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Testing the Inter-temporal Budget Constraint for Small States

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Abstract

The issue of fiscal sustainability has emerged as a major challenge for governments in small states due to spillovers of global shocks such as the global financial crisis, commodity price shocks, and the increased occurrence and intensity of natural hazards. Given the weak fiscal situation in small states -relatively high debt to GDP ratios and large fiscal imbalances- this paper follows the inter-temporal budget constraint approach to provide a robust econometric assessment of fiscal sustainability for a panel of 15 small states over the period 1991-2017 using recent advances in panel cointegration. The findings show the existence of cointegration between government revenues and expenditure, but with the magnitude of the long-run coefficient of public expenditure less one indicating that fiscal policy is "weakly" sustainable.

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1. Introduction

The 2008-2009 global financial crisis, the commodity price shocks of 2014-2015 and various natural hazards in the past decade have contributed to fiscal challenges and rising debt levels in many countries, with small states facing a disproportionate effect. The International Monetary Fund (IMF, 2013) found that slower economic growth and weak fiscal balances caused an accumulation of public debt in small states with their average debt levels estimated at about 20 percentage points of GDP above their larger counterparts. Some of the structural challenges that impact the fiscal performance of small states include revenue dependence on trade taxes and commodities which causes higher revenue volatility than other country groups, and high rigidity in recurrent expenditures linked to inflexible items such as wages and salaries and subsidies (IMF, 2013). Moreover, small states face challenges to effectively manage temporary fiscal shocks due to weak fiscal institutions, a shallow domestic banking system and limited access to international capital markets (Holden and Howell, 2009). Also, exposure to natural disasters results in considerable financing and economic costs in small states relative to their size than for larger economies (Roberts and Ibitoye, 2012). In 2015, the IMF classified most small states as having a debt risk rating of higher scrutiny and high risk, while only a few countries received a low risk rating (IMF, 2015).

This paper undertakes an empirical assessment of fiscal sustainability by testing the Hamilton and Flavin's (1986) inter-temporal budget constraint (IBC) for a sample of small states. The IBC's notion of fiscal sustainability is based on the idea that the market value of public debt must be equal to the present value of all discounted future budget surpluses. This approach involves testing for the existence of unit roots in public debt and fiscal deficits and/or testing for the presence of cointegration between the series of government revenues and expenditures. The rest of this paper unfolds as follows: the next section briefly outlines the IBC, followed by the data and the estimation strategy and results. Section 5 concludes the paper.

2. The model

If we let B_t denote the stock of public debt, R_t government revenue, G_t government expenditure, and r_t is the real interest rate payable on public debt, then we can write the government's budget constraint as follows:

$$G_t + (1 + r_t)B_{t-1} = R_t + B_t \tag{1}$$

Forward substitution yields the IBC:

$$B_t = \sum_{s=1}^{\infty} \frac{R_{t+s} - G_{t+s}}{\prod_{j=1}^{s}(1+r_{t+j})} + \lim_{s\to\infty} \prod_{j=1}^{s} \frac{B_{t+s}}{(1+r_{t+j})} \tag{2}$$

Equation 2 states that the stock of public debt (B_t) is equal to the discounted present value of future primary surpluses and the limit value of the discounted public debt. According to the transversality condition, sustainable fiscal policy requires that the second term on the right-hand side of equation 2 must be equal to zero to reflect the absence of a Ponzi scheme, i.e. $\lim_{s\to\infty} \prod_{j=1}^{s} \frac{B_{t+s}}{(1+r_{t+j})} = 0$, (see Hamilton and Flavin, 1986).

Assuming the real interest rate follows a stationary process with mean r, and letting $E_t = G_t + (r_t - r)B_{t-1}$, then the present value borrowing constraint (PVBC) is defined as:

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - E_{t+s}) + \lim_{s\to\infty} \frac{B_{t+s}}{(1+r_{t+j})^{s+1}} \quad (3)$$

Now, rewriting equation (3) as a ratio of nominal GDP we get:

$$b_{t-1} = \sum_{s=0}^{\infty} \left(\frac{1+y}{1+r}\right)^{s+1} (\rho_{t+s} - e_{t+s}) + \lim_{s\to\infty} b_{t+s} \left(\frac{1+y}{1+r}\right)^{s+1} \quad (4)$$

Where $b_t = \frac{B_t}{Y_t}$, $e_t = \frac{E_t}{Y_t}$, and $\rho_t = \frac{R_t}{Y_t}$ and where y_t is the real GDP growth rate. Combining equation 3 and the auxiliary equation $E_t = G_t + (r_t - r)B_{t-1}$ and defining of $GG_t = G_t + rB_{t-1}$ the intertemporal budget constraint can be rewritten as:

$$GG_t - R_t = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s-1}} (\Delta R_{t+s} - \Delta E_{t+s}) + \lim_{s\to\infty} \frac{B_{t+s}}{(1+r)^{s+1}} \quad (5)$$

For the no-Ponzi games condition to hold, the variables GG_t and R_t must be cointegrated of order one. An empirical test for fiscal sustainability is then obtained by estimating the following cointegration regression:

$$R_t = \alpha + \beta GG_t + u_t \quad (6)$$

3. Data

Fiscal variables for a sample of 15 small states from different regions in the world over the period 1991 to 2017 is used to construct a panel dataset to undertake the analysis.[1] The sample include countries from the Caribbean, Africa, the Pacific, Middle East and Asia. The primary source of data is the International Monetary Fund's World Economic Outlook database complemented by fiscal accounts data for some countries from their respective Central Banks and Ministries of Finance. The variables included in the model are general government revenue and general government expenditure. All the fiscal variables are expressed as a percentage of nominal GDP. Table 1 provides a brief summary of the fiscal variable and fiscal performance of each country.

[1] The fifteen countries were selected based on their current fiscal situation, expected fiscal and debt performance over the medium term and availability of data. Indeed, of the fifteen countries, the IMF (2015) classified four as having a high debt risk rating (Comoros, Djibouti, Dominica and Maldives) and another four as having high debt scrutiny rating (The Bahamas, Swaziland, Seychelles and Suriname). Bhutan and Guyana were classified as having moderate debt risk rating, and Trinidad and Tobago and Vanuatu were classified as lower debt scrutiny and low debt risk, respectively. In the case of the latter two, the IMF (2019) has projected increases in their debt to GDP ratios along with persistent fiscal imbalances over the next 5 years—worsening their fiscal stance

Table 1. Fiscal variables (percent of GDP)

	Revenue (Average: 1991-2017)	2017	Expenditure (Average: 1991-2017)	2017	Overall fiscal balance (Average: 1991-2017)	2017
Bahamas, The	12.2	17.2	14.4	22.7	-2.2	-5.5
Bahrain	24.6	18.2	28.4	32.5	-3.9	-14.3
Bhutan	35.5	26.7	37.2	30.1	-1.6	-3.3
Brunei Darussalam	37.5	26.0	39.0	36.6	-1.5	-10.6
Comoros	23.9	28.5	24.8	27.9	-0.9	0.6
Djibouti	33.1	32.2	38.7	38.3	-5.6	-6.1
Dominica	30.4	46.8	32.7	46.1	-2.3	0.7
Equatorial Guinea	27.3	17.0	85.5	19.6	-58.1	-2.5
Swaziland	25.1	28.2	26.7	37.0	-1.6	-8.8
Guyana	28.6	30.3	34.5	34.7	-5.9	-4.4
Maldives	25.1	29.0	31.7	32.3	-6.5	-3.3
Seychelles	42.8	36.4	45.3	36.1	-2.5	0.4
Suriname	22.3	19.6	25.5	27.0	-3.2	-7.4
Trinidad and Tobago	27.8	21.3	28.9	32.2	-1.1	-11.0
Vanuatu	23.6	31.5	26.2	39.0	-2.6	-7.5

Source: World Economic Outlook, October 2018 and Central Banks of selected countries.

4. Estimation strategy and results

The estimation of the long run relationship between government expenditure and revenue for small states involves four steps: (i) testing cross-sectional dependence, (ii) testing for unit roots, (iii) testing for cointegration and (iv) estimation of the panel cointegrating vector.

4.1 Cross-sectional independence and panel unit roots

Panel unit root tests are classified into two groups: first generation and second generation tests. The main difference between both groups of tests is the assumption of cross-sectional dependence. Cross sectional dependence is the contemporaneous correlation among countries that are caused by common global shocks such as movements in commodity prices, and processes related to market integration and globalization, among other factors (Banerjee and Carrion-i-Silvestre, 2017; Hsiao, Pesaran and Pick, 2012). First generation tests assume cross-sectional independence while second generation tests account for cross-sectional dependence across country units (see Hurlin an Migon, 2007). If cross-sectional dependence is present among the panel units, which are more likely to exist in macroeconomic variables (Breitung and Pesaran, 2005; Pesaran, 2004), then applying first generation panel unit root tests can be inappropriate (see for example Banerjee et al., 2004; 2005; Hurlin an Migon, 2007; Lyhagen, 2000; O'Connell, 1998; Phillips and Sul, 2003). Thus, the first step in our estimation strategy is to test for cross-sectional dependence. We use the Pesaran (2004) cross sectional dependence (CD) test which test a null hypothesis of cross-section independence. The CD test strongly rejects the null hypothesis of cross-sectional independence with a CD test statistic of 3.11 and 6.23 for government revenue and government expenditure respectively, implying the presence of cross-sectional dependence (Table 2).

Table 2. Cross section independence test for small states

Variables (in % of GDP)	CD-test	P-value	Avg. (pij)	Avg. |(pij)|
Revenue	3.11	0.00	0.06	0.25
Expenditure	6.23	0.00	0.12	0.36

Source: Authors estimates.

We use the Pesaran (2007) cross-sectionally augmented IPS (CIPS) test to examine the stationarity properties of each fiscal variable. The CIPS test is based on a cross-sectionally augmented ADF (CADF) regression and augments the standard ADF regressions the cross-sectional mean of lagged levels and first differences to filter out the cross-sectional dependence (Pesaran, 2007). It tests a null hypothesis of non-stationarity for all the time series in the panel. In cases where both the cross-sectional dimension (N) and the time dimension (T) are small, as in our study, the CIPS test is shown to have satisfactory size and power (Pesaran 2007). The CIPS test shows that both variables are non-stationary in levels. However, the CIPS test strongly rejects the null hypothesis of non-stationarity when it is applied to the first difference of the fiscal variables, indicating the presence of a unit root (Table 3).

Table 3. Panel Unit Root Test for small states

Pesaran (2007) (z-stat)

	Levels	*First differences*
Expenditure	-2.86	-4.99
Revenue	-2.56	-5.33

Source: Authors calculations.

Notes: The critical values for the Pesaran (2007) test with constant and trend are -2.89 (1%), -2.7 (5%) and -2.6 (10%).

4.2Panel cointegration

Having confirmed the that the fiscal variables are stationarity in first differences, we now apply the error correction based cointegration test of Westerlund (2007) to test for the existence of a long-run equilibrium relationship between the fiscal variables. The Westerlund (2007) test, unlike the residual-based tests of Pedroni (1999, 2004) and Kao (1999), treats with the presence of cross-sectional dependence of the panel units through bootstrapping and does not impose a common factor restriction which causes a significant loss of power in residual based tests. The Westerlund test has four panel cointegration tests allowing for unit-specific short-run dynamics, unit-specific trend and slope parameters and has a null hypothesis of no cointegration. There are two sets of alternative hypotheses (group-mean tests (G_t and G_a) and panel tests (P_t and P_a)) which depends in the homogeneity assumption of the error-correction term. The group-mean tests do not require equality of the error-correction term across panel units while the panel tests assume that the error-correction term is equal for all panel units. The four tests are conducted without constant and trend, constant only and with constant and trend. The test results reported in Table 4 were

based on 1000 bootstrap replications in order to obtain p-values that are robust to cross-section dependence. The results from all the tests, expect for one of the group mean test (G_a) in the constant and trend case, provides strong evidence of the cointegration between government revenues and government expenditures at the 5 percent level of statistical significance. Westerlund (2007) showed through Monte Carlo simulations that the panel tests have the highest power and second, among the group mean tests Gt has the highest power. Thus, there is sufficient evidence to conclude that null hypothesis of no-cointegration is rejected for our group of small states.

Table 4. Westerlund panel cointegration tests for small states

	Without constant and trend			Constant			Constant and trend		
	Value	**Z-value**	**Robust P-value**	**Value**	**Z-value**	**Robust P-value**	**Value**	**Z-value**	**Robust P-value**
G_t	-3.5	-9.6	0.00	-3.5	-7.3	0.00	-2.8	-2.1	0.01
G_a	-9.8	-5.1	0.00	-9.7	-1.8	0.04	-12.8	-0.5	0.13
P_t	-118.2	-99.6	0.00	-117.7	-112.7	0.00	-81.8	-84.2	0.00
P_a	-65.0	-85.6	0.00	-60.4	-49.0	0.00	-92.5	-52.8	0.00

Source: Authors estimates.

4.3Estimation of the panel cointegrating vector

We now proceed to estimate the panel cointegrating vector and obtain estimates for the long-run parameters $(\hat{\beta})$ and the error-correction term $(\hat{\alpha})$ of the cointegration regression of the two fiscal variables. Two panel cointegration estimation techniques are employed: mean group (MG) estimator and pooled mean group (PMG). The MG estimator of Pesaran and Smith (1995) estimates an individual regression for each country and then computes the unweighted mean of the coefficients over the N cross-sections. Pesaran, Shin and Smith (1997, 1999) developed the PMG estimator which is an alternative to the MG estimator and involves is a combination of pooling and averaging of coefficients. The main feature of the PGM estimators is that it allows the short run coefficients, the intercepts and error variances to be heterogeneous across groups but constrains the long-run coefficients to be the same. We test for the suitability of the PMG estimator compared to the MG estimator (the homogeneity of the long-run parameters) using a Hausman test which tests a null hypothesis that the difference between the PMG and MG estimation is not systematic. If the null hypothesis is rejected then the PGM estimation is favored over the MG estimator (see Pesaran et al. 1999; Hausman, 1978).

The Hausman test statistic of 5.37 rejects the null hypothesis that the difference between the PMG and MG estimation is not systematic, implying that the results from the MG estimator is more efficient (see Table 5). Also, the error-correction term is statistically significant at all conventional levels of statistical significance and has the appropriate negative sign (-0.51) which is an indication of a stable cointegration relationship between government revenue and expenditure. The long run coefficient of government expenditure has the expected positive sign, ranging from 0.23 (MG) to 0.49 (PMG) and is statistically significant at the 5 percent level.[2] Using the MG estimate, this implies that a one percentage point increase in the government spending to

[2] The magnitude of our coefficient is much lower than that what is observed for other country groups such as Central and Latin American countries where estimates range from 0.73 to 0.95 (see Alagidede and Tweneboah, 2015 and Christophe and Llorca, 2017).

GDP ratio, on average, increases the government revenue to GDP ratio by 0. 23 percentage points for small states. The size of the long run coefficient of government expenditure also allow us to classify fiscal sustainability as either "strong" or "weak". Quintos (1995) noted that if both fiscal variables are cointegration and the long-run coefficient of government expenditure $(\hat{\beta})$ is equal to one then fiscal sustainability exists in "strong" form, but if $0 < \hat{\beta} < 1$ then a weaker form of fiscal sustainability exists. Thus, given the evidence in Table 5, one can conclude fiscal policy in our sample of 15 small economies over the period 1991-2017 turns out to be "weakly" sustainable.

Table 5. Dependent variable: General government revenue

Explanatory variables	PMG	MG
Public spending $(\hat{\beta})$	0.498 [9.01]***	0.227 [7.98]**
Error correction term $(\hat{\alpha})$	-0.418 [7.19]***	-0.505 [9.80] ***
Expenditure (*t-1*)	0.153 [1.68]*	0.206 [2.27]**
Constant	5.161 [5.72]***	10.604 [4.22]***
Hausman test (MG vs. PMG)	5.37 [0.021]**	

Note: *** Statistically significant at the 1% level. ** Statistically significant at the 5% level. * Statistically significant at the 10% level.

5. Conclusion

This paper examined the issue of fiscal sustainability for a sample of fifteen small states using panel unit-root and cointegration tests and allowing for cross-sectional dependence. The evidence indicated the presence of cross-sectional dependence for the two fiscal variables used-government revenue and government expenditure. The application of second generation panel unit roots tests suggested that both fiscal variables were integrated to the order of one. Panel cointegration tests-both residual and error correction based tests- showed evidence of cointegration between government revenue and government expenditure, which indicates that both variables move together in the long run. However, the magnitude of the run coefficient of government expenditure is significantly less than one which implies a situation of "weak" fiscal sustainability in small states. Thus, amidst persistent fiscal imbalances and debt levels and in the presence of numerous risk factors (mostly exogeneous factors) facing small states, these findings suggest small states cannot continue their past fiscal behavior indefinitely without inducing sustainability risks.

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