or control variables, respectively. Columns 2 and 3 report the results respectively after including military spending changes only, as in Equation 5, and military spending changes along with control variables, as in Equation 6. Furthermore, while column 5 reports the results of the Markov-switching relation between military spending changes and economic growth including control variables and assuming fixed transition probabilities, as in Equation 1, column 6 lists the results of the time-varying transition probability Markov-switching model of the relation between military spending changes and economic growth, as in Equation 3, including also the growth-control variables.

The linearity hypothesis against the Markov-switching alternative cannot be tested using a standard likelihood ratio test as the parameters of the second state are not determined under the null of a single-state model. Garcia (1998) derives the asymptotic critical values for Hansen's (1992) test for several two-state Markov-switching models. The 1% critical value of the likelihood ratio statistic for the considered two-state Markov models is less than 17.38. In the case at hand, the likelihood ratio statistic, calculated from the models in columns 1 and 4, is 45.52, which is well above the critical value and indicates the significance of the second state. The nonlinear structure in the economic growth is also confirmed by Tsay (1986) test (see Table 4).

The OLS results in column 2 indicate that changes in military spending have a negative impact on the economic growth of China. After extending the growth regression with the control variables in column 3, the above impact remains negative but becomes weak (significant at the 12% level). This evidence is in contrast to Chen (1993), who found no causality between military spending and economic growth in China and also, opposite to Masih *et al.* (1997) and Lai *et al.* (2005), who estimated a positive effect. Among the control variables, only population growth appears to exert a positive effect on growth.

To obtain further insights into the form of the relationship between military spending changes and economic growth, we estimate a moving window to the OLS regression specified in Equation 5 (column 2). We select a window length equal to 3 years.[16] The estimated constant and slope coefficient of military spending changes with their corresponding SEs are displayed in Fig. 2. The graphical analysis indicates that both the intercept and the slope coefficient evolve significantly over time, confirming that the relation between economic growth and military spending changes is nonlinear. Hence, the relation between the two variables requires modelling by using a nonlinear specification. The Markov-switching model applied in this study is particularly useful and advantageous to other nonlinear specifications such as threshold regression and break analyses. When using break models, it is assumed that every break is permanent, which is not the case because of the dynamics of the business cycles. With regard to threshold regression analysis, Pieroni (2009, p. 332), in a recent paper, comments that 'the threshold at which the nonlinearities between military spending and economic growth occur is largely variable and depends on the country-specific perception about uncertainty'.

The results of the fixed as well as the time-varying transition probability two-state Markov-switching models (columns 5 and 6 of Table 4) allowing for a shift in the mean and the variance also indicate that the relationship between military spending changes and economic growth is state dependent. The estimated models are shown to be well defined: the standardized residuals exhibit no signs of linear or nonlinear dependence. The parameters of the mean and the variance are significant, and hence the periods of fast/slow economic growth and of high/low growth volatility seem to be accurately identified by the smoothed probabilities. The null hypotheses of H_0: $\mu_1 = \mu_2$ and H_0: $\sigma_1 = \sigma_2$ are clearly rejected at any

[16] The results are also confirmed by using a window length equal to 5 years. These results are available upon request.

Table 4. Linear and Markov-switching models (GDP growth source: China's Statistical Yearbooks)

	One-state			Two-state		
	OLS	Extended OLS		FTP	Extended FTP	Extended TVTP
	(1)	(2)	(3)	(4)	(5)	(6)
μ_1	0.051***	0.044***	0.035	0.032**	–0.022*	–0.026**
	(0.013)	(0.013)	(0.041)	(0.015)	(0.017)	(0.011)
μ_2				0.040***	0.078***	0.065***
				(0.010)	(0.017)	(0.011)
ϕ_1	0.365**	0.599**	0.574**	0.569***	0.297**	0.307**
	(0.124)	(0.239)	(0.214)	(0.105)	(0.106)	(0.136)
β_1		–0.102**	–0.080		–0.223***	
		(0.047)	(0.050)		(0.065)	
β_2					0.070**	
					(0.026)	
λ_1			–0.037		–0.071*	–0.016
			(0.096)		(0.039)	(0.060)
λ_2			–0.122		0.025	–0.006
			(0.107)		(0.040)	(0.054)
λ_3			2.300*		2.858**	2.896**
			(1.170)		(1.529)	(0.695)
λ_4			–0.025		–0.019	–0.029
			(0.029)		(0.012)	(0.021)
σ_1	0.068	0.065	0.065	0.082***	0.057***	0.082**
				(0.009)	(0.010)	(0.013)
σ_2				0.008***	0.019***	0.018**
				(0.001)	(0.002)	(0.001)
γ_0						2.686**
						(1.114)
γ_1						5.300**
						(2.332)
η_0						2.482***
						(0.833)
η_1						3.376
						(7.260)
p_{11}				0.975***	0.726***	
				(0.024)	(0.116)	
p_{21}				0.013	0.124*	
				(0.021)	(0.063)	
LogLike	73.29	75.665	78.63	96.05	102.699	106.214
$Q(2)$	2.413[0.120]	2.393[0.121]	1.620[0.203]	2.536 [0.111]	0.489 [0.484]	1.487 [0.222]
ARCH(2)	0.500[0.774]	2.033[0.141]	0.599[0.552]	0.135 [0.874]	0.189 [0.827]	0.022 [0.977]
Tsay test	6.619[0.000]					

Notes: FTP and TVTP denote fixed and time-varying transition probability Markov-switching models, respectively. $Q(2)$ is a Portmanteau test of serial correlation up to order 2. ARCH(2) is an ARCH test up to order 2. SEs are in parentheses, while p-values are reported in square brackets.
***denotes significance at 1%, ** at 5% and * at 10%.

conventional significance level; hence the shifts in both the mean and the variance are justified.

Using both fixed and time-varying transition probability Markov-switching models (columns 5 and 6), it appears that state one (two) is characterized by slow (fast) economic growth and high (low) growth volatility in the Chinese economy, corresponding to changes in trends and volatility over the sample period, as well as to the dynamics of business cycles rather than the long-term changes in the growth rates. Figure 3 shows the plot for the economic growth, y_t, smoothed probabilities, military spending changes, x_t, and the time-varying transition probability of the low growth–high variance state (state 1).

More specifically, the results of the fixed transition probability model (column 5) indicate that the probability of staying in state one (two) is 0.72 (0.87). The smoothed probabilities show a relatively low number of switches, consistent with the high persistence in the two states. There are 17 years (29.82%) where the process is in the first state and 40 years (70.18%) where the process is in the

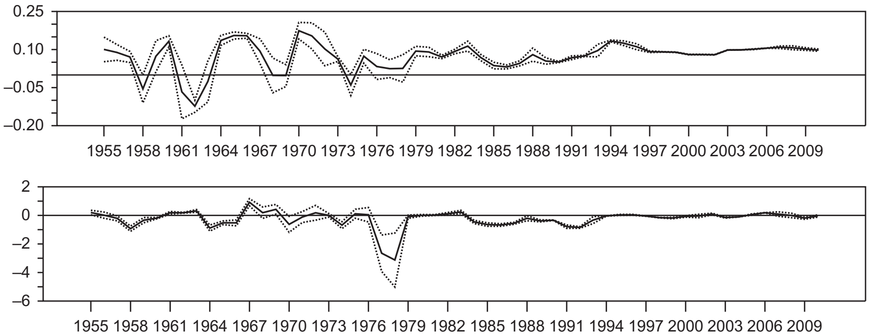

Fig. 2. The estimated constant (upper panel) and slope coefficient associated with military spending changes (lower panel) from moving window regression with SEs (in dotted lines) (window length is 3 years)

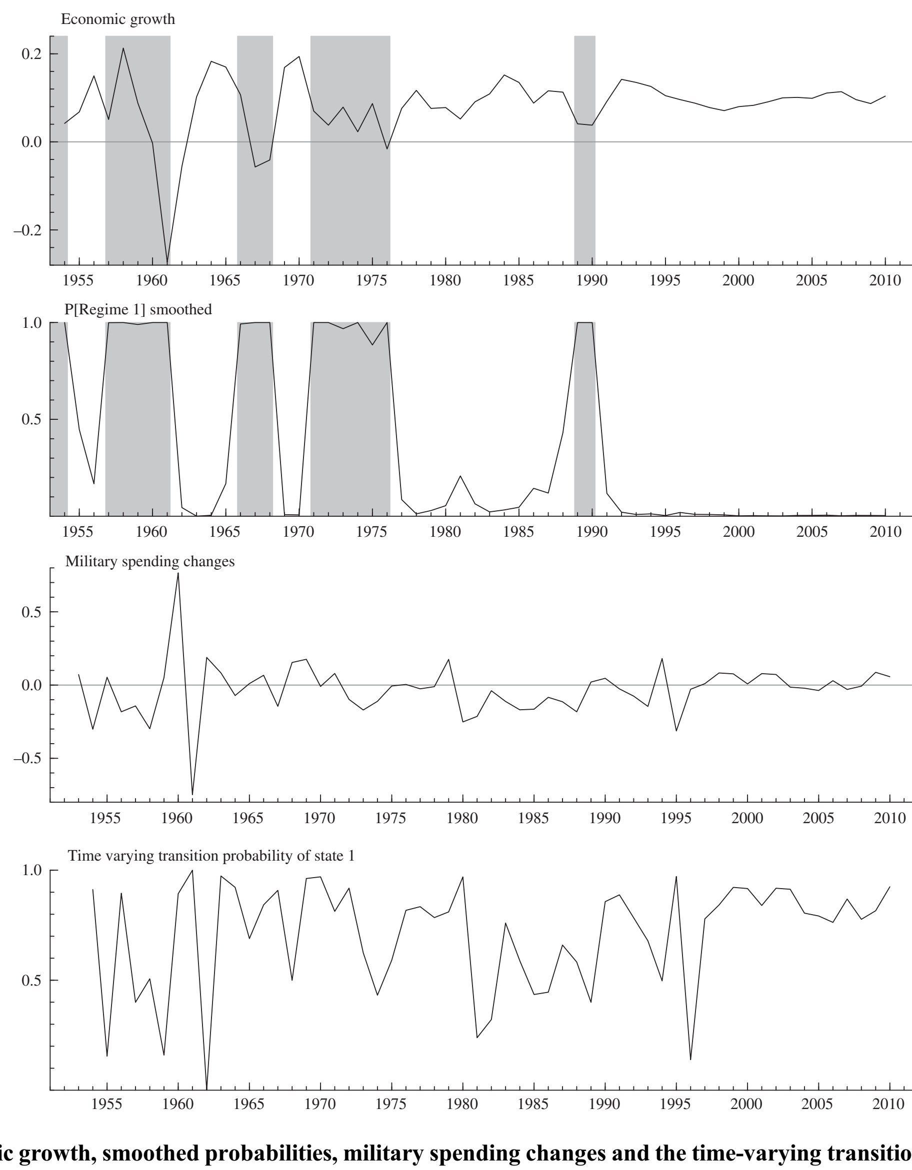

Fig. 3. Economic growth, smoothed probabilities, military spending changes and the time-varying transition probability of the low growth–high variance state (state 1)

second state (see Fig. 3). Furthermore, while the impact of military spending changes on economic growth in state one is negative, this impact turns out to be positive in state two, enforcing the nonlinear dependence between the two variables in China.

The negative impact associated with lower growth–high variance state is consistent with the occurrence of crowding-out effects, whereas the positive relationship in the high growth–low variance state is consistent with the Keynesian income multiplier effect. The latter effect has been a widely used framework in the analysis of developing countries. The crowding-out effects suggest that an increase in military expenditure is to be financed either by increasing current taxes or by borrowing, where the balance of payments deteriorates as a result of the latter. Nonetheless, the spending, in either case, not only reduces the expected after-tax return on productive capital, but also the flow of savings that is available for productive capital, which in turn undermines the economic growth (see Knight *et al.*, 1996). The Keynesian income multiplier effect, on the other hand, posits that an increase in military spending may boost aggregate domestic demand capacity by inducing an increase in utilization (Dunne, 1996). Particularly, it increases the growth of current production relative to full capacity production.

With regard to the control variables, nondefence spending changes are shown to have a negative impact on growth using fixed transition probabilities. Government investment and human capital changes appear to exert insignificant effects on growth. Finally, the impact of population growth is positive and significant, implying that an increase in the labour force increases economic growth (Mintz and Stevenson, 1995).

By considering the time-varying transition probability Markov-switching model, the results (see column 6) suggest that military spending changes also provide us with some inference about the transition probabilities of switching the two growth states, low growth–high variance and high growth–low variance. The estimate of γ_1 is positive and significant, indicating that an increase in military spending increases the probability of remaining in the low growth–high variance state (see Fig. 3). This finding is also consistent with crowding-out effects discussed earlier. With regard to the control variables, only population growth is shown to be significant.

The above results are based on real GDP growth from China's Statistical Yearbooks. Using the corresponding growth from the Penn World Table (version 8.0), the results, as displayed in Table A1 in the Appendix, do not exhibit much variability across the estimated models. Overall, this indicates the robustness of the results discussed earlier.[17]

VI. Conclusions

In this article, we have examined the dynamic relationship between economic growth and military spending changes in China over the period 1953 to 2010. Our argument is that the impact of military spending on economic growth is different between periods of faster and slower growth as well as between more and less volatile periods. Indeed, the results presented herein show that the dynamic linkage between military spending changes and economic growth is state dependent. Using a fixed transition probability Markov-switching model, the empirical findings suggest that military spending changes affect economic growth negatively in a slower growth–high variance state (consistent with crowding-out effects), whilst the effect is positive in the fast growth–low variance one (consistent with the Keynesian income multiplier effect).

Furthermore, the results of the time-varying transition probability Markov-switching model show that military spending changes also provide inference with regard to the evolution of the transition probabilities across the high growth–low variance and low growth–high variance states. Specifically, it is shown that increases in military spending keep economic growth in the lower growth–high variance state, consistent also with crowding-out effects. In a broad sense, these results indicate an important policy implication in which an increase in military spending hampers growth and affects the economy negatively during slower growth–higher growth volatility periods.

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References

Aizenman, J. and Glick, R. (2006) Military expenditure, threats, and growth, *The Journal of International Trade & Economic Development*, **15**, 129–55. doi:10.1080/09638190600689095

Arin, K. P. and Spagnolo, N. (2011) Short-term growth effects of fiscal policy revisited: a Markov-switching approach, *Economics Letters*, **110**, 278–81. doi:10.1016/j.econlet.2010.11.007

Azariadis, C. and Drazen, A. (1990) Threshold externalities in economic development, *The Quarterly Journal of Economics*, **105**, 465–90. doi:10.2307/2937797

[17] We thank an anonymous referee for the suggestion of using the real GDP growth from the Penn World Tables to check the robustness of the results.

Barro, R. J. (1990) Government spending in a simple model of endogeneous growth, *Journal of Political Economy*, **98**, S103–25. doi:10.1086/261726

Barro, R. J. and Sala-i-Martin, X. (1995) *Economic Growth*, MIT Press, Cambridge, MA.

Benoit, E. (1978) Growth and defense in developing countries, *Economic Development and Cultural Change*, **26**, 271–80. doi:10.1086/451015

Bing-Fu, C. and Liming, Z. (2006) The determinants of China's defense expenditure before and after transition, *Conflict Management and Peace Science*, **23**, 227–44. doi:10.1080/07388940600837730

Bo, C. and Xing, X. (2011) Military spending and economic growth in China, 1953–2007: a note on econometric analysis by using Eviews, in *Frontiers of Peace Economics and Peace Science (Contributions to Conflict Management, Peace Economics and Development)*, Chatterji, M., Bo, C. and Misra, R. (Eds), Emerald, Bingley, pp. 115–31.

Chang, T., Fang, W., Wen, L. F. *et al.* (2001) Defence spending, economic growth and temporal causality: evidence from Taiwan and Mainland China, 1952–1995, *Applied Economics*, **33**, 1289–99. doi:10.1080/00036840122529

Chang, T., Lee, C. C., Hung, K. *et al.* (2013) Does military spending really matter for economic growth in China and G7 countries: the roles of dependency and heterogeneity, *Defence and Peace Economics*. doi:10.1080/10242694.2013.763460.

Chen, C. H. (1993) Causality between defence spending and economic growth: the case of Mainland China, *Journal of Economic Studies*, **20**, 37–43. doi:10.1108/01443589310048145

Cuaresma, J. C. and Reitschuler, G. (2006) 'Guns or butter?' revisited: robustness and nonlinearity issues in the defense-growth nexus, *Scottish Journal of Political Economy*, **53**, 523–41. doi:10.1111/j.1467-9485.2006.00393.x

Cusack, T. R. and Ward, M. D. (1981) Military spending in the United States, Soviet Union, and the People's Republic of China, *Journal of Conflict Resolution*, **25**, 429–69. doi:10.1177/002200278102500303

Custers, P. (2010) Military Keynesianism today: an innovative discourse, *Race Class*, **51**, 79–94. doi:10.1177/0306396810363049

Deger, S. and Sen, S. (1995) Chapter 11 military expenditure and developing countries, in *Handbook of Defence Economics, Vol. 1*, Hartley, K. and Sandler, T. (Eds), Elsevier, Amsterdam, pp. 275–307. doi:10.1016/S1574-0013(05)80013-4

Devarajan, S., Swaroop, V. and Zou, H.-F. (1996) The composition of public expenditure and economic growth, *Journal of Monetary Economics*, **37**, 313–44. doi:10.1016/S0304-3932(96)90039-2

Dimitraki, O. and Menla Ali, F. (2013) The long-run causal relationship between military spending and economic growth in China: revisited, *Defence and Peace Economics*. Available at http://dx.doi.org/10.1080/10242694.2013.810024 (accessed 17 June 2014).

Dunne, P. (1996) Economic effects of military spending in developing countries: a survey, in *The Peace Dividend (Contributions to Economic Analysis)*, chapter 23, Gleditsch, N. P., Bjerkholt, O., Cappelen, A. *et al*. (Eds), North Holland, Amsterdam, pp. 439–64.

Elliott, G., Rothenberg, T. and Stock, J. H. (1996) Efficient tests for an autoregressive unit root, *Econometrica: Journal of the Econometric Society*, **64**, 813–36. doi:10.2307/2171846

Engle, R. F. and Granger, C. W. J. (1987) Co-integration and error correction: representation, estimation, and testing, *Econometrica: Journal of the Econometric Society*, **55**, 251–76. doi:10.2307/1913236

Feigenbaum, E. A. (1999) Soldiers, weapons and Chinese development strategy: the Mao era military in China's economic and institutional debate, *The China Quarterly*, **158**, 285–313. doi:10.1017/S0305741000005786

Filardo, A. J. (1994) Business-cycle phases and their transitional dynamics, *Journal of Business & Economic Statistics*, **12**, 299–308.

Garcia, R. (1998) Asymptotic null distribution of the likelihood ratio test in Markov switching models, *International Economic Review*, **39**, 763–88. doi:10.2307/2527399

Giavazzi, F., Jappelli, T. and Pagano, M. (2000) Searching for non-linear effects of fiscal policy: evidence from industrial and developing countries, *European Economic Review*, **44**, 1259–89. doi:10.1016/S0014-2921(00)00038-6

Hall, R. E. (2009) By how much does GDP rise if the government buys more output?, *Brookings Papers on Economic Activity*, **Fall**, 183–249.

Hamilton, J. D. (1989) A new approach to the economic analysis of non-stationary time series and the business cycle, *Econometrica: Journal of the Econometric Society*, **57**, 357–84. doi:10.2307/1912559

Hamilton, J. D. (1990) Analysis of time series subject to changes in regime, *Journal of Econometrics*, **45**, 39–70. doi:10.1016/0304-4076(90)90093-9

Hansen, B. E. (1992) The likelihood ratio test under nonstandard conditions: testing the Markov switching model of GNP, *Journal of Applied Econometrics*, **7**, S61–82. doi:10.1002/jae.3950070506

Hendry, D. F. and Ericsson, N. R. (1991) An econometric analysis of U.K. money demand in 'Monetary Trends in the United States and the United Kingdom' by Milton Friedman and Anna Schwartz, *The American Economic Review*, **81**, 8–38.

Johansen, S. (1995) *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, Oxford University Press, Oxford.

Kalaitzidakis, P. and Tzouvelekas, V. (2011) Military spending and the growth-maximizing allocation of public capital: a cross-country empirical analysis, *Economic Inquiry*, **49**, 1029–41. doi:10.1111/j.1465-7295.2009.00242.x

Knight, M., Loayza, N. and Villanueva, D. (1996) The peace dividend: military spending cuts and economic growth, *Staff Papers – International Monetary Fund*, **43**, 1–37. doi:10.2307/3867351

Kollias, C., Mylonidis, N. and Paleologou, S. M. (2007) A panel data analysis of the nexus between defence spending and growth in the European Union, *Defence and Peace Economics*, **18**, 75–85. doi:10.1080/10242690600722636

Kusi, N. K. (1994) Economic growth and defense spending in developing countries: a causal analysis, *Journal of Conflict Resolution*, **38**, 152–9. doi:10.1177/0022002794038001009

Lai, C. L., Huang, B. N. and Yang, C. W. (2005) Defense spending and economic growth across the Taiwan straits: a threshold regression model, *Defence and Peace Economics*, **16**, 45–57. doi:10.1080/10242690 52000323542

Lee, J. and Strazicich, M. C. (2004) Minimum LM unit root test with one structural break. Appalachian State University Working Paper Series No 04-17, Department of Economics, Boone, NC.

Levine, R. and Renelt, D. (1992) A sensitivity analysis of cross-country growth regressions, *The American Economic Review*, **82**, 942–63.

Majeski, S. J. (1992) Defence budgeting, fiscal policy, and economic performance, in *The Political Economy of Military Spending in the United States*, Mintz, A. (Ed), Routledge, London, pp. 217–37.

Masih, A. M. M., Masih, R. and Hasan, M. S. (1997) New evidence from an alternative methodological approach to the defence spending-economic growth causality issue in the case of Mainland China, *Journal of Economic Studies*, **24**, 123–40. doi:10.1108/01443589710167347

Meng, B., Lucyshyn, W. and Li, X. (2013) Defense expenditure and income inequality: evidence on co-integration and causality for China, *Defence and Peace Economics*. doi:10.1080/10242694.2013.810026.

Mintz, A. and Stevenson, R. T. (1995) Defense expenditures, economic growth, and the 'peace dividend': a longitudinal analysis of 103 countries, *Journal of Conflict Resolution*, **39**, 283–305. doi:10.1177/0022002795039002004

Naughton, B. (2007) *The Chinese Economy: Transitions and Growth*, MIT Press, Cambridge.

Orlik, T. (2012) *Understanding China's Economic Indicators: Translating the Data into Investment Opportunities*, FT Press, Upper Saddle River, NJ.

Pieroni, L. (2009) Military expenditure and economic growth, *Defence and Peace Economics*, **20**, 327–39. doi:10.1080/10242690701589876

Pradhan, R. P. (2010) Defence spending and economic growth in China, India, Nepal and Pakistan: evidence from cointegrated panel analysis, *International Journal of Economics and Finance*, **12**, 65–74.

Ram, R. (1995) Chapter 10 defense expenditure and economic growth, in *Handbook of Defence Economics: Vol. 1*, Hartley, K. and Sandler, T. (Eds), Elsevier, Amsterdam and Oxford, pp. 251–74. doi:10.1016/S1574-0013(05)80012-2

Richardson, P. (1999) *Economic Change in China, C. 1800–1950*, Cambridge University Press, Cambridge, MA.

Roy, D. (1994) Hegemon on the horizon? China's threat to East Asian security, *International Security*, **19**, 149–68. doi:10.2307/2539151

Sala-i-Martin, X. X. (1997) I just ran two million regressions, *The American Economic Review*, **87**, 178–83.

Sandler, T. and Hartley, K. (1995) *The Economics of Defence*, CUP, Cambridge, MA.

Shieh, J., Lai, C. and Chang, W. (2002) The impact of military burden on long-run growth and welfare, *Journal of Development Economics*, **68**, 443–54. doi:10.1016/S0304-3878(02)00022-6

Smith, R., Sola, M. and Spagnolo, F. (2000) The prisoner's dilemma and regime-switching in the Greek-Turkish arms race, *Journal of Peace Research*, **37**, 737–50. doi:10.1177/0022343300037006005

Stroup, M. D. and Heckelman, J. C. (2001) Size of the military sector and economic growth: a panel data analysis of Africa and Latin America, *Journal of Applied Economics*, **49**, 329–60.

Sun, Q. and Yu, Q. (1999) Determinants of China's military expenditures: 1965-93, *Journal of Peace Research*, **36**, 23–33. doi:10.1177/0022343399036001002

Tsay, R. S. (1986) Nonlinearity tests for time series, *Biometrika*, **73**, 461–6. doi:10.1093/biomet/73.2.461

Waller, D. (1997) Estimating non-transparent military expenditures: the case of China (PRC), *Defence and Peace Economics*, **8**, 225–41. doi:10.1080/10430719708404877

Wang, S. (1999) The military expenditure of China, 1989–98, in *SIPRI Yearbook 1999: Armaments, Disarmament and International Security*, Stockholm International Peace Research Institute (Ed.), Oxford University Press, Oxford, pp. 334–50.

Wolde-Rufael, Y. (2001) Causality between defence spending and economic growth-the case of Mainland China: a comment, *Journal of Economic Studies*, **28**, 227–30. doi:10.1108/EUM0000000005471

Wood, J. (2010) *Economic Factors Shaping China's Defence Spending: Historical Trends and Recent Developments*, Science Applications International Corp, McLean, VA.

Yang, A. J. F., Trumbull, W. N., Yang, C. W. *et al.* (2011) On the relationship between military expenditure, threat and economic growth: a non-linear approach, *Defence and Peace Economics*, **22**, 449–57. doi:10.1080/10242694.2010.497723

Zivot, E. and Andrews, D. (1992) Further evidence of great crash, the oil price shock and unit root hypothesis, *Journal of Business & Economic Statistics*, **10**, 251–70.

Appendix: Robustness results

Table A1. Linear and Markov-switching models (GDP growth source: PWT 8.0)

	One state			Two state		
	OLS	Extended OLS		FTP	Extended FTP	Extended TVTP
	(1)	(2)	(3)	(4)	(5)	(6)
μ_1	0.042*** (0.011)	0.038*** (0.011)	0.030 (0.030)	0.029* (0.015)	–0.024** (0.011)	–0.029** (0.013)
μ_2				0.061*** (0.011)	0.069*** (0.014)	0.060*** (0.018)
ϕ_1	0.459*** (0.120)	0.482*** (0.115)	0.764*** (0.175)	0.388*** (0.133)	0.388*** (0.091)	0.492*** (0.134)
β_1		–0.081** (0.035)	–0.052 (0.035)		–0.132*** (0.029)	
β_2					0.094** (0.044)	
λ_1			–0.053 (0.066)		–0.061* (0.030)	–0.084** (0.038)
λ_2			–0.121 (0.075)		0.035 (0.035)	0.024 (0.039)
λ_3			1.079 (0.856)		1.383*** (0.412)	1.784*** (0.648)
λ_4			–0.018 (0.021)		–0.023** (0.010)	–0.024 (0.015)
σ_1	0.051	0.049	0.048	0.068*** (0.010)	0.028*** (0.006)	0.045*** (0.011)
σ_2				0.023*** (0.002)	0.017*** (0.002)	0.017*** (0.002)
γ_0						1.569** (0.651)
γ_1						10.839** (5.088)
η_0						0.214 (0.766)
η_1						2.823 (3.148)
p_{11}				0.960*** (0.039)	0.473*** (0.131)	
p_{21}				0.010 (0.018)	0.227*** (0.075)	
LogLike	89.42	92.12	95.67	103.31	111.88	114.216
$Q(2)$	0.557 [0.455]	0.382 [0.536]	0.081 [0.775]	1.142 [0.285]	0.256 [0.612]	0.449 [0.502]
ARCH(2)	0.381 [0.684]	2.689 [0.077]	0.142 [0.867]	0.036 [0.964]	0.180 [0.835]	0.216 [0.806]

Notes: FTP and TVTP denote fixed and time-varying transition probability Markov-switching models, respectively. $Q(2)$ is a Portmanteau test of serial correlation up to order 2. ARCH(2) is an ARCH test up to order 2. SEs are in parentheses, while *p*-values are reported in square brackets.
*** denotes significance at 1%, ** at 5% and * at 10%.