MODELLING OF MILITARY EXPENDITURE OF THE CZECH REPUBLIC

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ABSTRACT

Within the EU, the economic environment of the Czech Republic belonged to dynamically developing environments characterized by an above-average speed of economic growth. The economic crisis affected the Czech Republic via a decline in domestic and foreign demand, reflecting in the slowing speed of economic growth. The growing deficit of public finances, together with growing indebtedness, made the government accept a number of anti-crisis measures lying in the regulation of the income and expense side of the state budget. The military expenses as a part of government expenditure were considerably reduced during the economic crisis and currently they form only 1.1% of the GDP. The current change in the security environment provoked a debate on long-term underfinancing of the department of defence in the Czech Republic and acknowledging the responsibility for the country´s security. Measures accepted in consequence of the changing perception of security threats will contribute to increasing military expenses to at least 1.4% of the GDP in 2020. The contribution focuses on military expenditure modelling and its economic determinants using the Autoregressive Distributed Lag (ARDL) model. This model is applied to economic data of the Czech Republic over the period 1993–2018. To quantify the determinants of military expenditure, the authors selected data from the database of the Czech Statistical Office defining economic determinants of the military expenditure. For modelling, the following macroeconomic and fiscal variables were used: gross domestic product per capita, inflation, government deficit, government debt. According to the estimated model, the authors compute and simulate possible future development of Czech military expenditure.

Keywords: *ARDL model, Economic Determinants, Military Expenditure*

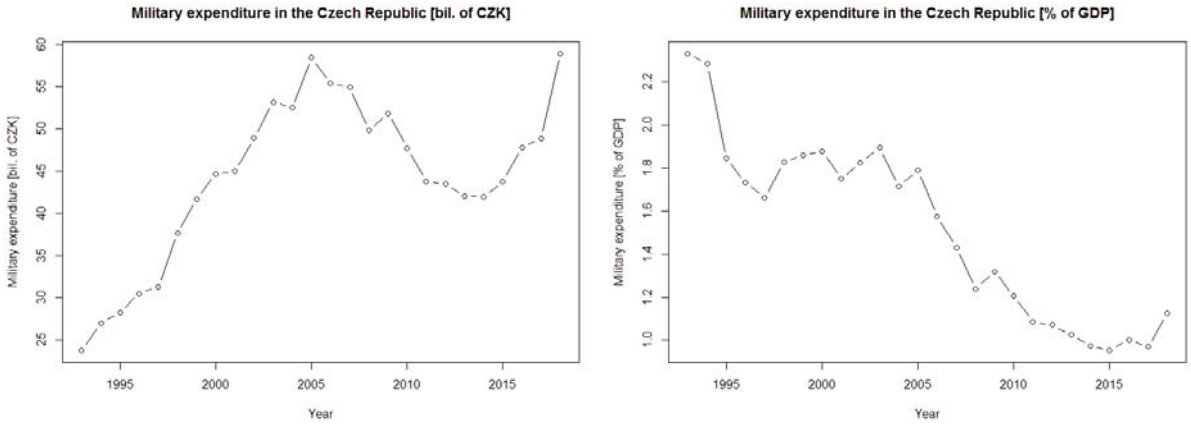
1. INTRODUCTION

Since 1999 the Czech Republic has been a NATO member state enjoying security guarantees arising from the membership. In 2002 an armed forces reform was implemented. However, the reform was hindered by insufficient funding manifested in a significant decline in military expenses as a percentage of Gross Domestic Product and long-term failure to follow the Alliance recommendations. The economic crisis which affected the Czech Republic together with the increasing public finances deficit and the public debt intensified pressure for further reduction of expenditures. Therefore, military expenditure[1] fell especially in 2010 (see Figure 1 – left) and kept falling until 2013 (more detailed in Holcner and Olejnicek (2017)). This long-term underfinancing endangers the fulfilment of roles and functions of the armed forces of the

[1] The SIPRI (Stockholm International Peace Research Institute) definition of military expenditure includes all current and capital expenditures on the following activities: the armed forces (including peace-keeping forces), the civil administration of the military sector (defence ministries and other government agencies engaged in defence activities), paramilitary forces (non-regular armed forces trained, equipped and available for military operations), military space activities. Such expenditure should include the following components: personnel, operations and maintenance, arms procurement, military research and development (R&D), military construction, military aid (in the military expenditure of the donor country).

Czech Republic. It is also evident that the decreasing trend in military expenses further increases investment deficit and prevents adherence to the 50–30–20 rule, i.e. spending 50% on mandatory expenses, 30% on common expenses, and 20% on investments in the department of defence.

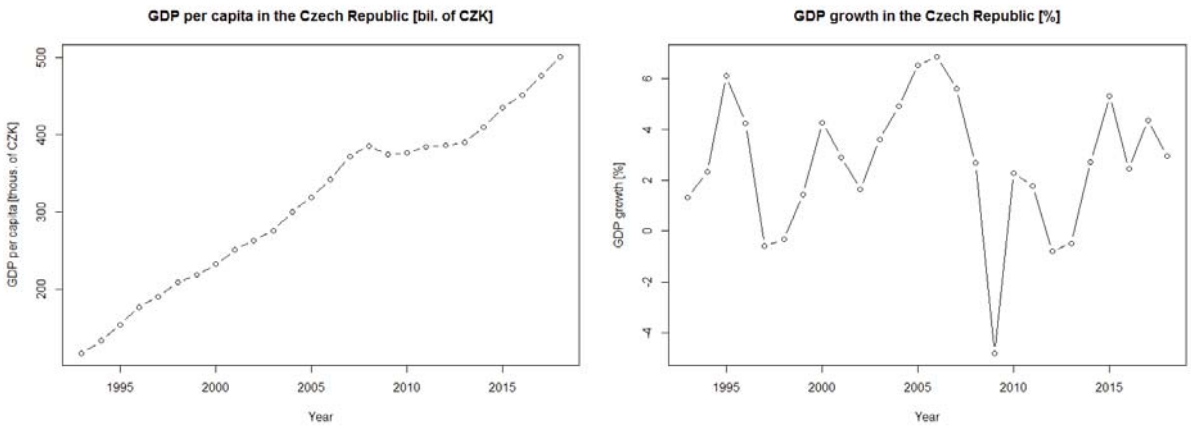
Figure 1: Military expenditure in the Czech Republic in billions of CZK (left) and as a percentage of GDP (right)



Source: SIPRI

Even the indicator showing the military burden as a percentage of military expenditure of GDP (see Figure 1 – right) points to significant underfinancing of defence. Long-term underfinancing of the department is apparent from the Figure 1 – the allocated amount of military expenses is lower than the amount recommended for NATO member countries in relation to GDP. Analogously, the indicator showing military expenses as a percentage of the state budget suggests decreasing trends where the biggest reduction took place during the economic crisis.

Figure 2: GDP per capita in thousands of CZK (left) and GDP growth (right) in the Czech Republic

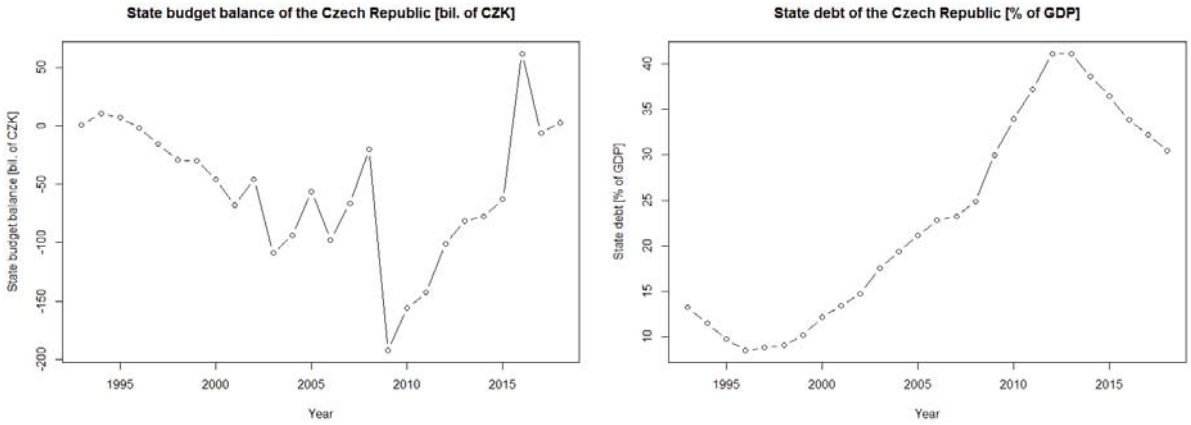


Source: Czech Statistical Office

The economic crisis which manifested itself in a significant decline in GDP was replaced by periods of economic growth during which the Czech Republic belonged to dynamically developing European economies characterized by an above-average pace of economic growth achieved in the European Union. The period of economic growth was replaced by a rapid decline in GDP in 2009 (Figure 2).

Within the analysed period the pace of GDP growth slackened in 2008, while in 2009 it slumped by almost 5% (–4,8%). In the following year GDP grew slightly; however, the Czech economy did not achieve the comparatively high GDP growth experienced before the economic crisis. The economic crisis which manifested itself, inter alia, in a growing public finance deficit (Figure 3) and mounting public debt exerted pressure on imposing economic measures influencing funds allocated for the defence[2] (Sezgin and Yildirim, 2002; Dunne and Nikolaidou, 2001). The development of the state budget deficit (the absolute value and a percentage of GDP) together with the government debt (the absolute value and a percentage of GDP) represent variables binding for the Czech Republic as the fiscal criterion for accepting the European currency. The state budget deficit in the Czech Republic increased even when the economy experienced economic growth. Considerable deficit growth was evident especially in 2009 when it represented more than 5% of GDP. Growing public finance deficits exert pressure on accumulating government debt that has been growing on a long-term basis since 2009. This involves considerable expenses on the accumulating debt service, which every year represents approximately an annual budget of the Ministry of Defence when taking into consideration the interest only. The downward trend is apparent for the variable describing the inflation rate. The figure 4 shows a significant decline between 1993 and 1997 related to the economic reforms resulting from the economic transition from a centrally planned economy to a market economy. Low inflation rate and the threat of deflation is evident from the figure after 2012. In order to ensure the price stability, the central bank started using the exchange rate as a tool of monetary policy in the Czech Republic. In 2013, after considering possible risks, the central bank initiated a targeted intervention on the monetary market and weakening the CZ crown (CZK) towards the Euro. The aim of this intervention was especially ensuring price stability and supporting the price competitiveness of exporters.

Figure 3: State debt of the Czech Republic in billions of CZK (left) and as a percentage of GDP (right)



Source: Czech Statistical Office

Figure following on the next page

[2] Empirical studies e.g. Sezgin, Yildirim (2002), Dunne, Nikolaidou (2001) aimed at identifying military expenditure determinants classify those determinants into groups of *economic* factors, *political* factors and *strategic* factors.

Figure 4: Inflation rate of the Czech Republic

Source: Czech Statistical Office

2. MODELS AND METHODS

Time series of military expenditure will be decribed by the autoregressive distributed lag model ARDL(p,q_1,q_2,…, p_k), where p is the number of lags of the dependent variable Y_t, $q_1, q_2, \dots, q_k$ are numbers of lags of explanatory variables X_{it}, $i = 1,2, \dots, k$. The model can be written in the form

$$Y_t = \alpha + \sum_{i=1}^{p} \gamma_i Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{q_j} \beta_{j,i} X_{j,t-i} + \varepsilon_t,$$

where ε_t is a one-dimensional zero mean error term. The lag lengths in the model can be determined by the standard information criterion such as Akaike, Schwarz or Hannan-Qiunn information criterion (Baltagi, 2011 or Hill, Griffiths and Judge, 2000). The ARDL model estimates the dynamic relationship between dependent and explanatory variables. It is possible to transform the model into a long-run representation showing the long-run response of the dependent variable to a change in the explanatory variables. The long run estimates are given by

$$\hat{\theta}_j = \frac{\sum_{i=1}^{q_j} \hat{\beta}_{j,i}}{1 - \sum_{i=1}^{p} \hat{\gamma}_i}.$$

Besides the dynamic description, the ARDL approach also enables testing of cointegration. The cointegrated system of time series can by estimated as ARDL model (Pesaran and Shin, 1999) with the advantage that variables in cointegrating relationship can be either $I(0)$ or $I(1)$ without having to specify which are $I(0)$ or $I(1)$. For the purpose of a cointegration analysis the form of the model in differences is used

$$\Delta Y_t = \sum_{i=1}^{p-1} \gamma_i^* \Delta Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{q_j-1} \beta_{j,i}^* \Delta X_{j,t-i} - \hat{\phi} EC_{t-1} + \varepsilon_t,$$

where $EC_t = Y_t - \hat{\alpha} - \sum_{j=1}^{k} \hat{\theta}_j X_{j,t}$, and $\hat{\phi} = 1 - \sum_{i=1}^{p} \hat{\gamma}_i$. Pesaran, Shin and Smith (2001) proposed a methodology for testing the existence of a long-run relationship between an independent variable and regressors.

Predictions of military expenditure for 2019–2023 are based on the estimated ARDL model. To calculate these predictions, it is necessary to know the values of explanatory variables X_{it}. These values are apparently not available. We have decided to forecast these values by Holt-Winters filtering (Holt, 1957; Winters, 1960). Using these forecasts we obtain one possible scenario for future development. Based on the estimated ARDL model and forecasts of explanatory variables, we compute predictions with 95% confidence intervals (Demirhan, 2019). Besides these predictions, we simulate possible paths of forecasted military expenditure using covariance matrix of estimated parameters of ARDL models. Using this matrix and with the assumption of normality, we simulate parameters of ARDL model.

3. RESULTS

Analysed data are downloaded from the databases CZSO and SIPRI (data for the period 1993 to 2018). We introduce the following notation:

- MILEX military expenditure per capita in billions of CZK
- Debt state debt in billions of CZK
- GDPpc gross domestic product per capita in thousands of CZK
- Inflation inflation rate in percent
- Saldo state budget balance in billions of CZK

Table 1 contains estimation results for full model (due to the length of time series, the maximum lag is 1). The final model was selected by backward elimination. We obtain an estimate

$$\widehat{MILEX}_t = 0.486\, MILEX_{t-1} - 0.014\, Debt_t + 88.588\, GDPpc_t - 0.659\, Inflation_t.$$

Table 1: ARDL model (standard errors in parentheses)

	Dependent variable: MILEX	
	Full model	Final model
$MILEX_{t-1}$	0.374	0.486***
	(0.232)	(0.104)
$Debt_t$	–0.003	–0.014***
	(0.026)	(0.003)
$Debt_{t-1}$	–0.014	
	(0.025)	
$GDPpc_t$	118.081	88.588***
	(100.299)	(20.421)
$GDPpc_{t-1}$	–5.969	
	(94.395)	
$Inflation_t$	–0.808**	–0.659***
	(0.372)	(0.254)
$Inflation_{t-1}$	0.189	
	(0.235)	
$Saldo_t$	0.005	
	(0.023)	
$Saldo_{t-1}$	–0.006	
	(0.017)	
Constant	9.054	10.451**
	(7.583)	(4.231)
Observations	25	25
R^2	0.942	0.936
Adjusted R^2	0.907	0.924
Residual Std. Error	2.721	2.462
F Statistic	26.953***	73.604***

*Note: *p<0.1; **p<0.05; ***p<0.01*

Table 2: ARDL model – long run coefficients (standard errors in parentheses)

	Dependent variable: MILEX	
	Full model	Final model
$Debt_t$	–0.027***	–0.027***
	(0.007)	(0.005)
$GDPpc_t$	179.180***	172.256***
	(47.084)	(29.733)
$Inflation_t$	–0.990	–1.282***
	(0.602)	(0.429)
$Saldo_t$	-0.002	
	(0.050)	
Constant	14.470	20.323***
	(11.082)	(4.231)

*Note: *p<0.1; **p<0.05; ***p<0.01*

The long run relationship for military expenditure is (see Table 2)

$$\widehat{EC}_t = MILEX_t - (-0.027\ Debt_t + 172.256\ GDPpc_t - 1.282\ Inflation_t + 20.323).$$

The models are shown graphically in Figure 5. According to the test of cointegration, so called F-Bounds test (Pesaran, Shin and Smith, 2001), the analysed time series are cointegrated (F-statistic is 7.47 with critical values at the significance level 0.05 for *I*(0) processes 2.79 and for *I*(1) processes 3.67).

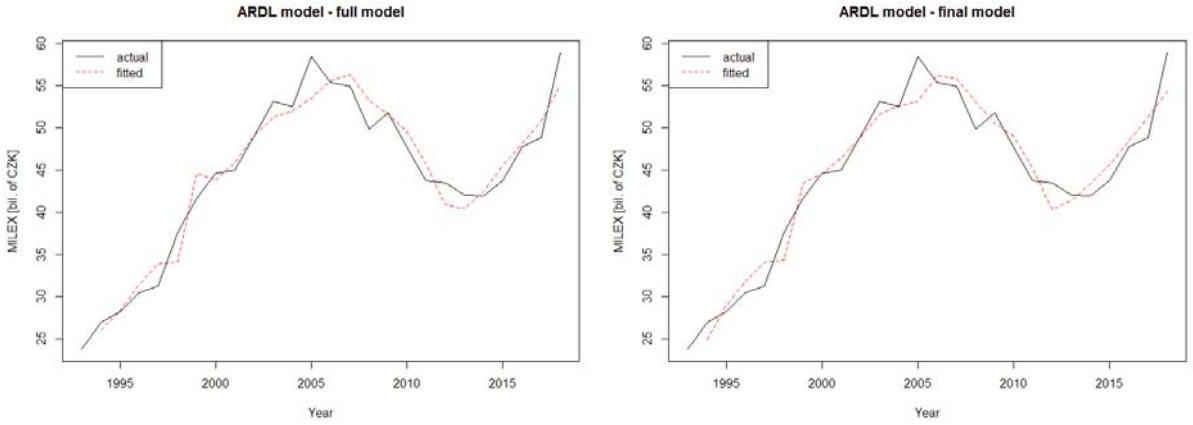


Figure 5: ARDL model of military expenditure in the Czech Republic

As the last step, we compute and simulate future development of military expenditure. A possible scenario is based on the estimated ARDL model and forecast of explanatory variables (Debt, GDPpc and Inflation). We apply Holt-Winters filtering to compute 5-step ahead forecast of given time series. Using these forecasts and estimated parameters of ARDL model, we compute the forecast of military expenditure and 95% confidence interval (Demirhan, 2019). The results are summarized in Table 3 and Figure 6 (left).

Table following on the next page

Table 3: The results of forecasting

Year	*Forecast*	*Lower 95% C.I.*	*Upper 95% C.I.*
2019	60.276	55.659	65.282
2020	62.114	56.489	68.162
2021	64.172	59.292	69.611
2022	66.337	60.891	71.996
2023	68.555	63.664	75.344

In addition to the computed forecasts, we simulate possible paths of forecasted military expenditure using covariance matrix of estimated parameters of ARDL models. Using this matrix and with the assumption of normality, we simulate parameters of ARDL model. We computed 1000 simulations of future development of military expenditure, see Figure 6 (right).

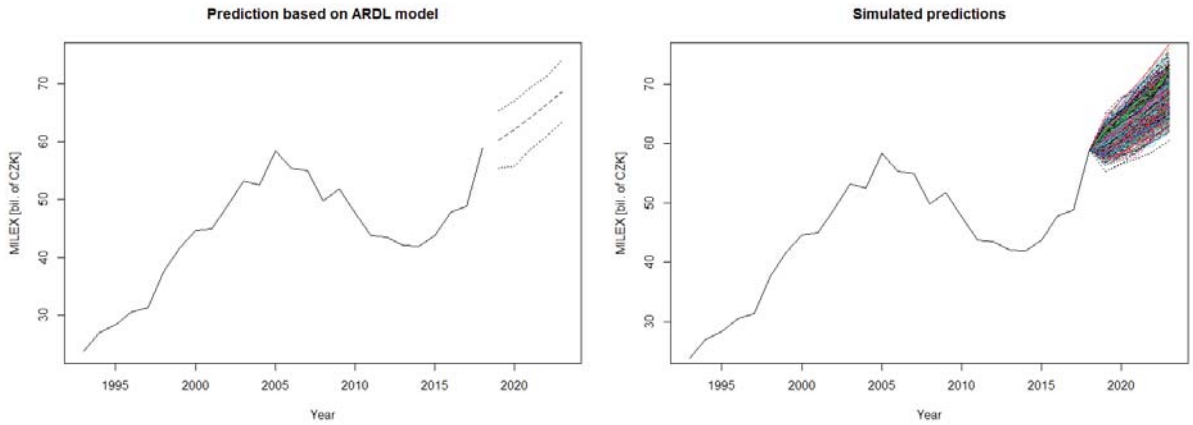


Figure 6: Predictions of military expenditure in the Czech Republic

4. CONCLUSION

The military expenditure of the Czech Republic has been influenced by a number of factors including the NATO enlargement process, the professionalisation of the military, the effects of the economic crisis, and the development of the security environment. The economic environment characterized by selected macroeconomic variables is one of the determinants of military expenditure, defined by the indicator of gross domestic product per capita, inflation, state budget deficit, and government debt. The estimated ARDL model and the simulation model based on the original ARDL model were used for the prediction of the military spending based on the development of the economic environment. The results obtained in the form of short-term predictions for the 2019–2023 confirm the comparability of the results in both approaches and thus the expected increase in military expenditure in the forecast period.

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