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Article

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Budgetary Research Review (BRR)

Provided in Cooperation with:

Budgetary Research Review (BRR)

Suggested Citation: Valeriu, Nalban (2010) : Estimating long-run equilibrium relationship between government expenditures and revenues in Romania, Budgetary Research Review (BRR), ISSN 2067-1784, Buget Finante, s.I., Vol. 2, Iss. 1, pp. 26-44

This Version is available at:

<https://hdl.handle.net/10419/62271>

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Estimating long-run equilibrium relationship between government expenditures and revenues in Romania

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Abstract: This study examines the long-run relationship between government expenditures and revenues series for Romania. The available quarterly data for these variables covers 1995 – 2007 period. Due to the large economic turbulences in 2008 and 2009 the database will not consider these years. After running the Granger causality test, two cointegration approaches are used to prove the existence of a long-run fiscal equilibrium. Engle and Granger, respectively Johansen methodologies accept the existence of at least one significant cointegration relation. The results confirmed

the hypothesis of no secular tendencies of budgetary imbalances.

JEL Classification: H6

1. Introduction

In order to achieve an optimal fiscal and budgetary policy, a general equilibrium framework is indispensable. Otherwise, budgetary deficits and surpluses (even if they have an apparent positive effect) will lead to major instabilities. Hence, a flexible mechanism of rapid adjustment of taxes and expenditures is recommended.

Romania is an EU member state, thus disequilibria in one state can impose relevant negative externalities on its economic stability, as well as on the overall credibility of the common fiscal policy. Conversely, Romanian imbalances can influence the member states' strength. Also, meeting budgetary

equilibrium is important for EMU accession – Romanian mid-term objective for this new decade. Article 104 of the Maastricht Treaty (1993) imposes a ceiling to debt and deficit of 60% and 3% of domestic GDP respectively as conditions for the admissions to the EMU.

Until 2008 Romania satisfied both conditions (with few exceptions). But currently only the debt restriction is satisfied (which was around 30% of GDP in 2009), but not the deficit one. The global financial crises led to a 20 billion EUR loan agreement with IMF and European structures. Thus, a deficit of around 7% of GDP in 2009 was registered.

2. Literature review

According to Legrenzi and Milas (2010), the most intuitive method for testing the equilibrium of budgetary activity, is running a regression of government revenues on government expenditures or contrariwise:

$$\begin{aligned} GOV_REV_t &= a_1 + b_1 \cdot GOV_EXP_t + \varepsilon_{1,t} , \\ GOV_EXP_t &= a_2 + b_2 \cdot GOV_REV_t + \varepsilon_{2,t} , \end{aligned}$$

where GOV_REV_t and GOV_EXP_t are government revenues and government expenditures respectively at the moment t , a_1 , a_2 , b_1 , b_2 are real parameters, and $\varepsilon_{1,t}$, $\varepsilon_{2,t}$ are independent and identically distributed (*i.i.d.*) residuals.

Apparently, in order to meet the budgetary equilibrium condition, that is not to record deficits or surpluses, it is necessary that the regression parameters have the values $a_1=a_2=0$ and $b_1=b_2=1$.

If we want to avoid the shortcoming of testing two relations, a Granger causality test is plausible. Its purpose is to show the causal relationships: are revenues influenced by expenditures or contrariwise. Zapf and Payne (2009) and Gounder, Naraya and Prasad (2007) used a pairwise Granger causality test to prove the exogenous nature of the expenditures series.

Nevertheless, a regression of this type can generate positive, but incorrect (in econometric sense) results, because GOV_REV_t and GOV_EXP_t may not be

stationary and these shortcomings were noticed in almost all cited sources: Hussain (2005), Owoye (1994), Zapf and Payne (2009), Legrenzi and Milas (2010). Using non-stationary series usually leads to trends and correlations that are not reflected by reality. Also, the coefficient of determination (*R-squared*) may be big (around 100%) but not justified¹. So, non-stationary series don't allow for a generalization of results, because these are valid just for the analyzed episode of time. Conversely, stationary series have the advantage of being time-invariant (or constant) in sense of its properties: mean, variance and auto-covariance of any lag.

The stationary condition can be met by differencing, but this would generate considerable informational losses and reduce the number of degrees of freedom². Thereby, cointegration approach is recommended as it provides evidences on long-run relationship between the analyzed variables.

¹ this phenomenon is known as *spurious regression*.

² cutting degrees of freedom would have a bigger effect on Romanian time series analysis because of their shortness.

Consequently, cointegration is the preferred model for testing the presence or absence of national public finance equilibrium. Prohl and Schneider (2006) test the relation between budgetary deficit and public debt in EMU countries, Legrenzi and Milas (2010) also check for equilibrium between government expenditures and revenues, and public debt in Italy and Stoian (2008) establishes the causality relation between budgetary revenues and expenditures in Romania.

Briefly, if two series are non-stationary (are integrated of order n , $I(n)^3$) but there is a linear combination that is stationary (it is integrated of order 0, $I(0)$) the series are cointegrated. Thus, the relation between cointegrated series is an intertemporal equilibrium phenomenon. This relation may not be stable in short-term, but variables' long-run association will adjust the deviations. Intuitive, if time series *GOV_REV* and *GOV_EXP* are cointegrated then the hypothesis of harmony between fiscal policy and budgetary policy would be valid. This thing is important for the long-term

³ differencing n times is necessary to obtain a stationary series.

economic growth process and integration of Romania in EMU.

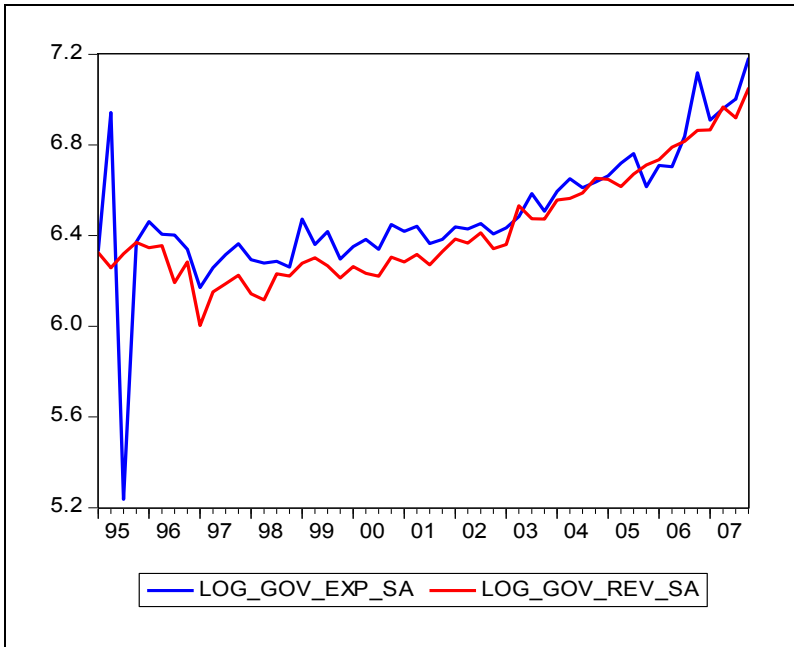
3. Data

Eurostat database⁴ offers quarterly statistics on Romanian nominal general government revenues and government expenditures for 1995Q1:2007Q4 with a total of 52 observations. The observations are deflated with the quarterly CPI in order to obtain real (constant prices) series. Because the observations are quarterly, the exclusion of seasonal factors is necessary. Seasonal adjustment process was realized using additive *Census X-12* procedure⁵. In addition, the observations are taken in natural logarithms, obtaining series named $LOG_GOV_REV_SA_t$ and $LOG_GOV_EXP_SA_t$.

⁴ http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

⁵ developed by *US Census Bureau* and based on ARIMA (AutoRegressive Integrated Moving Average) procedures for allowing the manifestation of non-stationary properties.

Figure 1. Logarithms of seasonally adjusted real government revenues and expenditures series



Legrenzi and Milas (2010) used government revenues and government expenditures series as percentage of GDP. Unfortunately, Romanian quarterly GDP series are available only starting from 1998. Thus, in order to have more observations it is preferred to use series in level.

4. Econometric methodology and results

First, $LOG_GOV_REV_SA$ and $LOG_GOV_EXP_SA$ are tested for stationarity using Augmented Dickey-Fuller (ADF) test. The results confirm non-stationarity of the tested variables at 5% significance level. More, both are integrated of first order, being $I(1)$ processes (are stationary in first difference).

Figure 2. ADF test results

| Series | Null hypothesis | t-Statistic | Prob. | Conclusion |
|---------------------|------------------------------------|-------------|--------|---------------------------------------|
| $LOG_GOV_EXP_SA$ | non-stationary in level | 2.240890 | 0.9999 | accepted \Leftrightarrow not $I(0)$ |
| | non-stationary in first difference | -14.75272 | 0.0000 | rejected $\Leftrightarrow I(1)$ |
| $LOG_GOV_REV_SA$ | non-stationary in level | 1.749806 | 0.9996 | accepted \Leftrightarrow not $I(0)$ |
| | non-stationary in first difference | -10.83281 | 0.0000 | rejected $\Leftrightarrow I(1)$ |

Engle and Granger⁶ suggest a simple method to check the cointegration between several variables, which consists in testing stationarity of the errors series extracted from the initial regression models.

Instead of testing two OLS models, a Granger causality test will be run to check if revenues are influenced by expenditures or inversely.

Figure 3. Pairwise Granger causality tests results

| Null Hypothesis | F-Statistic | Prob. | Conclusion |
|--|-------------|--------|------------|
| <i>LOG_GOV_REV_SA</i> does not Granger Cause <i>LOG_GOV_EXP_SA</i> | 59.6042 | 6.E-10 | rejected |
| <i>LOG_GOV_EXP_SA</i> does not Granger Cause <i>LOG_GOV_REV_SA</i> | 0.09699 | 0.7568 | accepted |

The results show that revenues series is influenced by expenditures series. So, *LOG_GOV_REV_SA* is the dependent variable and *LOG_GOV_EXP_SA* is the independent variable, and the appropriate error series may be

⁶ according to Brooks (2008).

$$\varepsilon_{1,t} = GOV_REV_t - a_1 - b_1 \cdot GOV_EXP_t,$$

and $\varepsilon_{1,t}$ series should be stationary.

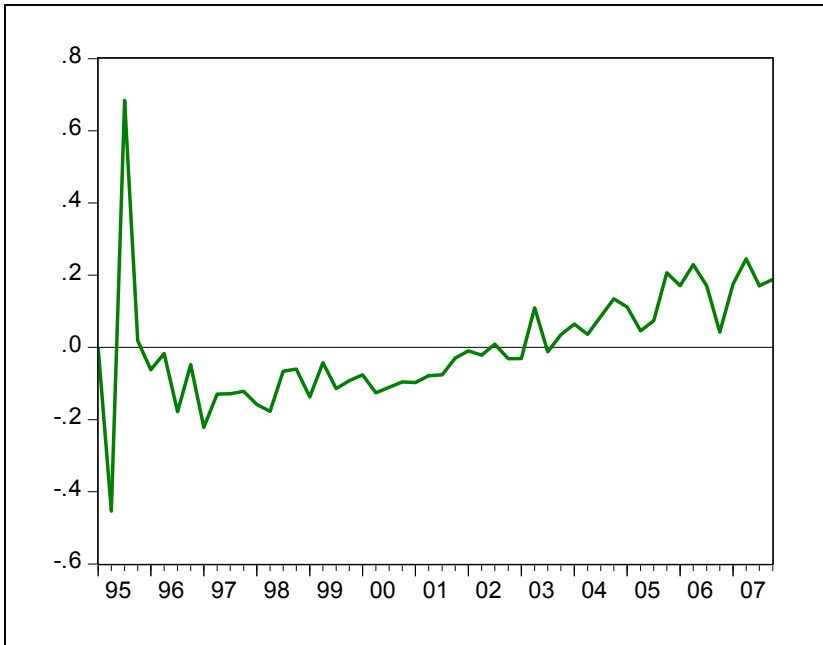
Zapf and Payne (2009) arrived at the same conclusion in testing causal relation between US local budget expenditures and revenues series. Also, according to Gounder, Naraya and Prasad (2007), Fiji Islands' government expenditure Granger causes government revenue in an aggregate sense. In the Romanian case, Stoian (2008) noticed a causality relationship running from budgetary revenues to expenditures. These antagonistic results may be caused by different periods used (Stoian (2008) used 1991-2005 quarterly data).

The u_t error series of the equation

$$LOG_GOV_REV_SA_t = a + b \cdot LOG_GOV_EXP_SA_t + u_t$$

is extracted and plotted.

Figure 4. Residual series



The results of ADF test confirm stationarity of the u_t residual series.

Figure 5. ADF test results for residual series

| Series | Null hypothesis | t-Statistic | Prob. | Conclusion |
|--------|-------------------------|-------------|--------|---------------------------------|
| u_t | non-stationary in level | -7.657697 | 0.0000 | rejected $\Leftrightarrow I(0)$ |

The hypothesis of long-run equilibrium between government expenditure and revenues seems to be proved. Even if the errors are quite robust in the initial

period, they are reduced at the beginning of 2000's (Figure 4), varying around the zero mean, suggesting a mean-reverting process.

Another methodology for testing the presence of cointegration relations was suggested by Johansen⁷. It is based on developing a Vector Error Correcting Model (VECM) and consists in extracting the cointegration vectors. An ideal balance is achieved when this vector has unitary coefficients:

$$GOV_REV = b_2 \cdot GOV_EXP \Leftrightarrow (b_1 \ -b_2) = (1 \ -1)^8$$

In order to make possible the inclusion of intertemporal effects, Akaike, Schwarz and Hannan-Quinn informational criterions suggest an additional lag (one previous observation). Because both series had an upward tendency, the inclusion of trend and intercept is allowed.

Both maximum eigenvalue test (λ -max) and trace test (λ -trace) confirm the existence of at least one

⁷ according to Brooks (2008) and Enders (2004).

⁸ the sign “-” in front of the b_2 coefficient results from passing the $b_2 \cdot GOV_EXP$ term in the right hand of the equality.

cointegration relation between *LOG_GOV_REV_SA* and *LOG_GOV_EXP_SA* series.

Fig. 6. λ -max and λ -trace tests results

| Null hypothesis | λ -max-Statistic | Prob. | λ -trace-Statistic | Prob. | Conclusion |
|---------------------------|--------------------------|--------|----------------------------|--------|------------|
| 0 cointegration relations | 35.64152 | 0.0000 | 37.85449 | 0.0000 | rejected |
| 1 cointegration relation | 2.212966 | 0.1369 | 2.212966 | 0.1369 | accepted |

Johansen cointegration test estimates a 2×2 coefficients matrix:

$$\begin{pmatrix} LOG_GOV_REV_SA & LOG_GOV_EXP_SA \\ -8.643070 & 9.022902 \\ 3.333508 & 1.285656 \end{pmatrix}$$

The cointegration vectors (-8.64 9.02) and (3.33 1.28) are sorted by the magnitude of the attached cointegration relations. Only the first one is statistically significant, because only one cointegration relation is detected by both maximum eigenvalue and trace tests,

and can be normalized to $(1 \ -1.04)^9$. Hence, a certain fact is that there exists a positive relation and a long-run equilibrium between government revenues and government expenditures, expressed by VECM model.

Figure 7. VECM. Standard errors in () & t-statistics in []

| Cointegrating Equation | | CointEq1 |
|----------------------------|---------------------|--------------------------------------|
| <i>LOG_GOV_REV_SA</i> (-1) | | 1 |
| <i>LOG_GOV_EXP_SA</i> (-1) | | -1.043946 (0.07439) [-14.0340] |
| C | | 0.351087 |
| <i>LOG_GOV_EXP_SA</i> = -1 | Chi-square Prob. | 0.318493 0.572515 |

The *LOG_GOV_EXP_SA* coefficient (that coincides with the normalized cointegration vector coefficient) is statistically significant at 1% confidence level and is very close to perfect value (-1). Imposing a

test for a unit value for the coefficient in the cointegration

⁹ $(1 \ -1.04)$ vector is obtained (normalized) dividing original $(-8.64 \ 9.02)$ vector by its first element.

vector, the Chi-square test reveals that the null hypothesis cannot be rejected at 1% confidence level. This means that the dynamic of expenditures is completely translated into dynamic of revenues. These results suggest the long-run equilibrium and the fiscal synchronization of Romanian budgetary process.

5. Conclusions

The sustainability of fiscal-budgetary policy is one the most discussed issues, especially in 2009, when the financial crises shook (and continues to shake) the economies around the world. In these circumstances, it is hard to satisfy the conditions of the Maastricht Treaty.

Two cointegration models were used to test public finances equilibrium: Engle and Granger approach, based on OLS regression and Johansen approach, based on VAR and VECM. The second is more appropriate, because simple regressions would be negative influenced by possible non-stationarity of the

series used¹⁰ (i) and by the short period of available data for Romanian economy indicators (ii).

Both tests confirmed the presence of at least one cointegration (equilibrium) relation between government revenue and government expenditure. These results are similar to those obtained by Legrenzi and Milas (2010) for Italy, by Gounder, Naraya and Prasad (2007) for Fiji Islands and by Stoian (2008) for Romania (even if the causality relation found is different from that obtained in this paper). At the same time, the budgetary process needs to be carefully supervised, because the economic slowdown unbalanced the successes obtained before UE admission. Also, interesting results may be provided by the cointegration relation (if such a relation exists) between budget deficit and public debt (Prohl and Schneider, 2006). The equilibrium indicated by the cointegration relation suggests a sufficient capacity of adjusting the government expenditures and revenues for maintaining expected balance state.

¹⁰ according to Brooks (2008), 95% of economic and financial series are non-stationary in levels.

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