Development and the cyclicality of government spending in the Czech Republic

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Abstract. This paper aims to provide direct empirical evidence on business cycle relations between GDP and government spending in the Czech Republic. Government spending plays an important role in a fiscal policy as a possible automatic stabilizer. We analyzed annual data on government spending in compliance with the COFOG international standard. We use cross-correlation on cyclically filtered adjusted time series over the period 1995-2008. The cyclical properties of GDP and government spending function were, in average, found as weakly correlated. However, we report considerable differences in correlations across the spending functions. The lowest correlation coefficient (0.06) was found for recreation, culture and religion and the highest average was reported for economic affairs (-0.51). As regards to using government spending as the stabilizer, total government spending, general public services, defense, economic affairs and education spending were negative correlated and it confirms countercyclical relation between these spending functions and GDP. It is in line with theory suggestion. On the other hand, the highest spending function (social protection) correlated weak positive and it mean procyclical development.

The results of Johansen cointegration test proved the existence of long-run relationship between GDP and total government spending, public order and safety and economic affairs.

Keywords: government spending, cyclicality, economic growth, correlation, cointegration.

JEL Classification: C32, H50, E62
AMS Classification: 90C15

1 Introduction

The economy of the country is greatly influenced by the level and the structure of government spending. The government spending is an important tool for national governments to mitigate the uneven economic development and economic shocks across individual countries. Government spending plays important role in a fiscal policy of each country as a possible automatic stabilizer as from a Keynesian perspective, there is a view that government spending should act as a stabilizing force and move in a countercyclical direction. Procyclical fiscal policy is conversely policy expansionary in booms and contractionary in recessions. Serven [13] points that procyclical fiscal policy is generally regarded as potentially damaging for welfare: it can raise macroeconomic volatility, depress investment in real and human capital, hamper growth, and harm the poor. If expansionary fiscal policies in "good times" are not fully offset in "bad times", they may also produce a large deficit bias and lead to debt unsustainability and eventual default. If a government respect a basic prescription that fiscal tools should function counter-cyclical, the optimal fiscal policy involves a decreasing of government spending in "good times" and a increasing of government spending in "bad times." Contrary to the theory (it implies that government spending is countercyclical), a number of recent studies found evidence that government spending is procyclical. See Hercowitz and Strawczynski [7], Alesina et al., [2], Rajkumar and Swaroop [12] or Ganeli [4] for more details. Talvi and Vegh [14] show that fiscal procyclicality is evident in a much wider sample of countries. Lane [10] finds procyclicality in a single-country time series study of Irish fiscal policy. As Fiorito and Kollintzas [3] document for G7 countries, the correlation between government consumption and output indeed appears to show no pattern and be clustered around zero. Lane [11] also shows that the level of cyclicality varies across spending categories and across OECD countries. Abbot and Jones [1] test differences in the cyclicality of government spending across functional categories. Their evidence from 20 OECD countries suggests that procyclicality is more likely in smaller functional budgets, but capital spending is more likely to be procyclical for the larger spending categories. Many of researches like Gavin et al. [5], Gavin and Perotti [6] focuse on Latin America. Previously published studies are weakly supported by the data particularly in emerging and post-transition economies in which results can vary. We would like to eliminate the literature gap in this field and analyze government spending in the Czech Republic. The aim of the paper is to provide direct empirical evi-

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dence on business cycle relation between Gross Domestic Product (GDP) government spending (G) and estimate long-run relationship between these variables in the Czech Republic.

We follow Abbot and Jones [1] and apply the cross-correlation technique and cointegration on annul data of GDP and government spending in compliance with the COFOG international standard during the period 1995-2009 from Eurostat. The paper is organized as follows. In the next section, we describe the dataset and empirical techniques used. In Section 3, we present the results of government spending development and cross-correlation. In Section 4, we estimate long- run relationship between output and government spending. In Section 5, we conclude with a summary of key findings.

2 Data and Methodology

The dataset consists of annual data on GDP and government spending in compliance with the COFOG international standard during the period 1995 – 2008. Although data from 2009 are available we prefer to work with a consistent dataset that excludes observations from a crisis period. All the data were collected from the Eurostat database. The series for GDP and total government spending and its subcomponent are adjusted at constant prices. We converted all series into logs and applied the Hodrick-Prescott filter with smoothing parameter 100 to each series with the aim to isolate the cycle component of time series. We apply cross-correlation to all combinations of GDP – category of government spending. Johansen cointegration test and the error correction model (ECM) are used to estimate the long-run relationship between output and government spending predicted by, for example, Wagner´s Law. Most of the results are calculated in econometric program Eviews 7.

Many studies point out that using non-stationary macroeconomic variable in time series analysis causes superiority problems in regression. Thus, a unit root test should precede any empirical study employing such variables. We decided to make the decision on the existence of a unit root through Augmented Dickey–Fuller test (ADF test). The equation (1) is formulated for the stationary testing.

$$\Delta x_t = \delta_0 + \delta_1 t + \delta_2 x_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta x_{t-i} + u_t \tag{1}$$

ADF test is used to determine a unit root x_t at all variables in the time t. Variable Δx_{t-i} expresses the lagged first difference and u_t estimate autocorrelation error. Coefficients δ_0, δ_1, δ_2 and α_i are estimated. Zero and the alternative hypothesis for the existence of a unit root in the x_t variable are specified in (2). The result of ADF test, which confirms the stationary of all time series on the first difference, is available on reguest.

$$H_0\!: \delta_2 = 0,\ H_\varepsilon\!: \delta_2 < 0 \tag{2}$$

The cross-correlation assesses how one reference time series correlates with another time series, or several other series, as a function of time shift (lag). Consider two series x_i and y_i where i = 0, 1, 2, …, N-1. The cross correlation r at delay d is defined as:

$$r = \frac{\sum_i \left[(x_i - m_x) * (y_{i-d} - m_{y)}\right]}{\sqrt{\sum_i (x_i - m_x)^2 \sqrt{(y_{i-d} - m_y)^2}}} \tag{3}$$

where m_x and m_y are the means of corresponding series.

The Hodrick-Prescott (HP) estimates an unobservable time trend for time series variables. Let y_t denote an observable macroeconomic time series. The HP filter decomposes y_t into a nonstationary trend g_t and a stationary residual component c_t, that is:

$$y_t = g_t + c_t \tag{4}$$

We note that g_t and c_t are unobservables. Given an adequately chosen, positive value of λ, there is a trend component that will minimize:

$$\min \sum_{t=1}^{T} (y_t - g_t)^2 + \lambda \sum_{t=2}^{T} \left[(g_{t+1} - g_t) - (g_t - g_{t-1})\right]^2 \tag{5}$$

The first term of the equation is the sum of the squared deviations which penalizes the cyclical component. The second term is a multiple λ of the sum of the squares of the trend component's second differences. This second term penalizes variations in the growth rate of the trend component. The larger the value of λ, the higher is the penalty. Hodrick and Prescott advise that, for annual data, a value of λ = 100 is reasonable.

The Johansen method [8] applies the maximum likelihood procedure to determine the presence of cointegrating vectors in non-stationary time series as a vector autoregressive (VAR):

$$\Delta x_t = C + \sum_{i=1}^{K} \chi_i \Delta x_{t-i} + \pi Z_{t-1} + \eta_t \tag{6}$$

where x_t is a vector of non-stationary (in log levels) variables and C is the constant term. The information on the coefficient matrix between the levels of the Π is decomposed as $\Pi = \alpha \cdot \beta'$, where the relevant elements the α matrix are adjustment coefficients band the β matrix contains the cointegrating vectors. Johansen and Juselius [9] specify two likelihood ratio test statistics to test for the number of cointegrating vectors. The first likelihood ratio statistics for the null hypothesis of exactly r cointegrating vectors against the alternative $r+1$ vectors is the maximum eigenvalue statistic. The second statistic for the hypothesis of at most r cointegrating vectors against the alternative is the trace statistic. Critical values for both test statistics are tabulated in Johansen–Juselius [9]. If the variables are non-stationary and are cointegrated, the adequate method to examine the issue of causation is the Error Correction Model (ECM), which is a Vector Autoregressive Model VAR in first differences with the addition of a vector of cointegrating residuals. Thus, this VAR system does not lose long-run information.

3 Development and the cyclicality of government spending

Government spending can help in overcoming the inefficiencies of the market system in the allocation of economic resources. It also can help in smoothing out cyclical fluctuations in the economy and influences a level of employment and price stability. Thus, government spending plays a crucial role in the economic growth of a country. We used government spending in compliance with the COFOG international standard (Classification of the Functions of Government) in our analysis. Total government spending is divided into 10 basic divisions:

- G10: General public services
- G20: Defense
- G30: Public order and safety
- G40: Economic affairs
- G50: Environment protection
- G60: Housing and community amenities
- G70: Health
- G80: Recreation; culture and religion
- G90: Education
- G100: Social protection

3.1 The structure of government spending and its development

Firstly we analyzed the structure of government spending in a period 1995-2009. Results in Table 1 show the share of government spending by functions, their average on total spending during the whole period and the share of total government spending on GDP. Data confirm unstable and cyclical development of total government spending on GDP. In 1995, a high government spending was connected with privatization and transformation process. Five spending functions, on average, account for more than 84% of the total spending: social protection, economic affairs, health, general public services and education. Table 1 shows that social protection (G100) was the largest item of government spending from 1996, economics affairs (G40) were on the second and health spending (G70) on the third place till the year 2004. From 2005 the second and the third position has changed.

	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**average**
G10	8.1	10.2	9.9	9.3	10	9.9	9.7	10.3	11	10.9	12	10.1	10.2	10.4	10.2
G20	3.4	3.8	3.9	3.5	3.9	4.1	3.6	3.4	4.1	3.1	3.7	2.9	2.8	2.6	3.4
G30	4.8	5.8	5.7	5.1	5.6	5.6	5	4.6	4.7	4.8	4.9	4.9	4.9	4.8	5.1
G40	37	18	19.9	22	19.5	17.5	20.9	19.3	17.6	16.7	15.4	16.2	16.1	16.8	19.3
G50	1.9	2.9	2.6	2.5	2.1	2.2	2.2	2.1	2.4	2.4	2.6	2.6	2.4	2.3	2.3
G60	1.8	2.9	2.5	2.8	2.4	2.6	2.7	1.4	2.6	3.5	3.6	3.6	2.7	2.6	2.7
G70	10.8	14.7	13.5	13.6	13.9	13.7	13.6	13.5	13.5	16.3	16	16.4	16.7	16.8	14.7
G80	2.1	3.1	2.6	2.6	2.4	2.4	2.5	2.7	2.7	2.7	2.7	3.1	2.9	2.9	2.7
G90	7.9	9.7	9.8	9.4	9.4	9.9	9.9	11.1	11	10.7	10.6	11.3	10.9	10.9	10.2
G100	21.9	28.9	29.7	29.2	30.7	32	30.1	31.5	30.3	28.9	28.5	29	30.2	30	29.4
G as % GDP	54.5	42.6	43.2	43.2	42.3	41.8	44.4	46.3	47.3	45.1	45	43.8	42.5	42.9	44.8

Table 1 Development of government spending function

The social protection spending G100 is the highest spending function and it takes nearly 1/3 of all government spending. It contains, for example, spending on sickness and disability, old age, survivors, family and children, unemployment, housing, social exclusion and R&D social protection.

3.2 The cyclicality of government spending

As was already noted, government spending is a possible automatic stabilizer. From this point of view, government spending should move in a countercyclical direction. We decided to assess the relationship between GDP and government spending and we analyzed the correlation between cycle components of GDP and all government spending functions. Figure 1 shows GDP and total government spending G before and after using HP filter.

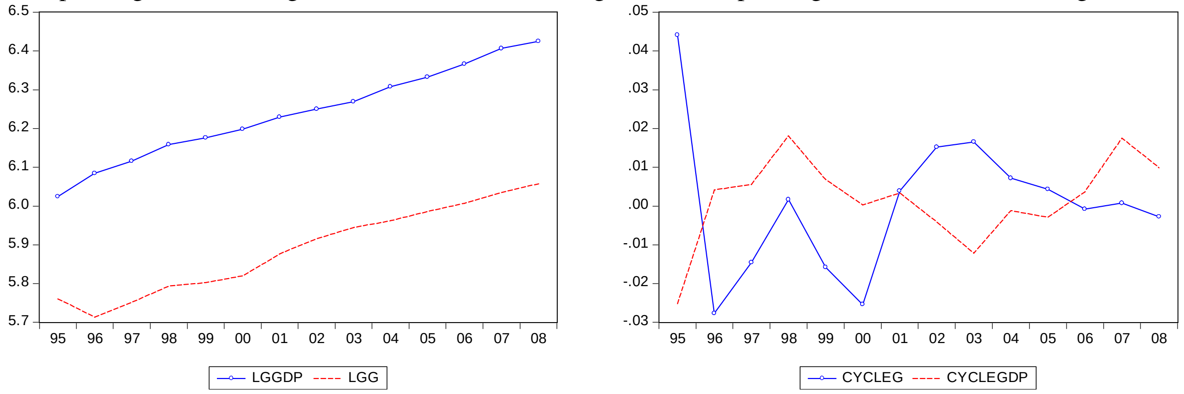

Figure 1 Development of GDP and G

Correlation is a statistical technique that can show whether and how strongly pairs of variables are related. The correlation coefficient can vary from -1 to +1. The correlation coefficient -1 indicates perfect negative correlation, and +1 indicates perfect positive correlation. Its value smaller 0.4 means weak correlation, from 0.4 to 0.7 moderate correlation and higher than 0.7 express strong correlation. A positive correlation coefficient indicates the procyclicality of government spending, negative value means that variables are countercyclical and value close to zero express acyclicality. We run cross-correlations for all possible combinations of GDP and government spending. The results are reported in Table 2. Here we present coefficients with no lag / lead; all results are available on request.

	Correlation coefficient	**Correlation**	**Cyclicality**
G10: General public services	-0.4320	moderate negative	countercyclical
G20: Defense	-0.5148	moderate negative	countercyclical
G30: Public order and safety	0.2479	weak positive	procyclical
G40: Economic affairs	-0.5184	moderate negative	countercyclical
G50: Environment protection	0.1410	weak positive	procyclical
G60: Housing and community amenities	0.1591	weak positive	procyclical
G70: Health	0.3272	weak positive	procyclical
G80: Recreation; culture and religion	0.0639	no correlation	acyclical
G90: Education	-0.3797	weak negative	countercyclical
G100: Social protection	0.3329	weak positive	procyclical
Total G	-0.6331	moderate negative	countercyclical

Table 2 Cyclicality of government spending

The results indicate significant difference across spending functions. We note that 70% of the correlation coefficients are lower than 0.4 in absolute value indicating a weak connection of spending to GDP. Total G, general public services, defense, economic affairs and education were negative correlated and it confirms countercyclical relation between these spending functions and GDP. It is in line with theory recommendation. Contrary to the theory, the correlation coefficients of the highest spending functions (social protection and health) were weak positive and it reports procyclical development of these sub-categories of government spending and GDP. The lowest correlation coefficient (0.06) was found for recreation, culture and religion and the highest average was reported for economic affairs (-0.51), except the coefficient for total government spending (-0.63).

4 Long- run relationship between government spending and GDP

We also analyzed the long-term relationship between GDP and all government spending functions. The Johansen cointegration test, which is also used in this paper, is nowadays frequently used for testing cointegration. Assumption for implementation of cointegration is done by the fact that time series are stationary at first difference.

Individual series are non-stationary, but their common cointegration movement in a long time lead (for example as a result of various market forces) to some equilibrium, though it is possible that in the case of short time periods there is a misalignment of such a long balance. The aim of cointegration test is to determine the number of cointegration relations *r* in the VAR models. It is also necessary to identify an optimal time lag. The optimal time lag is one period (year) ind it was found with using Akaike information criterion applied to estimation of the non-differenced VAR model. The results of Johansen cointegration test proved the existence of the long-run positive relationship between GDP and total government spending, public order and safety and economic affairs. Findings of test indicated no cointegration between GDP and other spending functions. Cointegration equations have the form expressed in (7), (8) and (9).

$$\Delta GDP = 1.083\,\Delta G - 0.134 \quad (7)$$
$$(0.131)^*$$

$$\Delta GDP = 1.243\,\Delta G30 + 0.530 \quad (8)$$
$$(0.0226)^*$$

$$\Delta GDP = 1.7433\,\Delta G40 - 2.7241 \quad (9)$$
$$(0.2198)^*$$

A symbol Δ means difference of log variables: *GDP*, total government spending G, Public order and safety spending *G30* and economic affairs spending *G40*. A symbol * denotes significance at standard 5% level. The above equation shows that increase of total government spending by 1% is connected with increase GDP by 1.08%. We can find similar relationship between GDP and G30 (1.24%) and GDP and G40 (1.78%).

The cointegration regression considers only the long-run property of the model, and does not deal with the short-run dynamics explicitly. Therefore, ECM is used to detect these fluctuations as it is an adequate tool to examine the short-run deviations necessary to the achievement of long-run balance between the variables. Here, the optimal number of lag is one as was found. We define the ECM for GDP and total government spending in (10) and (11).

$$\Delta GDP_t = \alpha_0 + \omega_1 (GDP_{t-1} - \gamma G_{t-1}) + \alpha_1 \Delta GDP_{t-1} + \alpha_2 \Delta G_{t-1} + u_{1t,} \quad (10)$$

$$\Delta G_t = \beta_0 + \omega_2 (GDP_{t-1} - \gamma G_{t-1}) + \beta_1 \Delta GDP_{t-1} + \beta_2 \Delta G_{t-1} + u_{2t,} \quad (11)$$

In (10) and (11), GDP_t and G_t are cointegrated with cointegrating coefficient γ, α_0 and β_0 are constants of the model, ω_1 and ω_2 note the coefficients of cointegration equition, u_{1t} and u_{2t} mean residual components of long-term relationship. The ECM equations are similar for G30 and G40 spending functions. The model specification was tested by several residual components tests. We used the autocorrelation LM-test based on Lagranger multipliers, the normality test, and heteroskedasticity test. The performed tests reject the existence of all three phenomena. The results of the ECM for all thee founded cointegration are reported in Table 3. Standard errors are in parenthesis.

Cointegration between	Dependent variable	ω_1 resp. ω_2	GDP_{t-1}	G_{t-1}	α_0 resp. β_0
GDP and G	GDP_t	-0.0581 (0.1498)	0.1661 (0.2941)	-0,1389 (0.1414)	0.0368* (0.0115)
	G_t	0.260305 (0.2122)	0.2003 (0.4165)	-0,0389 (0.2003)	0.03599* (0.0163)
GDP and C30	GDP_t	-0.5465* (0.2353)	-0.0467 (0.1878)	0.7594** (0.3348)	0.0346* (0.0092)
	$G30_t$	1.1608* (0.3149)	0.3390*** (0.2473)	-0,0389 (0.2003)	-0.0067 (0.0124)
GDP and C40	GDP_t	0.0879*** (0.0524)	-0.1400 (0.2493)	0.0217 (0.0337)	0.0330* (0.00826)
	$G40_t$	0.7623* (0.2167)	-0.0153 (1.0311)	0.1946*** (0.1405)	0.0281 (0.0342)

Table 3 The error correction models

Symbols *, ** and *** denote significance at the 1%, 5% and 10% level. The findings report that ECM does not provide significant results for short- run relationship between GDP and G. In the case of G30 (G40), the ECM through lagged values explains convergence to long-run relationship in the context of short-run shocks and dynamics. Generally, we proved long-run relationship between GDP and G (resp. G30, G40) and value of coefficient suggest that government spending tends to follow GDP (adjusting coefficients for G, resp. G30, G40 are higher than for GDP) and it adapts to GDP changes.

5 Conclusion

The aim of this paper was to provide direct empirical evidence on business cycle relations between GDP and government spending in the Czech Republic from 1995 to 2009. Government spending plays important role in a fiscal policy as it can help to reduce cyclical fluctuations in the economy.

Although many studies suggest government spending is procyclical despite the recommendations of the theory, our research does not prove that. The results confirm cyclical development of total government spending on GDP in the Czech Republic during 1995-2008. Five spending functions, on average, account for more than 84% of the total spending: social protection, economic affairs, health, general public services and education. The cyclical properties of GDP and government spending function were, in average, found as weakly correlated. However, we report considerable differences in correlations across the spending functions and some correlation coefficients are sufficiently high. The lowest correlation coefficient (0.06) was calculated for recreation, culture and religion and the highest value was reported for economic affairs (-0.51). As regards to using government spending as a stabilizer, total government spending, general public services, defense, economic affairs and education spending were negative correlated and it confirms countercyclical relation between these spending functions and GDP. It is in line with theory suggestion. On the other hand, the highest spending function (social protection) correlated weak positive and it suggests procyclical movement of these spending functions. We also analyzed the long-term relationship between GDP and all government spending functions. The results of Johansen cointegration test proved the existence of long-run positive relationship between GDP and total government spending, public order and safety and economic affairs spending functions. As findings verify, they tend to follow GDP and adapt to GDP changes. Tests indicated no cointegration between GDP and other government spending functions.

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