Fiscal Sustainability in the Caribbean: An Econometric Analysis

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Abstract

Many countries in the Caribbean have been grappling with persistent fiscal imbalances and rising debt levels. In 2017, the average fiscal deficit as a percent of GDP was 2.8 percent, but with significant heterogeneity across countries ranging from 0.5 percent to 11 percent. Also, debt levels have reached levels that have raised concerns among policymakers: the average debt-to-GDP ratio for Caribbean countries was 76.6 percent. Using the intertemporal budget constraint framework and various panel data econometric estimators, this article examines the issue of fiscal sustainability for a group of 10 Caribbean countries over the period 1991–2017. The evidence from panel cointegration models of government revenue and expenditure shows that past fiscal behavior is "weakly" sustainable. The "weak sustainability" finding is reinforced by evidence from an extended fiscal reaction function which showed that the primary balance improves by about 0.02 for a one percentage point increase in the debt ratio.

1. Introduction

The issue of fiscal sustainability has received increasing attention in Caribbean countries following the 2008–2009 global financial crisis and the more recent commodity price shocks of 2014–2015. These exogeneous shocks, combined with natural hazards such as tropical storms and floods, inadequate policy responses, and limited institutional arrangements to guide corrective measures, have contributed to persistent budgetary imbalances leading to increasing debt ratios in some Caribbean countries (see Acevedo, Cebotari, and Turner-Jones, 2013; Alleyne, Ötker, Ramakrishnan, and Srinivasan, 2017; Fajgenbaum and Loser, 2018; Samaké and Spatafora, 2012; Villafuerte, Lopez-Murphy, and Ossowski, 2010; Koetsier, 2017; Medina, 2010; Ramirez and Wright, 2017). The majority of Caribbean countries have relatively high debt ratios: the simple average of the general government debt-to-GDP ratio for the Caribbean increased from 66.4 percent in 2008 to 76.6 percent in 2017, ranging from 42 percent to 157 percent for countries in the region.[1] Moreover, fiscal deficits have also been increasing, rising from an average of 1.8 percent of GDP in 2008 to 2.8 percent of GDP, and ranging from 0.5 percent of GDP to 11 percent of GDP. Indeed, a few Caribbean countries are amongst some of the most indebted in the world, and the region is typically referred to as countries with high debt and low economic growth (Acevedo, Cebotari, and Turner-Jones, 2013; Alleyne, Ötker, Ramakrishnan, and Srinivasan, 2017).

High levels of debt are usually associated with downward pressure on economic growth. Combined with low credit ratings, they can trigger increases in long-term interest rates for sovereign bonds and increased interest payments, placing countries in a vicious unsustainable cycle of ever-increasing debt and interest payments (see Greenidge et al., 2012; IDB, 2016). Therefore, from a macroeconomic stability perspective, it is important for countries to pursue fiscal policies that are sustainable in the long run.

The concept of fiscal sustainability being tested for Caribbean countries in this paper is based on the intertemporal budget constraint of Hamilton and Flavin

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[1] The Caribbean refers to the 10 countries (The Bahamas, Barbados, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, Suriname, Trinidad and Tobago, and St. Vincent and the Grenadines) included in this study. Only two countries (Guyana and Trinidad and Tobago) have debt ratios below 60 percent of GDP.

(1986), which states 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 government debt and budget deficits and/or investigating the series of government revenues and expenditures for the presence of cointegration. Some empirical studies that have used this approach for the United States, European countries, and Latin America include Quintos (1995), Hakkio and Rush (1991), Afonso (2005), and Kirchgaessner and Prohl (2008). While most of the earlier work focused on the stationarity of budget deficit and public debt, this paper follows the approach used in more recent works that has moved towards testing for the presence of cointegration between government revenues and expenditures (see Westerlund and Prohl, 2010; Afonso and Jalles, 2012; Claeys, 2007; Ehrhart and Llorca, 2007). This paper also investigates fiscal sustainability through fiscal reaction functions, which examine how primary balances adjust to rising debt levels in a panel setting following the approach of Bohn (1998), while allowing for the control of other political and economic determinants of the primary balance.

Caribbean countries represent an interesting case study for an assessment of the fiscal sustainability hypothesis given their current fiscal and debt situation and the potential fiscal risks derived from their structural features. These include small open economies, vulnerability to commodity price shocks and natural hazards, and weak economic institutions, all of which exacerbate the impact of shocks on fiscal performance and debt. In this regard, the main contribution of this paper is to fill an empirical gap by applying recent advances in panel unit root testing and cointegration to obtain a deeper understanding of fiscal sustainability issues in the Caribbean. Such evidence has important implications for policymakers as it relates to long-term fiscal sustainability.

The remainder of this paper is organized as follows. Section 2 gives a brief description of the theoretical model of fiscal sustainability. The data and empirical results are reported in Section 3, and Section 4 concludes.

2. Theoretical Framework

Fiscal sustainability refers to the ability of governments to fulfil the intertemporal budget constraint (IBC). The IBC is based on the idea that governments are implicitly promising to post sufficient budget surpluses in the future to cover the accumulated debt and interest payments associated with fiscal deficits in current periods (Baglioni and Cherubini, 1993). In this regard, fiscal policy is considered sustainable if the IBC holds in present value terms, that is, the current debt levels

in an economy should be compensated by the present value of future fiscal surpluses.

The basic mechanics of the present value borrowing constraint (PVBC) and how it can be tested empirically are outlined below.[2] The theoretical framework of fiscal sustainability can be explained algebraically by starting with the government's flow budget constraint at time t:

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

where B_t is the stock of public debt, R_t is government revenue, G_t is the primary government expenditure (government expenditure excluding interest payments), and r_t is the real interest rate payable on public debt. The intertemporal budget constraint is derived by rewriting equation (1) for subsequent periods and solving recursively to yield:

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

The formulation in equation (2) implies that when the $\lim_{s \to \infty} \prod_{j=1}^{s} \frac{B_{t+s}}{(1+r_{t+j})} = 0$, the present value of public debt at time t will be equal to the present value of future primary surpluses. To obtain an appropriate specification for empirical testing, it is assumed that the real interest rate is stationary. With mean r, and defining $E_t = G_t + (r_t - r)B_{t-1}$ (total government expenditure), the present value borrowing constraint (PVBC) becomes:

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

From equation 3, sustainable fiscal policy requires that the present value of the stock of public debt goes to zero in infinity, thus constraining debt to grow no faster than that of the real interest rate and thereby imposing the no-Ponzi scheme condition.

The PVBC can be expressed as ratios, where y_t is the real GDP growth rate and Y_t is the nominal GDP:

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

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[2] See, for example, Afonso and Jalles (2012), Afonso and Rault (2010), Claeys (2007), Ehrhart and Llorca (2007), Ehrhart and Llorca (2017), and Westerlund and Prohl (2010).

$b_t = \frac{B_t}{Y_t}$, $e_t = \frac{E_t}{Y_t}$, and $\rho_t = \frac{R_t}{Y_t}$. When $r > y$, the solvency condition $\lim\limits_{s\to\infty} b_{t+s} \left(\frac{1+y}{1+r}\right)^{s+1} = 0$ is needed to bound the growth of public debt, implying that the growth of the debt-to-GDP ratio should be less than $\left(\frac{1+y}{1+r}\right)^{s+1}$ (see Afonso and Rault, 2010).

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 written as:

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

For the no-Ponzi game condition to hold, the variables GG_t and R_t must be cointegrated of order one, which implies sustainability, such that government debt today is matched by future primary surpluses in present value terms. It should be noted that the PVBC does not necessarily rule out periods of large primary deficits or high debt, but that the future primary surpluses required to satisfy the PVBC remains a viable policy option. An empirical test for fiscal sustainability is then obtained by estimating the following cointegration regression:

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

3. Estimation Strategy and Empirical Results

The approach used to estimate the long-run relationship between government expenditure and revenue involves four steps: (i) testing for cross-sectional independence, (ii) testing for stationarity, (iii) testing for cointegration, and (iv) estimation of the panel cointegrating vector. This section presents the empirical unit root and cointegration test results and the results of the estimated cointegration vector using different methods.

3.1 Data

The analysis is conducted for 10 Caribbean countries using annual data for the period 1991 to 2017. The countries included in the panel are The Bahamas, Barbados, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, Suriname, Trinidad and Tobago, and St. Vincent and the Grenadines. The fiscal variables are defined as general government revenue and general government expenditure. Both fiscal variables are expressed as a percentage of nominal GDP and sourced from the International Monetary Fund's World Economic Outlook, October 2018, central bank databases, and IMF Article IV reports.

3.2 Cross-sectional Dependence

Cross-sectional dependence refers to the contemporaneous correlation among countries that can be caused by common global shocks, such as commodity price shocks, which impact all individuals (although to varying degrees), decisions of economic agents that can lead to interdependence among individuals, market integration processes, and globalization (Banerjee and Carrion-i-Silvestre, 2017; Hsiao, Pesaran, and Pick, 2012). One important drawback of the cross-sectional independence assumption is that it is often restrictive and somewhat unrealistic in macroeconomic applications, leading to strong size distortions and limited power in testing for unit roots (see, for example, Banerjee et al., 2004; 2005; Hurlin and Mignon, 2007; Lyhagen, 2000; O'Connell, 1998; Phillips and Sul, 2003). If observations are dependent across countries, then panel unit root tests based on the assumption of cross-sectional independence may be inappropriate. For this reason, panel unit root tests are classified into two groups: first-generation panel unit root tests and second-generation panel unit root tests, with the main difference between them being that first-generation tests assume cross-sectional independence while second-generation tests accounts for cross-sectional dependence across panel units (see Hurlin and Mignon, 2007). Thus, as a first step in ascertaining the properties of the fiscal variables, a test for the presence of cross-country dependence is performed by applying the Pesaran (2004) cross-sectional dependence (CD) test, which tests a null hypothesis of cross-sectional independence. The CD test is based on the average of the pairwise correlation coefficients estimated from individual ordinary least squares regressions for each unit in the panel. The CD test statistic is formulated as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \qquad (7)$$

Where $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of residuals from an Augmented Dickey Fuller (ADF) type regression, N is the cross-sectional dimension, and T is the panel's time dimension (Pesaran, 2004). The CD statistic is normally distributed under the null hypothesis of cross-sectional independence and is also robust to the presence of single and multiple structural breaks in the slope coefficients and the error variances (Pesaran, 2004). The results from the CD test are reported in Table 1 and show that the null hypothesis of cross-sectional independence is strongly rejected for both fiscal variables. In addition, the average absolute cross-section correlation coefficients $|p_{ij}|$ are somewhat high at 0.30 for government revenues and 0.38 for government expenditures.

Hence, the evidence suggests the presence of cross-sectional dependence for a panel of Caribbean countries.

Table 1. Pesaran (2004) Tests for Cross-sectional Independence Caribbean Countries

Variables (in % of GDP)	CD-test	P-value	Avg. (pij)	Avg. |(pij)|
Revenue	5.53	0.00	0.16	0.30
Expenditure	8.01	0.00	0.23	0.38

Source: Author's estimates.

3.3 Panel Unit Root Tests

With the presence of cross-sectional dependence, this section employs Pesaran (2007) second-generation panel unit root test to examine the properties of the fiscal variables. The Pesaran test augments the standard ADF regressions with the cross-section average of lagged levels and first differences as the common factor to filter out the cross-sectional dependence (Pesaran, 2007). The cross-sectionally augmented IPS (CIPS) test statistic is based on the average of individual cross-sectionally ADF (CADF) statistic following the procedure in the Im, Pesaran, and Shin (2003) test, which yields:

$$CIPS\ (N,T) = N^{-1} \sum_{i=1}^{N} t_i\ (N,T) \qquad (8)$$

where $t_i(N,T)$ is the cross-sectionally ADF (CADF) statistic for the ith cross-section in the panel and is provided by the *t*-ratio of the least squares estimate of the $b_i\ (\hat{b}_i)$ coefficient obtained from the CADF regression below:

$$\Delta y_{it} = \alpha_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + e_{it} \qquad (9)$$

It tests a null hypothesis of non-stationarity under a non-standard distribution where critical values are computed for different combinations of N and T. The test has been shown to have satisfactory size and power even when N and T have small values, as in our case (Pesaran, 2007). For comparison, four first-generation panel unit tests are employed to examine the fiscal variables: Breitung (2000), Im, Pesaran, and Shin (IPS, 2003), Levin, Lin, and Chu (LLC, 2002), and Hadri (2000). The LLC, IPS, and Breitung statistics all test a null hypothesis that the variable has a unit root. Breitung (2000) showed that the power of the LLC and IPS test statistics is sensitive to the inclusion of deterministic components such as individual specific trends and proposed a modification to the LLC approach—the Breitung test—to address this shortcoming. The Breitung test statistic tests a null hypothesis of a unit root and an alternative hypothesis that the panel series is

stationary. It differs from the LLC test in the way it controls for serial correlation: the LLC uses additional lags of the dependent variable while Breitung allows for pre-whitening of the series prior to the computation of the test statistic. The Hadri residual-based Lagrange multiplier test, on the other hand, builds on the Kwiatkowski-Phillips-Schmidt Shin test (KPSS) from time series and examines a null hypothesis that the series follows a stationary process around a deterministic trend (Kwiatkowski et al., 1992). The null hypothesis of the Hadri test is that each series in the panel is stationary (Hadri, 2000), while the alternative hypothesis is that the panel has a unit root.

The results are reported in Table 2. The Pesaran (2007) CIPS test is applied to both variables with both constant and trend deterministics, and a maximum of 5 lags for each panel unit in the model. The critical values of the CIPS test with constant and trend in levels are -3.3 (1%), -2.94 (5%) and -3.3 (10%) and in first differences are -3.1 (1%), -2.82 (5%) and -2.67 (10%). The CIPS test indicates that the ratios of government revenues and government expenditures are not stationary in levels at the 5 percent level of statistical significance. Applying the CIPS test to the first difference of the fiscal variables leads to a rejection of the null hypothesis of non-stationarity at all levels of statistical significance, implying that the variables are integrated to the order of one. The application of first-generation tests also concludes the presence of a unit root for both fiscal variables (see Table 2).

Table 2. Panel Unit Root Test for Caribbean Countries

	LLC (t*-stat)	Breitung (t-stat)	Hadri (z-stat)	IPS (w-stat)	Pesaran (2007) (z-stat)*
Levels					
Expenditure	-0.23	-0.58	7.66	-0.28	-2.90
	[0.41]	[0.28]	[0.00]	[0.39]	
Revenue	-0.77	-1.3	9.63	-1.94	-2.60
	[0.22]	[0.10]	[0.00]	[0.03]	
First differences					
Δ **Expenditure**	-12.2	-3.03	0.89	-12.5	-5.55
	[0.00]	[0.00]	[0.19]	[0.00]	
Δ **Revenue**	-10.15	-1.6	-0.6	-12.04	-5.36
	[0.00]	[0.05]	[0.73]	[0.00]	

Source: Author's calculations.
Notes: Values in parenthesis denote p-values. Δ represents first difference of the variables. *** Statistically significant at the 1% level. ** Statistically significant at the 5% level. * Statistically significant at the 10% level.

3.4 Panel Cointegration Test

Having established the panel stationarity properties of the fiscal variables, this section proceeds to test for the existence of a long-run equilibrium relationship using panel cointegration tests. Panel cointegration testing can be applied to the non-stationary fiscal variables by using either residual-based tests of Pedroni (1999; 2004) and Kao (1999) or the error correction test of Westerlund (2007).

Pedroni's (1999; 2004) cointegration tests are based on the Engle and Granger (1987) approach of time series analysis and test a null hypothesis of no cointegration in non-stationary panels. The Pedroni tests consist of seven panel cointegration statistics that are obtained from the residuals of the static long-run regression and are separated into two groups: (i) panel statistics tests (panel variance statistics, panel p-statistics, panel PP-statistics, and panel ADF-statistics) and (ii) group statistics tests (group p-statistics, group PP-statistics, and group ADF-statistics). The panel statistics tests assume homogeneity of the autoregressive term while the group statistics tests allow for heterogeneity of the autoregressive term.

In our application, only the group statistics that allow for heterogeneity of the autoregressive term is presented in Table 3. Pedroni (1999) provided critical values for these tests, which can include individual short-run dynamics, specific slope coefficients, deterministic trends, and individual specific fixed effects. Kao (1999) also proposed a residual-based test that is similar to the Pedroni test and tests a null hypothesis of no cointegration, but unlike the Pedroni test, it is based on the assumption of homogeneity across individual units. Kao's panel test is found to have higher power than the Pedroni test when the number of observations is small.

Both residual-based tests assume the presence of a single cointegrating vector. However, one of the criticisms of the residual-based tests is their failure to reject the no-cointegration null hypothesis, even when theory strongly suggests that they should. One explanation for this is that most residual-based tests have a common factor restriction that requires the long-run parameters of variables in their levels to be equal to their short-run parameters in first differences, which causes a significant loss of power in residual based tests. Moreover, Kao and Pedroni tests assume cross-sectional independence among the units of the panel (Banerjee and Carrion-i-Silvestre, 2017), which is not consistent with the properties of both fiscal

variables for the panel of Caribbean countries, as established in the previous section.

The Westerlund (2007) panel cointegration test overcomes the shortcomings of the residual-based tests as it does not impose a common factor restriction. Westerlund proposed an error correction-based test which consists of four panel cointegration tests that allow for unit-specific short-run dynamics, unit-specific trend and slope parameters and also treats with the issue of cross-sectional dependence. First, Westerlund considered the following data-generating process for the error correction tests:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i\big(y_{i,t-1} - \beta_i' x_{i,t-1}\big) + \sum_{j=1}^{p_i} \alpha_{ij}\Delta y_{i,t-j} + \sum_{j=0}^{p_i} \gamma_{ij}\Delta x_{i,t-j} + e_{it}$$

(10)

where *t* and *i* represent the time-series and cross-sectional dimensions, respectively, d_t represents the deterministic components with δ_i' containing the respective parameters, and α_i is the error-correction term. Rewriting equation 10 below with $\lambda_i' = -\alpha_i\beta_i'$ gives:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i y_{i,t-1} + \lambda_i' x_{i,t-1} + \sum_{j=1}^{p_i} \alpha_{ij}\Delta y_{i,t-j} + \sum_{j=-q_i}^{p_i} \gamma_{ij}\Delta x_{i,t-j} + u_{it}$$

(11)

The parameter α_i provides information on the speed at which the system reverts to the equilibrium relationship $y_{i,t-1} - \beta_i' x_{i,t-1}$ after a shock. In this setup, error correction occurs if $\alpha_i < 0$, which implies that the variables x_{it} and y_{it} are cointegrated. However, if $\alpha_i = 0$, there is no error correction and no cointegration, which defines the null hypothesis as $H_0: \alpha_i = 0$. On the other hand, the alternative hypothesis depends on the homogeneity assumption of α_i for which there are two sets of tests: (i) group-mean tests that do not require equality of $\alpha_i s$, for which the alternative hypothesis is $H_1^G: \alpha_i < 0$, and (ii) panel tests, which assume that α_i is equal for all cross sections and yield an alternative hypothesis of $H_1^P: \alpha_i = \alpha < 0$. Moreover, the Westerlund test treats with the presence of cross-sectional dependence through bootstrapping.

The results from the three cointegration tests provide strong evidence of cointegration between government revenues and government expenditures (Table 3). The three group statistics of the Pedroni tests (Modified Phillips-Perron, Phillips-Perron, and Augmented Dickey-Fuller) strongly reject the null hypothesis of no-cointegration. Of the five Kao test statistics, the modified Dickey-Fuller test, the unadjusted modified Dickey and Fuller test, and the unadjusted Dickey-Fuller

test rejected the null hypothesis of no-cointegration at the 5 percent level of significance, and the Dickey-Fuller and Augmented Dickey-Fuller tests rejected the null hypothesis of no-cointegration at the 10 percent level of significance. Also, the robust P-values of the Westerlund tests show a strong rejection of the null hypothesis of no-cointegration for both the panel and the group mean tests in Table 3.

Table 3. Panel Cointegration Tests for Caribbean Countries

	Statistic	P-value
Pedroni test for cointegration		
Modified Phillips-Perron t	-2.12	0.02
Phillips-Perron t	-3.37	0.00
Augmented Dickey-Fuller t	-3.78	0.00
Kao test for cointegration		
Modified Dickey-Fuller t	-2.12	0.02
Dickey-Fuller t	-1.56	0.06
Augmented Dickey-Fuller t	1.47	0.07
Unadjusted modified Dickey Fuller	-4.33	0.00
Unadjusted Dickey-Fuller t	-2.49	0.01

Westerlund panel cointegration tests

	Value	Z-value	P-value	Robust P-value
G_t	-1.95	-2.97	0.00	0.00
G_a	-6.49	-1.87	0.03	0.01
Pt	-6.18	-3.91	0.00	0.00
Pa	-5.42	-4.79	0.00	0.00

Source: Author's estimates.

Note: 1000 bootstrap replications are used for to obtain Robust P-value in the Westerlund cointegration tests. The bootstrapped versions of the error-correction tests are robust to the presence of cross-sectional dependence.

3.5 Evidence of Weak Fiscal Sustainability

This section estimates the long-run parameters and short-run adjustment coefficients associated with the cointegration relationship of the fiscal variables. Three panel cointegration estimation techniques—the mean group (MG) estimator, the pooled mean group (PMG) estimator, and the dynamic fixed effects (DFE) model—are employed. Pesaran and Smith (1995) introduced the MG estimator, which estimates separate regressions for each cross section in the panel and computes a simple arithmetic average of country-specific long-run coefficients. The MG estimator allows for all parameters, including the intercepts, slope coefficients, and error variances, to differ across groups. Although the MG estimator yields consistent estimates of the average of the parameters, it is highly sensitive to outliers, especially for small N samples, and does not consider the

fact that certain parameters may be the same across groups (Pesaran and Smith, 1995; Pesaran, Shin, and Smith, 1999). Pesaran, Shin, and Smith (1997; 1999) provided an alternative approach—the PMG estimator—to the MG estimator, which involves a combination of pooling and averaging of coefficients. The PMG estimator allows for the short-run coefficients, the intercepts, and error variances to be heterogeneous across groups, while the long-run coefficients are restricted to be the same. The short-run adjustment is allowed to be country specific to reflect the different impact of vulnerabilities to financial shocks, external shocks, monetary policy shock, and stabilization policies, among other factors, across countries (Samargandi, Fidrmuc, and Ghosh, 2014). In addition to the MG and PMG, the DFE model is employed. It is based on pooling over cross-sections where the slopes are fixed, and the intercepts vary across countries. However, Pesaran and Smith (1995) noted that DFE estimates are affected by a potentially serious heterogeneity bias, especially in small samples.

In this regard, a Hausman test is employed to determine whether the homogeneity assumption of long-run parameters holds (see also Pesaran et al., 1999; Hausman, 1978). The Hausman test examines the efficiency of the PGM estimators in relation to the MG and DFE estimators by testing a null hypothesis that the difference between the PMG and MG estimation or the PMG and DFE estimation is not systematic. The results show that the PMG estimator is more efficient under the null hypothesis and is preferred over the MG and DFE estimators (see Table 4). Moreover, the error correction term $\hat{\alpha}$ has the correct sign and is statistically significant at all conventional levels of statistical significance. This reinforces the evidence of a long-run or cointegration relationship between the two fiscal variables. The error correction term is estimated to be -0.392 under the PMG estimator, indicating the system corrects any deviations in the previous period at a speed of 39.2 percent annually to revert to steady state. The magnitude is similar to what was found in studies of similar countries (see Hurlin and Llorca (2017) for a sample of Central and Latin American countries and Alagidede and Tweneboah (2015) for Latin American countries). This implies a relatively slow response and is reflected in persistent fiscal imbalances in most Caribbean countries, as shown in Figure A1. Moreover, as shown in Fajgenbaum and Loser (2018), most Caribbean countries have not undertaken fundamental reforms to fiscal institutions, including fiscal rules, fiscal limits, sovereign wealth funds, and procedural rules and transparency rules to promote fiscal discipline and to adequately respond to shocks.

The long-run coefficient of government spending is positive and highly statistically significant at all conventional levels of statistical significance, indicating that fiscal policies are consistent with their intertemporal budget constraints. The magnitude of the coefficient under the PGM estimator is 0.381. The other two estimators produced similar magnitudes, ranging from 0.329 for the MG estimator to 0.40 for the DFE estimator. This implies that a one percentage point increase in the government expenditure ratio leads to an increase in the government revenue ratio of 0.381 percentage points on average for the Caribbean. The magnitude of the coefficient is, however, much lower than what is observed for Central and Latin American countries, which have coefficient estimates closer to unity (ranging from 0.73 to 0.95. (Alagidede and Tweneboah, 2015; Hurlin and Llorca, 2017).

This finding has important implications, as the magnitude of the long-run coefficient on government expenditure (β) can be used to classify fiscal sustainability as either "strong" or "weak." Following Quintos (1995), a rejection of the null hypothesis of no-cointegration and where $\beta = 1$ implies that fiscal sustainability exists in "strong" form. However, the fiscal stance is only "weakly" sustainable if $0 < \beta < 1$. Under this weaker form of sustainability, government expenditure increases at a rate that is higher than government revenues. Based on this evidence and the classification of Quintos (1995), one can conclude that as the long-run coefficient on government expenditure for the Caribbean is less than unity, fiscal policy has been "weakly" sustainable over the period 1991–2017. In the next section, fiscal sustainability is further examined using fiscal reaction functions and controlling for other determinants of the primary balance.

Table 4. Dependent Variable: General Government Revenue

Explanatory variables	PMG	MG	DFE
Government expenditure ($\hat{\beta}$)	0.381	0.329	0.40
	[5.47]***	[2.80]***	[2.39]***
Error correction term ($\hat{\alpha}$)	-0.392	-0.454	-0.306
	[6.64]***	[7.88]***	[3.45]***
Expenditure (t-1)	0.263	0.267	0.328
	[2.99]***	[2.89]***	[3.47]***
Constant	5.726	7.963	4.40
	[6.48]***	[4.28]***	[2.01]**
Hausman test (MG vs. PMG)	0.24	Hausman test (PMG vs. DFE)	0.01

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

3.6 Fiscal Reaction Functions

This section estimates a linear fiscal reaction function for Caribbean countries following the approach of Bohn (1998). The fiscal reaction function relates the government's primary balance to the level of debt and shows the extent to which the level of debt influences fiscal policy (see Bohn, 1998; 2008; Mendoza and Ostry, 2008; Celasun and Kang, 2006):

$$pb_t = \tau \cdot d_{t-1} + \xi_t \qquad (12)$$

where pb_t is the primary balance to GDP ratio and d_t is the government debt-to-GDP ratio. The parameter τ measures the responsiveness of the primary balance ratio and ξ_t is the error term. The empirical specification above is extended below to include other economic and political factors:

$$pb_{it} = \alpha + \delta pb_{i,t-1} + \tau \cdot d_{i,t-1} + \sum_{i=1}^{n} \beta X_{i,t} + \theta_i + \gamma_t + \xi_{i,t} \qquad (13)$$

In the extended model estimation, the focus is to tackle estimation issues of endogeneity and cross-sectional correlation. In the first instance, as countries are slow to adjust fiscal policies to macroeconomic shocks, the lagged dependent variable is included in (13) to reflect the high persistence of the primary balance. The inclusion of $pb_{i,t-1}$ results in a dynamic panel regression which can cause the estimated coefficient $(\hat{\delta})$ of the lagged dependent variable to be biased (i.e., the Nickell bias) when estimated with the Least Square Dummy Variable (LSDV) or fixed effects estimators (Nickell, 1981). However, as the literature shows, the Nickell bias diminishes when the time dimension is relatively large (Nickell, 1981; Judson and Owen, 1999). The regressions in this section cover a period of 27 years, which is greater than the 'rule of thumb. This suggests that T should be greater than 20 to address the inconsistency of the FE estimator in a dynamic panel setting (see Checherita-Westphal and Žďárek, 2017 and EC, 2011 for application to European countries). Nevertheless, the bias-corrected LSDV estimator (LSDVC) of Bruno (2005) is used as a robustness check to account for any potential bias. The extended model also includes the output gap (difference between actual GDP and potential GDP) to control for the business cycle, and other economic and political factors such as the current account balance ratio and

an election year dummy variable. The election year dummy variable takes on a value of one for the year prior to a national election and the election year. Since the output gap and the current account balance ratio variables are both endogenous due to bi-directional causality with the contemporaneous primary balance, they should be instrumented. The lagged values (first and second lags) of both variables are used as instruments in the panel fixed effects instrumental variable (FE-IV) estimator (See, for example, Ayuso et al., 2008 and Gali and Perotti, 2004).[3] The countries in the panel also share similar features, such as high external dependence on either hydrocarbons and minerals or services and tourism, and relatively strong economic relations. These characteristics imply the presence of CD as shown by the Pesaran (2004) CD test in Table 5. Time fixed effects are used in the FE-IV estimator to control for these common shocks (see Jansen, 2016). Moreover, the Prais-Winsten estimator with correlated panels corrected standard errors (PCSEs) and the Driscoll-Kraay estimators are used as robustness checks for presence of cross-sectional dependence (see Prais and Winsten, 1954; Driscoll and Kraay 1998). In this regard, FE-IV is the base or preferred estimator against which other estimators mentioned above are used for robustness checks. The parameters θ_i, γ_t, and ξ_{it} are country fixed effects, time fixed effects and the error term which captures measurement errors and random shocks.

Table 5. Cross-sectional Independence (Pesaran, 2004)

Variables (in % of GDP)	CD-test	P-value	Avg. (pij)	Avg. |(pij)|
Primary balance ratio	2.05	0.04	0.06	0.29
Debt ratio	3.70	0.00	0.10	0.50
Current account ratio	2.78	0.00	0.08	0.34
Output gap	3.81	0.00	0.11	0.29

Source: Author's estimates.

3.6.1 Empirical Results

The results from the FE-IV estimator and other estimators used for robustness are shown in Table 6. All of the models include time fixed effects, while some include both time fixed effects and country fixed effects. In the panel IV-FE, the output gap and the current account balance are instrumented by their first and second lagged values. The panel IV-FE estimations perform well in various robustness tests for weak instruments (Kleibergen-Paap test) and the validity of instruments (Hansen

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[3] The US output gap, potential GDP growth rates and real oil price index were considered as potential instruments but were found to be inadequate.

test). However, as there is a potential for bias due to the inclusion of a dynamic term, Bruno's (2005) bias corrected LSDV estimator(LSDVC), which extends Kiviet (1995) results to treat with the inclusion of a lagged dependent variable, is employed. Judson and Owen (1999) showed that the LSDVC estimator is more efficient and performs better for panels with small T and N dimensions, as in our case, than other options such as the GMM estimators of Arellano and Bond (1991) or IV estimators such as Anderson and Hsiao (1982). Comparing the results from the standard OLS estimation in column 1 and the LSDVC in column 5 demonstrated that $\hat{\delta}$ is not likely to be biased, due to the relatively long time dimension.

The main coefficient of interest $\hat{\tau}$ (first lag of the debt ratio) is highly statistically significant in all empirical specifications with only a small variation between the various estimators, between 0.019 to 0.024.[4] The highest coefficient is from the Driscoll-Kraay estimator, which controls for both time and country fixed effects and cross-sectional independence. The remaining estimators including our preferred model report a coefficient estimate of 0.019. Based on these estimations and robustness checks, the evidence suggests a positive reaction of primary surpluses to higher debt: the primary balance improves by about 0.02 for every one percentage point increase in the debt ratio, after controlling for other factors. The other variables in the model have the expected sign, and except for the lagged (-2) current account balance in a few models are statistically significant at the 5 percent level of confidence. The output gap, which shows a negative sign, suggests some degree of procyclical fiscal policy (for further evidence on procyclical fiscal policy in the Caribbean, see Samuel, 2009; Araujo, 2009). The current account balance ratio is statistically significant in our preferred model when it is instrumented with its first and second lag but becomes insignificant in models that do not allow for endogeneity and the where the second lag is used. The election dummy variable is statistically significant in all model specifications and vary from -0.885 to -0.982 suggesting that on average, election years (and the year prior to a national election) have a negative effect on fiscal positions in the Caribbean.

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[4] Empirical studies have found that the size of the reaction parameter τ varies between 0.01 and 0.10 (for a summary of the literature, see Checherita-Westphal and Žďárek, 2017). It should be noted that the model estimates a linear response of primary balance to changes in debt ratios. However, it could be that for higher levels of debt the primary balance may have a larger response.

Table 6. Fiscal Reaction Functions: Panel Fixed Effects-IV and Robustness Checks

	Panel IV-FE	Pooled OLS	LSDVC	Driscoll-Kraay FE	PCSEs
Lagged primary balance	0.716	0.757	0.751	0.702	0.711
	[0.063]***	[0.052]***	[0.054]***	[0.068]***	[0.050]***
Lagged debt	0.019	0.019	0.019	0.024	0.019
	[0.007]***	[0.005]***	[0.009]**	[0.006]***	[0.007]***
Current account	0.057				
	[0.044]***				
Output gap	-0.230				
	[0.112]**				
Election dummy	-0.885	-0.907	-0.982	-0.979	-0.952
	[0.320]**	[0.309]***	[0.350]***	[0.164]***	[0.268]***
Lagged current account (-2)		0.018	0.007	0.011	-0.006
		[0.021]	[0.031]	[0.027]	[0.022]
Lagged output gap (-2)		-0.127	-0.126	-0.132	-0.133
		[0.051]**	[0.063]**	[0.037]***	[0.026]***
Constant		-0.909		-1.095	0.250
		[0.735]		[0.319]***	[1.098]
Number of observations	243	243	243	251	251
Number of groups	10	10	10	10	10
R-squared	0.58	0.72		0.61	0.76
Country FE	No	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Kleibergen-Paap (p-val)	0.000				
Hansen J-test (p-value)	0.225				

Source: Author's calculations.
Notes: p-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively.
Country fixed effects and time fixed effects are not reported, robust standard errors are reported.

4. Conclusions

Persistent fiscal imbalances and rising debt levels have emerged as perhaps the most important macroeconomic challenge facing Caribbean countries in the last decade. While some countries are undertaking reforms to strengthen their fiscal positions, relatively weak fiscal institutions, high vulnerability to exogeneous shocks, and limited fiscal buffers, combined with an expenditure profile rigidly focused on non-discretionary spending, can affect their ability to adjust fiscal policies in a timely manner to fiscal shocks. Within this context, this paper examined whether the fiscal behavior of Caribbean countries over the period 1991–2017 is sustainable in the long run.

The theoretical framework employed to test the sustainability of fiscal policy is the intertemporal budget constraint, which states that the market value of public debt

must be equal to the present value of all discounted future budget surpluses. The econometric exercises were undertaken in two parts: by (i) testing for cointegration between government revenues and expenditures and (ii) estimating fiscal reaction functions to determine how Caribbean governments adjust their primary fiscal balances to increases in debt levels. The analysis tested for and treated with endogeneity and cross-sectional dependence and other relevant econometric issues using various econometric tests and estimators.

The main findings from the panel cointegration analysis indicate the presence of a long-run relationship between the two fiscal variables, based on both the error-correction based panel cointegration tests of Westerlund (2007) and the residual-based tests of Pedroni (1999; 2004) and Kao (1999). Nevertheless, the estimated cointegration parameter is less than one and lower than estimates found for other countries using similar methodologies, which suggests a situation of "weak" fiscal sustainability: a one percentage point increase in the government expenditure ratio leads to an increase in the government revenue ratio of 0.381 percentage points. Also, the speed of adjustment parameter indicated that the system corrects any deviations in the previous period at a speed of 39.2 percent annually to revert to steady state, similar to other countries. The fiscal reaction functions showed that the primary balance improves by about 0.02 for every 1 percentage point increase in the debt ratio, reinforcing the findings from the cointegration analysis of "weak" sustainability. This estimate is marginally lower than what is observed for European countries, where the range is 0.03–0.05 for every 1 percentage point increase in the debt-to-GDP ratio. The extended fiscal reaction functions also showed evidence that there is some degree of procyclical fiscal policy, and national elections tend to worsen fiscal positions in the Caribbean. Taking these results together suggests that countries need to be cautious about continuing past fiscal policies into the future and should seek to enact measures to ensure that they can adequately respond to fiscal-related shocks.

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Appendices

**Table A1. Correlation Matrix**

|	Debt ratio	Revenue ratio	Expenditure ratio	Current account ratio	Output gap	Primary balance	Fiscal balance
Debt ratio	1.000						
Revenue ratio	0.367	1.000					
Expenditure ratio	0.520	0.798	1.000				
Current account ratio	-0.347	0.008	-0.175	1.000			
Output gap	-0.065	0.083	0.031	0.024	1.000		
Primary balance	0.215	0.329	-0.151	0.262	0.053	1.000	
Fiscal balance	-0.275	0.244	-0.389	0.294	0.078	0.747	1.000

Source: Author's estimates from World Economic Outlook, October 2018.

Figure A1. Selected Fiscal Variables for 2000–2017

The Bahamas

Barbados

Dominica

Grenada

Guyana

Jamaica
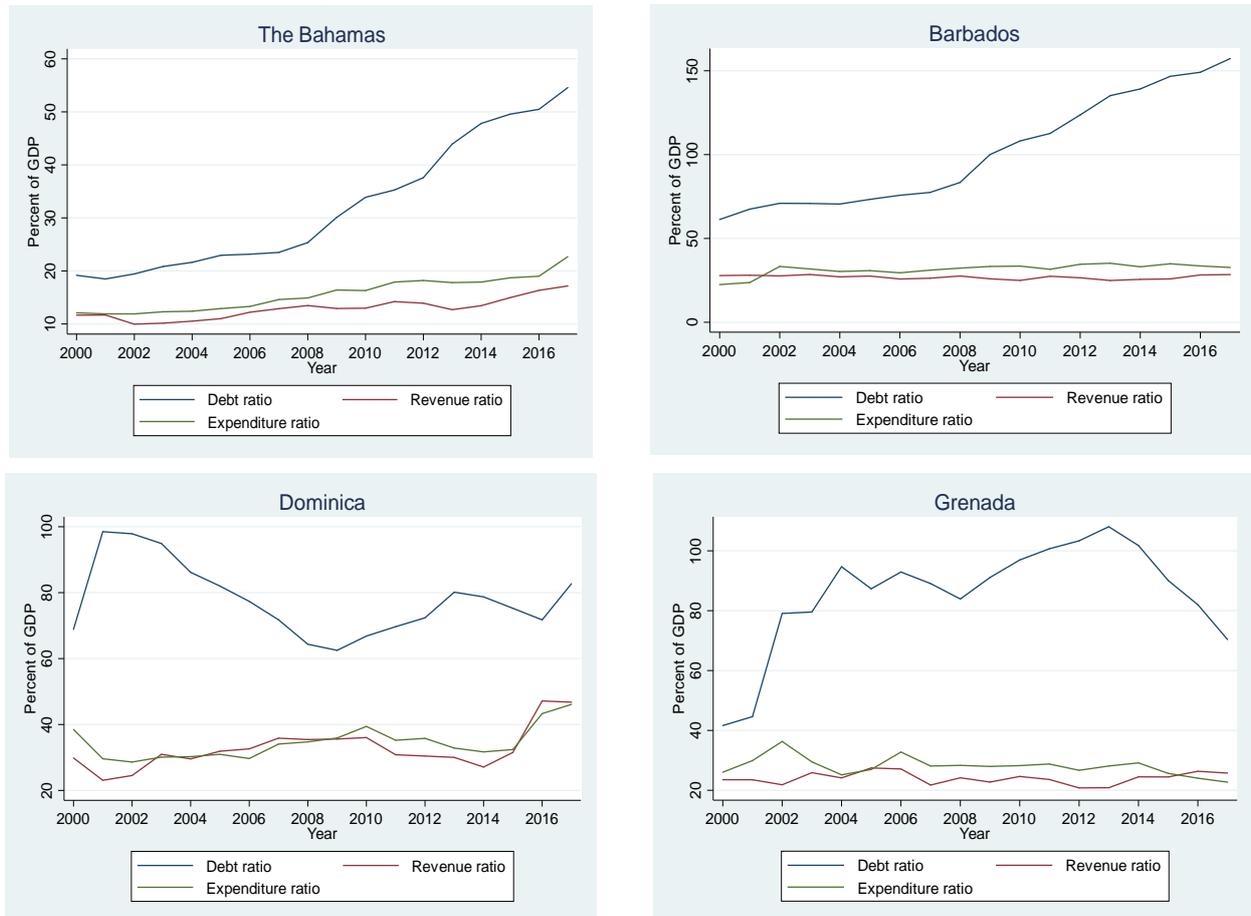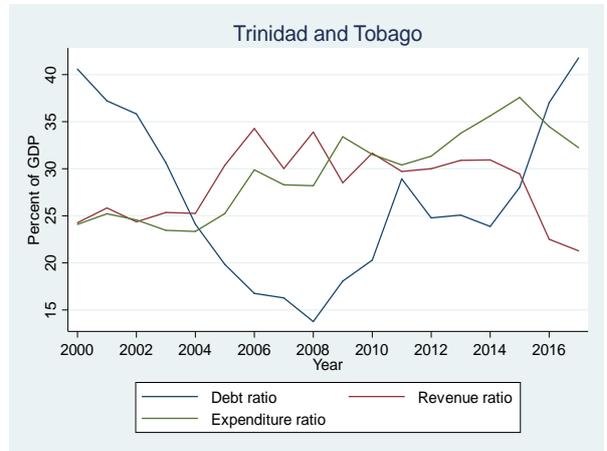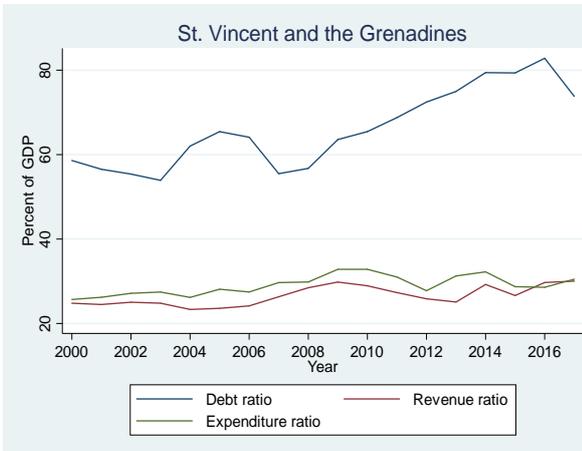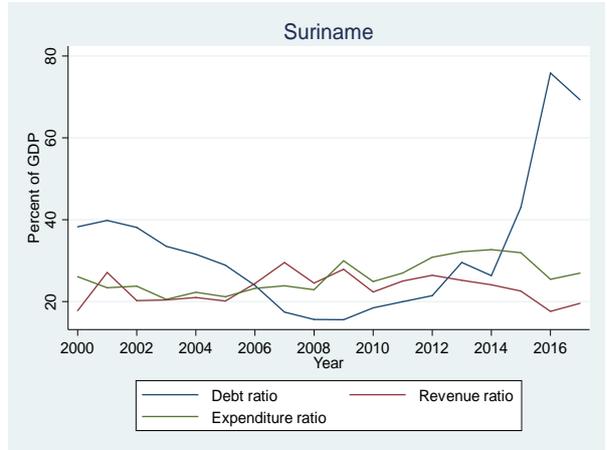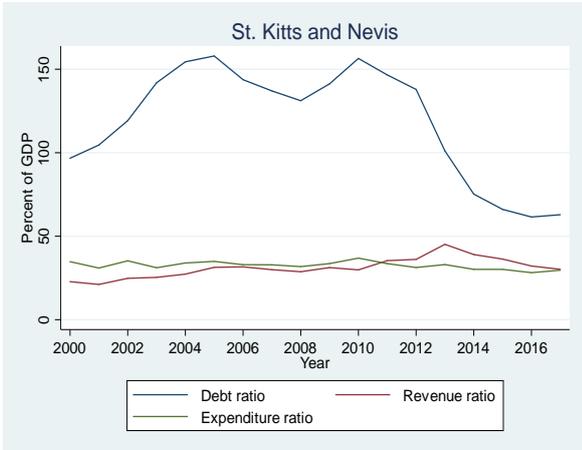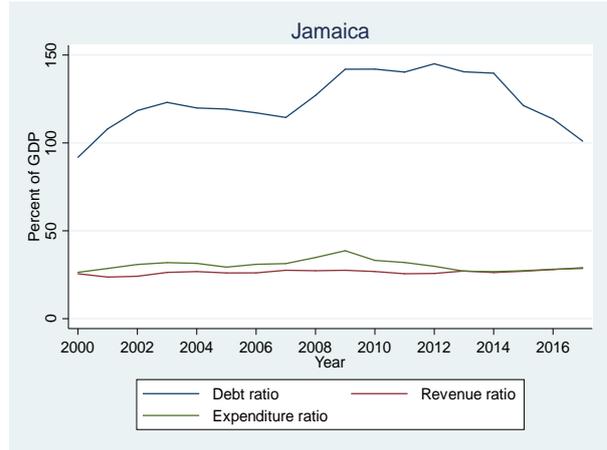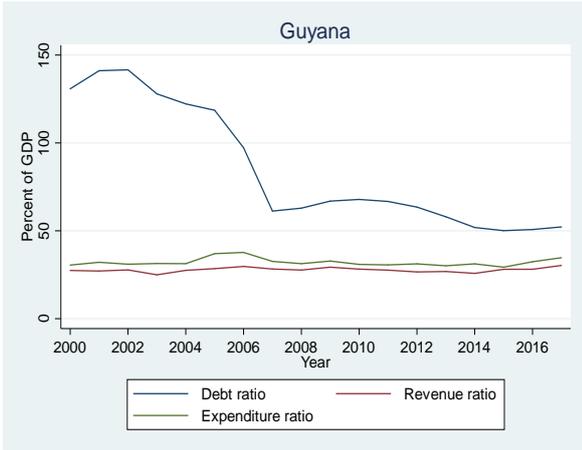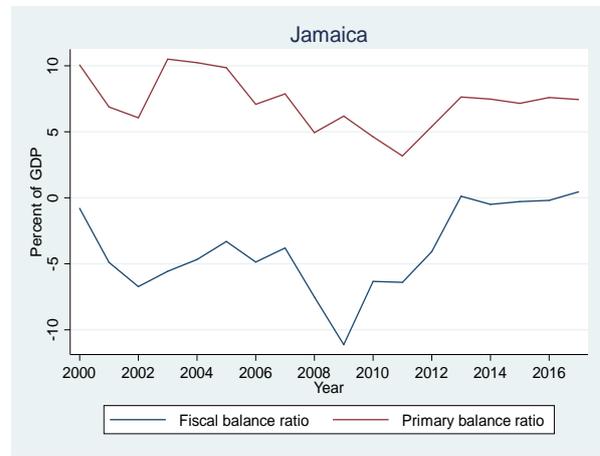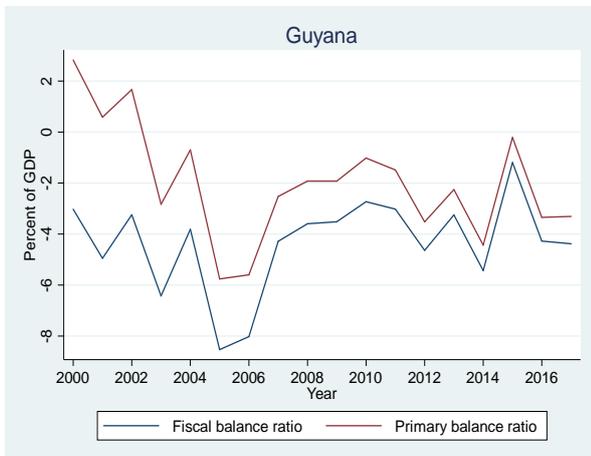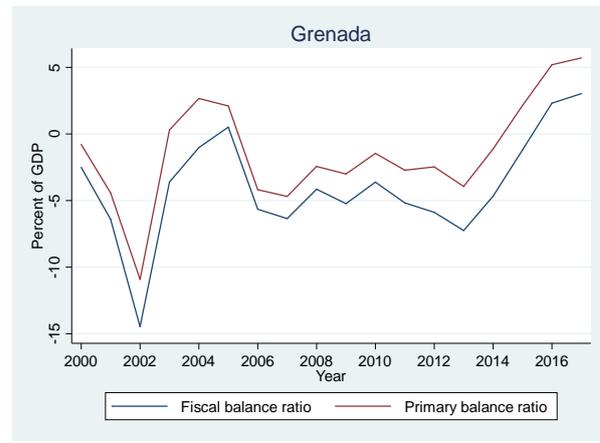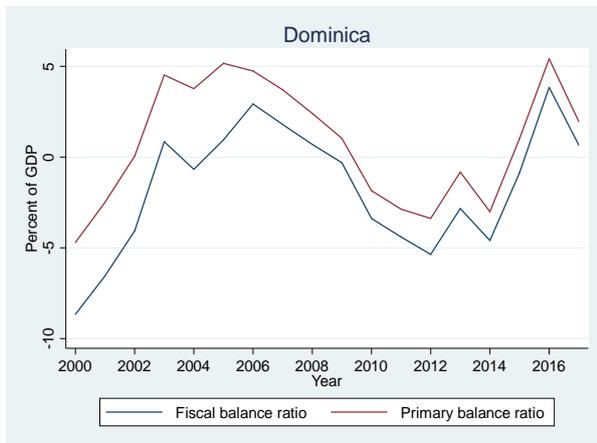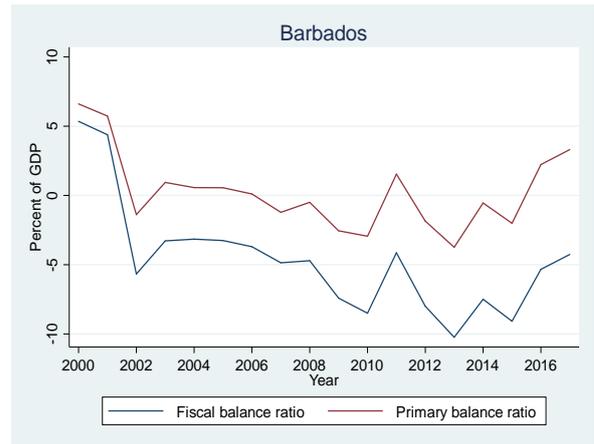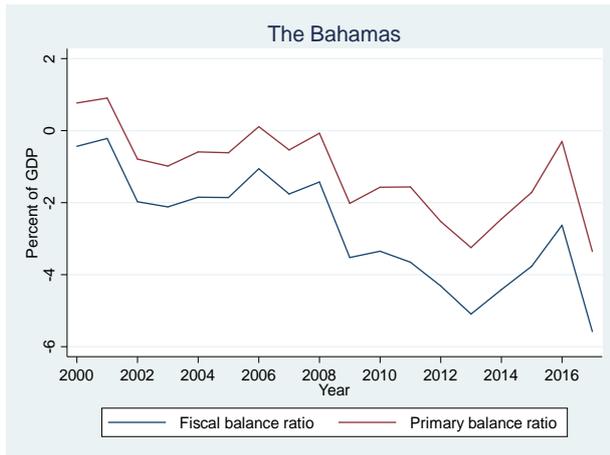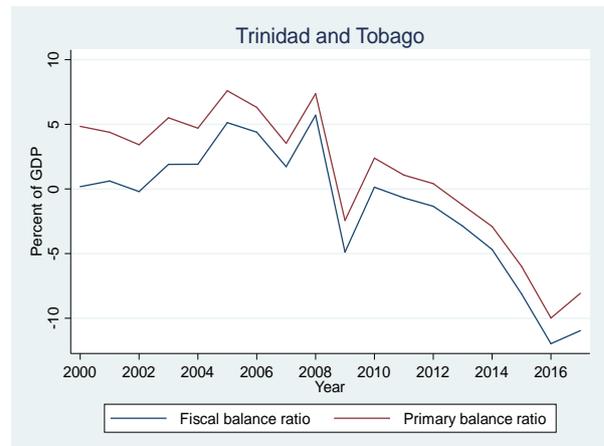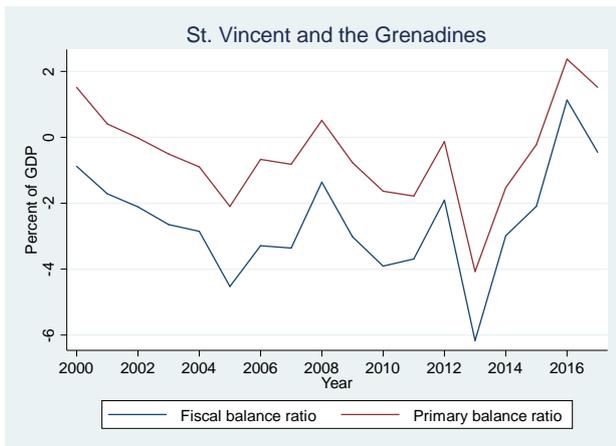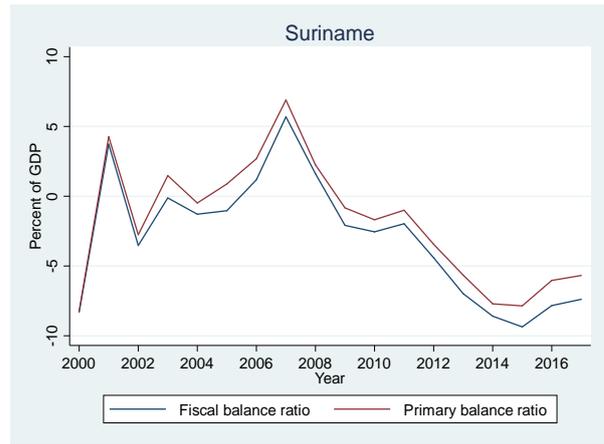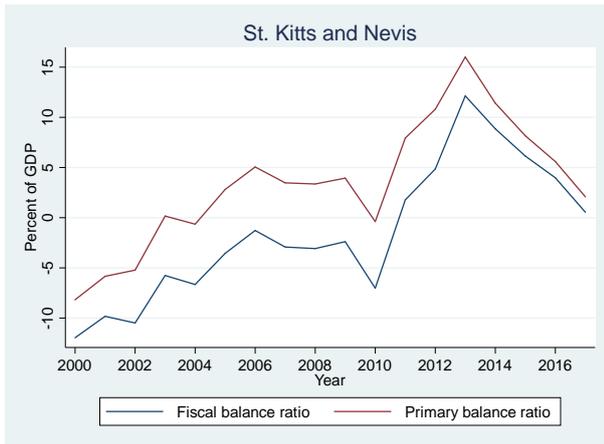
Source: World Economic Outlook, October 2018.