Government expenditure connection to economic performance in the Czech Republic

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Abstract
This paper aims to fill the gap in existing literature and provide direct empirical evidence on how government expenditure is connected to economic performance in the Czech Republic. We used cross-correlation on cyclically filtered time series over the period 1995-2010. In average, the cyclical properties of government expenditure variables and output were founded as weakly correlated (0.37). However, substantial differences among variables were revealed. The lowest correlation coefficient (0.06) was found for interest and investment, the highest value was reported for current expenditure and GDP (0.71). As regards to using government expenditure as the stabilizer, non-investment transfers to population GCP were the only negative correlated expenditure category and it confirms countercyclical development in line with the theory suggestion. Johansen cointegration test and the error correction model were used to estimate the long-run relationship between output and government expenditure. The results proved the existence of long-run relationship only between non-investment transfers to population and household consumption at the standard level.

Keywords: government expenditure, cyclicality, economic growth, correlation, cointegration m
JEL codes: C32, H50, E62

1. Introduction

The economy of the country is greatly influenced by the level and the structure of government expenditure. The government expenditure is an important tool for national governments to mitigate the uneven economic development and economic shocks across individual countries. Government expenditure 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 expenditure 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 (1998) has pointed 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 expenditure in "good times" and a increasing of government expenditure in "bad times." Contrary to the theory (it implies that government expenditure is countercyclical), a number of recent studies found evidence that government expenditure is procyclical. See Hercowitz and Strawczynski (2004), Alesina et al. (2008), Rajkumar and Swaroop (2008) or Ganeli (2010) for more details. Talvi and Vegh (2005) have shown that fiscal procyclicality is evident in a much wider sample of countries. Lane (1998) has found procyclicality in a single-country time series study of Irish fiscal policy. As Fiorito and Kollintzas (1994) document for G7 countries, the correlation between government consumption and output indeed appears to show no pattern and be clustered around zero. Lane (2003) has also shown that the level of cyclicality varies across expenditure categories and across OECD countries. Abbot and Jones (2011) test differences in the cyclicality of government expenditure across functional categories. Their evidence from 20 OECD countries suggests that procyclicality is more likely in smaller functional budgets, but capital expenditure is more likely to be procyclical for

the larger expenditure categories. Many of researches like Gavin et al. (1996), Gavin and Perotti (1997) have focused 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 expenditure in the Czech Republic. The aim of the paper is to provide direct empirical evidence on business cycle relation between main government expenditure categories and output and estimate long-run relationship between these variables in the Czech Republic.

We follow Abbot and Jones (2011) and apply the cross-correlation technique and cointegration on annul data of GDP and government expenditure during the period 1995-2010 from the Ministry of Finance of the Czech Republic. 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 expenditure development and cross-correlation. In Section 4, we estimate long- run relationship between output and government expenditure. In Section 5, we conclude with a summary of key findings.

2. Model and Data

The dataset consists of annual data on total gross domestic product (GDP), household consumption (CH), investment (I), import (M), export (X) and main public expenditure variables - total government expenditure (G), capital government expenditure (GI), current government expenditure (GC), non-investment transfers to population (GCP), interest (GCI) during the period 1995 – 2010. All the data (in millions CZK) were collected from the Ministry of Finance of the Czech Republic and were 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 expenditure. Johansen cointegration test and the error correction model (ECM) were used to estimate the long-run relationship between output and government expenditure predicted by, for example, Wagner´s Law. Most of the results were 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.

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

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 request.

$$H_0: \delta_2 = 0, H_\varepsilon: \delta_2 < 0 \qquad (2)$$

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:

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

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 non-stationary 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 (1991) 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 (1990) 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 (1990). 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. Cyclicality of government expenditure

Government expenditure 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 expenditure plays a crucial role in the economic growth of a country. Table 1 shows basic descriptive statistic of variables.

Table 1: Descriptive statistics

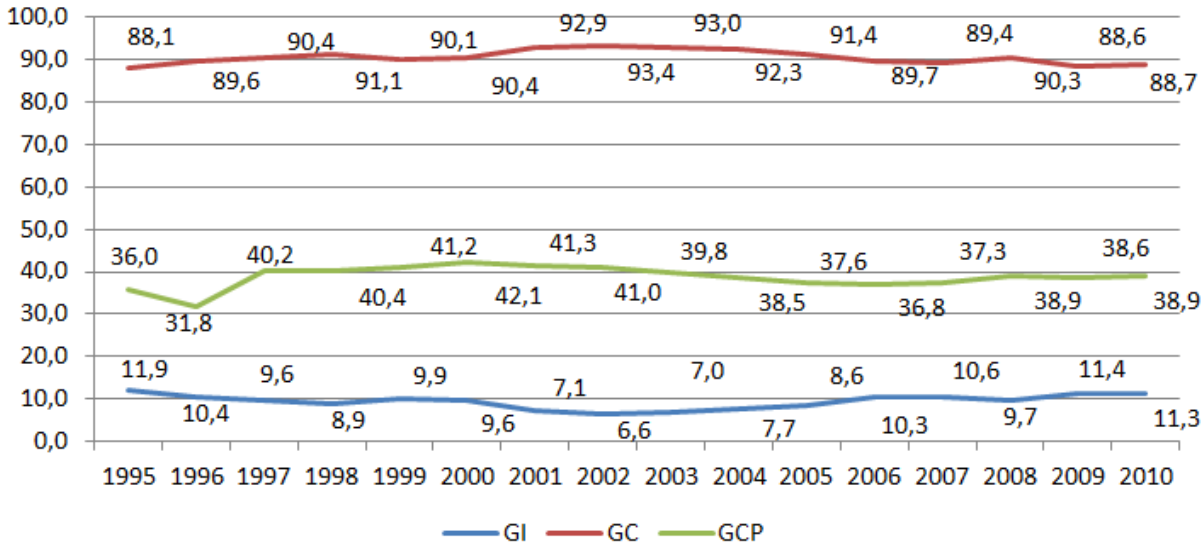
	G	GI	GC	GCH	GCI	GDP	CH	I	M	X
Mean	744674.7	69731.92	673966.9	288318.9	27800.06	2558477.	1278617.	724947.4	1523074.	1544734.
Median	719603.2	60410.39	670382.9	289010.5	26593.50	2425435.	1231485.	695372.5	1502702.	1470185.
Maximum	945092.3	107399.0	838700.2	367995.1	41852.00	3187090.	1537613.	922405.8	2048537.	2130713.
Minimum	591649.4	46121.67	528416.3	193540.3	18133.00	2126856.	1077138.	599822.4	1105593.	1028534.
Std. Dev.	137075.0	20963.38	120406.8	52547.39	6441.020	387693.6	158263.6	93207.26	314522.7	398837.1
Skewness	0.312158	0.737537	0.147651	-0.0605	0.650078	0.423212	0.465746	1.006580	0.168476	0.177966
Kurtosis	1.479370	2.040652	1.417136	2.027612	2.738775	1.575054	1.752071	3.272710	1.813518	1.630669

Jarque-Bera	1.801391	2.064127	1.728441	0.640141	1.172428	1.831270	1.616670	2.751457	1.014184	1.334503
Probability	0.406287	0.356271	0.421380	0.726098	0.556430	0.400262	0.445599	0.252656	0.602244	0.513117
Sum	11914795	1115711.	1,1E+07	4613102.	444801.0	4,1E+07	2E+07	1,2E+07	2,4E+07	24715740
Sum Sq. Dev.	2.82E+11	6.59E+09	2.17E+11	4.14E+10	6.22E+08	2.25E+12	3.76E+11	1.30E+11	1.48E+12	2.39E+12
Observations	16	16	16	16	16	16	16	16	16	16

Note: total government expenditure (G), capital government expenditure (GI) ,current government expenditure (GC), non-investment transfers to population (GCP), interest (GCI), household consumption (CH), investment (I), import (M), export (X), gross domestic product (GDP)
Source: author ´s calculations based on data from the Ministry of Finance of the Czech Republic

Firstly we analyzed the structure of government expenditure in a period 1995-2010. Figure 1 shows the share of capital expenditure *GI* and current expenditure *GC* on total government expenditure. Figure is complemented by share of non-investment transfers to population *GCP* on total government expenditure.

Figure 1: Share on total government expenditure in percentage

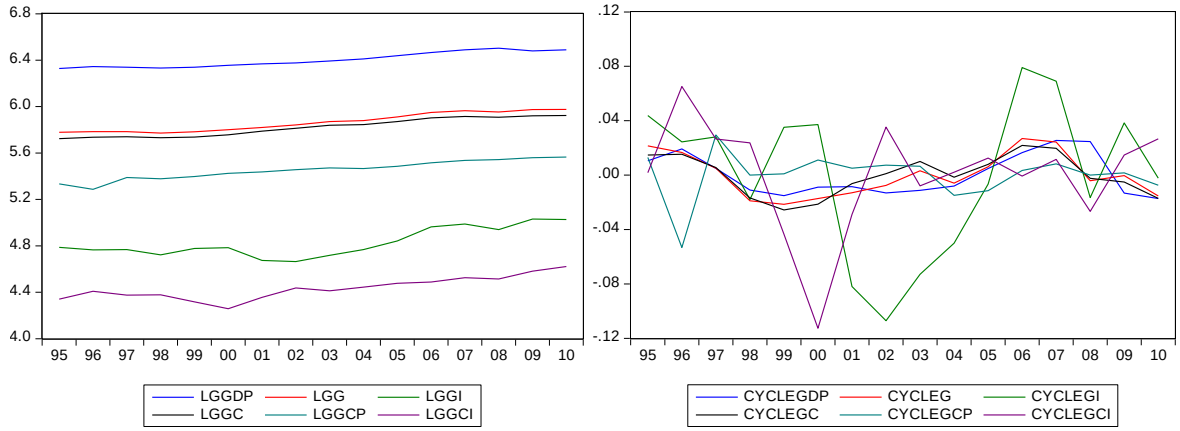


Source: author ´s calculations based on data from the Ministry of Finance of the Czech Republic

Current expenditure was higher than 88% of total government expenditure during the whole analyzed period. Its share on total government expenditure grew until 2002, when it reached a peak (93.4%). In subsequent years, the proportion gradually declined up to 88.7% of total government expenditure in 2010. Current expenditure included expenditure on expenditure on wages and salaries, other payments for work done, and premiums, non-investment purchases and related expenditure, non-investment transfers to private entities, non-investment transfers to public entities and between intra-entity money funds, non-investment transfers to population, non-investment transfers to the municipalities, non-investment loans, non-investment transfers to National Fund. Non-investment transfers to population were the highest item on current expenditure. Its share on current expenditure varied between 35.5% and 46.6%. The smallest value was in 1996 and it was due to government saving packages. In 2000, the highest value was connected with populism coupled with election.

As was already noted, government expenditure is a possible automatic stabilizer. From this point of view, government expenditure should move in a countercyclical direction. We decided to assess the relationship between GDP and government expenditure and we analyzed the correlation between cycle components of GDP and main government expenditure categories. Figure 2 shows GDP and government expenditure before and after using HP filter.

Figure 2: Development of GDP and government expenditure



Source: author ´s calculations based on data from the Ministry of Finance of the Czech Republic

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 expenditure, negative value means that variables are countercyclical and value close to zero express acyclicality. We run cross-correlations for all possible combinations of total GDP and government expenditure. But it is necessary have on mind, that total GDP is significantly influenced by government consumption. So we decided to eliminate the impact of general government consumption on GDP and we also calculated cross-correlations for all possible combinations of other GDP components (household consumption, gross capital formation, import, export) and government expenditure. The results are reported in Table 2. Here we present coefficients with no lag / lead; all results are available on request.

Table 2: Cyclicality of government expenditure

Variables	Correlation coefficient	Correlation	Cyclicality
GDP & G	0.767	strong positive	procyclical
GDP & GI	0.476	moderate positive	procyclical
GDP & GC	0.713	strong positive	procyclical
GDP & GCP	-0.159	weak negative	countercyclical
GDP & GCI	0.185	weak positive	procyclical
GI & CH	0.387	weak positive	procyclical
GI & I	0.299	weak positive	procyclical
GI & X	0.310	weak positive	procyclical
GI & M	0.259	weak positive	procyclical
GC & CH	0.538	moderate positive	procyclical
GC & I	0.596	moderate positive	procyclical
GC & X	0.381	weak positive	procyclical
GC & M	0.537	moderate positive	procyclical

GCP & CH	-0.103	weak negative	countercyclical
GCI & CH	0.241	weak positive	procyclical
GCI & I	0.060	no correlation	acyclical
GCI & M	-0.262	weak negative	countercyclical
GCI & E	-0.301	weak positive	countercyclical

Note: total government expenditure (G), capital government expenditure (GI), current government expenditure (GC), non-investment transfers to population (GCP), interest (GCI), household consumption (CH), investment (I), import (M), export (X), gross domestic product (GDP)
Source: author ´s calculations based on data from the Ministry of Finance of the Czech Republic

The results indicate significant difference across expenditure variables and GDP components. The cyclical properties of total GDP were found as strong positive correlated to total government expenditure and current government expenditure, moderate positive correlated to capital government expenditure. It can be explained by a significant proportion of current government consumption on total GDP. Interesting results were found between total GDP and non-investment transfers to population as the correlation coefficient was weak negative and it confirms countercyclical relation between these expenditure and GDP. It is in line with theory recommendation. Contrary to the theory, the correlation coefficients of GDP components and expenditure variables were mostly weak positive correlated (0.37) and it reports procyclical development of these sub-categories of government expenditure and GDP components. The only exception is relation between non-investment transfers to population *GCP* and household consumption *CH* as the correlation coefficient (-0.1) was found weak negative and it reported countercyclical development. The lowest correlation coefficient was found between interest and investment (0.06), these variables are nearly acyclical. Correlation was found also negative between interest and export and import, it is not because of the stabilization role of interest but due to unfavorable development of debt.

4. Long- run relationship between government expenditure and GDP

We also analyzed the long-term relationship between GDP, GDP components and government expenditure variables. 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 two periods (years) and it was found with using Akaike information criterion, Schwarz information criterion and Hannan-Quinn information criterion applied to estimation of the non-differenced VAR model. The results of Johansen cointegration test proved the existence of the long-run relationship between total GDP and non-investment transfers to population and between non-investment transfers to population and household consumption. Cointegration equations have for the cointegrated variables the form expressed in (7) and (8).

$$\Delta GDP = 1.106\,\Delta GCP + 0.360 \quad (7)$$
$$(0.201)^*$$

$$\Delta GCP = 1.183\,\Delta CH - 1.757 \quad (8)$$
$$(0.163)^*$$

A symbol Δ means difference of log variables: total *GDP*, non-investment transfers to population *GCP*, household consumption *CH*. A symbol * denotes significance at 1% level. The above equation shows that increase of non-investment transfers to population *GCP* by 1% is connected with increase *GDP* by 1.1%. We can find similar relationship between increasing household consumption *CH* and non-investment transfers to population *GCP* (1.18%).

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 two as was found. We define the ECM for variables *GDP* and *GCP* in (9) and (10), the ECM for variables *GCP* and *CH* is analogical.

$$\Delta GDP_t = \alpha_0 + \omega_1 (GDP_{t-1} - \gamma GCP_{t-1}) + \alpha_1 \Delta GDP_{t-1} + \alpha_2 \Delta GDP_{t-2} + \alpha_3 \Delta GCP_{t-1} + \alpha_4 \Delta GCP_{t-1} + u_{1t,} \quad (9)$$

$$\Delta GCP_t = \beta_0 + \omega_2 (GDP_{t-1} - \gamma GCP_{t-1}) + \beta_1 \Delta GDP_{t-1} + \beta_2 \Delta GDP_{t-2} + \beta_3 \Delta GCP_{t-1} + \beta_4 \Delta GCP_{t-2} + u_{2t,} \quad (10)$$

In (9) and (10), GDP_t and GCP_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 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 founded cointegrations are reported in Table 3. Standard errors are in parenthesis.

Table 3: The error correction models

Cointegration	Dependent variable	ω_1 resp. ω_2	α_1 resp. β_1	α_2 resp. β_2	α_3 resp. β_3	α_4 resp. β_4	α_0 resp. β_0
GDP and *GCP*	GDP_t	-0.326 (0.306)	0.580 (0.355)	-0.502 (0.465)	-0.051 (0.270)	-0.048 (0.209)	0.014 (0.011)
	GCP_t	0.332*** (0.202)	0.114 (0.234)	-0.121 (0.306)	-0.447** (0.178)	-0.2*** (0.137)	-0.2* (0.007)
GCP and *CH*	GCP_t	-0.219 (0.241)	0.375** (0.194)	-0.118 (0.157)	0.047 (0.284)	-0.324 (0.313)	0.027* (0.008)
	CH_t	**0.477** (0.245)**	**-0.126 (0.198)**	**0.0**	**0.011 (0.289)**	**-0.090 (0.319)**	**0.013*** (0.008)**

Source: author ´s calculations

Symbols *, ** and *** denote significance at the 1%, 5% and 10% level. The findings report that the ECM does not provide significant results for short- run relationship between variables. Long-run relationship between *GDP* and non-investment transfers to population *GCP* is significant only at 10% level. In the case of non-investment transfers to population *GCP* and household consumption *CH*, the ECM through lagged values explains convergence to long-run relationship in the context of short-run shocks and dynamics at the standard level. Adjusted coefficients express the speed of return to equilibrium. Here it means that about 47.7 % of disequilibrium is corrected each period (year) by changes in *GCP*. We proved long-run relationship between *GCP* and *CH* and the value of coefficient suggests that household consumption *CH* tends to follow non-investment transfers to population *GCP* (adjusting coefficient for *CH* is higher than for *GCP*) and it adapts to non-investment transfers to population *GCP* changes.

5. Conclusion

The aim of this paper was to provide direct empirical evidence on business cycle relation between main government expenditure categories and output and estimate long-run relationship between these variables in the Czech Republic. Government expenditure plays important role in a fiscal policy as it can help to reduce cyclical fluctuations in the economy. Many studies suggest

government expenditure is procyclical despite the recommendations of the theory, our research mostly also proves it. An average, the results confirm procyclical development of government expenditure on GDP in the Czech Republic during 1995-2010. The results indicate significant difference across expenditure variables and GDP components. The cyclical properties of total GDP were found as strong positive correlated to total government expenditure and current government expenditure, moderate positive correlated to capital government expenditure. It can be explained by a significant proportion of current government consumption on total GDP. Interesting results were found between total GDP and non-investment transfers to population as the correlation coefficient was weak negative and it confirms countercyclical relation between these expenditure and GDP. It is in line with theory recommendation. Contrary to the theory, the correlation coefficients of GDP components and expenditure variables were mostly weak positive correlated (0.37) and it reports procyclical development of these sub-categories of government expenditure and GDP components. The only exception is relation between non-investment transfers to population *GCP* and household consumption *CH* as the correlation coefficient (-0.1) was found weak negative and it reported countercyclical development. The lowest correlation coefficient was found between interest and investment (0.06), these variables are nearly acyclical. Correlation was found also negative between interest and export and import, it is not because of the stabilization role of interest but due to unfavorable development of debt.

We also analyzed the long-term relationship between GDP components and the government expenditure variables. The results of Johansen cointegration test proved the existence of long-run relationship only between non-investment transfers to population GCP and household consumption CH at the standard level. As findings verify, household consumption CH tends to follow non-investment transfers to population GCP and it adapts to non-investment transfers to population GCP changes. The tests indicated no cointegration between output and other government expenditure variables.

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