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Fiscal Reaction Functions Augmented with Bespoke Debt Indicators: Evidence from Small Island States

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ABSTRACT *Developing countries have a higher propensity for debt distress than their developed counterparts and small economies are more vulnerable to external shocks than larger ones. We examine the primary balances of two economies at the intersection of developing and smallness classifications – so-called small island developing states (SIDS) – Trinidad and Tobago (T&T) and Mauritius. These countries have comparable characteristics (smallness, openness, populations, and are former plantation economies with similar colonial histories) but differ in their natural resource wealth status (the former is resource-rich and the latter is resource-poor). Given the myopic insights provided by single metrics of government indebtedness, such as the debt-to-GDP ratio, we augment standard fiscal reaction functions with purpose-built debt sustainability measures that use principal component analysis to consolidate the information content imbedded in a comprehensive range of country-relevant fiscal ratios. Our results show while debt is sustainable in both countries, fiscal policy is procyclical. We also find that debt volatility is positive and significant for T&T's primary balance but is insignificant for Mauritius, which we attribute to the differing degrees of export-diversification between the countries. Policy recommendations include greater commitments to counter-cyclical fiscal policy in both SIDS and greater export-diversification initiatives in T&T.*

KEYWORDS: debt sustainability; fiscal reaction function; primary balance; principal component analysis (PCA); small island developing states (SIDS)

JEL CLASSIFICATIONS: C36; C38; H62; H63; O23; O57

1. Introduction

Government debt increased to unprecedented levels, as policymakers scrambled to support economies in the wake of the COVID-19 pandemic, giving limited consideration to the cost or source of funding. In many instances, extraordinary fiscal responses to the pandemic added fuel to already protracted debt levels. High debt can have detrimental effects on economic growth,

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especially if it exceeds a country-specific threshold (see, e.g. Baum, Checherita-Westphal, & Rother, 2013; Reinhart & Rogoff, 2010) and such adverse effects of elevated debt are further complicated with the heightened uncertainty of the current macroeconomic environment. In particular, debt dynamics becomes unstable in a high interest rate environment as the cost of acquiring debt increases, resulting in governments having to service higher interest payments (see, e.g. Cecchetti, Mohanty, & Zampolli, 2011). Alongside this, accessing concessional financing may be tranche with stringent conditions. As such, there is a need for policymakers to assess debt sustainability and manage public debt (see, e.g. Bouabdallah et al., 2017) given its interconnectedness with the macroeconomy (Montiel, 2005).

Moreover, the repercussions of increasing debt remain asymmetric, as developing countries (in the Pacific, Africa, the Caribbean, and Asia) with elevated debt continue to rollover such obligations into future time periods and some suffer from debt overhang – where high debt levels restrict access to future financing and investment (see, e.g. Turan & Yanıkkaya, 2021). In fact, developing countries face borrowing costs three times higher than their developed counterparts (UN DESA., 2022). Additionally, the debt threshold for harming growth is lower in developing economies, at approximately 88.2%, compared to advanced economies, where thresholds often exceed 100.0% (Yolcu Karadam, 2018). Caner, Grennes, Koehler-Geib, and Koehler-Geib (2010) find similar results from a panel of 25 developed and 74 developing economies between 1980 and 2008. Indeed, many developing countries have a debt storm brewing and some are on the verge of debt distress.[1] Further to this, over 40.0% of small island developing states (SIDS) are highly indebted or converging towards debt distress (Bharadwaj, Mitchell, Karthikeyan, & Kumar, 2023). In this paper, we examine debt sustainability in SIDS, which are the most vulnerable group of countries in the world (Turvey, 2007) and are characterised by limited diversification and shallow financial markets (Auty, 2017). In particular, we follow Auty (2017) and compare Trinidad and Tobago (T&T) to Mauritius, as both SIDS are parliamentary democracies with similar population sizes and ethnic compositions, and their contemporary economies have emerged from a reliance on a monoculture (sugarcane) plantation economy system. Nevertheless, these SIDS differ in their natural resource endowments – T&T is resource-rich (a petroleum-exporting economy), while Mauritius is resource-poor. The comparable initial conditions but divergence in resource wealth are interesting country characteristics to consider, as commodity booms are a primary cause of fiscal disequilibrium for intensive commodity-exporters, which arises when permanent or costly-to-reverse expenditure decisions are made based on windfall increases in government revenues (see, e.g. Tanzi, 1982).

We make four key contributions to the literatures on public debt management and development. First, acknowledging the limitations of using debt-to-GDP as the sole indicator of government debt (see, e.g. Rahaman & Mahadeo, 2024) and, by extension, its limitations in assessing debt sustainability within the fiscal reaction function (FRF) framework, we incorporate a comprehensive debt sustainability index (DSI) as the indicator of indebtedness within the standard FRF model specification. The DSI is constructed by applying principal component analysis (PCA) to a set of globally recognised and available indicators of government debt and debt repayment (see, e.g. IMF, 2003, 2014). These indicators include debt-to-GDP, debt-to-revenue, debt-to-exports, interest-to-revenue, external debt-to-exports, external debt-to-reserves and other country specific measures of indebtedness which capture both liquidity and solvency as it relates to debt sustainability.

Second, we highlight the value of including country-specific determinants in the FRF. For instance, we are able to explicitly account for a country's major exports within the FRF, which becomes especially important when a government tends to rely heavily on the revenue such a sector generates. In the case of SIDS who, because of their smallness are often further characterised by openness (see, e.g. Mahadeo, 2020), trade-related variables – such as exports or imports – are important to consider. While it is typical for studies to incorporate oil price as an instrument or endogenous variable, we argue that oil price alone may not reflect the true

contribution of the energy sector to resource-rich countries. For one thing, oil prices can decouple from gas prices (see, e.g. Erdős, 2012) and other energy-related commodities. As economies diversify to other downstream activities, oil prices alone cannot fully capture the volatility of the energy sector earnings. In addition, the inclusion of prices (P) only reflects one multiplicative component of the revenue equation ($R = PQ$) and neglects the production variable (Q). As energy production changes over time, using a price series alone is a fundamental misspecification of energy revenue function that arises from the omitted energy production variable. As such, we also extend the FRF to include changes in total energy export revenue as an endogenous variable. Likewise, for resource-poor economies, it is equally helpful to tailor the FRF to capture a country-specific indicator of performance, to represent the main source of revenue or exports. For Mauritius, this takes the form of various multifactor productivity indexes.

Third, we advance using other globally recognised indicators of government debt in the FRF including debt-to-revenue, debt-to-exports, and interest-to-revenue (see, e.g. Roubini, 2001). Finally, after our multiple specifications on debt sustainability assessment, we take another novel path to explore the fiscal response to debt volatility by incorporating a debt volatility index (DVI) within the FRF. We are, therefore, able to assess whether resource-rich economies facing frequent shocks to commodity earnings should incorporate debt volatility in its fiscal response when compared to resource-poor economies that face less frequent shocks. Again, we apply PCA on the 5-year rolling standard deviation of the same DSI indicators to derive the DVI. Similar to studies that analyse the volatility and variability of government revenue (see, e.g. Afonso & Furceri, 2010), we are motivated to assess the volatility of debt in FRFs, given the increasing frequencies of crises (such as the COVID-19 pandemic and the Global Financial Crisis of 2008); the increasing occurrence of natural disasters (such as flooding and hurricanes) to SIDS – some of the most disaster-prone countries in the world; as well as other shocks that can impact the energy sector and the cost of borrowing (such as the Russia-Ukraine war), and swings in policy rates (whether to shorten a recession or combat inflation).

The remainder of this paper is structured as follows: in section 2, we present a brief review of the two dominant strands of empirical literature. Section 3 follows with the data and empirical specification, and we display our baseline results using our novel DSI in section 4. We advance with a comprehensive robustness analysis across different specifications and sustainability tests in section 5. In section 6, we provide some policy insights based on the estimation results and we conclude the paper in section 7.

2. Literature review

Debt is described as sustainable if the government is solvent and can honour both current and future obligations. The purely arithmetic view of solvency is a situation in which the present value of the government's total expenditure is covered by the present value of the government's total revenue. Importantly, fiscal policy sustainability cannot be differentiated from debt sustainability (Celasun, Debrun, & Ostry, 2006). Another sustainability rule that has a consensus in the literature is that the real interest rate must be lower than real economic growth, and this relationship must prevail in the medium to long-term (Navarro-Ortiz & Sapena, 2020).

The literature on debt sustainability analysis is dominated by two main approaches: stationarity testing and the FRF. The first approach is simple but influential – Trehan and Walsh (1991) propose one of the pioneering stationarity testing approaches which show that if the primary balance is stationary, then the intertemporal budget balance is stationary if, and only if, the debt-to-GDP ratio is stationary. Furthermore, if public debt is differenced stationary, this test to satisfy the intertemporal budget constraint reduces to testing the interest-inclusive primary balance for stationarity. In contrast, Hamilton and Flavin (1986) propose that government spending and revenue must be stationary for public debt to be sustainable. It also stands

to reason that if the two variables have unit roots but are cointegrated, then the deficits are sustainable as well. Indeed, if the long-run coefficient of government spending is equal to one, it classifies as 'strong' form sustainability with bounded public debt but if it lies between zero and one, it classifies as 'weak' form sustainability without bounded public debt (Afonso, 2005; Quintos, 1995).

A popular application of this infrequent stationarity testing approach to debt sustainability analysis is by Camarero, Carrion-I-Silvestre, and Tamarit (2015) in their study of 17 OECD countries between 1970 to 2012. They extend the approach to include structural breaks along with a multicointegration framework as well as the stock-flow mechanism. The results from the stationarity tests find evidence of weak sustainability and that fiscal policy adjusts to satisfy the government's intertemporal budget constraints. Similar conclusions were drawn from their cointegration analysis where they find 6 out of 17 countries have a cointegrated relationship and, hence, debt is sustainable. Convincingly, Fincke and Greiner (2010) maintain that the stationarity testing approach is important to gain additional insight into debt sustainability and Beqiraj, Fedeli, and Forte (2018) is agreeable.

We now turn our attention to the FRF approach. Undoubtedly, this is one of the most influential and popular approaches to debt sustainability assessment, and it comes in a series of papers by Bohn (1998, 2007). Such works suggest that an accumulation of debt should result in an increase or favourable movement in the primary balance, which signals a greater ability to service the increase in debt while controlling for factors such as the output gap, exchange rate, financial development, and other determinants. Indeed, the FRF offers a test for debt sustainability that is not interest rate dependent. According to Bohn (1998), a positive parameter for the coefficient of the debt-to-GDP ratio is a sufficient condition to guarantee the sustainability of public debt and satisfy the intertemporal budget constraint. The influence, popularity and use of the Bohn (1998) FRF has grown over the last two decades since it offers a simple yet comprehensive way to assess the impact of evolving government debt and the response of the primary balance.

Ghosh, Kim, Mendoza, Ostry, and Qureshi (2013) realise the significance of non-linear specifications as they investigate the notion of fiscal space and fiscal fatigue across a panel of 23 advanced economies between 1970 and 2007 using a FRF with a cubic function and find support for fiscal fatigue with a non-linear relationship between the primary balance and debt levels. Specifically, they find no relationship at low debt levels, a positive relationship at moderate debt levels, and a negative relationship when debt levels reach 90-100 percent as governments may run into the Laffer curve effect. Afonso and Jalles (2017) adopt a nuanced approach and tweak the FRF with a time-varying coefficient model, as well as fiscal rules for 11 Euro area countries. They find evidence of sustainability in four countries but could not reach a conclusion for the other countries. Yet, despite the lack of uniformity on fiscal policy and sustainability, they find a consensus within the panel for fiscal rules which they find to be a strong determinant of debt sustainability.

While a panel approach to the FRF is predominant within specific regions such as the EU (see, e.g. Debrun, Moulin, Turrini, Ayuso-I-Casals, & Kumar, 2008) or countries that share characteristics – developing and developed economies (see, e.g. Mendoza & Ostry, 2008), its application and use for a comprehensive time series perspective of individual country cases is imperative. Legrenzi and Milas (2012) use the FRF within a non-linear error correction framework for Italy with the novel spotlight on changes in the average tax rate in satisfying the government's intertemporal budget constraint. They find that changes in the average tax rate are entirely needed to correct budget imbalances, with greater pace non-linear adjustments required for larger imbalances. In another prominent time series analysis in the FRF discourse, Legrenzi and Milas (2013) use a non-linear FRF to assess fiscal sustainability for Greece, Ireland, Portugal, and Spain. Using the work of Reinhart and Rogoff (2009), the authors introduce a state-varying threshold to capture financial pressures as policy makers adjust the debt ceiling to

which they can then implement corrective action. They conclude that for all countries, the corrective action debt ceiling trigger is lowered in the face of financial market pressures, and this appears more effective than formal deficit procedures.

There is, undoubtedly, a consensus in the empirical literature regarding the estimation techniques for the FRF. Popular techniques include instrumental variable (IV) along with two-stage least squares (2SLS) and Generalised Methods of Moments (GMM) (see, e.g. Afonso & Jalles, 2017). There is also a consensus in the literature on the use of the output gap as a regressor and specifically instrumenting the output gap to address simultaneity issues that may arise (see Checherita-Westphal & Žd'árek, 2017 and references therein). Common instruments include the lagged first difference of the output gap, change in the nominal exchange rate, and governance effectiveness indicators, trade openness, inflation rate, terms of trade, and fuel prices (Medeiros, 2012; Paret, 2017).

3. Data and empirical framework

Studies augment the FRF to investigate the impact of other macroeconomic and socioeconomic variables on the primary balance. This often involves the inclusion or exclusion of variables and instruments, or the transition between endogenous variables and instruments that fit the features of the country or panel of countries within the study. One of the most notable adjustments is by Ghosh et al. (2013) while investigating 23 advanced economies. The authors adjust the FRF to include polynomials of lagged debt-to-GDP, fiscal rules, IMF arrangements, oil prices (OP), nonfuel commodity prices, and common instruments as endogenous variables. In light of this, we adopt country-specific variables for T&T such as oil price and the change in energy exports, and for Mauritius, we explore the total exports multifactor productivity growth (EMFG) index and the textile exports multifactor productivity growth (TMFG) index which captures the growth in the productive efficiency of overall exports and textile exports, respectively.

Following the consensus in the literature (see, e.g. Afonso & Jalles, 2017; Paret, 2017), we augment and specify a novel approach to the FRF to include a DSI,[2] as the measure of indebtedness, as well as the country-specific measures. The baseline FRF is written as:

$$pb_t = a_1 + a_2 pb_{t-1} + a_3 DSI_{t-1} + a_4 OG_{t-1} + a_5 CV + \varepsilon_t \tag{1}$$

where pb_t is the primary balance-to-GDP ratio, DSI_t is the debt sustainability index, OG_t is the output gap,[3] CV is the country-specific variable, and ε_t is the error term. Using GMM estimation, we instrument the OG due to simultaneity problems and based on the data availability for T&T and Mauritius – available instruments include the lagged output gap, inflation rate, change in exchange rate, trade openness, oil prices, an election dummy, the current account balance as a percent of GDP and financial development, which we parsimoniously include across specifications (see Appendix A1 for description).

We expect a_2 and a_3 to be positive if the primary balance is persistent and the government tightens its fiscal policy in response to rising debt levels (Bohn, 1998). Furthermore, a positive coefficient of a_2 captures the inertia of the primary balance (Medeiros, 2012). Coefficient a_4 captures the response of the primary balance to the output gap. If a_4 is positive, fiscal policy is countercyclical which implies that the primary balance increases with the output gap. If a_4 is negative, fiscal policy is procyclical and the primary balance decreases with the output gap (Daude, Melguizo, & Neut, 2011). Procyclical fiscal policy can undermine debt sustainability (Gootjes & de Haan, 2022) by contributing to output volatility, which can negatively impact long-term growth (Woo, 2009). It is also accompanied by reduced fiscal space (Ahmad, McManus, & Ozkan, 2021), which can amplify economic cycles and result in debt accumulation. Conversely, countercyclical fiscal policy allows for stimulus measures during downturns

and fiscal contractions and debt reductions during upturns (Keita & Turcu, 2023) which can promote debt sustainability.

We expect a_5 to be positive as the country-specific performance metric improves the primary balance. Based on data availability, we use annual data from 1967 to 2021 for T&T – which covers just over five decades of economic history – and we use annual data from 1980 to 2021 for Mauritius – which covers four decades of economic history. We illustrate the descriptive statistics in Appendix A2 and correlation between the main variables in Supplementary Materials Section B.

4. Baseline estimation results

All instrument identification diagnostics from the estimations in Tables 1 (T&T) & 2 (Mauritius) are satisfied. The coefficient of the lagged primary balance is positive and statistically significant, which captures the persistence and inertia of the primary balance for both T&T and Mauritius. To date, no country-specific analysis is published on a FRF for T&T. However, our results are consistent with the FRF from a panel of Caribbean countries (see, e.g. Cevik & Nanda, 2020). The only country level study existing for Mauritius is covered in Fincke and Greiner (2010) but the primary balance is not included.

In addition, the coefficient of the lagged DSI for T&T and Mauritius is positive and statistically significant across all specifications. What this means is that, holistically, the primary balance responds to the various facets of debt and repayment capacities, and not just the debt-to-GDP ratio. In this light, we conclude that from a more comprehensive perspective, debt is sustainable in T&T and Mauritius.

The coefficient of the lagged output gap is negative and statistically significant across all specifications for T&T and Mauritius, which indicates that the fiscal stance is procyclical. These findings support the prevailing view that fiscal policy in developing countries (see, e.g. Ilzetzki & Vegh, 2008), oil exporting countries (see, e.g. El Anshasy & Bradley, 2012) and countries with export concentration (see, e.g. Ouedraogo & Sourouema, 2018) is procyclical. Particularly for energy-dependent economies such as T&T, government spending is a complement to the private sector, rather than a substitute. Thus, the fiscal stance is procyclical and this is consistent with our estimates. For economies like Mauritius that are relatively export concentrated, fiscal policy tends to be procyclical and driven by public investment.

As it relates to the country-specific variables, both the current and lagged oil price does not impact the primary balance, and this is consistent with our hypothesis that other factors drive the performance of the hydrocarbon sector in T&T such as production, and diversification to other energy related products. Conversely, the results show that the current and lagged change in energy exports positively impact the primary balance, and this is consistent with the rent-seeking behavior and dependence of T&T on the energy sector with the potential to lead to favourable movements in the primary balance. Similarly, the total exports multifactor productivity growth (EMFG) and the textile exports multifactor productivity growth (TMFG) indexes have an immediate and positive impact on the primary balance, and this is consistent with exports being a key driver of overall macroeconomic performance in Mauritius. However, the lagged growth in these indexes were statistically insignificant. We also recognise that as part of the Public Debt Management Act 2008, Mauritius introduces a fiscal rule in the form of a debt ceiling, with a debt-to-GDP limit of 65.0%. As such, we continue by including a dummy variable within the FRF to analyse the impact of the fiscal rule. The dummy takes a value of one from 2008 onwards to capture the fiscal rule, and zero prior to 2008. The results from Table 2 show that the fiscal rule has a positive impact on the primary balance, and it is statistically significant when we include TMPG but becomes insignificant when we include EMPG. T&T has no fiscal rules.

Table 1. Baseline fiscal reaction function with the DSI – T&T

Dependent variable: primary balance	(1)	(2)	(3)	(4)
l.pb	0.594***	0.614***	0.667***	0.538***
	(0.086)	(0.082)	(0.072)	(0.083)
l.DSI	0.756***	0.715***	0.471**	0.513***
	(0.229)	(0.246)	(0.188)	(0.151)
l.OG	−0.179**	−0.147*	−0.098*	−0.192***
	(0.069)	(0.081)	(0.053)	(0.060)
OP	0.034			
	(0.023)			
l.OP		0.021		
		(0.027)		
CEE			0.146**	
			(0.060)	
l.CEE				0.097**
				(0.044)
constant	−1.347	−0.828	−0.092	−0.027
	(1.077)	(1.235)	(0.422)	(0.481)
N	51	51	51	51
R – squared	0.578	0.563	0.632	0.559
Test of overidentification: Hansen J p-value	0.108	0.113	0.360	0.490
Test for underidentification: Kleibergen-Paap rk LM statistic p-value	0.015	0.008	0.002	0.031
Test for weak identification: Kleibergen-Paap rk Wald F statistic	17.497	14.131	13.186	15.443

Notes: The GMM estimations from columns 1 to 4 correspond to specifications including the oil price, lagged oil price, change in energy exports to GDP, and lagged change in energy exports to GDP respectively. We instrument the lagged output gap with the change in the exchange rate, financial development, trade openness, and inflation except for column 3 which we parsimoniously instrument with change in the output gap, trade openness and financial development. Other instruments such as the election dummy is not valid in this specification. For each estimation, we report the sample size (N) and R-squared. For the overidentification test, we report the p-value of the Hansen J statistic. The null assumption is that the overidentifying restrictions are valid. We report the p-value for the Kleibergen-Paap rk LM statistic where the null assumption is that the model is underidentified. We also report the Kleibergen-Paap rk Wald F statistic against the Stock & Yogo (2005) critical value with 10% maximal IV relative bias where the null assumption is weak identification. Robust standard errors are in parentheses and *,**,*** denotes statistical significance at the 10%, 5% and 1% significance level respectively.

5. Robustness

To reinforce the robustness of our analysis, we continue by estimating the Bohn (1998) FRF with debt-to-GDP, and further extend the specification to include the country-specific variables. With the exception of the sparse use of debt-to-revenue and debt-to-exports in debt analysis, studies incorporating these indicators within the FRF are nearly non-existent, but they play a key role in comprehensively assessing debt sustainability. We follow by incorporating other recognised indicators of government debt (d) including debt-to-revenue (DTR), debt-to-exports (DTX) and interest-to-revenue (ITR) within the FRF and we display the estimation results in Tables 3 and 4, respectively.

The results from Table 3 for T&T are consistent with the baseline specification using the DSI. All debt indicators are positive and statistically significant which satisfies the sustainability condition. ITR has the largest impact on the primary balance as rising interest payments consume governments revenue requiring the primary balance to increase to meet future interest payments. Fiscal policy remains procyclical and the impact of the change in energy exports remain roughly the same. All instrument identification diagnostics are satisfied.

Table 2. Baseline fiscal reaction function with the DSI – Mauritius

Dependent variable: primary balance	(1)	(2)	(3)	(4)
l.pb	0.390***	0.415***	0.449***	0.483***
	(0.086)	(0.079)	(0.103)	(0.100)
l.DSI	0.436**	0.525**	0.438*	0.582**
	(0.209)	(0.220)	(0.230)	(0.255)
l.OG	−0.295***	−0.301***	−0.347***	−0.351***
	(0.092)	(0.095)	(0.103)	(0.106)
TMPG	0.199***	0.201***		
	(0.060)	(0.056)		
EMPG			0.197***	0.208***
			(0.069)	(0.067)
FR Dummy		0.940*		0.870
		(0.524)		(0.608)
constant	−0.270	−0.591*	−0.302	−0.566
	(0.364)	(0.334)	(0.389)	(0.372)
N	39	39	39	39
R − squared	0.499	0.542	0.452	0.489
Test of overidentification: Hansen J p-value	0.356	0.379	0.365	0.360
Test for underidentification: Kleibergen-Paap rk LM statistic p-value	0.011	0.007	0.009	0.008
Test for weak identification: Kleibergen-Paap rk Wald F statistic	11.426	11.179	10.469	10.698

Notes: The GMM estimations from columns 1 and 2 correspond to specifications including the textile exports multifactor productivity growth (TMFG) index and a fiscal rule dummy. Columns 3 and 4 corresponds to total exports multifactor productivity growth (EMFG) index and a fiscal rule dummy respectively. We instrument the lagged output gap with the change in the output gap, financial development, trade openness, and an elections dummy for columns 1 and 3 and we exclude the elections dummy for columns 2 and 4. See all other notes from Table 1.

The results from Table 4 for Mauritius varied based on the debt indicator. Without the country-specific measures of TMPG and EMPG, the coefficient of the debt-to-GDP ratio is positive but not statistically significant. Fincke and Greiner (2010) find similar insignificant results as they explore debt sustainability in Mauritius. However, as we incorporate the country-specific indicator of TMPG, the coefficient of the debt-to-GDP ratio was positive and statistically significant. When we replaced TMPG with EMPG, the coefficient of the debt-to-GDP ratio was not statistically significant. This reinforces the use of the comprehensive DSI as the debt indicator is statistically significant with both TMPG and EMPG in levels. Surprisingly, debt indicators of debt-to-revenue and interest-to-revenue yield inconclusive results but debt-to-exports was positive and statistically significant.

We continue by applying the sustainability parameters test to specifications 1 and 2 from Table 3 and specification 2 from Table 4 following Bohn (1998) and we confirm that debt is sustainable since the following condition is met:

$$\frac{\alpha_3}{(1-\alpha_2)} > \alpha^* = \frac{(r-g)}{(1+g)} \tag{2}$$

where α_3 is the coefficient of debt-to-GDP, α_2 is the coefficient of the lagged primary balance, r is the real (effective) interest rate, and g is the real GDP growth rate. We illustrate these results for both SIDS in Figures 1 and 2.

To further explore the procyclicality of fiscal policy in T&T and Mauritius, we construct two variables. The first captures the interaction between the lagged primary balance and the output gap, while the second captures the interaction between the lagged primary balance and a

Table 3. Robustness – fiscal reaction function with alternative debt indicators for T&T

Dependent variable: primary balance	(1)	(2)	(3)	(4)	(5)
l.pb	0.600***	0.529***	0.533***	0.558***	0.481***
	(0.076)	(0.084)	(0.083)	(0.085)	(0.087)
l.d	0.067**	0.059**	0.013**	0.017**	0.202***
	(0.029)	(0.025)	(0.005)	(0.007)	(0.048)
l.OG	−0.174***	−0.190***	−0.177***	−0.191***	−0.191***
	(0.062)	(0.059)	(0.060)	(0.057)	(0.057)
l.CEE		0.105**	0.103**	0.103**	0.099**
		(0.045)	(0.044)	(0.044)	(0.043)
constant	−2.006*	−1.816*	−1.469*	−1.304	−1.96**
	(1.135)	(0.979)	(0.854)	(0.815)	(0.774)
N	54	53	53	53	53
R – squared	0.513	0.539	0.550	0.543	0.571
Test of overidentification: Hansen J p-value	0.247	0.419	0.399	0.581	0.284
Test for underidentification: Kleibergen-Paap rk LM statistic p-value	0.040	0.051	0.065	0.035	0.053
Test for weak identification: Kleibergen-Paap rk Wald F statistic	12.250	12.807	13.104	13.317	13.828

Notes: The GMM estimations in columns 1 to 5 correspond to specifications including debt-to-GDP, debt-to-GDP with the energy sector, debt-to-revenue, debt-to-exports, and interest-to-revenue respectively. We instrument the lagged output gap with the change in the exchange rate, financial development, trade openness, and inflation. See all other notes from Table 1.

dummy variable. This dummy variable takes a value of one if actual output exceeds potential output and zero otherwise. For both countries, the estimated coefficients remain negative across all specifications including the DSI and other debt indicators, and this further confirms the presence of procyclical fiscal policies. However, in some cases, the coefficients are statistically insignificant. We display the results in Supplementary Materials Section C.

Thus far, we use different country-specific variables for T&T and Mauritius which limits our comparison between countries. As such, we follow by including a common variable – the terms of trade (TOT) – within the FRF to enable such a comparison. The results support a positive relationship between the TOT and the primary balance in T&T, and this is consistent with our *a priori* expectations given the dominance and contribution of the energy-trade sector to the economy, and the heavily managed exchange rate regime. For robustness, we continue by constructing and including a TOT for energy-exporting economies (TOT-E) in the FRF. To do this, we calculate a weighted index of energy export value for oil, gas, and other hydrocarbon products and we scale this index by the index of total import value. Like the TOT, we find a positive and statistically significant relationship between TOT-E and the primary balance. However, we find a negative and statistically significant relationship between the TOT and the primary balance for Mauritius. This reflects an external vulnerability of the Mauritian economy given its export dependence with a floating exchange rate regime. Moreover, our results are consistent with the findings of Brueckner and Carneiro (2017) in their study of 175 countries. We illustrate the results in the Supplementary Materials Section D.

For a further comparison, we incorporate another common variable – the Government Effectiveness Indictor (GEI) – within the FRF. This standard institutional variable measures the perceived credibility of governments, and the quality of their policy formulation, implementation, and commitment, with values ranging from -2.5 to 2.5 (Kaufmann, Kraay, & Mastruzzi, 2010). The results support a positive and statistically significant relationship between the GEI and the primary balance for Mauritius. The results remain positive for T&T but statistically insignificant. We illustrate the results in the Supplementary Materials Section D.

We continue with the Trehan and Walsh (1991) test for debt sustainability which states that if the primary balance-to-GDP is stationary, it satisfies the government's intertemporal budget

Table 4. Robustness – fiscal reaction function with alternative debt indicators for Mauritius

Dependent variable: primary balance	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
l.pb	0.361***	0.400***	0.428***	0.417***	0.451***	0.438***	0.472***	0.339***	0.379***
	(0.112)	(0.084)	(0.107)	(0.116)	(0.147)	(0.103)	(0.127)	(0.103)	(0.120)
l.d	0.034	0.069**	0.060	0.014	0.012	0.021**	0.020*	0.044	0.045
	(0.024)	(0.035)	(0.039)	(0.011)	(0.013)	(0.011)	(0.012)	(0.083)	(0.093)
l.OG	−0.145***	−0.234**	−0.276**	−0.197*	−0.239**	−0.278***	−0.320***	−0.228**	−0.271**
	(0.050)	(0.097)	(0.110)	(0.107)	(0.117)	(0.094)	(0.111)	(0.109)	(0.120)
TMPG		0.191***		0.210***		0.168***		0.163**	
		(0.061)		(0.037)		(0.060)		(0.072)	
EMPG			0.156**		0.181**		0.143**		0.142*
			(0.068)		(0.091)		(0.068)		(0.081)
constant	−1.280	−3.748**	−3.148	−3.982	−3.288	−2.218**	−2.060*	−0.869	−0.872
	(1.335)	(1.855)	(2.013)	(3.041)	(3.559)	(1.090)	(1.207)	(1.671)	(1.873)
N	41	39	39	39	39	39	39	39	39
R − squared	0.454	0.549	0.482	0.523	0.470	0.525	0.462	0.487	0.436
Test of overidentification: Hansen J p-value	0.326	0.678	0.573	0.411	0.368	0.651	0.582	0.165	0.211
Test for underidentification: Kleibergen-Paap rk LM statistic p-value	0.017	0.010	0.007	0.023	0.011	0.011	0.012	0.010	0.012
Test for weak identification: Kleibergen-Paap rk Wald F statistic	17.073	11.406	11.370	13.037	12.210	11.695	11.654	11.176	10.403

Notes: The GMM estimations in columns 1 to 3 includes debt-to-GDP as the debt indicator. Columns 4 and 5 include debt-to-revenue as the debt indictor, columns 6 and 7 include debt-to-exports as the debt indicator and columns 8 and 9 include interest-to-revenue as the debt indicator. Each debt indicator from columns 2 to 9 include the textile export multi-productivity growth (TMPG) index and total export multi-productivity growth (EMPG) index respectively. We instrument the lagged output gap, and the specifications with debt-to-GDP and debt-to-exports as the debt indicator are instrumented by the change in the output gap, financial development, trade openness, and an elections dummy while we parsimoniously exclude the elections dummy as an instrument in the specifications with debt-to-revenue and interest-to-revenue as the debt indicator. See all other notes from Table 1.

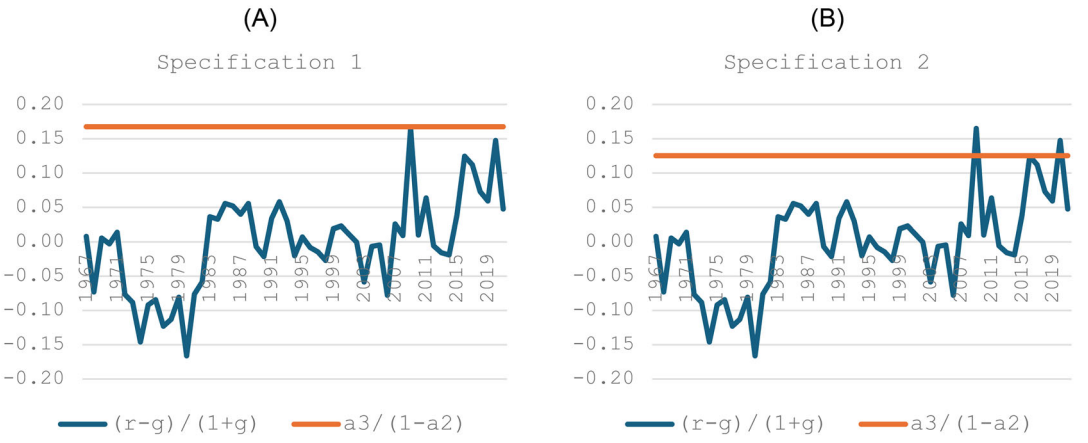

Figure 1. Sustainability parameters test – T&T.
Note: We derive the results for panels A and B by applying equation (2) to the results from columns 1 and 2 respectively from Table 3.

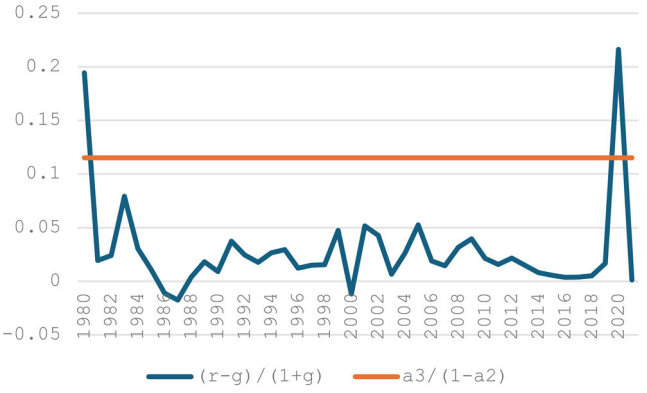

Figure 2. Sustainability parameters test – Mauritius.
Note: We derive the results by applying equation (2) to the results from column 2 from Table 4.

constraint, and debt is sustainable. We test for stationarity using the Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) tests and we conclude that the primary balance is stationary, and debt is sustainable for both T&T and Mauritius (see Supplementary Materials Section E).

We then test government revenue and expenditure for stationarity following the Hamilton and Flavin (1986) approach, the results of which are displayed in Supplementary Materials Section F. We conclude that the government revenue and expenditure exhibit a unit root for both T&T and Mauritius. We subsequently apply the Johansen test for cointegration to investigate further and we show the results in Supplementary Materials Section G. For T&T, we conclude that government revenue and expenditure are cointegrated, with and without a trend and this signals that the no-Ponzi game condition holds. We then estimate a cointegrating regression to explore the cointegrating vector $(1, -\beta)$ with and without a trend, which yields cointegrating vectors $(1, -0.84)$ and $(1, -0.92)$ respectively. According to Hamilton and Flavin (1986), the conditions for sustainability are $(1, -1)$ but Quintos (1995) states that if $0 < \beta < 1$, debt is sustainable, but it is described as weakly sustainable. Except for the Johansen test with no trend, all cointegration tests for Mauritius indicated that no cointegration exists which suggest that debt is not sustainable.

While studies assess the fiscal response to changes in debt-to-GDP, there is a clear gap in the literature as it relates to the volatility of debt and its fiscal response. We expect that as unconditional volatility for resource-rich countries increase, primary surpluses should increase to

accommodate the uncertainty. For resource-poor countries, the fiscal response can be positive or negative. As such, we make another novel contribution to the literature by including a debt volatility index (DVI) in the FRF.[4]

The estimations using the DVI, shown in Supplementary Materials Section H, satisfies all identification diagnostics and reveal that an increase in the DVI positively impacts the primary balance for T&T. This signals that greater volatility in the various facets of debt and debt repayment leads to a favourable movement in the primary balance as the government tries to respond or alleviate the impact of uncertainty and volatility of repayments derived from the disproportionately large resource sector and idiosyncratic price shocks. A similar conclusion is drawn by Penalver and Thwaites (2006) where they find that macroeconomic uncertainty led to more responsive fiscal policy rules in Brazil. The DVI for Mauritius is statistically insignificant and we illustrate the results in Supplementary Materials Section H.

Along with fiscal sustainability, fiscal consolidation has received much attention (Afonso, Alves, & Jalles, 2022) since it has the potential to lead to more permanent debt sustainability. Fiscal consolidation is a strategic approach that aims to minimise budget deficits and curtail debt to eventual sustainable levels (Cogan, Taylor, Wieland, & Wolters, 2013). In light of its implications for debt sustainability, we continue by investigating the effects of the 'need' for fiscal consolidation and the 'implementation' of fiscal consolidation strategies on debt sustainability. The need for implementing fiscal consolidation results in a deterioration in debt sustainability for both T&T and Mauritius. However, the results are statistically insignificant. For T&T, the actual implementation of a fiscal consolidation strategy also results in a deterioration of debt sustainability, and this can be due to the late implementation of such strategies following sharp shocks to the energy sector as well as political and social challenges. Conversely, the actual implementation of fiscal consolidation strategies improves debt sustainability in Mauritius, but the results are statistically insignificant. We illustrate the construct and results in Supplementary Materials Section I.

6. Policy insights

The findings from our study have two important implications for government policies. First, the relationship between the primary balance and output gap captures the stabilisation function of the government's fiscal policy or stance. Our estimates show that fiscal policy is procyclical in nature and this intuitively reflects the situation in T&T and Mauritius.

Although fiscal policy can have procyclical or countercyclical stances, countercyclical policies are seen as optimal because they emphasise proper debt management and promote economic growth and macroeconomic stability (see, e.g. Christiano, Eichenbaum, & Rebelo, 2011; Nakata, 2016). To transition from procyclical to countercyclical policies, T&T needs stronger institutional qualities, especially as the exchange rate is fixed (or managed at a fairly constant rate). While the results capture that fiscal policy is procyclical in Mauritius, it has been beneficial since export subsidies has gradually reduced export concentration and total spending cyclicality trend downwards between 2000 to 2015 (Ouedraogo & Sourouema, 2018). We expect this to continue as Mauritius rebuilds its strong fiscal buffers following its pre-pandemic trends and continue to enhance the soundness of its institutions and policies in a similar manner as the last few decades.

Fiscal rules can also play a pivotal role in transitioning to countercyclical fiscal policies and promoting debt sustainability. In fact, implementing and complying with fiscal rules can lower sovereign spreads, improve credit ratings, and reduce the probability of debt issues (Ardanaz, Ulloa-Suárez, & Valencia, 2024). Like Mauritius and other Caribbean countries such as Jamaica, T&T can benefit from the implementation of flexible and realistic fiscal rules, and we particularly recommend debt and structural balance rules, which can contribute to fiscal solvency and sustainability and address procyclical fiscal policy bias (see, e.g. Ulloa-Suarez & Valencia, 2022). This flexible approach can be particularly useful for T&T since it allows for recalibrations to different macroeconomic environments and shocks such as wider output gaps

or accelerated inflation (see, e.g. Ulloa-Suárez, 2023). Guerguil, Mandon, and Tapsoba (2017) is agreeable and find that investment-friendly fiscal rules enhance the countercyclicality of investment and overall spending.

Secondly, the impact of country-specific variables such energy exports and multifactor productivity growth on the primary balance is positive and significant, which reinforces the importance of the hydrocarbon sector and trade to T&T and Mauritius, respectively. However, as the dependency syndrome on the hydrocarbon sector continues for T&T, any adverse shocks to this sector will have a negative impact on the primary balance and macroeconomic performance. In the long-run, this can also threaten debt sustainability. As such, these findings strengthen the two-decade long argument for a greater need for diversification, and other areas of rent-seeking behaviour, as it can cushion the primary balance from adverse shocks in the energy sector and maintain debt on a sustainable path. Mauritius has diversified over the last few decades, and they continue to adapt given the high growth in other sectors such as financial services. As a result, fiscal policy should continue to transition from procyclical to countercyclical. In this regard, T&T can learn from the experience of Mauritius when it comes to diversification.

7. Conclusion

To date, studies assessing government debt sustainability in T&T and Mauritius are sparse, and this study is the first to assess debt sustainability using both the stationarity testing and fiscal reaction function (FRF) approaches. The study makes a novel contribution to the overall debt sustainability literature, especially for small states and developing countries, by incorporating a comprehensive debt sustainability index (DSI) as a more robust measure of debt and illustrating its application using two examples – a resource-rich and a resource-poor country. It also contributes to the debt sustainability literature for small island developing states (SIDS), as such economies tend to be coupled with their regional neighbours (Latin America or South America in the case of T&T; and Sub-Saharan Africa or East Africa in the case of Mauritius). Indeed, such groupings can have distorting effects as the experience of SIDS, with respect to their unique vulnerabilities and debt-related issues, can differ from their continental neighbours.

We propose using a DSI as a comprehensive measure of indebtedness in baseline FRFs. The DSI captures a more complete measure of government debt when compared to the commonly used debt-to-GDP as the sole indicator of government debt. We find the DSI is positive and statistically significant, which signals debt is sustainable for both T&T and Mauritius. We also include country-specific variables based on the country's dynamics in the FRF. For T&T, we include the change in energy export revenue to capture the performance of the energy sector and compare it with the traditional measure of the energy sector – oil prices. The change in energy exports positively impacts the primary balance but oil prices are statistically insignificant. For Mauritius, we include two measures of productivity, the textile multifactor productivity growth (TMPG) index and total export multifactor productivity growth (EMPG) index and find they both have a positive and statistically significant impact on the primary balance. Another important contribution of this study is that we recognise that there are other plausible measures of government debt and repayment capacity, and we use other indicators of debt, such as debt-to-revenue, debt-to-exports, and interest-to-revenue as a form of robustness, and to contribute to the absent literature. The results further support the view of debt sustainability in T&T, but the results were mixed for Mauritius. We show that from the alternative metrics available, debt-to-exports may be the most important for the Mauritian economy and this measure signals debt sustainability. We reinforce the FRF approach with the stationarity testing approach for both T&T and Mauritius.

We then propose the idea that the volatility of government debt and its repayment capacity, especially interest payments and revenue for resource-rich, rent-seeking economies can influence the primary balance. We proceed to estimate the FRF with a novel debt volatility index (DVI) and find that the DVI had a positive and statistically significant impact on the primary balance

in most instances for T&T, due to the known volatility of the hydrocarbon sector coupled with the lack of diversification. However, the DVI was statistically insignificant for Mauritius, and this can be partly attributable to its diverse exports and revenue base resulting in overall revenue sustainability. The results highlight the need for governments in resource-rich economies to not only consider debt but the volatility of debt, especially in the present environment of turbulent interest rates and commodity prices. In all estimations, we find that fiscal policy is procyclical. We argue that this is not conducive to economic growth and prudent fiscal management. As such, we recommend measures to move towards countercyclical fiscal policy.

Notes

1. The debt distress ratings of low-income countries are available at https://www.worldbank.org/en/programs/debt-toolkit/dsa (accessed in January 2024).
2. See Supplementary Material Section A for details on computing the DSI.
3. We estimate the output gap as the difference between actual GDP and potential GDP (expressed as a percent of potential GDP). We estimate potential GDP using the Hodrick and Prescott (HP) filter with a lambda value of 100 for annual data. We select the HP filter based on its common use in the empirical literature for estimating the FRF.
4. See Supplementary Materials Section A for details on computing the DVI.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix A1. Available instruments

Variable	Description
Trade openness	The sum of exports and imports, expressed as a per cent of nominal GDP.
Financial development	This is the ratio of private sector credit as a per cent of nominal GDP.
Exchange rate	The cost of US dollars in terms of the national currency.
Inflation	This is the year-on-year per cent change in the Index of Retail Prices for all items with a base year of 2015 for Trinidad and the year-on-year change in the Consumer Price Index for all items with a base year of 2017 for Mauritius.
Oil price	The price of crude oil (measured in US$ per barrel) as priced by West Texas Intermediate (WTI).
Elections dummy	The elections dummy had a value of 1 for the year immediately preceding elections and elections year, and 0 otherwise.
Current account balance	This is the ratio of the current account balance as a per cent of nominal GDP.

Appendix A2. Summary statistics

Table A2.1. Summary statistics for key variables for Trinidad and Tobago

Variable	Sample size	Mean	Standard deviation	Minimum	Maximum
Debt-to-GDP	55	30.0	15.3	10.1	63.0
Debt-to-Revenue	55	116.3	65.6	25.6	268.0
Debt-to-Exports	55	72.5	50.5	11.4	220.9
Interest-to-Revenue	55	10.0	6.3	1.5	24.1
Primary Balance to GDP	55	0.7	5.4	−13.6	10.6
Energy-Exports to GDP	55	42.4	15.5	20.8	93.0

Table A2.2. Summary statistics for key variables for Mauritius

Variable	Sample Size	Mean	Standard Deviation	Minimum	Maximum
Debt-to-GDP	42	51.7	10.0	35.0	78.6
Debt-to-Revenue	42	262.2	40.1	188.5	349.2
Debt-to-Exports	42	100.1	30.1	66.3	182.0
Interest-to-Revenue	42	17.7	5.0	9.8	28.1
Primary Balance to GDP	42	−0.1	3.4	−12.3	3.8