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# Is military spending quantitatively important for business cycle fluctuations?

Aleksandar Vasilev\*

July 30, 2021

## Abstract

We introduce a military sector and external security considerations into a real-business-cycle setup with a public sector. We calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). We investigate the quantitative importance of the presence of a military sector and external threat considerations for the cyclical fluctuations in Bulgaria. We find the quantitative effect of such aspects to be very small, and thus not important for business cycle stabilization, or public finance issues, as in Bulgaria the spending on military is relatively small relative to the size of the economy.

**Keywords:** business cycles, military spending, security considerations, external threats, Bulgaria

*JEL Classification Codes:* E24, E32

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# 1 Introduction and Motivation

The standard real-business-cycle (RBC) model with government sector, e.g. Christiano and Eichenbaum (1992), Braun (1994) and McGrattan (1994), among others, assumes that government purchases are only made on civilian consumption-, or final goods. In reality, however, even in peaceful times a non-trivial share of government spending is on military matters, and some of the spending is an investment in security capacity. In other words, this spending is incurred to provide households with certain level of security from external threats, which could be viewed as a component of households' welfare. This distinction is important, as spending on defense has a different objective, such as responding to external threats, and providing security. This public service provides a different source of utility, as compared to private consumption.<sup>1</sup>

Furthermore, government military spending has public finance aspects, and potentially macroeconomic effects, which are generated via interaction with the other model variables. Therefore, military spending falls within the scope of macroeconomics, and given its insufficient treatment in textbooks, the current paper aims to fill this small gap in the literature. In addition, as argued by some politicians, the "military-industrial complex" (a term coined by US President Dwight Eisenhower) could be even driving aggregate economic activity. We will put this to the test in this paper using a disciplined micro-founded general-equilibrium model. Last, but not least, the issues raised in this paper might be of interest to economists working at the Ministry of the Exterior, and those involved in military budget planning and impact assessment studies. The findings in this paper could be also of interest to small countries in the region considering NATO accession, such as Ukraine, Albania, North Macedonia, etc.<sup>2</sup>

Indeed, investment decisions in the aggregate economy are made not only by households, but also by the government at different level (federal, state and local). In other words, the

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<sup>1</sup>The way we will model the two would be as imperfect substitutes in the households' bundle.

<sup>2</sup>Indeed, those countries look up to Bulgaria, which is both an EU member state and a NATO member, so this study would provide some insights in their path towards NATO membership. In addition, countries in the so-called Warsaw Pact during Communism were excessively militarized at the expense of consumption goods availability.

government is an important agent in every economy. Still, very few macroeconomic models consider the role of military spending during peace time in a disciplined way, based on a micro-founded general equilibrium model. In this paper we take those issues seriously and set up a calibrated real-business-cycle (RBC) model, where we distinguish between government military spending and non-military purchases. We calibrate the model for Bulgaria in the period 1999-2018, due to the short time series; Bulgaria provides a good testing case for the theory.<sup>3</sup> This is because Bulgaria is part of the EU, but is the poorest EU member state, and still developing. More specifically, it is still transitioning to being a full-fledged NATO member, and acting as an equal partner to the other member states in the Alliance. Being a post-communist state, Bulgarian experience could be valuable for other transition countries considering NATO membership.<sup>4</sup> In addition, as a member of NATO, Bulgaria needs to invest more<sup>5</sup> in its military to be an equal partner, and to be able to adequately respond to the increase in global terrorism. In this sense, the Bulgarian case provides us with a natural experiment in a sense, of a small country moving towards NATO standards in terms of its military.

We then proceed to quantitatively evaluate the effect of military sector and security considerations for business cycle fluctuations in Bulgaria.<sup>6</sup> The theoretical setup with military sector improves the model fit, especially when it comes to unobservables like security provision. To the best of our knowledge, this is the first study on the issue for Bulgaria that utilizes modern macroeconomic modelling techniques, and thus is an important contribution to the literature.<sup>7</sup> Last, but not least, we are able to address the relationship between military spending

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<sup>3</sup>In mid-1997, Bulgaria adopted a currency board regime, which is an extreme form of a fixed exchange rate. This monetary arrangement acted as a "straight jacket" for the then volatile Bulgarian economy, and brought aggregate economic stability; this explains why the particular period was chosen, and why the model is expressed in terms of real variables.

<sup>4</sup>In addition, all those countries share similar history with Bulgaria, as well as military strategy and ideology that was based on Russian-made tanks, vehicles, and jets. This all needs to change if the country wants to have weapon systems that are NATO-compatible.

<sup>5</sup>Bulgaria spends between 0.6 % of the government budget on military expenditure.

<sup>6</sup>Barro (1981) was the first to study the effect on output of transitory and permanent government purchases, and finds both to have a positive effect.

<sup>7</sup>We abstract away from episodes of major military build-ups, corresponding to WWII, Korean and Vietnam Wars. The interested reader is referred to Eggertson (2011), and Ramey (2016), among others. In

and economic growth, which is a topical question for policy makers.<sup>8</sup> Beniot (1973, 1978) reports a positive relationship between military spending and growth. In contrast, Smith (1980b) obtains a negative effect of military spending on private investment of -1, i.e, a full crowding-out effect for 14 large OECD countries over the period 1954-73. Deger (1986) finds a negative overall effect on the economy as well. Still, the results are largely inconclusive, which motivates us to exclude military spending as a productive output in the aggregate production function.<sup>9</sup>

The rest of the paper is organized as follows: Section 2 describes the model framework and describes the decentralized competitive equilibrium system, Section 3 discusses the calibration procedure, and Section 4 presents the steady-state model solution. Sections 5 proceeds with the out-of-steady-state dynamics of model variables, and compared the simulated second moments of theoretical variables against their empirical counterparts. Section 6 concludes the paper.

## 2 Model Description

There is a representative household, which derives utility out of consumption and security from external threats. The time available to households is fully spent working. The government taxes consumption spending, and levies a common proportional ("flat") tax on all income, in order to finance purchases of government non-military consumption goods, military expenditure and government transfers. On the production side, there is a representative firm, which hires labor and capital to produce a homogeneous final good, which could be used for consumption, investment, or government military and non-military spending.

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those papers, government expenditures are in most models interpreted as military spending and enter the utility function but usually in additively separable way and thus fall out from the households first order conditions.

<sup>8</sup>For a survey of the literature, the reader is referred to Sandler and Hartley (1995) and Ram (1995), as well as the references therein.

<sup>9</sup>Thus, in the model, military spending would have a complete crowding out effect on private consumption. In addition, in contrast to Fernandez-de-Cordoba and Torres (2016), we do not find an increase in the external threat (worsening in the external environment) to increase output in the simulated model calibrated to Bulgarian data. In our model, the effect of increased military spending on output is not different from zero.

## 2.1 Households

There is a representative household, which maximizes its expected utility function, which, as in Amano and Wirjanto (1998), and Fernandez-de-Cordoba and Torres (2016) is a function of consumption and security:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln[\omega c_t^\eta + (1 - \omega) s_t^\eta]^{1/\eta} \right\} \quad (2.1)$$

where  $E_0$  denotes household's expectations as of period 0,  $c_t$  denotes household's private consumption in period  $t$ ,  $s_t$  is the level of (perceived) security from external threats provided by the government in period  $t$ ,  $0 < \beta < 1$  is the discount factor,  $0 < \omega < 1$  is the weight attached to consumption, and  $\eta < 1$  parameter is linked to the elasticity of substitution between consumption and security.<sup>10</sup> Note that the household takes the level of security provided by the government as given.

The household starts with an initial stock of physical capital  $k_0 > 0$ , and has to decide how much to add to it in the form of new investment. The law of motion for physical capital is

$$k_{t+1} = i_t + (1 - \delta)k_t \quad (2.2)$$

and  $0 < \delta < 1$  is the depreciation rate. Next, the real interest rate is  $r_t$ , hence the before-tax capital income of the household in period  $t$  equals  $r_t k_t$ . In addition to capital income, the household can generate labor income. Hours supplied to the representative firm are rewarded at the hourly wage rate of  $w_t$ , so pre-tax labor income equals  $w_t$ , as the total time endowment of unity will be supplied inelastically, i.e., labor supply is unity in all time periods. Lastly, the household owns the firm in the economy and has a legal claim on all the firm's profit,  $\pi_t$ .

Next, the household's problem can be now simplified to

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln[\omega c_t^\eta + (1 - \omega) s_t^\eta]^{1/\eta} \right\} \quad (2.3)$$

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<sup>10</sup>In particular, the elasticity of substitution can be expressed as  $\sigma = \frac{1}{1-\eta}$ . Note that if  $\sigma < 1$ , consumption and security are complements; if  $\sigma > 1$ , the two are substitutes, and when  $\sigma = 1$ , i.e.  $\eta = 0$ , the two are unrelated and preferences are separable in consumption and security.

s.t.

$$(1 + \tau^c)c_t + k_{t+1} - (1 - \delta)k_t = (1 - \tau^y)[r_t k_t + w_t + \pi_t] + g_t^t \quad (2.4)$$

where  $\tau^c$  is the progressive tax on consumption,  $\tau^y$  is the proportional income tax rate ( $0 < \tau^c, \tau^y < 1$ ), levied on both labor and capital income, and  $g_t^t$  denotes government transfers. The household takes the two tax rates  $\{\tau^c, \tau^y\}_{t=0}^\infty$ , government non-military consumption and transfers  $\{g_t^c, g_t^t\}_{t=0}^\infty$ , profit  $\{\pi_t\}_{t=0}^\infty$ , the realized technology process  $\{A_t\}_{t=0}^\infty$ , prices  $\{w_t, r_t\}_{t=0}^\infty$ , and chooses  $\{c_t, h_t, k_{t+1}\}_{t=0}^\infty$  to maximize its utility subject to the budget constraint.<sup>11</sup>

The first-order optimality conditions are as follows:

$$c_t : \frac{\omega c_t^{\eta-1}}{\omega c_t^\eta + (1 - \omega)s_t^\eta} = \lambda_t(1 + \tau^c) \quad (2.5)$$

$$k_{t+1} : \lambda_t = \beta E_t \lambda_{t+1} [1 + (1 - \tau^y)r_{t+1} - \delta] \quad (2.6)$$

$$TVC : \lim_{t \rightarrow \infty} \beta^t \lambda_t k_{t+1} = 0 \quad (2.7)$$

where  $\lambda_t$  is the Lagrangean multiplier attached to household's budget constraint in period  $t$ . The interpretation of the first-order conditions above is as follows: the first one states that for each household, the marginal utility of consumption equals the marginal utility of wealth, corrected for the consumption tax rate. The second equation is the so-called "Euler condition," which describes how the household chooses to allocate physical capital over time. The last condition is called the "transversality condition" (TVC): it states that at the end of the horizon, the value of physical capital should be zero.

## 2.2 Firm problem

There is a representative firm in the economy, which produces a homogeneous product. The price of output is normalized to unity. The production technology is Cobb-Douglas and uses

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<sup>11</sup>Note that labor choice is trivial; also, by choosing  $k_{t+1}$  the household is implicitly setting investment  $i_t$  optimally.

both physical capital,  $k_t$ , and labor hours,  $h_t$ , to maximize static profit<sup>12</sup>

$$\Pi_t = A_t k_t^\alpha h_t^{1-\alpha} - r_t k_t - w_t h_t, \quad (2.8)$$

where  $A_t$  denotes the level of technology in period  $t$ . Since the firm rents the capital from households, the problem of the firm is a sequence of static profit maximizing problems. In equilibrium, the optimal condition for capital is

$$r_t = \alpha \frac{y_t}{k_t}, \quad (2.9)$$

while given that the firm chooses  $h_t = 1, \forall t$ , the wage rate will be determined as

$$w_t = A_t k_t^\alpha h_t^{1-\alpha} - r_t k_t. \quad (2.10)$$

This condition reflects the fact that the unit time endowment was supplied inelastically by the household, and it was fully employed. Lastly, in equilibrium,  $\pi_t = 0, \forall t$ .<sup>13</sup>

## 2.3 Government

In the model setup, the government is levying taxes on labor and capital income, as well as consumption, in order to finance spending on military and non-military purchases, and government transfers. The government budget constraint is as follows:

$$m_t + g_t^c + g_t^t = \tau^c c_t + \tau^y [w_t + r_t k_t], \quad (2.11)$$

where  $m_t$  and  $g_t^c$  denote military and non-military spending in period  $t$ . Tax rates, military and non-military spending-to-output ratio would be chosen to match the average share in data. Finally, government transfers would be determined residually in each period so that the government budget is always balanced.

Next, following Smith (1980a), and Fernandez-de-Cordoba and Torres (2016), the security production function is provided as follows:

$$s_t = B_t m_t^\theta z_t^\gamma, \quad (2.12)$$

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<sup>12</sup>As in Fernandez-de-Cordoba and Torres (2016), we will assume that military spending does not enter the aggregate production function. In other words, it is considered differ from any other government investment spending.

<sup>13</sup>Since the firm chooses  $h_t = 1, \forall t$ , this is not an interior condition, and hence there is no FOC for labor.



where  $B_t$  captures the state of technology of the national security production function,  $0 < \theta < 1$  captures the importance of military expenditure in the provision of security,  $z_t$  is the strategic environment (or, equivalently, the perceived external threat for the country), and  $-1 < \gamma < 0$  is a (negative) weight associated to the importance of the threat factor in the provision of security.<sup>14</sup>

## 2.4 Dynamic Competitive Equilibrium (DCE)

For the given processes followed by technology and the external environment  $\{A_t, B_t, z_t\}_{t=0}^{\infty}$ , tax rates  $\{\tau^c, \tau^y\}_{t=0}^{\infty}$ , and initial capital stock  $\{k_0\}$ , the decentralized dynamic competitive equilibrium is a list of sequences  $\{c_t, i_t, k_t, h_t, s_t\}_{t=0}^{\infty}$  for the household, a sequence of government military and non-military spending and transfers  $\{m_t, g_t^c, g_t^t\}_{t=0}^{\infty}$ , and input prices  $\{w_t, r_t\}_{t=0}^{\infty}$  such that (i) the household maximizes its utility function subject to its budget constraint; (ii) the representative firm maximizes profit; (iii) government budget is balanced in each period; (iv) all markets clear.

## 3 Data and Model Calibration

To characterize business cycle fluctuations with a military sector in Bulgaria, we will focus on the period following the introduction of the currency board (1999-2018). Quarterly data on output, consumption and investment was collected from National Statistical Institute (2020), while the real interest rate is taken from Bulgarian National Bank Statistical Database (2020). The calibration strategy described in this section follows a long-established tradition in modern macroeconomics: first, as in Vasilev (2016), the discount factor,  $\beta = 0.982$ , is set to match the steady-state capital-to-output ratio in Bulgaria,  $k/y = 13.964$ , in the steady-state Euler equation. The labor share parameter,  $1 - \alpha = 0.571$ , is obtained as in Vasilev (2017d), and equals the average value of labor income in aggregate output over the period 1999-2016. This value is slightly higher as compared to other studies on developed economies, due to the overaccumulation of physical capital, which was part of the ideology of the totalitarian regime, which was in place until 1989. Next, the average income tax rate

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<sup>14</sup>Note that in the special case when  $\theta = -\gamma$ , an increase in the external threat will be exactly offset by an equal increase in military spending, leaving the level of national security unchanged.

was set to  $\tau^y = 0.1$ . This is the average effective tax rate on income between 1999-2007, when Bulgaria used progressive income taxation, and equal to the proportional income tax rate introduced as of 2008. Similarly, the average tax rate on consumption is set to its value over the period,  $\tau^c = 0.2$ .

Next, as in Fernandez-de-Cordoba and Torres (2016), the relative weight attached to the utility out of consumption in the household's utility function,  $\omega$ , is set to a high value, 0.9, to reflect the fact that security has a secondary role in the household's consumption bundle. Similarly, the curvature of the CES aggregator is set to  $\eta = 0.4$ , which is a typical value in the literature.<sup>15</sup> The weight of military expenditure in the provision of security is set to  $\theta = 0.86$  to reflect that only the investment spending on defence matters in the provision of security. Due to the lack of information, we set  $\gamma = -0.5$  to reflect that the military build-up will overcompensate for the size of the increase in the perceived level of external threats.<sup>16</sup> Next, the depreciation rate of physical capital in Bulgaria,  $\delta = 0.013$ , was taken from Vasilev (2016). It was estimated as the average quarterly depreciation rate over the period 1999-2014. Finally, the process followed by the TFP is estimated from the detrended series by running an AR(1) regression and saving the residuals. Due to the lack of data, the same moments will be used for the technology process in the security production function and the level of external threat.<sup>17</sup> Table 1 below summarizes the values of all model parameters used in the paper.

## 4 Steady-State

Once the values of model parameters were obtained, the steady-state equilibrium system solved, the "big ratios" can be compared to their averages in Bulgarian data. The results are reported in Table 2 below. The steady-state level of output was normalized to unity (hence the level of technology  $A$  differs from one, which is usually the normalization done in other

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<sup>15</sup>Robutness checks for  $\omega$  and  $\eta$  do not affect the results in this paper in any major way.

<sup>16</sup>This could be rationalized with the high degree of conservativeness and risk aversion among military personnel. Again, varying this parameter does not change the results in any major way.

<sup>17</sup>This is not a serious limitation, as Fernandez-de-Cordoba and Torres (2016) show the estimated moments for the processes in the US not to differ substantially from one another.

Table 1: Model Parameters

Parameter	Value	Description	Method
$\beta$	0.982	Discount factor	Calibrated
$\alpha$	0.429	Capital Share	Data average
$1 - \alpha$	0.571	Labor Share	Calibrated
$\omega$	0.900	Relative weight attached to consumption	Set
$\eta$	0.400	Curvature, consumption aggregation function	Set
$\theta$	0.800	Military expenditure share, security provision	Data average
$\gamma$	-0.500	Importance of external threat factor	Set
$\delta$	0.013	Depreciation rate on physical capital	Data average
$\tau^y$	0.100	Average tax rate on income	Data average
$\tau^c$	0.200	VAT/consumption tax rate	Data average
$\rho_a$	0.701	AR(1) persistence coefficient, TFP process	Estimated
$\sigma_a$	0.044	st. error, TFP process	Estimated
$\rho_b$	0.701	AR(1) persistence coefficient, security process	Set
$\sigma_b$	0.044	st. error, security process	Set
$\rho_z$	0.701	AR(1) persistence coefficient, external threat process	Set
$\sigma_z$	0.044	st. error, external threat process	Set

studies), which greatly simplified the computations. Next, the model matches consumption-to-output and government purchases ratios by construction; The investment ratios are also closely approximated, despite the closed-economy assumption and the absence of foreign trade sector. The shares of income are also identical to those in data, which is an artifact of the assumptions imposed on functional form of the aggregate production function. The after-tax return, where  $\bar{r} = (1 - \tau^y)r - \delta$  is also relatively well-captured by the model. Lastly, given the absence of debt, and the fact that transfers were chosen residually to balance the government budget constraint, the result along this dimension is understandably not so close to the average ratio in data.

Table 2: Data Averages and Long-run Solution

Variable	Description	Data	Model
$y$	Steady-state output	N/A	1.000
$c/y$	Consumption-to-output ratio	0.648	0.674
$i/y$	Investment-to-output ratio	0.201	0.175
$k/y$	Capital-to-output ratio	13.96	13.96
$m/y$	Military spending-to-output ratio	0.005	0.005
$g^c/y$	Govt non-military cons-to-output ratio	0.146	0.146
$wh/y$	Labor income-to-output ratio	0.571	0.571
$rk/y$	Capital income-to-output ratio	0.429	0.429
$\bar{r}$	After-tax net return on capital	0.014	0.016

## 5 Out of steady-state model dynamics

Since the model does not have an analytical solution for the equilibrium behavior of variables outside their steady-state values, we need to solve the model numerically. This is done by log-linearizing the original equilibrium (non-linear) system of equations around the steady-state. This transformation produces a first-order system of stochastic difference equations. First, we study the dynamic behavior of model variables to an isolated shock to the total factor productivity process, and then we fully simulate the model to compare how the second moments of the model perform when compared against their empirical counterparts.

### 5.1 Impulse Response Analysis

This subsection documents the impulse responses of model variables to a 1% surprise innovation to technology, to productivity of the security provision (which we label also "defense shock"), and in the external environment ("threat shock").

#### 5.1.1 Total factor productivity shock

The impulse response functions (IRFs) are presented in Fig. 1 and on the next page, where the dotted line depicts the dynamics of model variables when the military channel is turned off. The only major difference is the dynamics of military spending and the level of per-

ceived security. This is taken as a clear indication that the augmented model dominates the standard model along the new dimensions.

As a result of the one-time unexpected positive shock to total factor productivity, output increases upon impact. This expands the availability of resources in the economy, so used of output - consumption, investment, and government military and non-military consumption also increase contemporaneously. As a result of the increase in military expenditure, the level of security enjoyed increases as well.

At the same time, the increase in productivity increases the after-tax return on the two factors of production, labor and capital. The representative households then respond to the incentives contained in prices and start accumulating capital, and supplies more hours worked. In turn, the increase in capital input feeds back in output through the production function and that further adds to the positive effect of the technology shock. In the labor market, the wage rate increases, and the household increases its hours worked. In turn, the increase in total hours further increases output, again indirectly.

Over time, as capital is being accumulated, its after-tax marginal product starts to decrease, which lowers the households' incentives to save. As a result, physical capital stock eventually returns to its steady-state, and exhibits a hump-shaped dynamics over its transition path. The rest of the model variables return to their old steady-states in a monotone fashion as the effect of the one-time surprise innovation in technology dies out.

### 5.1.2 National defense shock

The IRFs to a one-unit shock to the productivity of national defence provision (i.e., the technology variable B), are presented in Fig. 2 on the next page.<sup>18</sup> As we see, the effect on the economy, following the realization of that shock, is quite small. First, as a result of the shock, the level of security increases. Next, due to the fact that consumption and security are substitutes, consumption falls. Given that output is unaffected upon impact of the shock, investment increases to compensate for the drop in consumption. Capital subsequently in-

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<sup>18</sup>In reality, this can be mapped to Bulgaria establishing a US military base in Novo Selo.

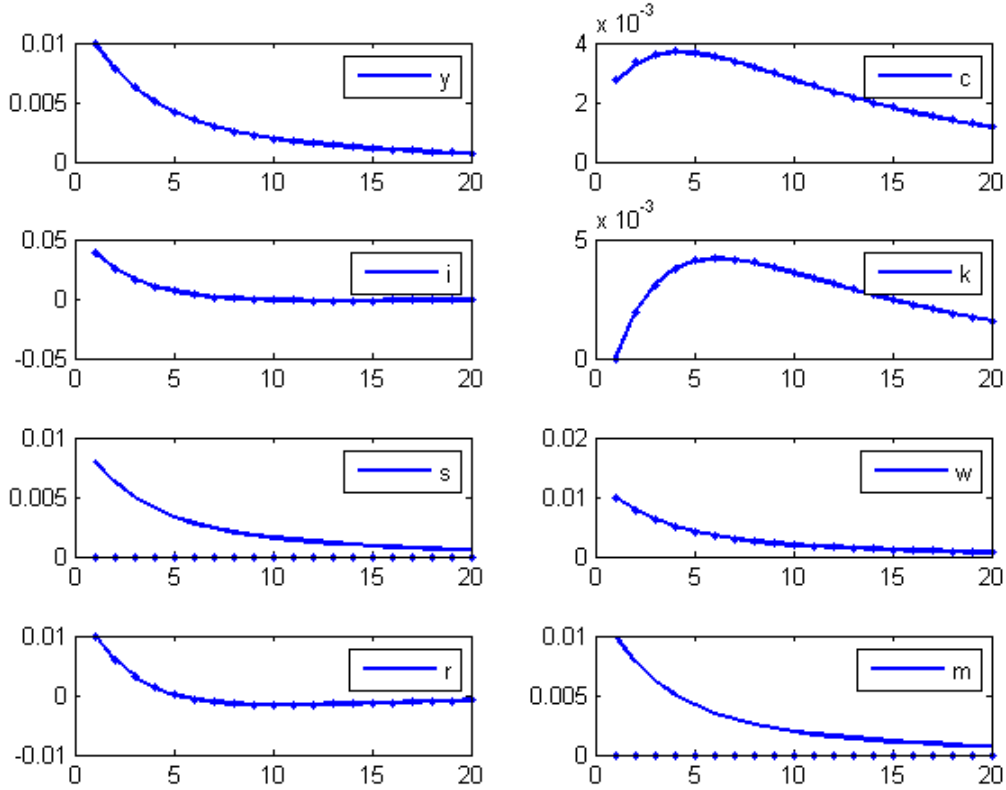


Figure 1: Impulse Responses to a 1% surprise innovation in technology

creases, which feeds back into output, and the government spending programs; The increase in military spending further increases the level of security, but this indirect effect is very weak.

Again, over time, as capital is being accumulated, its after-tax marginal product starts to decrease, which lowers the households' incentives to save. As a result, physical capital stock eventually returns to its steady-state, and exhibits a hump-shaped dynamics over its transition path. The rest of the model variables return to their old steady-states in a monotone fashion as the effect of the one-time surprise innovation in the defence provision technology dies out.

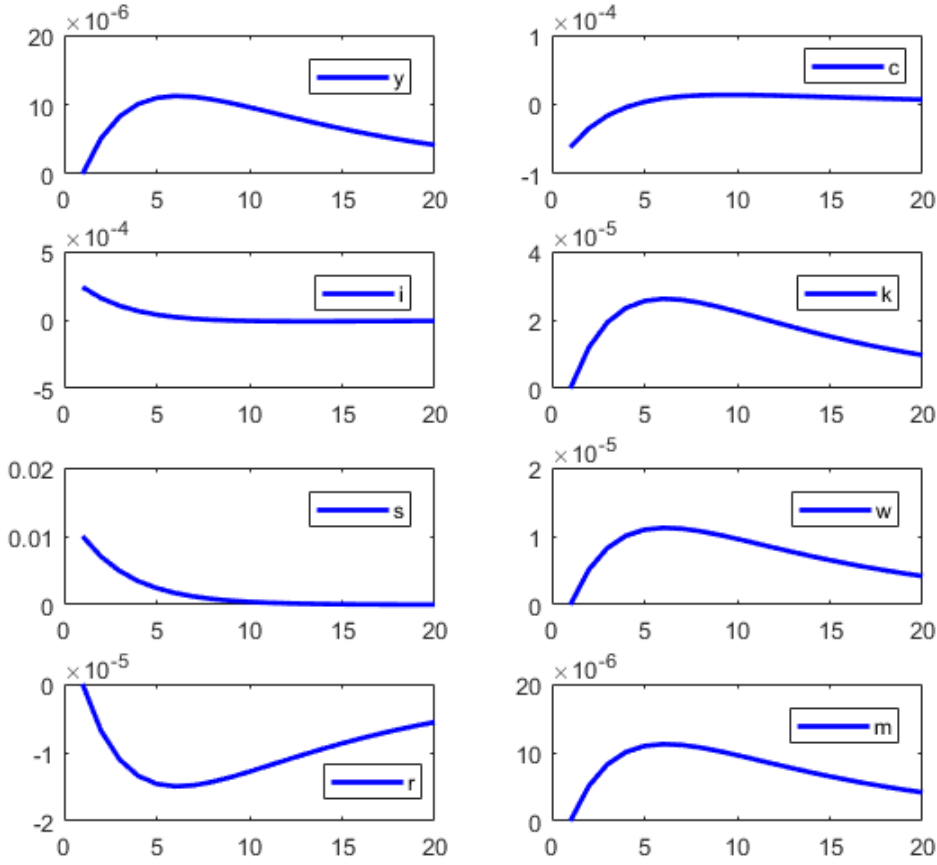


Figure 2: Impulse Responses to a 1% surprise innovation in security provision

### 5.1.3 Shock to external environment (threat level)

Lastly, Fig. 3 on the next page documents the IRFs in the model economy when there is a one-unit increase in the perceived external threat. This decreases directly the level of security upon impact of the shock. Consumption increases to preserve the marginal utility of consumption from changing. As a result of the change in consumption, investment falls. Capital subsequently decreases, which feeds back into output, and the government spending programs; however, this effect is quantitatively small. The decrease in military spending further decreases the level of security, but this indirect effect is again very weak. As capital is being de-cumulated, its after-tax marginal product starts to increase, which increases the households' incentives to save. As a result, physical capital stock eventually returns to its

steady-state from below. The rest of the model variables return to their old steady-states in a monotone fashion as the effect of the one-time surprise innovation in technology dies out.

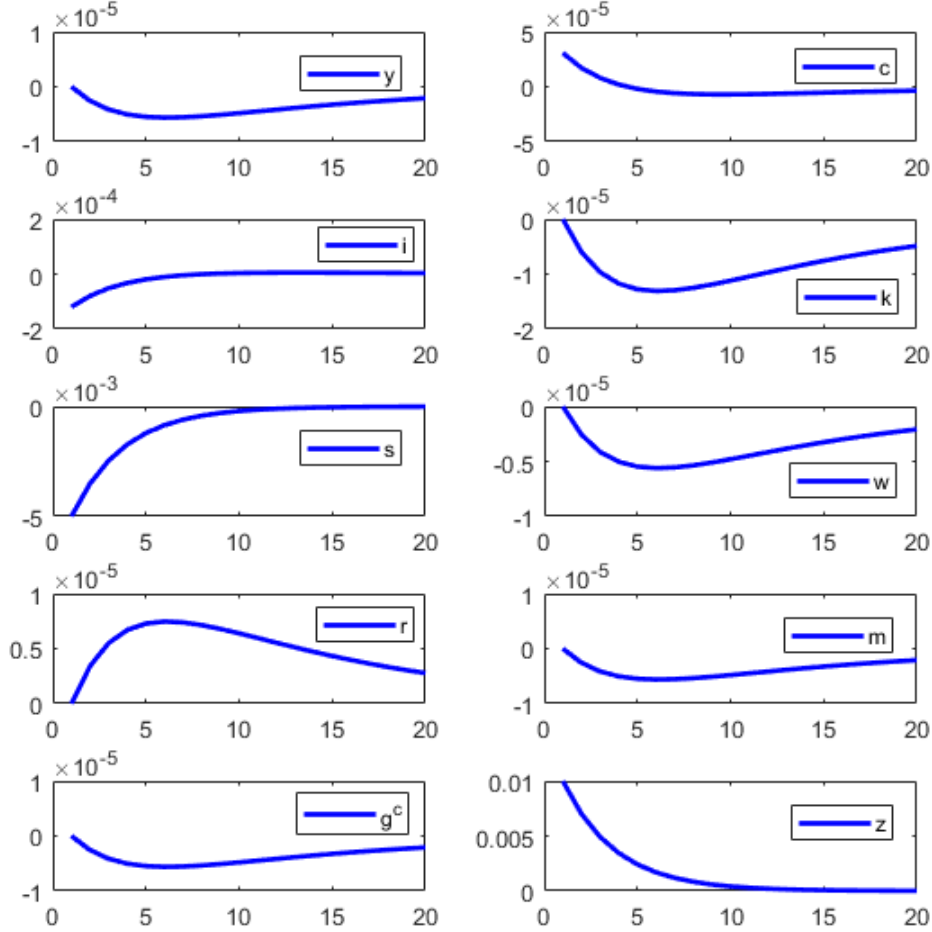


Figure 3: Impulse Responses to a 1% surprise innovation in external threat level

Importantly, our results differ from those in Fernandez-de-Cordoba and Torres (2016). In particular, in the case of Bulgaria, there is no positive output effect as a result of the increase in global uncertainty.<sup>19</sup>

<sup>19</sup>Our model differs from theirs: we assume that the level of security provision is taken as given by the household, while Fernandez-de-Cordoba and Torres (2016) solve the Social Planner problem. Since our setup



## 5.2 Simulation and moment-matching

As in Vasilev (2017b), we will now simulate the model 10,000 times for the length of the data horizon. Both empirical and model simulated data is detrended using the Hodrick-Prescott (1980) filter. Table 3 on the next page summarizes the second moments of data (relative volatilities to output, and contemporaneous correlations with output) versus the same moments computed from the model-simulated data at quarterly frequency.<sup>20</sup> To minimize the sample error, the simulated moments are averaged out over the computer-generated draws.

We proceed to compare and contrast the results from a model with TFP shocks only, the case with all shocks present, and evaluate the model fit against the benchmark RBC setup without military expenditure, as well as against data. As in Vasilev (2016, 2017b, 2017c), the model matches quite well the absolute volatility of output and investment. In addition, the predicted consumption volatility with a military sector is higher, as security considerations make consumption more variable. On the other hand, the investment volatilities is a bit lower than that in the benchmark model, but still substantially higher than the observed variability of investment. Still, all three models are qualitatively consistent with the stylized fact that consumption generally varies less than output, while investment is more volatile than output.

With respect to the labor market variables, the variability of employment predicted by the models with military sector is zero, much lower than that in data, as we hold hours fixed. As a result, the variability of wages in the model is one-to-one with output, which is higher than the observed wage volatility. This is yet another confirmation that the perfectly-competitive assumption, e.g. Vasilev (2009), as well as the benchmark calibration here, does not describe very well the dynamics of labor market variables. Next, in terms of contemporaneous correlations, the model systematically over-predicts the pro-cyclicality of the main aggregate variables - consumption, investment, and government spending categories (which co-move perfectly with output). This, however, is a common limitation of this class of models. Along features distortionary taxes, this setup is not feasible for us. Solving for the optimal (Ramsey) fiscal policy regime, i.e., the second-best allocation, is left for future research.

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<sup>20</sup>The model-predicted 95 % confidence intervals are available upon request.

Table 3: Business Cycle Moments

	Data	Model (TFP shocks only)	Model (all shocks)	Benchmark RBC (no military spending)
$\sigma_y$	0.05	0.05	0.05	0.05
$\sigma_c/\sigma_y$	0.55	0.86	0.85	0.82
$\sigma_i/\sigma_y$	1.77	2.11	2.14	2.35
$\sigma_h/\sigma_y$	0.63	0.00	0.00	0.28
$\sigma_w/\sigma_y$	0.83	1.00	1.00	0.86
$\sigma_{y/h}/\sigma_y$	0.86	1.00	1.00	0.86
$corr(c, y)$	0.85	0.91	0.82	0.81
$corr(i, y)$	0.61	0.81	0.81	0.82
$corr(h, y)$	0.49	0.00	0.00	0.26
$corr(w, y)$	-0.01	1.00	1.00	0.96
$corr(w, h)$	0.33	0.00	0.00	0.36

the labor market dimension, the contemporaneous correlation of employment with output in the setup with military sector is zero, as hours are kept unchanged over time. With respect to wages, all three model predicts strong cyclical, while wages in data are acyclical. This shortcoming is well-known in the literature and an artifact of the wage being equal to the labor productivity in the model.

In the next subsection, as in Vasilev (2016), we investigate the dynamic correlation between labor market variables at different leads and lags, thus evaluating how well the model matches the phase dynamics among variables. In addition, the autocorrelation functions (ACFs) of empirical data, obtained from an unrestricted VAR(1) are put under scrutiny and compared and contrasted to the simulated counterparts generated from the model.

### 5.3 Auto- and cross-correlation

This subsection discusses the auto-(ACFs) and cross-correlation functions (CCFs) of the major model variables. The coefficients empirical ACFs and CCFs at different leads and

lags are presented in Table 4 below against the averaged simulated AFCs and CCFs from the model with military sector, and all shocks present.<sup>21</sup>

As seen from Table 4 above, the model compares relatively well vis-a-vis data. Empirical ACFs for output and investment are slightly outside the confidence band predicted by the model, while the ACFs for total factor productivity and household consumption are well-approximated by the model. Overall, the model with military sector generates too much persistence in output and wages, and is subject to the criticism in Nelson and Plosser (1992), Cogley and Nason (1995) and Rotemberg and Woodford (1996b), who argue that the RBC class of models do not have a strong internal propagation mechanism besides the strong persistence in the TFP process. In those models, e.g. Vasilev (2009), and in the current one, labor market is modelled in the Walrasian market-clearing spirit, with perfectly-inelastic labor supply, and output and unemployment persistence is low.

## 6 Conclusions

We introduce a military sector and security considerations into a real-business-cycle setup augmented with a detailed government sector. We calibrate the model to Bulgarian data for the period following the introduction of the currency board arrangement (1999-2018). We investigate the quantitative importance of the presence of a military sector and external threat considerations for the cyclical fluctuations in Bulgaria. We find the quantitative effect of such aspects to be very small, and thus not important for business cycle stabilization, or public finance issues, as in Bulgaria the spending on military is relatively small relative to the size of the economy.

Those negative results are particularly of interest to small economies to remind policy makers that excessive government spending, and excessive militarization for that manner, is not the path to riches and welfare, as the effect on the economy is in the best case a tiny positive one, and more often in reality - even a negative one.

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<sup>21</sup>Following Canova (2007), this is used as a goodness-of-fit measure.

Table 4: Autocorrelations for Bulgarian data and the model economy

		k			
Method	Statistic	0	1	2	3
Data	$corr(y_t, y_{t-k})$	1.000	0.810	0.663	0.479
Model	$corr(y_t, y_{t-k})$	1.000	0.956	0.904	0.845
	(s.e.)	(0.000)	(0.027)	(0.052)	(0.076)
Data	$corr(a_t, a_{t-k})$	1.000	0.702	0.449	0.277
Model	$corr(a_t, a_{t-k})$	1.000	0.953	0.898	0.833
	(s.e.)	(0.000)	(0.030)	(0.058)	(0.084)
Data	$corr(c_t, c_{t-k})$	1.000	0.971	0.952	0.913
Model	$corr(c_t, c_{t-k})$	1.000	0.959	0.911	0.856
	(s.e.)	(0.000)	(0.024)	(0.047)	(0.068)
Data	$corr(i_t, i_{t-k})$	1.000	0.810	0.722	0.594
Model	$corr(i_t, i_{t-k})$	1.000	0.952	0.894	0.827
	(s.e.)	(0.000)	(0.031)	(0.059)	(0.085)
Data	$corr(w_t, w_{t-k})$	1.000	0.760	0.783	0.554
Model	$corr(w_t, w_{t-k})$	1.000	0.956	0.904	0.845
	(s.e.)	(0.000)	(0.027)	(0.052)	(0.076)

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