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Fiscal Sustainability: A Panel Cointegration for CEE Countries

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Abstract

The study assesses the sustainability of public finance in CEE countries using stationary and cointegration analysis. Data series properties were analyzed to determine their stationarity using the LLC and IPS unit root tests which resulted that the series are integrated of order one. By applying Kao and Perroni panel cointegration tests a relationship between government revenue and government expenditure has been founded. The causality tests indicate that there is a bidirectional causal relationship between government expenditure and revenues in both the long and the short run and Fiscal synchronization hypothesis is confirmed

Kewords: Intertemporal Fiscal Constraint, Panel Co Integration, Fiscal Sustainability,

Introduction

In order to have an appropriate alignment in government revenue and expenditure, which is important in price stability and sustainable growth in output, the fiscal policy plays an important role. Within the European Union fiscal framework, fiscal discipline is an important support for the implementation of monetary policy; countries have to respect the requirements of the Stability and Growth Pact. The focus of this paper is to examine the intertemporal relationship between government revenues and government expenditures for four countries from Central and Eastern Europe: Czech Republic, Hungary, Poland and Romania.

Literature Review

Over the years, the relationship between government revenues and expenditures has been analyzed and debated. In literature, several hypotheses have been proposed to characterize the inter-temporal relationship between government revenues and expenditures. In 1978, Friedman proposed the hypothesis of tax-and-spend which sustains the fact that changes in government revenues lead to changes in government expenditures. Buchanan and Wagner (1978) motivates that the decreased revenues lead to increase in spending, as the public will perceive the cost and demand more programs. The theory of “spend and tax”, the second school is based on the idea that changes in government expenditures lead to changes in government revenues. Peacock and Wiseman (1961, 1979) argue that increases in government spending drawn by crisis situations lead to permanent changes in expenditures. This effect, known as “displacement effect” generates a tax increasing, which although

initially was justified by the economic then became permanent tax policies. If in the first school tax and spend the hypothesis is defined by unidirectional causality from government revenues to government expenditure, in the second school the assumption is the other way around. The third school, known as fiscal synchronization hypothesis sustains the fact that government may change expenditure and revenues and citizens decide on the level of spending and taxes through comparing the benefits of government to citizens marginal cost (Musgrave,1966; Meltzer and Richard, 1981). Since those variables are jointly determined, the hypothesis is characterized by bidirectional causality between government revenues and government expenditures. This fiscal synchronization hypothesis was sustained by Barro's (1979) tax smoothing model, based on Ricardian equivalence view that deficit financed government expenditure from the present results in future tax increases. The non causality between government revenues and government expenditures represents the assumption of the fourth school, fiscal neutrality school, stated by Baghestani and McNown (1994). Afonso and Rault (2009) investigated causality between government expenditures and revenues in the EU using bootstrap panel analysis in period 1960-2006. The main conclusion is that spend and tax hypothesis causality has been found for countries as Italy, Greece, Spain, France and Portugal, while the Friedman theory is evidenced for Germany, Belgium, Austria, Finland and UK. On a sample of 15 OECD countries Chang and Chiang (2009) find evidence of bidirectional causality between government revenues and expenditures using panel cointegration. Davig et al (2011) estimate fiscal reaction functions for the assessment of a Ricardian behaviour. The main purpose of the paper of Afonoso and Jalles (2012) is to investigate the fiscal sustainability of fiscal policy in a set of 18 OECD countries.
The paper content is the following: the first section is presenting the theoretical framework, the second section contains the empirical part and the last part concludes.

Theoretical Framework

Although a universal definition of sustainable fiscal policy doesn't exists it is accepted the fact that exploding debt is not sustainable. Budget policy is constrained by the process of financing the deficit, borrowing without restraint and to finance the interest on debt by another debt, any pattern of deficit would be sustainable. However, government face a present-value borrowing constraint, meaning that governments must intertemporarly balance their budgets by fixing the current market value of debt equal to the discounted sum of expected future surpluses. The value of the debt would explode over time at a rate faster than the one of the growth if the intertemporal constraint budget balance is not respected. Hakkio and Rush (1991a) demonstrated that this constraint is not violated if expenditures and revenues are cointegrated and the estimated coefficient on expenditure equals 1.

$$B_t = \sum_{i=t+1}^{\infty} (\rho_{t+j})^{-1}(T_t - G_t) + \lim_{j\to\infty}(\rho_{t+j})^{-1} B_{t+j} \quad [1]$$

Where B is debt and T and G are the total revenues and expenditures. The intertemporal balance condition implies that the right term limit equals zero.

Quintos (1995) stated that a sustainable fiscal policy doesn't necessary to fulfil the condition of cointegration, as long as the independent variable's parameter estimated in the bivariate regression lies between 0.1
In 2007 Bohn criticises Quintos(1995) and challenged the necessity to have first difference stationary debt or cointegration between expenditures and revenues. The second Proposition from his research stated the following: Suppose $G \sim I(mG)$ and $T \sim I(mT)$ with possible

different order of integration, then $B \sim I(m)$ with $m \leq nax(mG, mT) + 1$ so TC ad IBC hold, where IBC: $B_t = \sum_{i=1}^{\infty}(\rho)^i E_t(T_{t+i} - G_{t+i})$ and Transversality Condition: $\lim_{n\to\infty} \rho^n E_t B_{t+n}=0$

The purpose of this paper is to verify the fiscal sustainability hypothesis for the selected four CEE countries. In this respect the analysis started with an assessment of unit root condition. The following unit root test are used in the panel data, Im et al (2003) and Levin et al (2002) . The IPS test is based on the following model:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij} \Delta y_{i,t-1} + \varepsilon_{it}, \quad i=1,....N,\ t=1,...,T \qquad [2]$$

Where Δ is the first difference operator, y_{it} is the series for country i in the panel over period t, p_i is the number of lags selected for the ADF regression and ε_{it} are iid variables for all i and t with zero means and σ_i^2 finite heteregenous variances.

The test has the null hypothesis of a unit root for each individual country in the panel and is $H_0: \beta_i = 0\ \forall\ i$ against the alternative $H_1: \beta_i < 0, i = 1, \dots, N;\ \beta_i = 0, i = N_1 + 1, \dots N$, wich allows for some of the individual series to be integrated. The LLC test is also based on the model (1) but the coefficients of autoregressive term are considered as homogenous across all individuals, thus $H_0: \beta_i = \beta\ \forall\ i$ against $H_1: \beta_i < \beta\ \forall\ i$ the alternative one, which assumes that all single series are stationary. The statistic t asymptotically follows a standard normal distribution. LLC test is part of the panel unit root test that assumes that there is a common unit root process.

Another two tests are Breitung and Hadri. While Breitung have the null hypothesis of a unit root, Hadri test uses a null of stationary. The Breitung method differs from LLC by constructing standardized proxies and then de-trended. This test requires only a specification of the number of lags used for every cross-section ADF regressions and no kernel computations are necessary as for LLC test.

The second part of the analysis is to test the cointegration. When two series are respectively non-stationary but some linear combination of them is a stationary process then those two series are cointegrated. The Engle-Granger (1987) cointegration test is based on evaluation of residuals of a spurious regression performed using variables with unit root. If the variables are cointegrated then the residuals should be stationary, then I (0), Pedroni (1999, 2004) and Kao (1999) have modified the Engle-Granger procedure in order to be applied on panel data. Pedroni proposed test that allow for heteregenous intercepts and trend coefficients across cross-sections. Considering:

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \cdots + \beta_{Mi} x_{Mi,t} + \varepsilon_{i,t} \qquad [3]$$

For t=1... T; i=1... N; m=1... M; where x and y are assumed to be integrated of order one. The parameters α_i and δ_i are individual and trend effects which may be set to zero. The null hypothesis is of no cointegration and assumes that the residuals have unit root. Pedroni shows that the standardized statistic is asymptotically normally distributed, $\frac{\aleph_{N,T} - \mu\sqrt{N}}{\sqrt{v}} \rightarrow N(0,1)$, where μ and v are generated by the author using Monte Carlo simulations.

Kao (Engle-Granger based) cointegration test is constructed on the same approach as the Pedroni test but specifies cross-section intercepts and homogenous coefficients on the first stage regressors.

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{i,t} \qquad]$$

The test assumes the running the first stage regression from Eq 2, requiring α_i to be heterogenous and β_i to be homogenous across cross-sections and setting all trend

coefficients to zero. Under the null hypothesis of no cointegration, Kao shows that the following statistics[1], $DF_\rho = \frac{T\sqrt{N}(\hat{\rho}-1+3\sqrt{N}}{\sqrt{10.2}}$; $DF_t = \sqrt{1.25t_\rho} + \sqrt{1.875N}$ converge to N(0,1) asymptotically, where the estimated variance is $\hat{\sigma}_v^2 = \hat{\sigma}_u^2 - \hat{\sigma}_{u\epsilon}^2\sigma_\epsilon^2$ and $\hat{\sigma}_{0v}^2 = \hat{\sigma}_{0u}^2 - \hat{\sigma}_{0u\epsilon}^2\sigma_{0\epsilon}^2$. Gutierrez's paper (2003) reveals the fact that Kao's panel test has higher power than Pedroni's tests when a small-T number of observations are included in a homogenous panel.

Empirical Results

The study was developed using government expenditures and revenues for Czech Republic, Hungary, Poland and Romania covering the period 2000Q1-2011Q4. The data was collected from EUROSTAT, the variables were deseasonalised and used in real terms (2000=100).[2]

The first step for the panel analysis an assessment of unit root hypothesis has been developed by calculating LLC, IPS, ADF, PP and Hadri Z stat. The results are presented in Table 1[3] and the conclusion is that for both revenues and expenditure the null hypothesis of unit root is accepted in case of both common unit root classes of tests and individual unit root classes. The p-value of 0.00 attached to Z statistics Hadri test indicates the fact the null hypothesis is rejected, meaning that variables government revenues and government expenditures are *I(1).*

Table 1

Results For Panel Unit Root Tests

Panel unit root test: Summary		
Series: G-EXPENDITURES		
Sample: 2000Q1 2011Q4		
Method	Statistic	Prob.
Null: Unit root (assumes common unit root process)		
Levin, Lin & Chu t*	-0.46662	0.3204
Null: Unit root (assumes individual unit root process)		
Im, Pesaran and Shin W-stat	0.67904	0.7514
ADF - Fisher Chi-square	4.96847	0.7609
PP - Fisher Chi-square	8.35965	0.3991
Null Hypothesis: Stationarity		
Hadri Z-stat	9.22435	0.0000
Heteroscedastic Consistent Z-stat	9.08189	0.0000

When the hypothesis of unit root is accepted the next step is to test if the variables are cointegrated. The long-run equilibrium relationship has been tested using Pedroni's and Kao's tests and Table 2 presents the main results. The null hypothesis of no c integration has been rejected for both tests since the probabilities attaches are 0.00 in case of Pedroni and 0.0146 in case of Kao Residual Cointegration Test.

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[1] $DF_\rho{}^* = \frac{\sqrt{N}T(\hat{\rho}-1+3\sqrt{N}\hat{\sigma}_v^2/\hat{\sigma}_{0v}^2}{\sqrt{3+36\hat{\sigma}_v^4/(5\hat{\sigma}_{0v}^4)}}$ and for p>0, the augmented version, $ADF = \frac{t_{\hat{\rho}}+\sqrt{6N}\hat{\sigma}_v/(2\hat{\sigma}_{0v})}{\sqrt{\hat{\sigma}_{0v}^2/(2\hat{\sigma}_v^2)+3\hat{\sigma}_v^2/(10\hat{\sigma}_{0v}^2)}}$

[2] The logarithms of variables are used in empirical analysis.

[3] The results for the variable *Revenues* are presented in Annexes.

Table 2
Results For Panel Cointegration Tests

Series: G-EXPENDITURES, T-REVENUES		
Sample: 2000Q1 2011Q4		
Null Hypothesis: No cointegration		
Pedroni Residual Cointegration Test		
Alternative hypothesis: common AR coefs. (within-dimension)		
	Statistic	Prob.
Panel v-Statistic	3.249	0.0006
Panel rho-Statistic	-10.387	0.0000
Panel PP-Statistic	-5.713	0.0000
Panel ADF-Statistic	-5.728	0.0000
Group rho-Statistic	-5.995	0.0000
Group PP-Statistic	-5.231	0.0000
Group ADF-Statistic	-5.597	0.0000
Kao Residual Cointegration Test		
ADF	-2.18111	0.0146
Residual variance	0.00571	
HAC variance	0.00173	

Conclusions

The study was developed using government expenditures and revenues for Czech Republic, Hungary, Poland and Romania covering the period 2000Q1-2011Q4. The first step for the panel analysis an assessment of unit root hypothesis has been developed by calculating LLC, IPS, ADF, PP and Hadri Z stat. The results conclude that for both revenues and expenditure the null hypothesis of unit root is accepted in case of both common unit root classes of tests and individual unit root classes. The long-run equilibrium relationship has been tested using Pedroni's and Kao's tests. The null hypothesis of no cointegration has been rejected for both tests.

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Annexes

Annexes-Table 1-

Results For Panel Unit Root Tests

Panel unit root test: Summary		
Series: T-REVENUES		
Sample: 2000Q1 2011Q4		
Method	Statistic	Prob
Null: Unit root (assumes common unit root process)		
Levin, Lin & Chu t*	-0.86619	0.1932
Null: Unit root (assumes individual unit root process)		
Im, Pesaran and Shin W-stat	-0.11332	0.4549
ADF - Fisher Chi-square	7.42795	0.4912
PP - Fisher Chi-square	24.7309	0.0017
Null Hypothesis: Stationarity		
Hadri Z-stat	9.22435	0.0000
Heteroscedastic Consistent Z-stat	3.6744	0.0001

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