Essays on fiscal sustainability in the Caribbean

A Thesis

by

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Foreword

I give the utmost thanks to the Almighty God for his favour and continued blessings.

I dedicate this PhD thesis to my loving and supportive wife Mrs Cherisse Mitchell, and to my two children Teejay Mitchell and Cienna Mitchell, without whom this feat would not be possible. I pay special tribute to my late mother Janice Mitchell and to my late sister Keisha Mitchell, both of whom I miss dearly.

I am grateful to my supervisors Dr Gabriella Legrenzi and Dr Christopher Tsoukis for their unwavering support, particularly through my most difficult moments. I also extend gratitude to Dr Rumman Khan for his timely and excellent academic advice.

I acknowledge the valuable support of my dear friends, professional supervisors, and colleagues who were persistent in their encouragement throughout my PhD journey.

Abstract

The PhD thesis sets out to improve fiscal sustainability assessment in the English-speaking Caribbean and to provide the tools for more robust dialogue on the topic. It also seeks to influence Caribbean governments' fiscal policy actions by providing evidence on debt sustainability issues, and appropriate fiscal responses. The guiding questions of the thesis are whether Caribbean fiscal policy is conducive to debt sustainability now and into the future, and what is the region's debt limit, important enquiries considering the islands' comparatively high vulnerability and prolonged debt challenges.

The thesis makes several original contributions, including bridging the wide gap in Caribbean research; original empirical testing; some new recommendations for policy action; methodological innovation; and lays new foundations for future research.

The literature on fiscal sustainability, particularly from the perspective of the Caribbean, is extremely shallow in comparison to that of other indebted regions, including Latin America and Europe. This paucity of research on the region is startling owing to the region's high and established rank within the halls of the globally indebted, crystallised by the region's omission in the most recent and prominent survey on global debt issues.

The lack of focus on the region and accompanying implications is the primary gap which the thesis aims to fill, as is unearthed in a critical literature review that also helps to determine the most appropriate methods for responding to the thesis' research questions, as well as assists with establishing the status quo as pertains the state of fiscal sustainability in the Caribbean. Moreover, from the perspective of fiscal policy limits, to establish the current perspectives on the Caribbean's debt threshold, which is important for guiding the region's debt reduction.

In search of answers on the region's fiscal sustainability, an innovative empirical test for cointegration between the Caribbean's revenue and expenditure outlays is undertaken using an adapted sustainability cointegration approach. From this the thesis confirms the presence of sustainable fiscal policy in 6 of the 9 Caribbean countries tested, but with a debt ratio that is seemingly unbounded. In this regard, it is recommended that governments consider implementation of expenditure rules, enshrined in the constitution, to strengthen the region's sustainability position.

Further, motivated by two recent empirical studies on debt sustainability in the region, with the use of panel data, the thesis employs fiscal reaction functions but with an estimator selected by way of Monte-Carlo simulations to determine the least biased approach for assessing fiscal sustainability in the Caribbean, noting an incongruence between recent methods employed and the Caribbean's data structure. Through this novel approach, and with the addition of institutional variables as controls to the Caribbean fiscal response function – another original contribution, the thesis again confirms the region's weak fiscal sustainability and finds that diversifying trade in services, reducing election spending, and improving on the perception of corruption in the region are key policy initiatives for improving the primary balance and the region's fiscal sustainability going forward.

On the question of the region's debt capacity, the rise in Caribbean debt post COVID-19 stemming from large fiscal stimulus and positive interest-growth rate differentials, evidences the thesis' concern on the matter. A debt threshold is an important anchor for fiscal policy generally, and more so in the Caribbean where fiscal policy is the primary policy tool. A clearly established debt threshold provides the basis for debt reduction targeting and for assessing risks around the debt trajectory. A very wide margin of thresholds has been the feature of research in this area in the Caribbean, leaving much at bay as regards the region's debt limit.

In a fresh bid to answer the related question, the thesis employs Gosh *et al*. (2013) fiscal fatigue theory, which postulates a positive response of fiscal policy to debt as debt rises, but a negative fiscal response at ever higher levels of debt owing to a government's eventual fiscal fatigue. Despite this theory's intuitive appeal and in contrast to the findings of Cevik and Nanda (2020), the thesis concludes that there is no evidence of a cubic fiscal reaction function for the Caribbean, and therefore it does not appear that a debt threshold for the region exists as defined by the theory. Instead, the thesis finds that the Caribbean's debt threshold is defined by way of a dynamic threshold model at 106.2 percent, nearly double the IMF rule of thumb and the thresholds estimated via the debt-growth nexus.

Several policy approaches are proposed to enhance and strengthen Caribbean governments' fiscal sustainability based on the results unearthed in the thesis. These include: the introduction of fiscal rules for better expenditure management; establishing a debt threshold assessment method and undertaking regular assessments; strategic fiscal adjustment to avoid default; diversification of trade in services; containment of election spending; and improving the Caribbean's ranking in the perception of corruption index.

Collectively, the thesis' findings imply a renewed relevance of cointegration approaches to fiscal sustainability and the applicability of the revenue-expenditure method for fiscal sustainability assessment to the Caribbean, where data is severely limited. It raises questions on the suitability of the fiscal fatigue theory for assessing debt thresholds in developing countries, given the theory's developed country origins and due to the contrasting composition of developed countries versus Caribbean countries' debt portfolios. The thesis warns of making policy decisions based on regional assessments that could mislead owing to the heterogeneity at country level, which could readily be missed due to the necessity of panel data to overcome serious data issues, especially as regards fiscal data. The thesis provides an excellent foundation for future research, much of which surrounds old theoretical questions on the long run, and on the limits to fiscal sustainability.

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Figures and Tables

Chapter 1 Introduction

1.1 Overview

The PhD thesis aims to improve debt sustainability assessment in the English-speaking Caribbean region, a set of 13 sovereign nations[1] located in the Caribbean Sea just east of the Americas, southwest of Europe, and to the west of Africa (Figure 1). Additionally, it provides these governments the tools for more robust dialogue on debt sustainability. It also seeks to influence Caribbean government's fiscal policy actions by providing evidence on debt sustainability issues, and appropriate fiscal responses.

Research questions investigated in the thesis surround the state of debt sustainability in the Caribbean region, and in particular, inquiry as to whether Caribbean fiscal policy is conducive to debt sustainability now and into the future. Moreover, for policy purposes, it studies the Caribbean's debt capacity, and whether it differs from the IMF rule of thumb on debt sustainability.

[1] The English-speaking Caribbean countries include: Antigua and Barbuda, (The) Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St Kitts and Nevis, St Lucia, Suriname, St Vincent and the Grenadines, and Trinidad and Tobago.

In its attempt to answer these questions the thesis contributes to the research base on Caribbean debt sustainability, which is shallow in comparison to that of other indebted regions, including Latin America and Europe. Further, it sheds light on whether governments follow a conducive fiscal rule and to what extent fiscal policy is adequate. It extends the literature on debt capacity through application of the fiscal fatigue hypothesis.

The main objective of the accompanying research is to critically assess the literature on debt sustainability to decipher the most appropriate methods for helping to respond to the thesis' research questions. Further, to contextualise the most appropriate methodology for an indebted region, and from the perspective of fiscal policy limits, establish the Caribbean's debt threshold to provide a marker for fiscal policy and to improve fiscal policy guidance as it relates to maintaining sustainable debt.

The line of inquiry and methods applied leads to interesting findings. For starters, the thesis finds that the econometric application of Autoregressive Distributed Lag (ARDL) cointegration with a traditional revenue-expenditure approach to debt sustainability assessment can add great value to sustainability assessment in the data starved Caribbean and that fiscal policy sustainability is mixed, as all Caribbean countries do not follow a sustainable fiscal policy. If approached from the regional level debt sustainability assessments can provide misleading conclusions, and a fiscal reaction function that sees government respond positively to increases in debt is intuitive and useful for identifying developed countries' debt thresholds but is not necessarily appropriate for establishing the Caribbean's debt limits. Heterogeneity in the Caribbean fiscal policy reaction at rising levels of debt shows delayed fiscal responses which turn positive only at very high levels of debt, leading one to dispute the relevance of a fiscal fatigue hypothesis, and a corresponding debt threshold for the region.

1.2 Thesis Topic and Aims

The PhD thesis is comprised of three empirical essays on debt sustainability in the Caribbean region, which have the aim of improving Caribbean policymakers' and practitioners' understanding of debt sustainability issues, particularly its methodological assessment, strengthening government's policy dialogue on debt challenges and helping to shape appropriate Caribbean fiscal policy.

Such technical research is needed, especially in regions like the Caribbean where public debt inquiries and policies are still largely based on simple indicators, such as the size of the fiscal balance and debt to GDP ratio on the part of government (ECCB, 2023), and on analyses with slightly more technical treatment at the level of regional and multilateral institutions (See for example IDB, 2023 and McClean *et al*., 2020), rather than on evidence emanating from carefully designed research as would be found in peer reviewed journals. The thesis will fill this gap in technical research and improve evidence-based fiscal policy in the Caribbean.

Figure 1.1: Map of the English-Speaking Caribbean Islands

Note*: Except for the non-English speaking territories, Caribbean countries are those encircled in the map above. Interestingly, despite Belize and Guyana effectively lying on the continent of the Americas, these countries identify as part of the Caribbean chain of Islands.

Debt as discussed in Barro (1979) is a tool for smoothing taxation over time. If governments find themselves illiquid, where they must raise significant finance suddenly to respond to unexpected shocks, they will have to raise levies sharply in the absence of borrowing. Sharp rises in taxation could have several negative effects on an economy including high inflation; sudden stops in foreign investment; negative growth and economic hardship. Debt is therefore important for increasing liquidity and for smoothing fiscal policy changes (Burnside, 2013).

At the same time, too much debt can be harmful. An increasing debt stock against national income results in an increasing share of GDP being diverted to debt service as opposed to capital investment or development spending, with negative effects on growth. In a region as vulnerable as the Caribbean, it also has the consequence of constraining policy flexibility, limiting Caribbean countries' ability to respond to future shocks, and in turn increasing their vulnerability (Nicholls and Peters, 2014). For example, IDB (2023) notes in their report that an ever-increasing debt burden would see deleterious effects on human and social development, and growth, in the Caribbean, and increase these countries' already high vulnerabilities. Avoiding a debt crisis in the region is therefore critical, as default and consequent cut-off from capital markets, would force Caribbean governments to make drastic shifts in either taxation or expenditure (Mendoza and Oviedo, 2009), with the effects on the economy and society as described above.

Key questions in the literature debating these matters are therefore, when is debt sustainable (Bohn 1995; 1998) and how much debt is too much debt (Uctum and Wickens, 2000)? Though definitive answers remain quite elusive (Burnside, 2004), these lines of inquiry have shaped debt sustainability theory and methods of assessment that are intuitive and useful for guiding policy measures. As will be discussed, the core debt sustainability theory follows from the recognition that borrowers cannot continue to refinance debt inevitably – the so-called no-Ponzi game condition - as bondholders will eventually raise the cost of debt in line with the increased debt burden to compensate for the risks of non-repayment, to a point where repayment is inevitably prohibitive, and where potential investors become discouraged from investing in that country's debt securities.

Based on this observation and standard debt determinants, as regards the positive relationship between fiscal deficits and debt, and the role of taxes and revenues in reducing debt balances, the basic definition of debt sustainability that arises in the literature is the situation in which the debt stock of a country does not cause government to sharply change its fiscal policy to respond to increasing debt repayments (Burnside, 2004; IMF, 2002).

Assessing empirically whether the current debt stock meets this sustainability criterion has for a long time involved testing whether the no-Ponzi game condition holds, and by implication, whether a government will have the future means (primary balance) to cover the real costs (real interest rate – economy growth rate) of the existing debt stock. Rooted in this same theory, the more mainstream approach in the recent literature is to assess whether governments' fiscal policy appropriately responds to increases in debt over time such that on average, the government's fiscal reaction is positive in relation to rising debt. Such would satisfy both the no-Ponzi game condition and positive debt dynamics (Bohn, 1998).

In practice, however, governments target a benchmark debt-to-GDP ratio as a guide to sustainable fiscal policy. This benchmark rate is normally the IMF rule of thumb of 60 percent of debt to GDP, which to large degree does not have any theoretical footing. The IMF rule of thumb follows from the observation that although debt crises have occurred at lower debt to GDP ratios, roughly two-thirds of debt crises transpire at ratios below 60 percent of GDP (Finger *et al*., 2007; IMF, 2003a; IMF, 2003b; Reinhart *et al*., 2003).

Gosh *et al*. (2013) provide a theoretical basis for assessing debt thresholds through their fiscal fatigue hypothesis, and others including Rogoff and Reinhart (2003) through the debt-growth nexus. These developments in the literature are important because a debt threshold too large could feed too loose a fiscal policy, whereas a debt threshold too small would lead to the opposite, hindering growth as well as investment (Patillo *et al*., 2002). More importantly, a well-established indigenous debt threshold provides a useful anchor for a sustainable fiscal policy (Everaert and Jansen, 2018).

1.3 Current state of the literature on debt sustainability and gaps

This PhD thesis largely represents the core focus of the current literature. However, there are several nuances. As surmised in Chapter 3, debt sustainability theory derives from the dynamics of bond markets that are characteristic of developed countries. In most developing countries, including those of the Caribbean, bond markets are shallow or non-existent given these countries' very small populations and nascent stages of development (Commonwealth, 2001). In fact, most Caribbean countries lack significant access to capital markets and depend primarily on multilateral and bilateral credit (See Figure 1.7). Hence the applicability of debt sustainability theory to these countries can present issues and represent a gap in the literature.

For the Caribbean, the gap in the literature is compounded by the lumping of countries in the region with Latin America in most international studies on debt sustainability (highlighted in the literature review). This practice, which derives from international organisations' regional typologies (for example IMF, 2023), leads to conclusions on Caribbean debt sustainability that may not accurately represent the region's reality or be helpful for Caribbean fiscal policy guidance.

Of the few Caribbean studies on the topic (for example Grenade, 2011; Scott-Joseph, 2008), the breadth of investigation has been quite narrow. There are not more than 15 Caribbean specific studies that have researched the region's issues with debt since the advancement of debt sustainability theory in the 1970s. To this end, there is huge potential for more research on the region and for the introduction of innovations in methodological assessment to circumvent past methodological and data challenges.

Evidencing and supporting the observation of a significant research gap is the recent literature survey by Mitchener and Trebesch (2023) published in the Journal of Economic Literature[2] and covering the past 200 years of debt crises. It is hard to ignore that despite holding the third largest debt share globally (covered in section 1.4), and with almost one (0.86) debt crisis per year since 1978 (Table 1.1), the latest and most up-to-date survey of sovereign debt issues globally, does not mention the Caribbean experience even once.

This glaring absence of research focus on debt issues in the Caribbean is the primary gap which the thesis uncovers and aims to fill. The region provides an excellent opportunity to study issues of debt sustainability because of the number of debt defaults that have occurred there. Additionally, due to the challenges faced by these countries, the recommendations from the research could be of use to policymakers and international financial institutions (IFIs) serving the region.

[2] Ranked the second most influential journal in the world according to https://ideas.repec.org/top/top.journals.simple.html.

1.4 Importance of the research and its contributions

All Caribbean countries are classified as Small Island Developing States (SIDS), which are in the majority middle-income countries with populations below 2 million and that are very vulnerable to external shocks, including from natural disasters, economic disruption, and other hazards (Easterly and Kraay, 2000; Briguglio, 2016).[3]

Caribbean SIDS as compared to the other 39[4] countries characterised as such, have managed to achieve a high level of human development. According to the UN Human Development Index (HDI), Caribbean countries are at least 60 percent more developed than the least developed country, with these countries ranked between medium and high human development (UNDP, 2022). As a region, the Caribbean averages an HDI score of 0.753 which is almost equal the high HDI threshold value (0.754), reflecting a level of development greater than that for Sub-Saharan Africa, South Asia, East Asia and the Pacific, and the collective Latin America and Caribbean regions. The Caribbean level of human development also exceeds that of Least Developed Countries (LDCs), the developing countries group and SIDS (Figure 1.2).

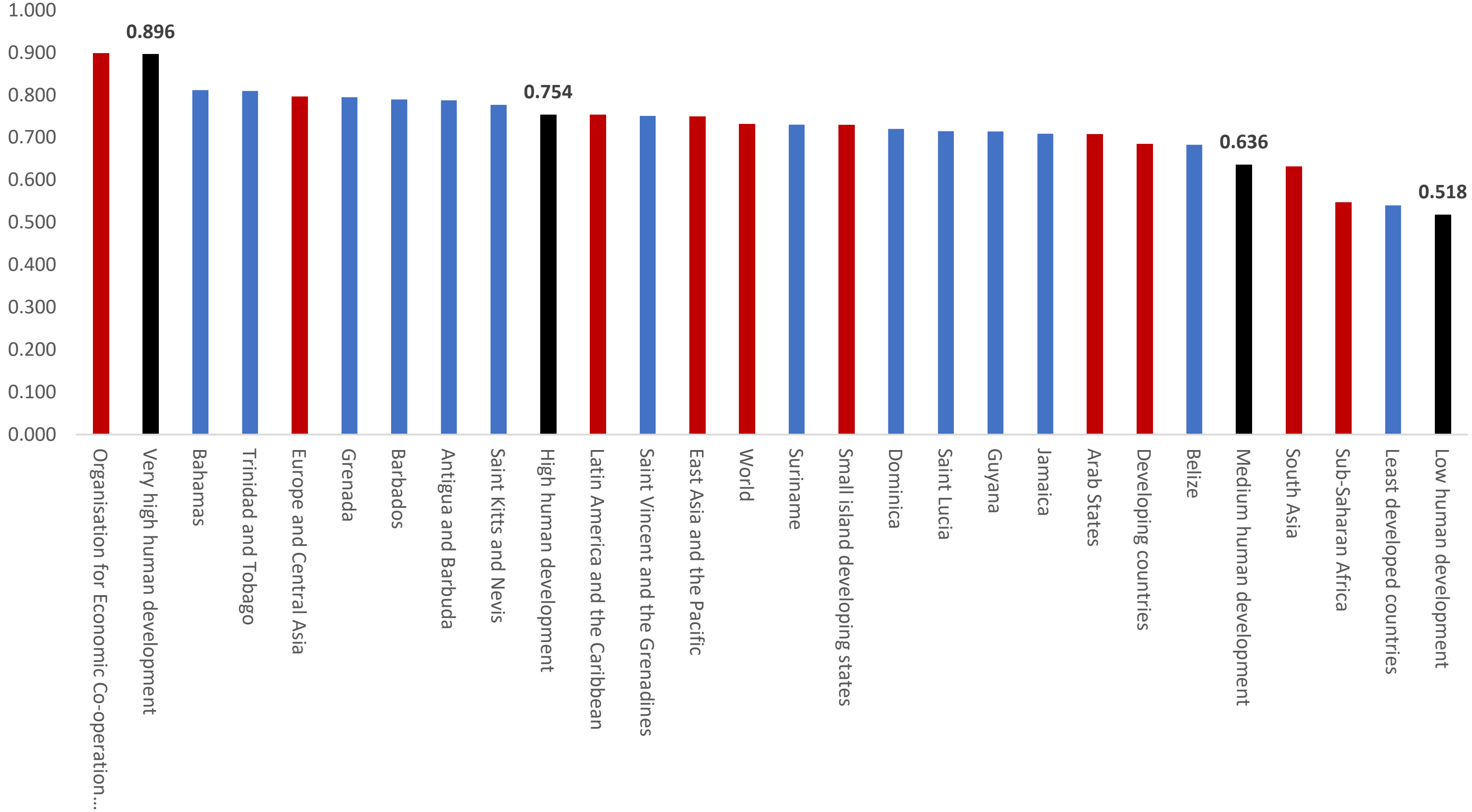
[3] See World Bank and Commonwealth Secretariat definition of small states and the UN definition of Small Island Developing States (SIDS).
[4] See https://www.un.org/ohrlls/content/list-sids.

Table 1.1 Debt Restructuring Experiences of the Caribbean 1978 - 2019

Country	Year	Nature of Default
Antigua and Barbuda	2005	Debt relief
	2010	Commercial
	2010	Paris Club
Barbados	2018	Domestic Debt Exchange
	2019	External Debt Exchange
Belize	2007	Commercial (bond exchange)
	2013	Commercial (bond exchange)
Dominica	2004	Commercial, official
Grenada	2005	Commercial (bond restructuring)
	2006	Paris Club
	2013	Commercial (bond restructuring)
Guyana	1989	Paris Club
	1990	Paris Club
	1992	Commercial (buyback, donor funded)
	1993	Paris Club
	1996	Paris Club
	1999	Commercial, Paris Club
	2004	Paris Club (HIPC debt relief)
Jamaica	1978	Commercial
	1979	Commercial
	1981	Commercial
	1984	Commercial, Paris Club
	1985	Commercial, Paris Club
	1987	Commercial, Paris Club
	1988	Paris Club
	1990	Commercial, Paris Club
	1991	Paris Club
	1993	Paris Club
	2010	Commercial (debt exchange)
	2013	Commercial (debt exchange)
St. Kitts and Nevis	2012	Commercial (debt exchange)
	2012	Paris Club
St. Vincent and the Grenadines	2007	Debt relief
Suriname	2001/02	Rescheduling of government debt
	2006	Debt relief (repayment with partial debt cancellation
	2009	Debt relief (repayment with partial debt cancellation
Trinidad and Tobago	1989	Commercial, Paris Club
	1990	Paris Club

Source: Adapted from Nicholls (2014), Table 9.1, page 10, and respective IMF Article IV publications for the Caribbean.

Figure 1.2: The Level of Human Development in the Caribbean



Source: https://hdr.undp.org/ human-development-report-2021-22.

Table 1.2 Composition of Caribbean Human Development

Countries	Human Development Index (HDI)	Life expectancy at birth	Expected years of schooling	Mean years of schooling	Gross national income (GNI) per capita	GNI per capita rank minus HDI rank
Bahamas	0.81	71.60	12.90	12.64	30486.18	-8.00
Trinidad and Tobago	0.81	72.97	14.54	11.61	23392.02	1.00
Grenada	0.80	74.94	18.66	9.03	13483.58	18.00
Barbados	0.79	77.57	15.71	9.85	12306.34	26.00
Antigua and Barbuda	0.79	78.50	14.18	9.29	16792.37	2.00
Saint Kitts and Nevis	0.78	71.68	15.43	8.66	23358.33	-16.00
Saint Vincent and the Grenadines	0.75	69.63	14.67	10.83	11961.09	11.00
Suriname	0.73	70.27	13.04	9.78	12672.20	-6.00
Dominica	0.72	72.81	13.32	8.14	11487.62	0.00
Saint Lucia	0.72	71.11	12.87	8.55	12048.30	-7.00
Guyana	0.71	65.67	12.50	8.62	22464.66	-47.00
Jamaica	0.71	70.50	13.40	9.15	8834.48	4.00
Belize	0.68	70.47	12.99	8.85	6309.10	6.00

Source: https://hdr.undp.org/ human-development-report-2021-22.

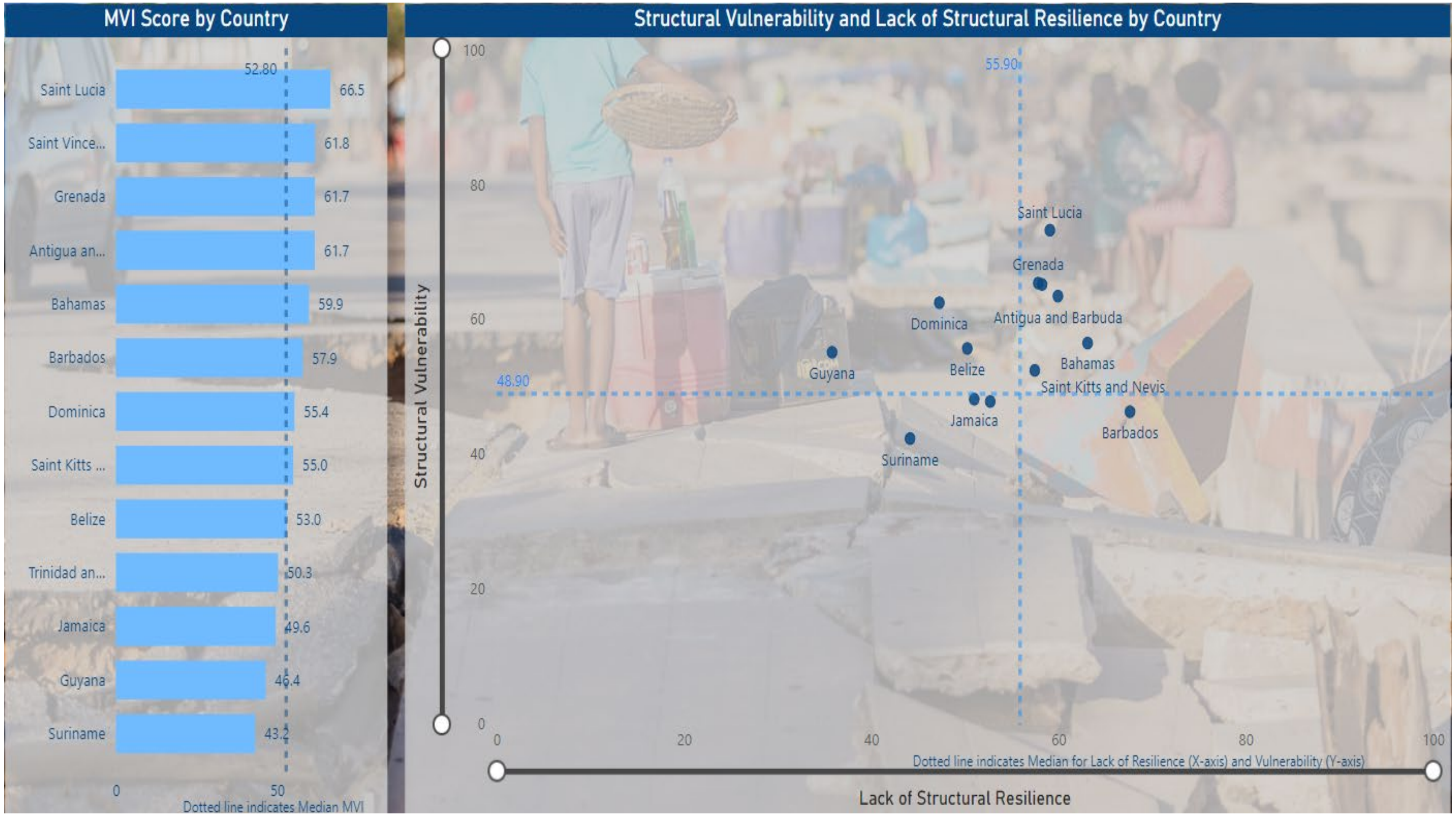
All Caribbean nations rank highly across the HDI indicators including life expectancy at birth, years of schooling and levels of gross national income (GNI) (Table 1.2).

As per their susceptibility to external shocks, the UN Multidimensional Vulnerability Index (MVI) (UN, 2023; Guillaumont, 2022) ranks Caribbean SIDS in the medium to high range of vulnerability based on their levels of inherent exposure to shocks (structural vulnerability) against their ability to respond to such shocks, otherwise known as structural resilience. As illustrated in Figure 1.3, most Caribbean countries fall into the top right quadrant of the vulnerability-resilience spectrum, reflecting a high level of structural vulnerability while at the same time lacking in large measure, structural resilience. Structural resilience includes factors such as a country's level of investment, levels of education, age dependency, level of production concentration, level of tree cover and cropland for example. On the other hand, structural vulnerability includes a country's exposure to foreign exchange fluctuations, spillover effects of regional violence, exposure to strategic export and import prices, exposure to weather events and natural disasters.

SIDS' lack of economic diversification renders them more highly exposed to shocks. For example, in the majority of SIDS, tourism is the sole mainstay, and particularly in the Caribbean representing as a share of total economic output up to 57 percent in Antigua and Barbuda, 47 percent in the Bahamas, and 42 percent in St Lucia (Acevedo *et al.*, 2017; Figure 1.4). This explains why during the COVID-

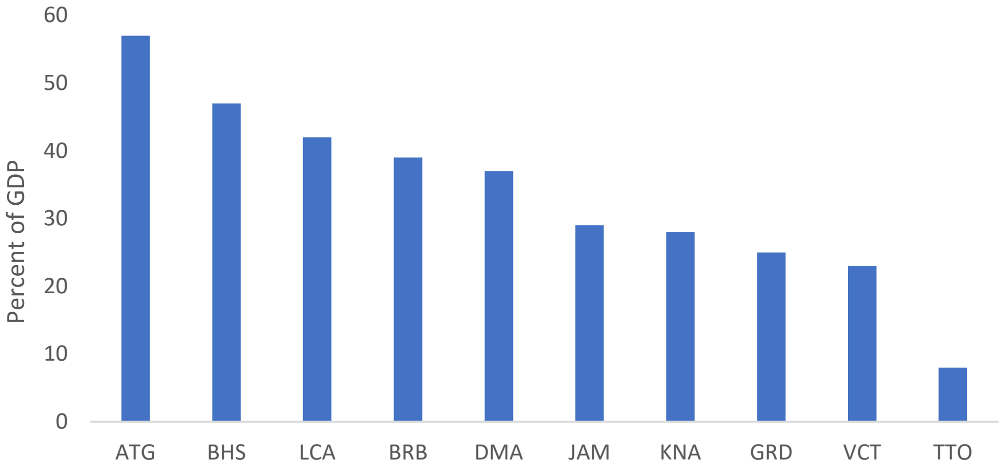
19 pandemic, Caribbean economies were literally ground to a halt (IDB, 2023). The losses in tourism across SIDS were reported to have been as high as 60 percent of GDP (Mitchell, 2020). SIDS' vulnerability is also exacerbated by their narrow tax bases, and very open economies which causes their trade balance to be highly susceptible to terms of trade shocks (Briguglio and Vella, 2018).

Figure 1.3: The Vulnerability of Caribbean Islands



Source: https://hdr.undp.org/ human-development-report-2021-22.

Figure 1.4: Total Tourism Contribution to Caribbean Economies



Source: Figures are from Acevedo *et al.* (2017).

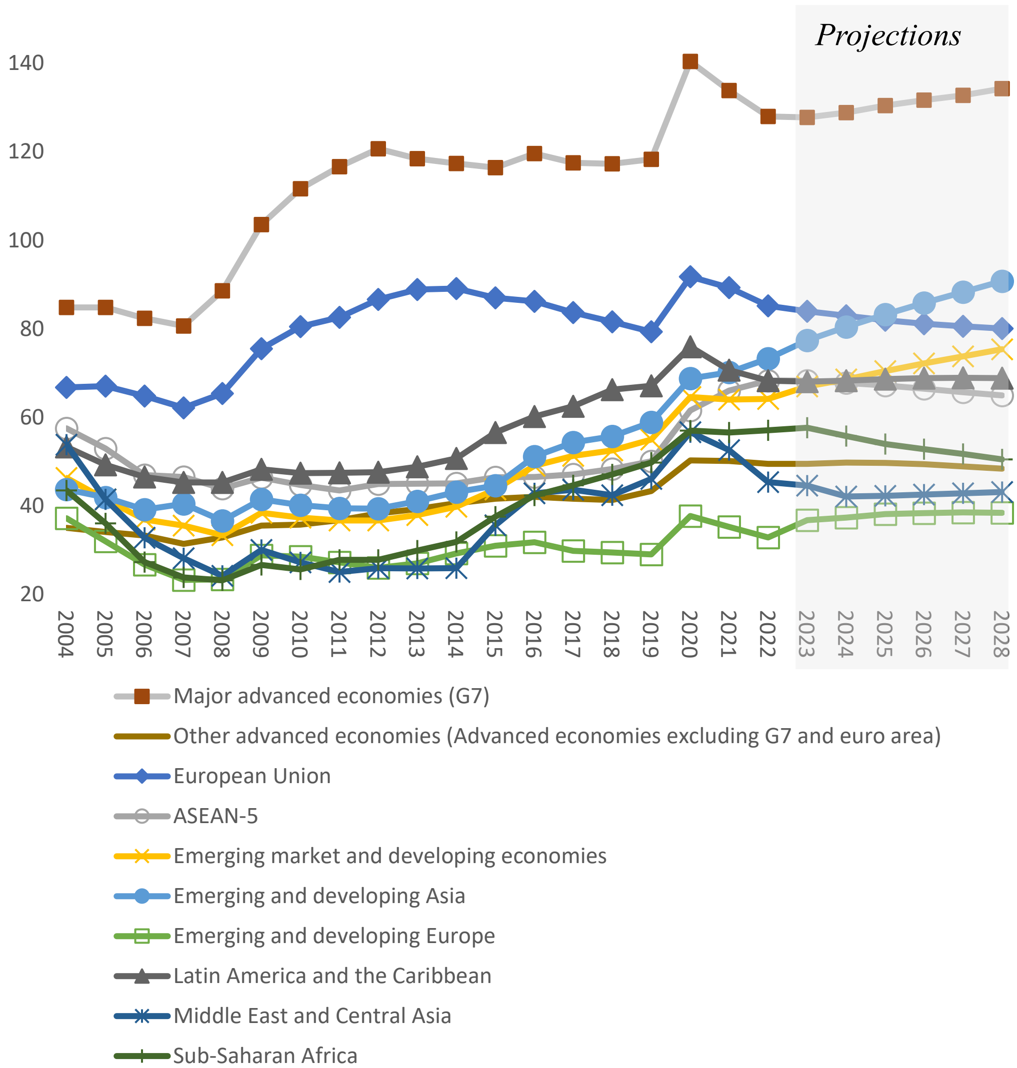
Managing these small economies, therefore, often requires a line of credit to smooth the impact of shocks, particularly given their narrow income base and fixed and quasi-fixed exchange rate regimes. The combination of these factors puts significant weight on fiscal policy, the key policy anchor for SIDS and lever for sustainable debt management. On the latter, SIDS' characteristics including their vulnerability, anaemic growth trends and relatively poor access to financial markets, heightens the role of effective fiscal policy and debt management in ensuring sustainable debt and development. Writing on fiscal sustainability and public debt limits in the Caribbean, Nicholls and Peters (2014) highlight four main perils of unchecked high debt, including lower growth, reduced policy flexibility and higher vulnerability.

This central role for debt in SIDS and the consequent importance of sustainable fiscal policy reflects the substance and relevance of the PhD thesis to the Caribbean, which are the most highly indebted countries among the SIDS and in the top 5 across the world.

As depicted in Figure 1.5, since the early 2000s Latin America and Caribbean (LAC) countries have collectively been ranked as the third most indebted countries in the world, behind only G7 and European Union countries. The IMF WEO projection is that the region will improve its future position and be overtaken by developing Asia, which is seeing an ever-rising debt stock post the COVID-19 pandemic. However, it is worth noting that the Caribbean experience with debt also suggests a high probability of default, with the region having registered 38 default episodes between 1978 and 2019, at low levels of debt ranging on average between 40 – 60 percent (Reinhart and Rogoff, 2003).

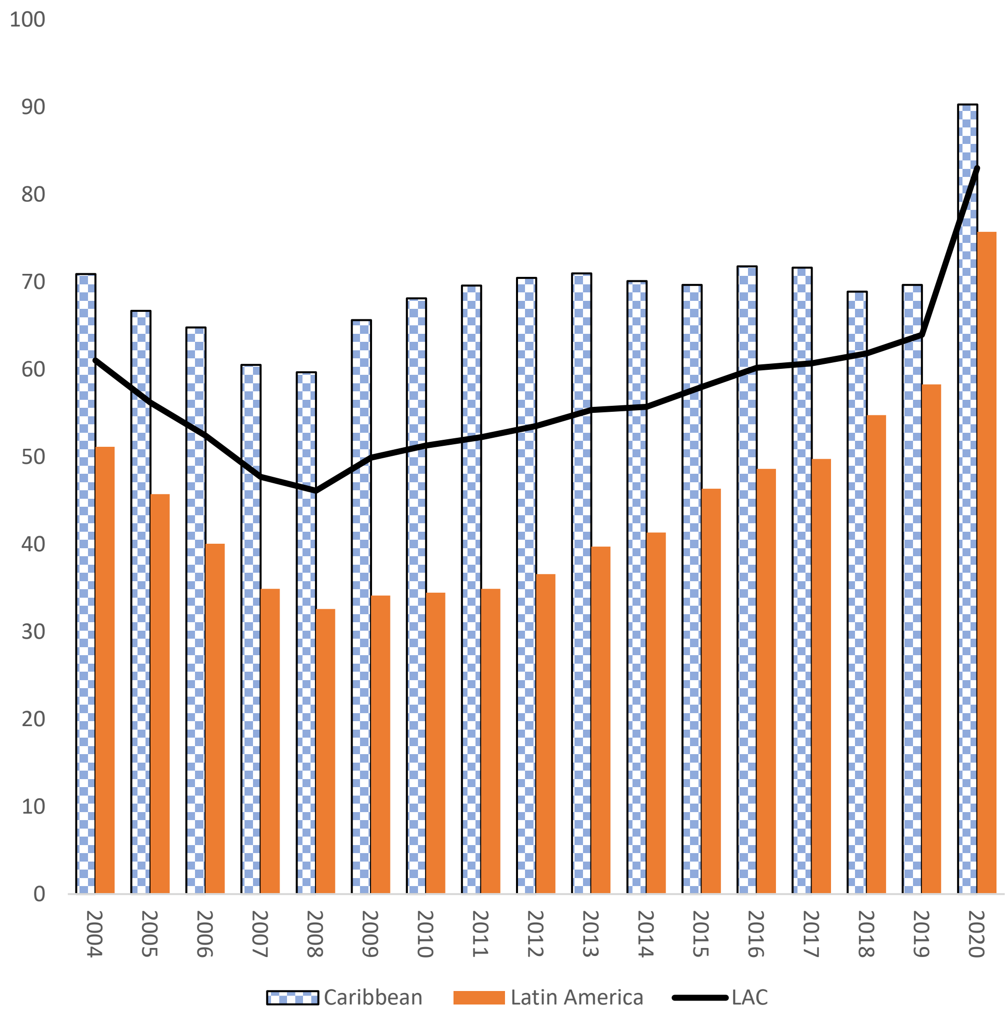
Disaggregating the LAC region supports the argument for focusing specifically on the Caribbean. As shown in Figure 1.6, Caribbean countries have consistently held the higher debt ratio and are the major drivers of the LAC debt burden. Moreover, given their global rankings, many countries in the Caribbean underpin movements in the global debt trajectory. Barbados, Suriname, and Dominica were ranked 8 (131.3 percent), 13 (118.1 percent) and 20 (104.3 percent) globally between 2019 and 2022 measured against average debt to GDP ratios.

Figure 1.5: Trends in Global Debt (2004-2022)



Source: IMF World Economic Outlook Database (2023).

Figure 1.6: Trends in Latin America and Caribbean Debt (2004-2020)



Source: IMF World Economic Outlook Database (2023). Some Caribbean debt ratios are estimates post-2020, while for Latin America debt ratios are estimates post 2021.

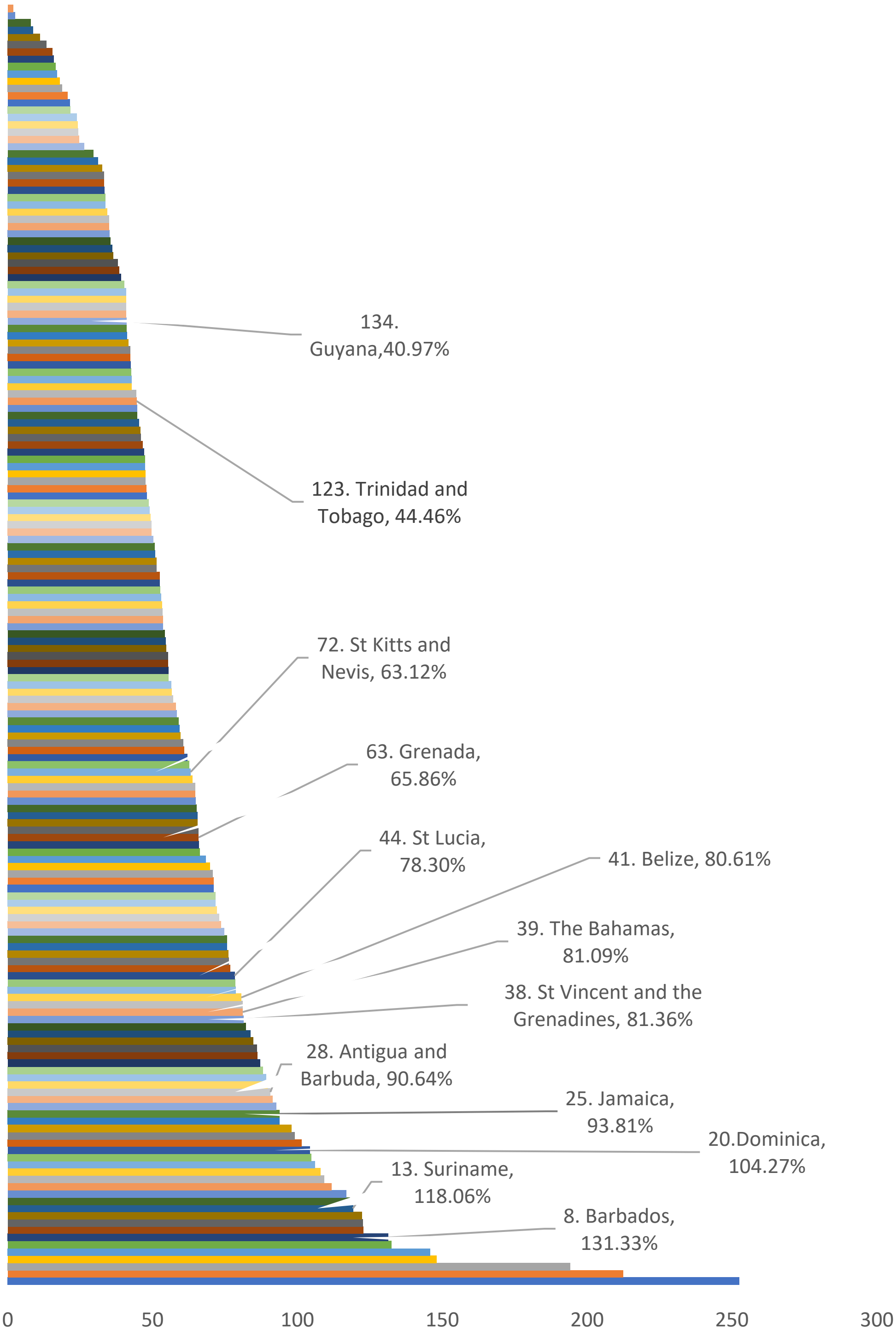
They were followed closely by Jamaica and Antigua and Barbuda who ranked in the top 30, and by St Vincent and the Grenadines, The Bahamas, Belize, and St Lucia who were in the top 50 of the group of 176 countries (Figure 1.7).

Beyond the Caribbean's debt prominence within the LAC region, another noteworthy argument for focusing specifically on the Caribbean in this research is that the LAC group represents a very dissimilar set of countries, in terms of productive capacities, market access and levels of economic development. For example, Argentina is a member of the G20, while much of the Caribbean are tiny middle-income nations.

In the new context of increasing and consecutive global shocks, and heightened uncertainty (UNDP, 2022), this PhD thesis makes a valid contribution to the literature and to policymakers and practitioners managing fiscal policy in the Caribbean and SIDS. It adds to the literature's knowledge base on debt sustainability in SIDS and provide Caribbean governments with targeted research relevant to their economies, and with policy direction not blurred by factors specifically attached to Latin America.

Further, the thesis offers innovations in methodological approaches to circumvent data issues common in SIDS, and which prevent the application of advanced debt sustainability theory.

Figure 1.7: Global Rank of Caribbean Countries by Debt to GDP Ratios (2019-2022)

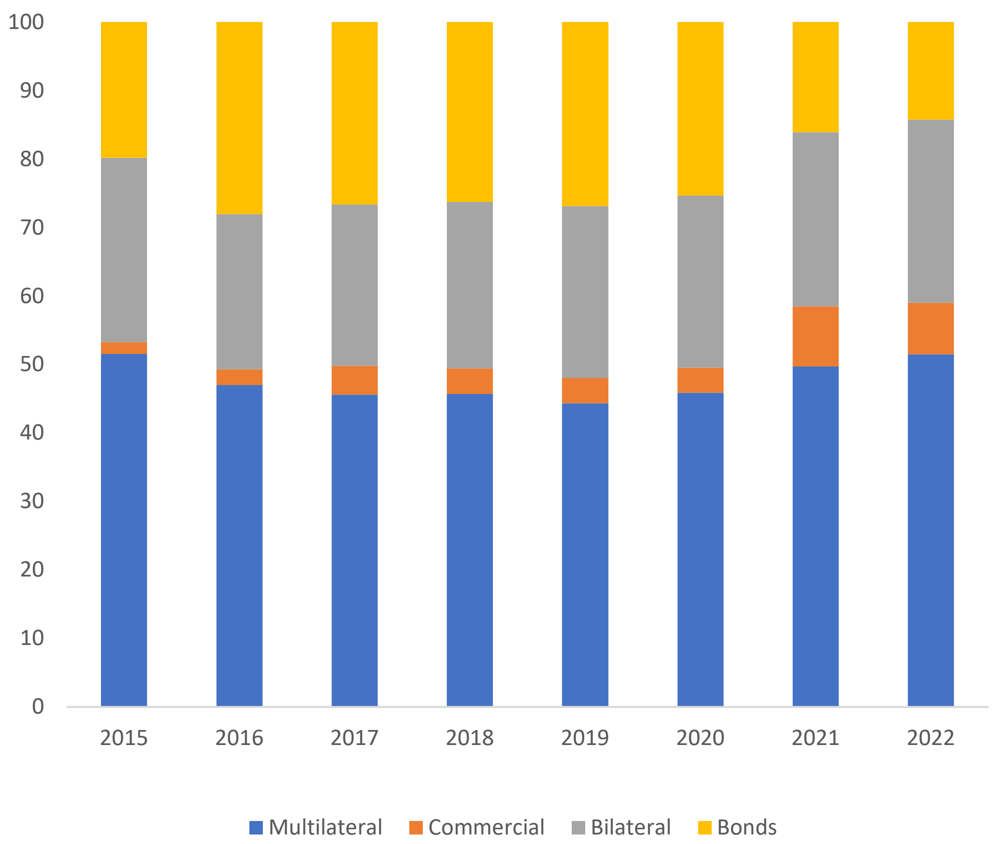


Source: IMF World Economic Outlook Database (2023). The bars in the figure represent the lowest to highest ranked, the world's 176 countries. Figures against the callout lines are the global rankings of Caribbean countries, with additional information provided on their country names and average debt to GDP ratios between 2019 and 2022.

With reference to the debt to GDP ratio, primary balance and real GDP, key variables for debt sustainability assessments, note that for the Caribbean 30 percent of these data on average, are missing.[5]

As per debt sustainability theory, the thesis will provide clarity on its relevance to SIDS, whose economies and particularly their debt dynamics may differ from that in advanced countries (where debt sustainability theory derives), due mainly to the prevalence of multilateral debt relative to capital markets liabilities (Figure 1.8).

Figure 1.8: Composition of Caribbean Outstanding Debt



Source: World Bank International Debt Statistics (2023).

[5] See the appendix for a brief description of issues with Caribbean fiscal data.

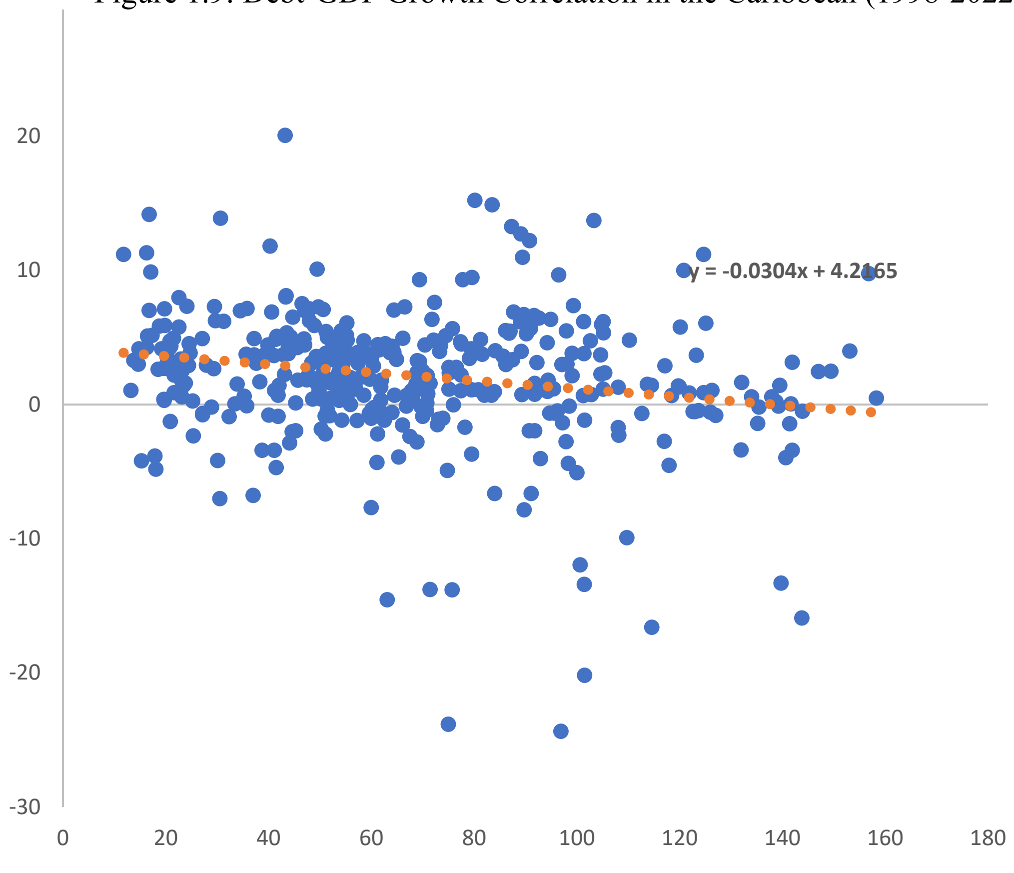
Lastly, having already recognised the importance of a well-established debt threshold to fiscal policy, the thesis in its attempt to empirically derive one for the Caribbean, will add to the policy debate on the relevance of well-known thresholds including that of the IMF (60 percent debt to GDP ratio) and of Rogoff and Reinhart (2003) (90 percent debt to GDP ratio).

In the public domain, opinion on the sustainability of government's fiscal policy is largely driven by how far above the IMF rule of thumb a country's debt to GDP ratio emerges. This is because the 60 percent debt to GDP ratio is the benchmark that policymakers in and across most governments, including in the Caribbean, reference when communicating their fiscal strategy and that is utilised by the IMF in structural adjustment and debt restructuring campaigns, of which they have been many in the Caribbean region. The Eastern Caribbean Central Bank (ECCB) adopted the rule of thumb as the anchor for debt sustainability following the global financial crisis (IMF, 2022), and it is the key performance benchmark for the achievement of debt sustainability in the current Barbados (IMF, 2021) and Jamaica (IMF, 2023) IMF programmes, respectively.

Further, since 1998 the region has been in a debt trap, characterised by long periods of high debt (>60 percent of GDP) combined with low GDP growth (<3 percent) (Figure 1.10), lending to the conclusion that Caribbean governments are not leading sustainable fiscal policies. Indeed, at the current high levels of debt, basic correlation analysis implies that there is a drag on growth (Figure 1.9) in the region, which together with the current rise in interest rates could eventually exacerbate underlying negative debt dynamics (r-g) (Figure 1.11) as observed during the impact of COVID-19.

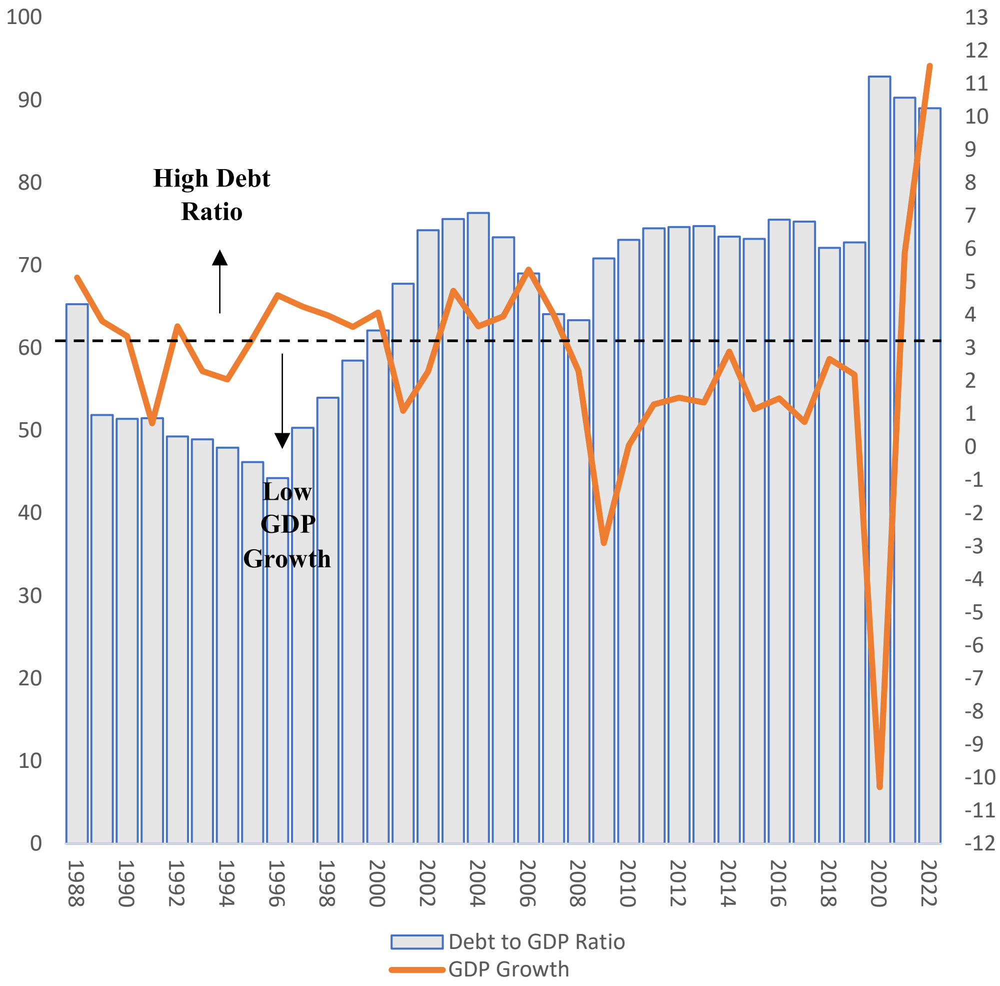
On this basis, the prevailing viewpoint at the commencement of this thesis is that fiscal policy and debt in the Caribbean is not sustainable.

Figure 1.9: Debt-GDP Growth Correlation in the Caribbean (1998-2022)



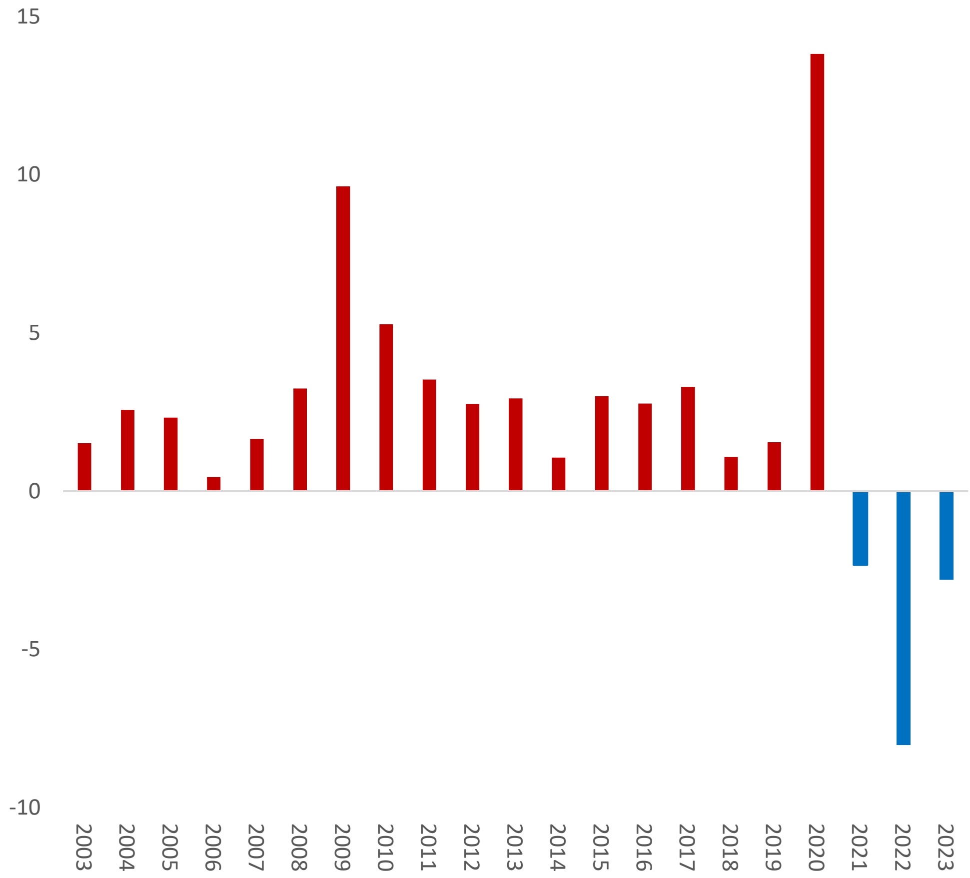
Source: IMF World Economic Outlook Database (2023).

Figure 1.10 Growth and Debt in the Caribbean



Source: IMF World Economic Outlook Database (2023). Debt is on the primary y-axis and GDP growth on secondary y-axis.

Figure 1.11 Average Interest-Growth Rate Differential for the Caribbean



Source: Author's calculations from data extracted from the World Economic Outlook (2003). Interest rates calculated as interest payments over previous period's debt. Interest payments measured by primary balance less fiscal balance. Some variables are estimated from 2020.

1.5 Main research questions

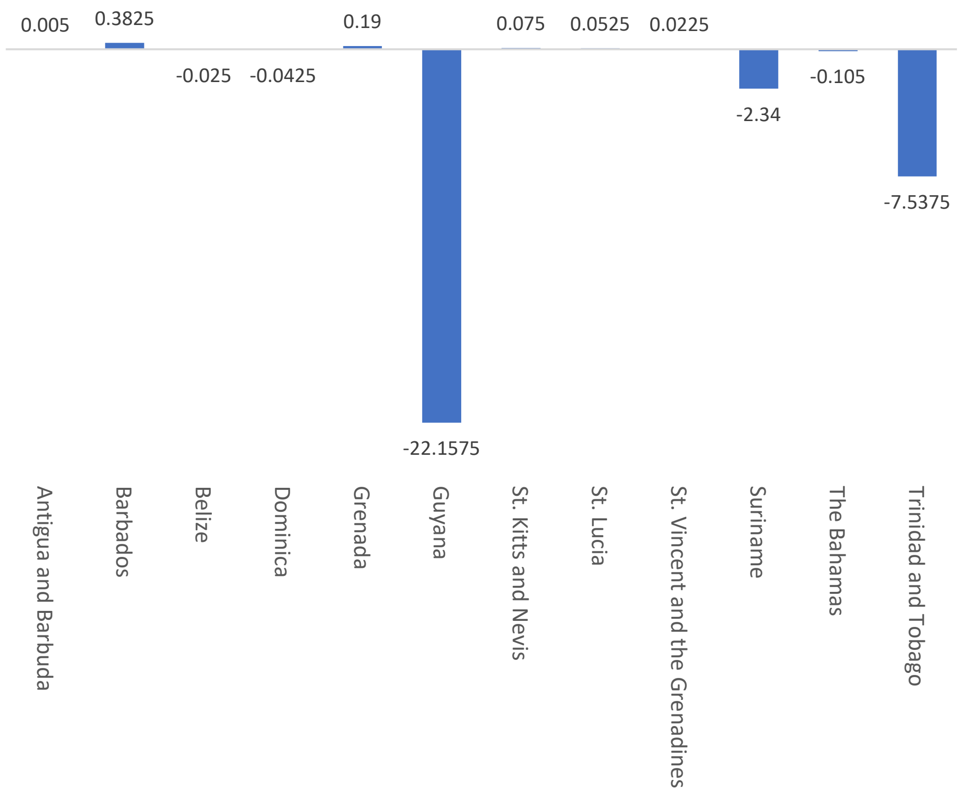
Drawing on basic knowledge of the debt sustainability literature and other related sustainability indicators, however, one could easily show that the current reality is not so clear. Bohn (1998) in his manipulation of the core debt theory proved that there were different degrees of sustainability, where weak sustainability can occur if governments respond positively to increases in debt on average, but not by so much as to reduce the debt ratio, so that debt is still ever increasing. It could then be the case in the Caribbean, that despite debt to GDP ratios exceeding the IMF fiscal sustainability benchmark, and increasing, that fiscal policy against the existing Caribbean debt ratio is nonetheless sustainable.

For instance, Caribbean average primary balances (2004-2022) as reflected in Figure 1.12 provides support for the weak sustainability argument. Specifically, Caribbean countries' average primary balances are mostly near zero or exhibit a small primary deficit, as would be expected with a weakly sustainable fiscal policy.

Additionally, recounting that solvency issues are normally preceded by liquidity challenges, for example as reflected in a rising debt service burden, one would expect that if the Caribbean's debt stock were unsustainable, it would be accompanied by a large debt service cost. Nevertheless, the Caribbean's debt service outlays relative to these governments' revenues and expenditures have been falling consistently since the late 2000s, reflecting sustainable debt outlays and not coinciding with the a priori expectations on Caribbean debt sustainability (Figures 1.13 - 1.14).

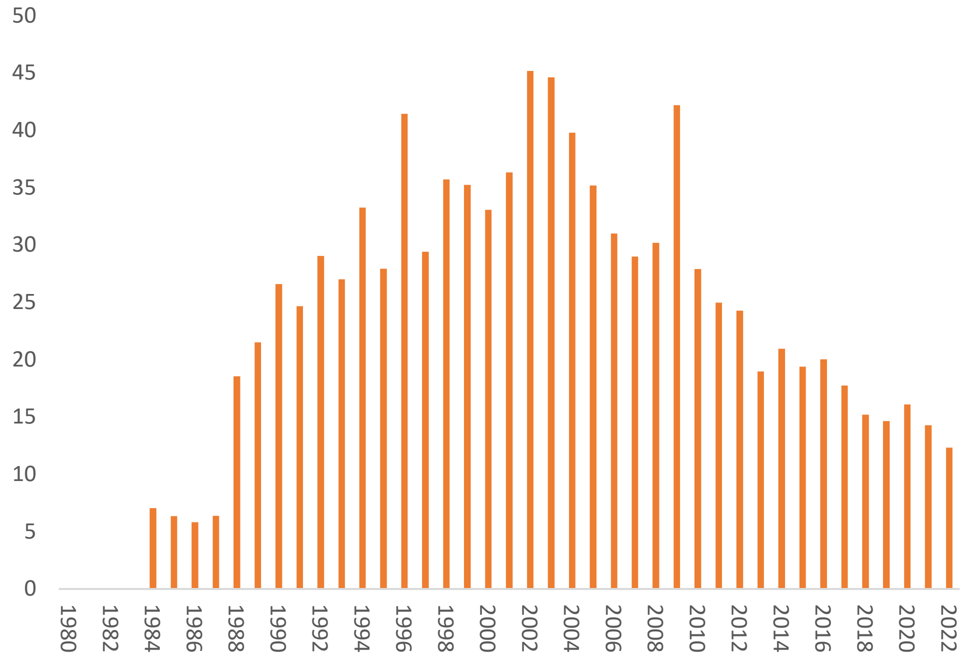
A more rigorous approach to assessing debt sustainability in the Caribbean is needed. Without it, fiscal policy assessment could be misleading, and this involves even that associated with the IMF and World Bank, which because of a lack of capacity in Caribbean governments are the main agents for debt sustainability assessments in the region, as well as for most SIDS.

Figure 1.12: Caribbean Average Primary Balances (2004-2022)



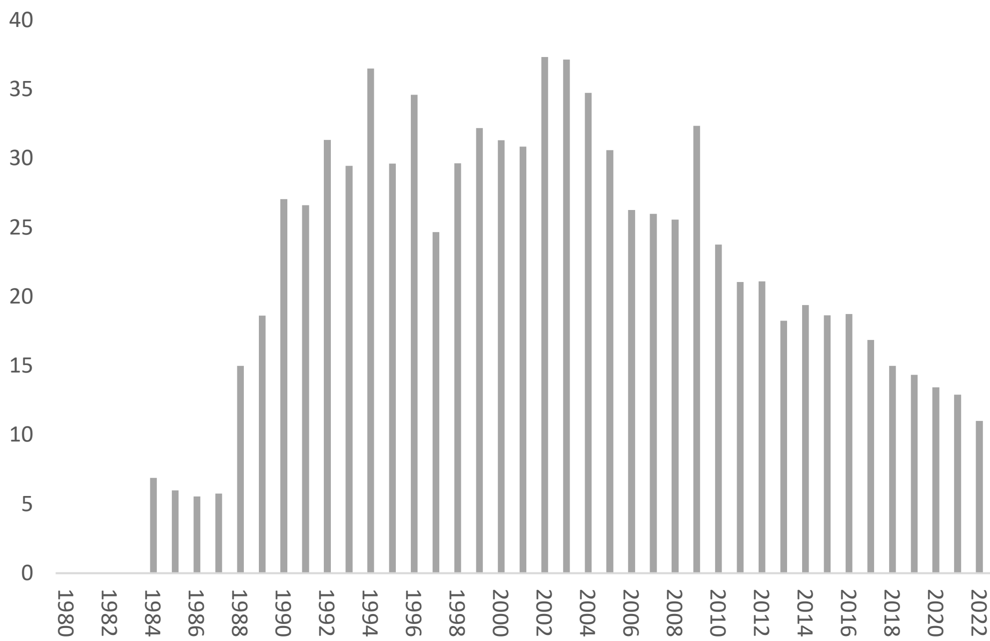
Source: IMF World Economic Outlook Database (2023).

Figure 1.13: Caribbean Interest Expense Ratio to Government Revenue



Source: IMF World Economic Outlook Database (2023)

Figure 1.14: Caribbean Interest Expense Ratio to Expenditure



Source: IMF World Economic Outlook Database (2023).

The literature covers in much detail some of the many problems with the IMF/World Bank Debt Sustainability Assessment (DSA) but the key challenge worth highlighting is the central importance of forecasting, particularly of GDP growth, which has been shown to be overly optimistic and as result, highly problematic with regards concluding accurately on debt sustainability (Wysploz, 2007).

Together these problems, including the paucity of theoretical application and accompanying empirical research on debt sustainability in the Caribbean, contrasting evidence from sustainability indicators, and doubts around the prominence of the IMF rule of thumb as a debt sustainability benchmark, underlines the key research questions of the thesis, which are: (1) Is debt in the Caribbean sustainable? (2) what is the Caribbean's debt threshold?

1.6 Important concepts and variables

Noting the possibility of erroneous conclusions based on sustainability indicators, the thesis applies debt sustainability theory, and particularly the theory of fiscal reaction functions (Bohn, 1998) to answer the main research questions. The concept of fiscal reaction functions has significant intuitive appeal and brings to the fore the importance of the long-run perspective.

Governments may be running a fiscal deficit and carrying seemingly high debt, but according to the notion of fiscal reaction functions, so long as on average the fiscal policy response as measured by the primary balance is positive on average, the debt stock as a ratio to GDP is sustainable at its current level. This is because a long-run average primary surplus in response to rising debt is consistent with satisfaction of a government's intertemporal budget constraint.

A primary focus of the thesis with regard key variables are therefore the primary balance to GDP ratio, debt to GDP ratio, output and expenditure gaps, and other key determinants of the Caribbean's fiscal policy. These are the core components of any fiscal reaction function, where added control variables allow further contextualisation of the model and results relevant to the Caribbean.

In response to the first research question on the sustainability of the Caribbean's debt, a cointegration analysis of fiscal sustainability is employed as a contrast to fiscal reaction functions, and to examine the suitability of the leading concept to assessing the sustainability of Caribbean debt. Cointegration approaches to debt sustainability were the leading approaches in the early stages of the sustainability literature but lost prominence since the emergence of the fiscal reaction function. Nonetheless, as will be discussed in the following chapters, the region's data challenges, and economic structure lend to doubts about the superiority of fiscal reaction functions for assessing fiscal sustainability in the Caribbean context. The utilisation of cointegration to examine the status of the region's fiscal sustainability reduces the data burden significantly as the technique borrowed from Afonso (2005) only requires revenue and expenditure variables.

On the second question around the Caribbean's debt limits, the concept of fiscal reaction functions is still the core theory, but it is extended to test for the presence of fiscal fatigue (Gosh *et al*., 2013). Fiscal fatigue theorises that a government will respond positively to debt as the debt ratio rises but will eventually become fatigued at very high levels of debt and increasingly so, after which point the government could be cut off from debt markets. At this juncture the government is said to have reached its debt threshold or debt limit.

1.7 Methodology

Having gained their independence in the late 1960s and early 1970s, Caribbean nations are still quite young. Application of time series approaches to empirically investigate issues in the Caribbean are by consequence, naturally restricted. Ordinary Least Squares (OLS), which is the traditional estimation methodology for fiscal reaction functions requires a minimum of 30 years of continuous annual data, whilst fiscal data is roughly available on a consistent basis for the Caribbean only for the past 20 years (See Appendix A.1-A.2).

The central methodology is through necessity, panel data econometrics since it allows for estimable regression even in the face of short time series and noncontinuous data. More importantly, as gleaned from Woodridge (2010) and Baltagi (2013), panel data regression not concerned with cointegration analysis can proceed without unit root testing, which complicates time series analysis owing to the complexity of concluding on the existence or not of unit roots. Problems of this nature have plagued the debt sustainability literature and have led to much disagreement on debt sustainability assessments. As such, the thesis also employs the autoregressive distributed lagged (ARDL) Bounds Testing cointegration approach, which also does not require unit root testing.

Panel data econometrics and specifically panel data with instrumental variables and fixed and time effects, is utilised to tackle methodological challenges characteristic of fiscal reaction functions including endogeneity of certain determinants, autocorrelation of the error term, and possible omitted variables.

1.8 Main findings

Bringing the literature, core concepts, key variables, and methodologies together, the main finding in relation to the first research question is that at the regional level Caribbean fiscal policy is weakly sustainable. This conclusion stems from evidence provided by the cointegration as well as fiscal reaction approach to assessing the region's fiscal sustainability. Essentially, there is no homogeneity in these countries' fiscal approaches to debt increases, and therefore, some countries appear to react positively to debt expansion, while others do not, summing up to a weak regional fiscal response to debt on average. At the individual level, this point is more clearly reflected. Cointegration between revenues and expenditures, the key criterion for concluding sustainability, is not found in all the Caribbean countries.

Another key finding as relates the first research question is that apart from the debt to GDP ratio, the other key determinants of fiscal policy are the business cycle as represented by the output gap; the availability of credit to satisfy government's financing requirements as encapsulated in the relationship between the primary balance and credit to the private sector; the impact of the external balance on primary balances known as the twin deficit problem, and captured in the primary balance relation with the current account; inflation financing opportunities; and the occurrence of elections due to the tendency of governments in the region to hike expenditure during election campaigns.

Interestingly, despite the region's heightened vulnerability to shocks, shocks to the primary balance from natural disasters do not seem to be a major factor in determining the course of fiscal policy. Neither are the various institutional factors such as policy effectiveness and political stability. Another surprising finding as regards the Caribbean's fiscal policy is that IMF programmes do not play a significant role. One would have thought that with the large share of debt restructurings throughout the past four decades, which this thesis covers, that there would be some significant impact of IMF programmes on the course of Caribbean fiscal policy, since the Fund's lending arrangements come with several fiscal conditionalities.

Further, the Caribbean debt threshold as postulated by the theory of fiscal fatigue does not seem to hold for the Caribbean. Application of the theory does not yield significant results and consequently, a debt sustainability threshold for the Caribbean based on fiscal fatigue is found to be undefined. Instead, the thesis concludes on a debt threshold of 106.2 percent of GDP arrived at through the application of a dynamic panel threshold model which is underpinned by an assumption of a sharp shift in the primary balance at extremely high levels of debt to GDP ratios, rather than the curvilinear type of relationship theorized by Gosh *et al*. (2013).

The results lead to other conclusions on the general relevance of fiscal reaction functions theory to countries like those in the Caribbean that do not have well-developed debt markets, more characteristic of the advanced countries about which the fiscal reaction function and fiscal fatigue theory refers.

1.9 Structure of the thesis

This thesis continues with a review of the literature on debt sustainability in Chapter II focusing on the core theories, methodological approaches, the application to different countries and regions, and corresponding findings. This chapter also articulates the gaps which the thesis aims to explore, and which help form the basis for the key research questions.

It then moves on in Chapter III to an initial empirical investigation of debt sustainability in the Caribbean making use of a more traditional revenue-expenditure approach to sustainability analysis, enhanced through application of the ARDL time series methodology, made possible for the Caribbean through utilisation of quarterly data.

Chapter IV is an important pillar of the PhD thesis as it delves into the workings of fiscal reaction functions and applies it to the context of the Caribbean. In this chapter, the key challenges encountered in the application of fiscal reaction functions and the innovations used to circumvent them are discussed.

The final piece before concluding is covered in Chapter V, which extends the discussion on fiscal reactions to fiscal fatigue to uncover the region's indigenous debt threshold, which as mentioned is an important anchor for fiscal policy.

Finally, the thesis concludes in Chapter VI, recalling motivations for the thesis, key research questions, findings, and conclusions.

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Appendix

Beyond their short time series (IMF, 2023), the additional difficulty for the Caribbean is that there are a host of missing data for key variables of interest, including the debt to GDP ratio, primary balance, and real GDP.

Table A 1.1 Analysis of Data Issues in the Caribbean (1980-2019)

Countries	Primary Balance	Debt Ratio	Real GDP	Total Years of Missing Data	Percent Missing
Antigua and Barbuda	30	30	40	20	16.7
Bahamas, The	30	30	40	20	16.7
Barbados	26	26	40	28	23.3
Belize	24	19	40	37	30.8
Dominica	30	30	40	20	16.7
Grenada	30	29	40	21	17.5
Guyana	23	23	40	34	28.3
Jamaica	30	21	40	29	24.2
St Kitts and Nevis	30	24	40	26	21.7
St Lucia	35	30	40	15	12.5
St Vincent and the Grenadines	36	30	40	14	11.7
Suriname	30	30	40	20	16.7
Trinidad and Tobago	32	32	40	16	13.3
Average	29.7	27.2	40.0	23.1	19.2

Approximately 30.8 percent of observations across the primary balance, debt ratio, and real GDP are missing for Belize. At best, one Caribbean country St Vincent and the Grenadines can estimate with 83.3 percent of the necessary observations for a debt sustainability model including these variables. The average amount of missing data for the selected variables is 19.2 percent, driven largely by missing observations for the debt ratio which account for around 12.8 of missing data, and the primary balance where 10.3 percent of data are missing (Table A 1.1).

Against the time dimension, data after 2001 is balanced, that is not considering other possible variables for estimation. However, between 1980 and 2000, 50.9 percent of the primary balance data are missing and 39.2 percent of the data on the debt ratio, respectively. This approximates to an average of 30 percent missing data during this period (Table A 1.2).

Table A 1.2 Analysis of Data Issues by Period Decade (1980-2019)

Variable	1980-2000	2001 - 2019	Total Missing	Percent Missing 1980-2000	Percent Missing 1980-2019
Primary Balance Ratio	139	247	134	50.9	34.7
Debt Ratio	107	247	166	39.2	46.9
Real GDP	273	247	0	0.0	0.0
Average	173	247	100	30.0	27.2

Note: Visualisations of the Caribbean fiscal data with missing points is available in Figure A1-A2 in the Appendix.

Chapter 2 Literature Review

The literature review discusses past studies on debt sustainability to shed light on the theory and methods for helping to respond to the thesis' research questions. In doing so, it provides a chronological review of the literature's development, offering insights on the applicability, advantages, and disadvantages of employing different methodologies in debt sustainability assessments.

It helps to contextualise the assessment of debt sustainability in the Caribbean region as well as to provide a quick update on the adequacy of Caribbean government's fiscal policy to date, or as is available in the literature, relative to the goal of sustained debt sustainability and in the context of a chronically indebted region.

The review compares the motives for sustainability research in other regions with that of the Caribbean and the approaches to assessment to understand the relatively limited focus on sustainability issues in the region., the latter of which has been brought to the fore in Mitchener and Trebesch (2023). In this most recent literature survey on international debt issues covering over 200 years, there is not one mention of debt issues in the Caribbean despite the region accounting for the top three most globally indebted.

From the perspective of fiscal policy limits, the literature review seeks to gather research evidence on the Caribbean's debt threshold and examines whether the literature provides consensus on a credible fiscal policy anchor as it relates to maintaining sustainable debt in the region.

Through this assessment of the literature on fiscal sustainability the thesis updates earlier reviews by the likes of Burnside (2004); Chalk and Hemming (2000); and Cuddington (1997), as well as fills the gap in Mitchener and Trebesch (2023). Specifically, the literature survey reviews the main theory of fiscal sustainability and provides a summary of the principal methodological approaches. The latter are divided into four main strands: (1) sustainability indicators, (2) econometric tests on the intertemporal budget constraint, (3) fiscal reaction functions, and (3) simulated debt forecasts and debt threshold analysis, respectively. The survey then attempts to situate the Caribbean literature and examines where there is scope to close the wide gap between international and Caribbean research on the topic.

In the next Section, the theory of fiscal sustainability is examined and in Sections 3 and 4, the review turns to an evaluation of the key methodological approaches. Following this discussion, Section 5 proceeds to a review of motivations and consequent approaches to debt sustainability research from around the regions and the Caribbean, and Section 6 concludes.

2.1 Theory of Fiscal Sustainability

The government's budget constraint articulated in models such as those by Ramsey (1928), Cass (1965) and Koopmans (1965) is the usual starting point of fiscal sustainability analysis (Romer, 2006). The main assertion in these models is that Government cannot consume more than it can finance from its initial wealth, revenues from taxes and from the issuance of public debt. This hypothesis is deemed true when we abstract from options such as seigniorage, exchange rate revaluation, and debt repudiation.

2.1.1 Government's Budget Constraint

$$\mathrm{T}_t - [G_t + i_t D_{t-1}] = D_t - D_{t-1} \tag{2.1}$$

Let's denote revenues from taxes T_t, G_t total government spending and D_t gross government debt. Where i_t is the nominal interest rate and the expression $\mathrm{T}_t - [G_t + i_t D_{t-1}]$ the traditional fiscal deficit. Equation (1) is the focus of policy debates but is not of interest to the academic literature. It can be shown, as will be below, that the conventional fiscal deficit is biased both by an inflation and growth term. This essentially means that observed changes in the conventional fiscal deficit can occur without an alteration of government's actual fiscal stance through either inflation or growth effects, or both (Bohn, 2005). Hence if one wanted to assess the true direction of government's fiscal policy and by extension fiscal sustainability, using the conventional fiscal deficit would not be appropriate.

Also note that the government's budget constraint is a stock-flow relationship, with the government's gross financing requirements equal to the change in its gross debt position $D_t - D_{t-1}$. At this point it is clear to see that government's debt exposure is a barometer for the sustainability of its fiscal stance. A better way to express this relationship, however, is in terms of the government's primary deficit S_t, which is the fiscal deficit without interest rate payments. Removing interest obligations from the gross deficit more accurately reflects government's fiscal actions and the impact of increased spending on the debt level.

$$D_t = (1 + i_t)D_{t-1} - S_t \tag{2.2}$$

Then in reduced form as in (2.2), the government's nominal budget constraint can be expressed in terms of the current debt level D_t, which is the sum of government's accumulated principal and interest payments plus its current primary deficit.

2.1.2 Debt Dynamics

As intimated, government's nominal fiscal balance is confounded by inflation and growth factors, which means that stating the deficit in terms of the primary balance is still not sufficient for an accurate representation of government's fiscal policy. In the literature this is addressed by expressing the government's budget constraint in real terms and as a ratio to GDP. Or more succinctly, as a ratio to nominal GDP (Bohn, 2005).

$$\Delta d_t = \left(\frac{r_t - \gamma_t}{1 + \gamma_t}\right) d_{t-1} - s_t \tag{2.3}$$

Deflating the nominal budget constraint by the price level and output reveals that the government's fiscal deficit is biased by a term π_t and a term γ_t, respectively, where π is inflation and γ the GDP growth rate. More intuitively, it reflects that real debt accumulation Δd_t is a function of the real interest and growth rate differential $\left(\frac{r_t - \gamma_t}{1+\gamma_t}\right)$. Hence, a government would need to increase its primary surplus s_t to prevent debt from rising. On the other hand, with a constant primary deficit, government's public debt dynamics suggest that if growth exceeds interest rates, government's debt should be on a declining path.

2.1.3 Intertemporal Budget Constraint

Knowing what drives government's debt accumulation is interesting but does not provide for a full analysis of sustainability. If debt is already at very high levels, public debt dynamics can give insights into how that level of debt can be reduced or kept constant, as will be reviewed, but it will not tell the policymaker whether that level of debt is sustainable in the long run.

As has been observed from the above equations, whether in real or as a ratio to GDP, government's budget constraint can be compactly expressed in the form of (2.3). Solving this equation recursively forward, discounting debt by $(1+r)^n$ and the surplus by $(1+r)^j$, reflecting bond holder's preferences and the opportunity cost of money, and taking limits to infinity yields the government's Intertemporal Budget Constraint (IBC).

$$d_t = \sum_{j=0}^{\infty} (1+r)^j \, s_{t+j} \tag{2.4}$$

The IBC shows that for the government to maintain its current debt level, it has to run, in present value terms, an average future primary surplus equal to the level of initial debt. A consequence is that government cannot then run primary deficits forever. At some point in the future, its intertemporal budget constraint suggests that past deficits will have to be offset with increases in the primary balance.

2.1.4 No-Ponzi Game Condition

The crucial assumption underlying this theoretical result in (2.4) is satisfaction of the No-Ponzi Game (NPG) condition $\lim_{n \to \infty} \frac{d_{t+n}}{(1+r)^n} = 0$.

The No-Ponzi Game condition implies that government cannot perpetually finance its outstanding debt stock and interest rates with new debt issuance. For if the converse were true, it would imply that debt is unbounded and that bondholders would always be willing to hold an extra unit of government debt. This line of thought is supported by the Ricardian Equivalence theorem articulated in the writings of David Ricardo and later developed by Barro (1988). Bohn (1995) and others show, however, through an equivalent assessment of a consumer's utility maximization problem that in a dynamically efficient economy, the consumer's transversality condition (which is the NPG to a consumer) also goes to zero in the limit. In other words, bondholders in a dynamically efficient economy would not allow government to run a ponzi scheme against them since taking on an additional unit of debt would not be Pareto optimal.

An economy is considered dynamically efficient when the marginal product of capital exceeds the GDP growth rate Abel *et al*. (1989). Conversely, when the GDP growth rate exceeds capital's marginal product, an economy is deemed dynamically inefficient. This is primarily because a GDP growth rate above the marginal rate of capital suggests that savings could otherwise be reduced, or similarly, debt increased to expand the level of consumption.

Implicitly, if the NPG term does not go to zero in the limit, then debt is growing at a rate above $(1+r)^n$ and the economy is dynamically inefficient. As a result, the existence of dynamic efficiency is crucial for the intertemporal budget constraint argument to hold.

2.2 Principal Methodological Approaches

Stemming from the theoretical requirement of a stable long-run relationship between the debt to GDP ratio and discounted primary surplus for a non-explosive debt path, there have been various interpretations of the terms, debt and fiscal sustainability (Table 2.1), culminating in different methodological approaches to empirically testing its existence. The varied interpretations of the theory also underpin the interchangeable use of the terminologies - debt and fiscal sustainability, respectively, in the literature.

Common to the varied interpretations is the agreement that debt stocks cannot increase indefinitely, and therefore, a fiscal policy that coincides with, or supports an ever-increasing debt burden is not sustainable. See for example, the IMF (2002), Horne (1991), Burnside (2004), Wilcox (1989), Quintos (1995), Polito and Wickens

(2007), Blanchard (1990), and Tanner and Samake (2006) (Table 1). The different methodological approaches for testing the existence of debt sustainability are in large part varied ways of examining whether this perspective holds.

Specifically, the main methodologies for assessing debt sustainability consist of sustainability indicators; econometric tests on the IBC; fiscal reaction functions; fiscal vector auto-regressions and probability forecasts.

Table 2.1 The Various Definitions of Fiscal Sustainability

Articles	**Selected Perspectives**
IMF (2002)	Fiscal policy is sustainable if it satisfies the solvency condition without a major correction in given costs of financing.
Horne (1991) Burnside (2004) Wilcox (1989) Quintos (1995)	Government's ability to service its debt in perpetuity without default.
Polito and Wickens (2007)	Sustainability of government's fiscal stance.
Blanchard (1990)	Can the course of fiscal policy be sustained without exploding or imploding debt? Will the government have to increase taxes, decrease spending, have recourse to monetization or even repudiation?
Cuddington (1997)	Whether the government's fiscal stance ultimately requires levels of financing that lenders would find objectionable.
Callen et. al (2003)	If government can generate enough future primary surpluses to pay its outstanding debt.
Abiad and Baig (2005)	Maximum debt level consistent with intertemporal sustainability.
Tanner and Samake (2006)	If fiscal policy were to be continued, would fiscal policy be sustainable, or will a modification of policies be required?
	What policies should be undertaken today to prevent the need to further adjustments in the future.
Bohn (1998)	Government's ability to respond positively to an increase in debt through increases in the primary surplus.

Note: The above definitions are not exhaustive but provide a rounded view of the various definition of fiscal/debt sustainability in the arising from the literature.

2.2.1 Sustainability Indicators

The most basic debt sustainability analysis is conducted using debt sustainability indicators. The more popular of these is the gross debt stock to GDP ratio, which is a public sector statistic that provides a measure of how much of a country's income is being used to repay public sector borrowing, a main indicator of potential debt related risks. The IMF rule of thumb is that this ratio should generally be less than 60 percent of GDP for a country to remain solvent, where solvency is defined as a state in which the current value of debt is equal or less than the present value of future primary surpluses, or where the present value of interest payments does not exceed the present value of current account inflows. There are other ratios such as the debt to export, and debt service to revenues and expenditure ratios, which provide insights into a country's possible liquidity and solvency challenges. A good summary table of these debt sustainability ratios is provided in IMF (2013) and replicated in the Appendix Table 2.1.

Solvency and liquidity ratios can both provide useful information on fiscal sustainability[6]. However, Horne (1991) makes an important distinction between solvency and sustainability worth mentioning. The distinction is relevant for understanding the factors underpinning development of medium and long-term sustainability indicators. Horne notes that solvency is an assessment of whether a government will have enough resources to service its debt, whilst sustainability is a longer-term view on whether current fiscal policies can be sustained indefinitely without major correction. Solvency can always be achieved whether by debt repudiation or seigniorage, but a government's resort to these financing options would violate sustainability, which requires a stable long-run fiscal equilibrium.

[6] In the sense that prolonged liquidity challenges can eventually lead to solvency concerns.

As it pertains to concluding on fiscal sustainability, therefore, medium and long-term indicators are by consequence more robust than solvency ratios, which are more robust than liquidity ratios, respectively, largely because the former are based on stricter definitions. Liquidity ratios are less strict indicators of sustainability due mainly to their short-term outlook.

The medium and long-term indicators are measures such as the primary gap, tax gap and debt target indicators. Primary gap indicators pioneered by Blanchard (1990) have seen extensive use in sustainability literature. In practice, they are mainly utilised by the International Monetary Fund (IMF) when conducting Debt Sustainability Assessments (DSAs).

(2.5)

$$\bar{s}_t = (r - \gamma)d_t$$

The primary gap indicator (2.5) derives from the public debt dynamic equations. It provides judgements on sustainability and the required fiscal adjustment. Assuming steady state and that $\Delta d = 0$ primary gap indicators give the debt stabilizing primary balance $\bar{s}_t$. With further rearrangement it also allows one to gauge the primary balance required to achieve a particular debt target $\bar{d}_t$. These indicators have the advantage of being simple, requiring minimal data, while being easy to interpret and to communicate (Scotts-Joseph, 2008).

Nonetheless, policy prescriptions from these indicators can be quite questionable and of little practical use. This is particularly when the indicators suggest large and sustained fiscal adjustments. The assumption of steady state in this regard, is the object of chief criticism. Governments, particularly those in emerging markets, can expect fiscal and macroeconomic shocks with non-negligible probability. Additionally, in these contexts, governments' ability to sustain a large primary surplus is often unrealistic and politically infeasible.

A conceptually similar approach in the fiscal sustainability literature is Blanchard *et al*. (1991) tax gap indicator, which deems a fiscal policy sustainable if the current tax rate τ, in ratio to GDP, is below the sustainable tax rate $\tau*$. Expressing the primary surplus as the sum of its three main components: government spending ω_t, transfers h_t and taxes τ, it can be shown through solving for τ in the government's IBC that $\tau*$ is equal to the annuity value of future expected spending and transfers, plus the difference between the ex-ante interest rate and growth rate, times the ratio of debt to GDP $(r_t - \gamma_t)d_0$.

$$\tau^* - \tau = \omega_t + h_t + (r_t - \gamma_t)d_0 - \tau \tag{2.6}$$

A tax rate above the sustainable tax rate $\tau > \tau^*$ implies a need for fiscal adjustment. However, if the level of taxes to GDP is already well above τ^*, a government is characterized to be at risk of fiscal crisis. The tax gap indicator has medium-gap and long-term gap extensions. These are more useful for making judgements further out into the government's projection horizon.

In both the primary gap and tax gap indicators, the intent is to establish whether some fiscal policy variable has crossed some threshold that would render the government insolvent, and to offer advice on how government can return to a more sustainable path. The idea of a natural debt limit, proposed by Mendoza and Oviedo (2009), has a similar objective. The major difference here is that the natural debt limit indicator assumes a budget constraint that is self-imposed rather than imposed by bondholders. Under the natural debt limit assessment method, the government follows a fiscal rule which requires it to maintain a minimum number of outlays during a fiscal crisis. Where a fiscal crisis is defined as a situation of sustained and historically low levels of tax revenue (two standard deviations below the historical average). In essence, the government restricts itself to holding at most d∗ in debt obligations.

(2.7)

$$d_{t+1} \leq d^* \equiv \frac{t^{min} - g^{min}}{r - \gamma}$$

This natural debt limit (2.7) is synonymous with a debt target with revenues at level t^{min} and expenditure at g^{min}, respectively. And it represents a credible commitment by the government to service its outstanding debt. This is why the government would resist holding levels of debt d_{t+1} above d^*. Levels of debt in this range could lead to sustainability problems mainly because of the signal it sends to the bond market.

Debt targets are therefore a central focus of sustainability indicators. Uctum and Wickens (2000) develop a medium-term sustainability indicator (2.8) assuming that the government's intention is to target a given level of debt-to-GDP ratio d^*_{t+n}. In their words, "fiscal policy can be said to be sustainable, or intertemporally consistent if it is able to achieve a given target level of the debt-to-GDP ratio."

(2.8)

$$d_t - E_t \delta_{t,n} d^*_{t+n} = E_t \sum_{t=1}^{n} \delta_{t,i} \left(-s_{t+i}\right)$$

There are two differentiating factors between the indicators of Mendoza and Oviedo (2009) and Uctum and Wickens (2000) worthy of note: (1) in the latter indicator the target debt-to-GDP ratio d^*_{t+n} is in discounted terms $E_t \delta_{t,n}$ and (2) a deviation between the target level of debt and the current level d_t is interpreted as the desired change in discounted debt. The right-hand side term is the value of the discounted surplus that would have to be generated to achieve the desired change in discounted debt, where $\delta_{t,i}$ is the discount factor.

The IMF, World Bank, and European Union's method for assessing debt sustainability is also a type of fiscal sustainability indicator. It draws on the equation of the IBC (2.4), which indicates that for debt to be sustainable, the future discounted surplus ratio must at least be as large as the current debt ratio. These International Financial Institutions (IFIs) use forecasts of growth, interest rates, revenues, and expenditures to estimate the future discounted surplus, rendering the method a forward-looking debt sustainability indicator. There have been several improvements in the basic IFI framework over time to include other key sources of income such as remittances when calculating the future discounted surplus, and the inclusion of shocks to the baseline forecasts for a more realistic assessment of the shocks to fiscal policy, particularly for shock prone countries. At the same time, the indicator is hugely criticized, largely because of the level of judgment involved in producing key forecasts. Criticisms mostly surround the subjectivity involved in forecasting aggregates and the fact that practitioners and academics even with access to the same data as IFIs struggle to reproduce similar debt sustainability forecasts (Wysploz, 2007).

2.2.2 Econometric Tests on Existence of the IBC

The pioneering work by Hamilton and Flavin (1986) is the genesis of econometric approaches to assessing debt sustainability. They observe that the null hypothesis of an intertemporal budget constraint is equivalent to $H_0\colon E_t \lim_{n\to\infty} \frac{d_{t+n}}{(1+r)^n} = 0$ against the alternative hypothesis $H_1\colon E_t \lim_{n\to\infty} \frac{d_{t+n}}{(1+r)^n} = A_0$. Specifically, in the situation where the NPG term does not go to zero in the limit, the authors assert that one can expect that at any time t, the NPG term will be equal to some constant A_0.

By way of transition and drawing on the econometric literature on unit roots and the presence of cointegration (Engle and Granger,1991; Granger, 1986), and assuming that the government's discounted sum of primary surpluses is a stationary series, if the null hypothesis holds, then it implies that the debt ratio is also a stationary series. Testing for unit roots in the debt series and in the discounted primary surplus series is by consequence a test for debt sustainability.

The insight by Hamilton and Flavin is intriguing. However, the econometric approach rests on some restrictive and disputable assumptions, including the stationarity of the primary surplus and real interest rate. Such disputes have characterized the subsequent literature on econometric methodological approaches aimed at testing the existence of the government's IBC.

Trehan and Walsh (1988) analyse the implied long-run relationship between debt and the discounted primary surplus also through the lens of cointegration. From the one-period budget constraint with real interest rate r (2.3), if r is assumed stationary, a long-run relationship between real debt and the discounted surplus variable suggests stationarity of s_t and d_t, but also of the lagged debt ratio d_{t-1}. Briefly, that a cointegrated relationship with cointegrating vector [1, -1] exists between debt and the primary surplus. The original contribution from Trehann and Walsh arose by challenging the assumption that s_t is a stationary series. They looked at the case in which the primary surplus is a non-stationary series and showed that in such a situation, if this long-run relationship does exist it implies that debt and the primary surplus are cointegrated with a cointegrating vector [1+r, -1]. Rather than testing for cointegration directly, however, like Hamilton and Flavin, Trehann and Walsh utilise unit root tests on these variables, finding stationarity of s_t but not in d_t, giving no reason to explore the existence of the cointegrating vector [1+r, -1].

Naturally, it is logical to also explore the relationships that exist if we disaggregate the primary surplus into revenue and expenditure as was done in the sustainability indicator literature by Mendoza and Oviedo (2009) and Uctum and Wickens (2000). This approach was adopted in the study by Hakkio and Rush (1991), who were the first to test for a cointegrating relationship, and later by Afonso (2005) who introduced a testing template and the application of panel unit root and cointegration techniques.

By the same arguments as those used in the works of their predecessors, Hakkio and Rush (1991) manipulate the one-period budget constraint (2.3) and show that the test for fiscal sustainability is also equivalent to asking whether the expected value of the discounted debt term converges to zero, given discounted levels of government's expenditure and revenue. Following on from the previous discussion, another way to pose this question is to ask whether there is a cointegrating relationship between expenditure and revenues. Statistically, it is possible to assess this via a test for unit roots. The null hypothesis is that the coefficient b =1 against the alternative b =0 in (2.9).

(2.9)

$$T_t = a + bG_t + \varepsilon_t$$

If the error term ε_t is stationary, which is consistent with the classical normality assumption N ~ (0, σ), then cointegration between T_t and $G_t$holds, that is if these variables are both I(1). Acceptance of the null hypothesis thus confirms cointegration. Afonso's (2005) testing template on the other hand calls for unit root testing of the individual variables and clarifies the hypothesis and decisions at each stage of the testing process. Cointegration is only tested if both variables are I(1). Should one variable be I(0) then cointegration is rejected.

Consistent throughout the alternative econometric methods presented is the assumption that the interest rate is constant. Wilcox (1989) investigated the situation of a stochastic interest rate while also allowing the non-interest primary surplus to be I(1). They found a structural break in the debt series in 1974, shining light on the issues with regard cointegration and unit roots, and possible misdiagnosis of debt sustainability.

Their work motivated a study by Quintos (1995) who tested for structural breaks in fiscal policy by looking for changes in cointegrating ranks. Most notable is the introduction of the concept of "strong sustainability" and "weak sustainability". Before this point in the literature, tests on the IBC using cointegration techniques failed to explore the possibility of higher orders of integration in the debt series. Operating using a similar framework as Hakkio and Rush (1991), in this study it is proved that the debt series, derived from a dynamic form of the one-period budget constraint (equation 12), converges at a rate Op(1) if the dynamic debt series is stationary, and if the debt series is I(1) then it still converges but at a rate Op(T)1/2. The key point relayed by Quintos is that cointegration is sufficient for debt sustainability but not necessary.

The point cast a shadow over the econometric work initiated by Hamilton and Flavin (1986) and others and begged the question - of whether cointegration is necessary to establish fiscal sustainability. Bohn (2007) gave perspectives on whether cointegration is necessary and through a review of various cointegration propositions by key authors (surveyed above), concluded that cointegration assumptions were too restrictive, and that cointegration was sufficient but not necessary as implied by Quintos. This is because at higher orders of integration I(m), debt can always be found to be sustainable. In short, the debt series can be differenced until it eventually shows stationarity. These doubts about cointegration and the restrictive assumptions used in previous work, particularly about the constancy of the interest rate and its definition, led to the introduction of fiscal reaction functions.

2.2.3 Fiscal Reaction Functions

In his seminal study, Bohn (1995) observes that the underlying assumption of dynamic efficiency does not appear to hold in post-1980s U.S data given that interest rates have tended to be consistently below growth rates in this period. Against this backdrop he asserts that there is a discrepancy between the traditional fiscal sustainability theory and reality, given that with growth rates consistently above interest rates, the debt to the GDP ratio at that time would be sustainable. The only assumption that would satisfy both theory and reality is if one assumed a stochastic rather than a deterministic economic framework, according to Bohn.

Bohn proves by way of a simplified Lucas growth model that in a stochastic economy, the NPG condition goes to zero in the limit even with interest rates below growth rates. More importantly, he establishes that the traditional discount rate employed - namely, the holding period interest rate on government bonds - is not the relevant discount factor for sustainability tests consistent with a stochastic economic environment.

It turns out that in a stochastic economy, debt is sustainable if the expected value of the fiscal deficit in some state of nature is offset by a fiscal surplus in some other state of nature, and if the expected value of the limit term (NPG) goes to zero.

Notably, a point of departure from traditional debt sustainability theory is that in a stochastic economy, the government is not required to accumulate a discounted surplus equal to initial debt, only that deficits in one state of nature be offset by surpluses in other states of nature, emphasizing the role of expectations in a stochastic economy. In other words, what matters most for sustainability is whether bondholders expect that the government will honour its commitments, which is signalled by their ability to run a required surplus in at least some states of nature.

The discount rate in the stochastic setting is the average Marginal Rate of Substitution (MRS) and reflects consumers' intertemporal preferences. Hence, Bohn notes that discounting by discount rate r rather than by the MRS would give incorrect results, assuming a stochastic economy. The difficulty is that it is not possible to proxy average discounted consumer preferences.

$$s_t = \alpha + d_{t-1}\rho + X_{kt}\gamma_k + \epsilon_t \tag{2.10}$$

Drawing on Barro (1979) tax smoothing model, it is possible, however, to conduct the test for fiscal sustainability via a fiscal reaction function (2.10). Bohn (1998) shows that the fiscal reaction function is consistent with the theory of an intertemporal budget constraint. In this framework, if the government responds positively to an increase in debt (if $\rho > 0$) then fiscal policy can be regarded as sustainable. X_{kt} is a matrix of other determinants of the primary balance s_t, including the output and expenditure gaps, and ϵ_t is the normal error term with N ~ (0, σ).

This approach has been used extensively in the recent literature (including by Abiad and Baig, 2005; Celasun *et al*., 2006; Daniel *et al*., 2003) to assess fiscal sustainability.

Compared to the econometric tests for the existence of government's IBC, the model-based test has several comparative advantages. It circumvents assumptions about interest rates and issues mentioned with respect to cointegration. Data requirements are also reduced, and the interpretation of sustainability is intuitive. A notable disadvantage nonetheless is that the approach is backward rather than forward looking. Most policymakers are interested in the sustainability of current not past policies. The fiscal reaction function assumes that past policy behaviour will carry on into the future. However, as has been shown by Quintos (1995) and Wilcox (1989), this is not necessarily the case. Approaches which embody the advantages of fiscal reaction functions but that can provide forward-looking advice would in this regard be superior to the basic fiscal reaction function. This type of framework has been achieved in the debt forecasts literature.

2.2.4 Simulated Debt Forecasts and Debt Thresholds Analysis

Recognizing the importance of anticipating future sustainability issues and the challenge of accounting for uncertainty, the literature's most recent innovation is the introduction of debt sustainability forecasts, represented pictorially in fan charts. In this area of work, the objective is to predict with some degree of certainty, whether the future path of debt is likely to surpass some debt sustainability threshold. Running a Vector Auto-Regression (VAR) model inclusive of dynamic variables is usually the starting point to generating probabilistic debt trajectories.

Garcia and Rigobon (2004) employ the approach to testing sustainability in emerging market economies, particularly Latin America. Providing their rationalization, the authors make some strong and relevant points:

"The properties of the covariance matrix are important to debt sustainability. For example, in developed economies, recessions (lower growth) are usually accompanied by a decrease in interest rates (expansionary monetary policy). If this is the case, then the recession and the deterioration of the primary deficit - which are hurting debt sustainability - comes with a reduction in the interest rate - which is helping sustainability. There is an automatic stabilizer in the equation. On the other hand, in emerging market economies, usually a recession deteriorates the fiscal accounts, increases the real interest rate, induces inflation, and depreciates the exchange rate. If the sovereign debt is in dollars, then all the variables are

making the debt dynamics worse. Therefore, for emerging economies, the risk(covariance) part of debt sustainability becomes predominant, and simulations that postulate independent paths for the relevant variables badly miss this key feature."

(2.11)

$$Y_t = c + B(L)X_t + v_t$$

Where,

$$X_t \equiv \left(\tilde{\varepsilon}_t, \tilde{r}_t, \tilde{g}_t, \tilde{f}_t, \tilde{s}_t, \tilde{\pi}_t\right)$$

$$v_t \sim N(0, \Omega)$$

They construct a VAR model as in (2.11), where X_t is a vector of stochastic debt determinants, B(L) are coefficients of lagged variables and v_t is a vector of reduced form residuals with variance-covariance matrix **Ω**. The VAR model is deduced from the debt accumulation equation (2.3), rearranged to estimate stochastic shocks $\tilde{\varepsilon}_t$. The Choleski decomposition of the reduced form residuals are used to generate paths of stochastic shocks, whereas B(L) are used to calculate several paths of the variables in X_t via Monte-Carlo simulation. More importantly, several possible debt paths are generated using (2.3), contingent on the estimated joint dynamics.

This approach produces risk probabilities that allows for an assessment of the uncertainties surrounding the projected debt paths. For example, Garcia and

Rigobon use the approach to estimate the probability of debt surpassing a debt to GDP ratio of 75 percent.

Likewise, Celasun *et al*. (2006) construct risk probabilities but using a fan chart approach. In this method, simulated economic scenarios (produced by the VAR variance-covariance matrix) are combined with the estimated fiscal policy process (represented by a fiscal reaction function) to produce annual public debt paths. Subsequently Monte-Carlo simulations of random shocks (for example, repetitions of 10, 000 simulations) are used to construct a large sample of public debt forecasts for each year in the forecast horizon. Extracted from these forecasts is the frequency distribution which allows for a probabilistic assessment of debt dynamics. The distribution of paths around the median projection is interpreted as confidence bands for varying degrees of uncertainty.

Note that Celasun *et al*. (2006); Garcia and Rigobon (2004) do not specify a VAR with debt levels. As such, Favero and Giavazzi (2007) imply that their models are not well specified. Kawakami and Romeu (2011) improve debt forecast studies using the Favero and Giavazzi approach to calculate stochastic debt forecasts. This enables projected debt distributions of both the joint realization of the fiscal policy reaction to contemporaneous stochastic macroeconomic projections, and the second-round effects of fiscal policy on macroeconomic forecasts.

As covered in Section 2 on sustainability indicators, debt targets are a common way to assess whether debt sustainability has been breached. In the indicator literature, this is done by exogenously determining a debt threshold or desired fiscal rule and examining whether the current debt level or fiscal policy targets exceed the expected threshold.

For example, for non-market access countries, the IMF, and World Bank Debt Sustainability Framework (DSF) derives from a probit model that attempts to rule on the probability that a country will default, provided various debt sustainability thresholds, including against predetermined debt to export and debt to revenue ratios. A country's average growth rate and rating on the World Bank's country policy institutional assessment (CPIA) are the main explanatory variables of the model. Depending on the probability of default estimated, a country is assigned one of four ratings: at low, moderate, high risk of debt distress, or in debt distress (Mitchell, 2016).

However, there is another strand of debt sustainability threshold literature which aims to endogenously determine debt thresholds, based on the hypothesis that a country will have a debt limit. These models include that of Rogoff and Reinhart (2013) who posit that the debt threshold is at the point where an increase in debt leads to negative growth. They inspire a long line of research through their finding that globally, as debt ratios rise above 90 percent of GDP, growth turns negative on average, and as a result debt is not sustainable beyond this point. Gosh *et al.* (2013), on the other hand, treats a debt threshold as the point beyond which further increases in debt paralyses a government's ability to raise further primary surpluses. There's is known as the fiscal fatigue theorem and follows from Bohn (2005) fiscal reaction functions.

Another method for identifying debt thresholds has been to assess the point beyond which further increases in debt will drive a sharp increase in interest rates – the so-called doom loop (Alcidi and Gros, 2019), forcing debt default. Methods of this kind include tests of debt intolerance by Reinhart and Rogoff (2003); and the fair spread approach by Xu and Ghezzi (2003). They are market-based approaches to identifying debt thresholds and with regard debt sustainability theory, are related to the impact of the interest-growth rate differential. Interest rates grow exponentially, for example, in the case of debt intolerance if countries have a record of default in the past and begin to incur what creditors believe to be worrying levels of debt. The exponential interest rate growth in turn worsens debt dynamics, eventually causing countries to default. The point at which countries default is regarded by Reinhart and Rogoff as the debt threshold.

2.3 Motivations and Approaches to Debt Sustainability Assessments from Across the Regions and the Caribbean

Recognising the deleterious effects of unsustainable debt as witnessed in countries like Argentina (Daseking *et al*., 2005) and Greece (Kouretas and Vlamis, 2010), and in regions like Africa (Callagy, 1984; Nyerere, 1985) and Asia (Wade, 1998; Benmelech and Dvir, 2013), authors have developed the different methods of assessment described above. However, the approaches to debt sustainability assessment per region have tended to vary depending on the characteristics of the countries or regions in question, reflecting in many instances the peculiar challenges faced by governments in these contexts.

2.3.1 Non-Caribbean Regions

For example, academic disputes over the sustainability of U.S fiscal policy (Hamilton and Flavin, 1986; Trehan and Walsh, 1988; Hakkio and Rush, 1991; Quintos, 1995; Bohn, 1995; 1998; Uctum and Wickens, 1993;1997), as discussed earlier in this review, have fueled methodological approaches to assessing debt sustainability in North America, and particularly the U.S. However, these approaches, for example, the various econometric tests on the IBC and the fiscal response function, have also been widely applied to examine debt sustainability issues in other regions (as evidenced below), and to large extent, globally, making North American market characteristics a core feature of debt sustainability assessment.

Research on the European Union also features highly in the literature. The EU's central interest in the topic is primarily due to the EU's Maastricht Treaty, which accords a regional debt sustainability target of 60 percent of GDP for all EU countries (Barnes *et al*., 2016; Gaspar, 2020). There have been other related motivating factors for the EU, including the impact of the

2008 global financial crisis (Peterson and Nadler, 2014), known as the Euro debt crisis (Mitchener and Trebesch, 2023), which saw the collapse of Europe's debt sustainability and consequent economic decline in Greece, as well as contagion in several neighbouring European nations (Mink and Haan, 2013). Additionally, and more recently, the effects on EU debt of the Global COVID-19 pandemic (Papaioannou and Tsetsekos, 2021). These crises spurred work on the transmission of sovereign risk to firms, and the investment and output impact. Moreover, on sovereign-bank "doom-loops" as well as the financialization of the global economy (Mitchener and Trebesch, 2023).

The bi-directional relation between the fiscal and current accounts, coined by Canale and Marani (2014) "Siamiese Twins", and the implications for the common currency and economic stability in Europe has been another prime motivation for fiscal sustainability research in the region. Largely, debate amongst Eurozone academics on the direction of causality, that is, whether fiscal imbalances in Europe have led to current account imbalances and crises, or vice versa (Cessarato, 2012), as well as whether imbalances are symptoms rather than core causes of crisis. The latter school of thought (Gros, 2012; Lavoie, 2015; Micossi, 2015a; Micossi, 2015b) points to structural issues such as the EU's design flaws, lack of fiscal integration, and lack of economic competitiveness as core causes.

Authors such as Afonso (2005; 2008) (See also Afonso and Coelho, 2022; 2023; Afonso and Jalles 2012; 2016; 2017; Afonso and Rault, 2010; Afonso and Alves, 2021; 2023), among others, have also contributed significant research on the EU region, and have largely sought to ascertain the applicability of the principal methods of assessment to the EU context and to provide perspectives on whether the EU's debt or fiscal policy remains sustainable, amid the various challenges and crises.

The other methodological approaches in the literature, including the various sustainability indicators and debt sustainability forecasts have been founded elsewhere, for example in emerging markets, and are primarily applied in these contexts, as they are motivated by the region's challenges and peculiarities.

From Latin America, the most notable contributions have been Garcia and Rigobon (2004) and Celasun *et al*. (2006) probability forecasts, and Mendoza and Oviedo (2009) natural debt limit, both of which have been reviewed, and adaptations of the fiscal response function to identify debt thresholds. On the latter, Celasun *et al*. (2006) specifies a fiscal reaction function for 34 emerging market economies using panel regression methods. The model is expressed with a debt to GDP ratio with kink - representing a threshold of 50 per- cent debt to GDP. Modification of the fiscal reaction function with the kink term allows one to gauge the threshold beyond which government can no longer respond positively to increases in debt. With debt ratios beyond this point, the government's fiscal policy is deemed unsustainable.

In Sub-Saharan Africa, a combination of high debt, anemic growth, and consequent extreme poverty in the 1980s led to the highly indebted poor country initiative (HIPC) (Easterly, 2002) and subsequent development of the IMF and World Bank debt sustainability assessment framework (DSF) (Boote, 1997), which is used to assess the sustainability of debt in low-income and middle-income countries that do not have market access (Berg *et al*., 2014).

Owing to the large number of low-income countries in Africa, the IMF DSF though meant to be a global tool for debt assessment of non-market access countries, is almost Africa specific. That is, the usual method for assessing Africa's debt sustainability is the IMF DSF due mainly to the high number of low and low-middle income countries in the region. At the year 2022 there were 19 low-income and 22 low-middle income countries in Sub-Saharan Africa (Nada *et al*., 2023). In the larger African countries like Nigeria, Ghana and South Africa, however, there have been numerous studies employing, for example, the fiscal response function to investigate the sustainability of these countries' debt (See for example Nya and Onyimadu, 2019; Akosa, 2015; Jooste *et al*., 2011), as fiscal policy is more likely to be influenced by market pressures given their access to financial markets.

For these larger countries in Africa and other regions that do have market access, the IMF and World Bank employ the DSF for Market Access Countries (MACs) (Cassimon *et al*., 2017), which is also a popular assessment method owing to a lack of capacity in African and Caribbean Central Banks and governments, as well as due to data scarcity. Note that apart from the sustainability indicators, most of the other key approaches, and especially debt sustainability forecast methods, require extensive historical or high frequency data, and these are not generally in ample supply in developing countries (WEO, 2023).

2.3.2 Caribbean Region

This is partly why the Caribbean region is often lumped with Latin America in the debt sustainability literature, and additionally, why there is a paucity of specific studies on debt sustainability in the Caribbean. The English-speaking Caribbean region is small, consisting of only 13 countries, and data is quite limited, especially on fiscal trends. Since these countries' independence in the 1960-70s, the literature survey reveals that there have only been 15 Caribbean specific studies on debt sustainability issues, which despite the data challenges is rather astonishing considering that the region is the most highly indebted of the developing country regions in the world and has been constantly saddled with high debt (Figure 2.1: Trends in Global Debt), as well as a comparatively large number of debt defaults and restructurings (Buerman *et al*., 2021). Typically, these would be very strong motivations for extensive research in the area.

A related issue is that the methods of research employed in Caribbean fiscal research have generally not kept pace with the innovations and consensus in the broader literature, raising questions about the validity of some studies and the actual state of fiscal sustainability in the region.

For instance, Scott-Joseph (2008) in a quest to examine the most appropriate approach for assessing fiscal sustainability in the Caribbean, concludes that the most suitable are primary gap indicators, citing their lack of complexity. In addition, Scott-Joseph also seems to suggest that for the region, the use of econometric approaches ranks second-best, noting that while they permit the utilization of quantitative techniques to support macroeconomic theory, they present weaknesses due to assumptions of certain fixed parameters.

This preference for the very basic primary gap indicators and traditional econometric tests in Caribbean debt sustainability research is evident. Five of eight (8) studies, Archibald and Greenidge (2003); Grenade (2011); Kufa et al. (2003); Sahay (2005); Wright et al. (2009) seeking to assess fiscal sustainability in the Caribbean employ primary gap indicators, while two utilize cointegration techniques - Archibald and Greenidge (2003) and Wright et al. (2009). Further, until recently, none but a working study by La Corbiniere and Craigwell (2011) employed the fiscal reaction function. However, in 2020 two studies by Cevik and Nanda (2020) and Khadan (2019) applied fiscal reaction functions to test for the region's fiscal sustainability.

Turning back to the issue of motivation, the countries under study in the Caribbean's research on debt sustainability are for the most part Barbados, Jamaica and St. Kitts and Nevis, due primarily to their historically high debt ratios. This constant high debt burden that has characterized the Caribbean countries has been a prime motivation for the existing research, particularly in the context of the region's high vulnerability and dependence on external financing for social development.

Another important motivation for research on the Caribbean's fiscal sustainability, which is known but often overlooked in the extant studies, is the dominance and importance of fiscal policy in the region.

Table 2: Caribbean Exchange Rate Regimes

	Exchange Rate Regime	
Countries	**Flexible**	**Fixed/Managed**
Antigua and Barbuda	☐	☒
Bahamas, The	☐	☒
Barbados	☐	☒
Belize	☐	☒
Dominica	☒	☒
Grenada	☐	☒
Guyana	☐	☒
Jamaica	☒	☐
Saint Lucia	☐	☒
St Kitts and Nevis	☐	☒
Suriname	☒	☐
St Vincent and the Grenadines	☐	☒
Trinidad and Tobago	☒	☐

Note: Jamaica's exchange rate regime is recorded as floating but in practice the Central Bank of Jamaica intervenes regularly to ensure a stable exchange rate.[7] Also note that Suriname's regime was changed from fixed to floating only recently (June 2021).[8]

As mentioned in Chapter 1 and hereby illustrated in Table 4, 10 of the 13 Caribbean

[7] See https://sta.uwi.edu/conferences/09/finance/documents/EXCHANGE_RATE_IN_JAMAICA.pdf.

[8] See UNECLAC Economic Survey for Latin America and the Caribbean, Chapter: Suriname, Section 2. Economic Policy, Subsection c. Exchange Rate Regime. https://repositorio.cepal.org/server/api/core/bitstreams/425ef63d-ede1-4469-b123-7138b6ccaab4/content#:~:text=On%207%20June%202021%2C%20the,%24%2021.126%20per%20US%24%201.

countries under study hold fixed/managed exchange rate regimes, which by way of the impossible trinity[9] voids their monetary autonomy and renders fiscal policy the dominant policy tool for addressing shocks, exchange rate misalignment, and sustainable development. Disturbances to fiscal policy sustainability, for example, from excessive indebtedness, are therefore of critical importance to Caribbean policy makers.

Not having monetary autonomy means that alternative financing of the Caribbean's public debt either through inflation surprises, exchange rate appreciation, or seigniorage, is ruled out. Therefore, the fiscal sustainability models that do not concern themselves with these alternative avenues for debt financing are appropriate in this context. These, except for the IMF extended market-based approach[10], would include most assessment methodologies surveyed in this literature review since they are all derived from basic debt theory, which usually ignore alternative avenues for financing the fiscal deficit and debt.

In particular, the irrelevance of alternative financing modalities for the Caribbean together with Quintos' (1998) and Bohn's (2007) findings that 'cointegration is sufficient but not necessary, justifies this thesis' preference for Bohn's fiscal reaction function for modelling public debt sustainability in the Caribbean, at least a priori.

[9] Brief discussion in https://escholarship.org/uc/item/9k29n6qn.
[10] The IMF debt sustainability analysis for market-based countries can be extended to account for exchange rate, interest rate and possible inflation fluctuations that can help to finance the fiscal deficit and debt obligations.

Of course, all debts are not born equal as noted in Debrun *et al.* (2019). Hence it should also be recognised that the fiscal reaction function as a standalone instrument of assessment, though preferred, is not optimal. This is because the fiscal reaction function does not account for countries' debt vulnerabilities which can explain why a sovereign with the same debt to GDP ratio as another might be subject to default, while the other might not. A country's debt vulnerability will typically depend not only on its overall debt to GDP ratio or history of default (Reinhart and Rogoff, 2003), but also on its debt's currency composition, maturity structure, ownership, creditor type, and contract type that can cause liquidity and eventually, solvency challenges.

The review of the Caribbean literature in Table 2.3 highlights that apart from the IMF's debt sustainability assessment contained in its Article IV Reports, none of the previous research on the Caribbean have attempted such granular analysis. This is primarily because consistent data on the Caribbean's debt composition is not readily available or published, but more often piecemeal due to a lack of debt transparency (Robinson, 2021). This seems to hold not only for the Caribbean but for most developing regions, thereby underlining the IMF's recent and keen interest in this area (IMF, 2023).

In the IMF Article IV Reports 2023-24, the IMF presents only graphical illustration of the most recent public debt composition in Caribbean countries. There is no country specific data for the Caribbean. The graphical illustrations extracted from the IMF Article IV reports are presented in the Appendix Figures A.1 – A.9 by country of origin.

For the most part, the illustrations suggest that beyond their high average debt to GDP ratios, debt vulnerabilities in the Caribbean at the year 2023 were not significantly high. The majority share of debt portfolios in the region is held by domestic creditors, roughly 60 percent from the charts, and relatedly, denominated in domestic currency. Foreign currency debt is only high in St Lucia, Jamaica and Bahamas, where at least half of the portfolio is to foreign creditors. Nevertheless, the lion share of foreign creditors are multilaterals rather than private entities or individuals. The proportion of marketable debt though has been rising across the region, meaning that the Caribbean is increasingly subject to market scrutiny. This seems to be occurring due to larger holdings on non-concessional multilateral debt. In terms of the maturity profile of Caribbean debt, it is mostly long tenured. Only St Kitts and Nevis and The Bahamas hold a sizeable share of debt with average medium-term maturities (1-5 years).

Accordingly, the studies in this area have found that the Caribbean's public debt, despite its relatively high global share and some mixed results, is largely sustainable (for example see Grenade (2011); Wright et al. (2009). Grenade (2011) and Thacker and Acevedo (2011); Cevik and Nanda (2020) and Khadan (2019)) (Table 2.3).

Table 2.3 Primary Research on Fiscal Sustainability in the Caribbean

Research Objectives	**Authors**	**Methodology Applied**
Is debt in the Caribbean Sustainable? What is the Level of Fiscal Adjustment Needed?	Grenade (2011)	Primary Gap Indicators
	Wright *et al*. (2009)	Primary Gap Indicators; Cointegration; Unit root tests
	Sahay (2005)	Primary Gap Indicators
	Kufa *et al*. (2003)	Primary Gap Indicators
	La Corbiniere and Craigwell (2011)	Fiscal Reaction Functions
	Archibald and Greenidge (2003)	Primary Gap Indicators Cointegration and Unit root tests
	Cevik and Nanda (2020)	Fiscal Response Function
	Khadan (2019)	Fiscal Response Function
What is the Optimal Level of Debt in the Caribbean?	Wright and Grenade (2014)	Panel Dynamic OLS - Debt and Growth regression
	Greenidge *et al*. (2012)	Threshold Model - Debt and Growth Regression
	Thacker and Acevedo (2011)	Panel VAR Growth -Tourism, Debt and Growth
	Nicholls and Peter (2014)	Primary Gap Indicator Natural Debt Limit
	Leonce and Hope (2013)	Primary Gap Indicator; Natural Debt Limit; Fiscal Reaction Functions
	Branch and Adderley (2009)	Calibration of Static Fiscal Sustainability Equations
What is the Most Appropriate Model for Assessing Fiscal Sustainability in the Caribbean?	Scott-Joseph (2008)	Primary Gap Indicators Cointegration and Unit root techniques

Another key driver of the existing research on the Caribbean is the need to identify the region's debt limit. Around one fifth of the studies surveyed here are concerned with this research question and derive primarily from the proposition of a debt-growth nexus, hypothesizing that the threshold debt level is the point at which the debt to GDP ratio is consistent with a negative growth rate.

Estimates from these Caribbean studies range between 30 and 61 percent of debt to GDP. Employing a panel dynamic ordinary least squares specification of a debt-growth model and data for Grenada, Jamaica, St. Kitts and Nevis, Antigua and Barbuda and Barbados, Wright and Grenade (2014) find a debt limit of around 61 percent. This contrasts slightly with the results of Greenidge *et al*. (2012) who uses Hansen *et. al* (1999) threshold model and estimates a lower threshold of 55-56 percent based on a wider dataset of countries.[11] Moreover, these estimates differ slightly with that of Thacker and Acevedo (2011) and Leonce and Hope (2013)[12] who find thresholds of 60 percent and 30 percent, respectively.

The threshold evidence supports Caribbean governments' adoption of the Maastricht and IMF 60 percent debt to GDP ratio rule of thumb and the debt ratio itself as a key barometer of Caribbean debt sustainability. Its adoption in the region, and in many other developing countries, is also due to the debt ratio's simplicity and communicative ability. The debt to GDP ratio is intuitive, communicating the

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[11] Includes Antigua and Barbuda, The Bahamas, Barbados, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, St Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago.
[12] For countries in the Eastern Caribbean Currency Union (ECCU).

share of earned income that a country is spending on its total debt obligations, the capacity of the country to service its outstanding liabilities (Blanchard *et al*. 1990). Further, amongst the list of traditional debt sustainability indicators, the debt to GDP ratio is the international reference point for assessing potential risks to solvency.[13]

However, the literature examining the intertemporal consequences of ever rising debt and its determinants as well as the discussion in Horne (1991) on the distinction between solvency and sustainability, reminds us of the shortcomings which can emanate from depending solely on the debt to GDP ratio to provide information on long term debt sustainability issues.

2.4 Conclusion

Whilst the theory of debt sustainability is intuitive, the different interpretations of the implications surrounding government's IBC, and by consequence fiscal sustainability, have led to competing methodological approaches to assessing its existence. Approaches to fiscal sustainability assessment are also shaped by their regional origins, give for example the natural debt limit and probability forecasts of Latin America, which seek to account for the region's high volatility. Further, attention to the issue of sustainability is usually driven for the most part by the

[13] These include the debt service to exports ratio, debt service to revenue ratio, debt service to expenditure ratio, external debt to GDP ratio and domestic debt to GDP ratio etc.

occurrence of crises, or the prevalence of high debt within countries or regions.

Stimulated by fiscal policy debates of the 1980s, the literature on debt sustainability assessment experienced rapid development but seems to have stalled since the 1990s post discovery of fiscal response functions, which is now the main method of choice. On this matter, note that developments on sustainability assessment methods since Bohn (1995), including for example the probability forecasts of Garcia and Rigobon (2006) and the fiscal fatigue hypothesis of Gosh *et al*. (2013) are but extensions of the fiscal response function, rather than completely new initiatives.

Amongst the regions, studies on Caribbean debt sustainability are highly limited, despite the region's prominence in debt crises and its high-ranking global share of debt. This has caused a glaring gap in the literature, observed most prominently in the recent survey by Mitchener and Trebesch (2023) covering over 200 years of debt issues. A key consequence for the region is that the scarce evidence against fundamental questions on the sustainability of Caribbean debt is largely dated and based primarily on rudimentary methodological approaches.

Only within the past two years have published works made use of more contemporary assessment methods, primarily the fiscal reaction function and its extensions. With a short regional timeseries and 14 country cases data scarcity remains a significant challenge to debt sustainability research in the region. The recent works by Cevik and Nanda (2020) and Khandan (2019) employ panel data frameworks in a bid to overcome the data hindrance, but data constraints are still problematic for Caribbean wide implementation of debt forecasts, for example, which require high frequency fiscal data.

More attention towards overcoming constraints to research on Caribbean debt sustainability would help fill the wide gap with reference to studies focusing specifically on this region and would create the basis for more relevant policy advice. The fact that there are these constraints begs a relook at the question posed by Scott-Joseph (2008) – what is the most appropriate method for assessing debt sustainability in the Caribbean? And ultimately, what is the status as regards the sustainability of the Caribbean's debt? The literature review points to Bohn's fiscal reaction function as the method of choice and the key to updating on this question of the region's fiscal sustainability.

Moreover, with debt to GDP ratios in the region ranked amongst the highest in the world, and with most of the research on the region concluding in favour of fiscal policy sustainability, a natural and related question then is what is the Caribbean's debt threshold, if the region's current average debt to GDP ratio is already above 75 percent? Does the IMF rule of thumb apply to the region and are the estimates by Greenidge *et al*. (2012) and Wright and Grenade (2014) valid?

The above questions are critical to future Caribbean fiscal policy. Without a proper gauge of the region's debt limit, governments in the region, even with the necessary data, cannot adequately gauge the risks to their debt path, nor act with the appropriate policy speed.

The thesis provides an opportunity to revisit old questions and to unlock innovations which can overcome hurdles to Caribbean debt sustainability research. Its findings, however small, will assist in filling a wide gap.

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Appendix

Table A 2.1 Overview of Debt Sustainability Ratios

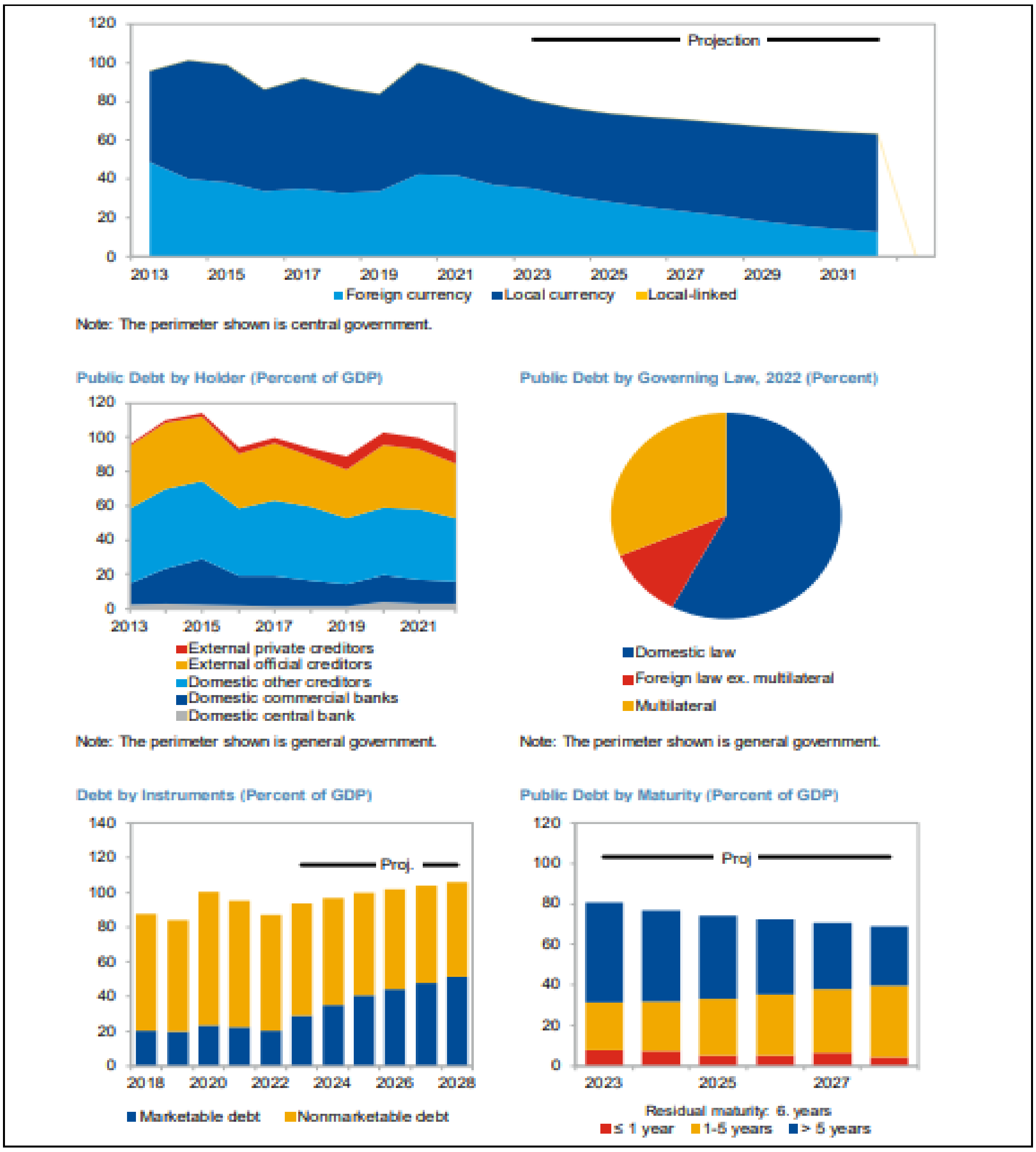
Indicator	Evaluation/Use
Solvency	
Interest service ratio	Ratio of average interest payments to export earnings indicates terms of external indebtedness and thus the debt burden
External debt to exports	Useful as trend indicator closely related to the repayment capacity of a country
External debt over GDP	Useful because relates debt to resource base (for the potential of shifting production to exports so as to enhance repayment capacity)
Present value of debt over exports	Key sustainability indicator used, for example, in HIPC Initiative assessments comparing debt burden with repayment capacity
Present value of debt over fiscal revenue	Key sustainability indicator used, for example, in HIPC Initiative assessments comparing debt burden with public resources for repayment
Debt service over exports	Hybrid indicator of solvency and liquidity concerns
Liquidity	
International reserves to short-term debt	Single most important indicator of reserve adequacy in countries with significant but uncertain access to capital markets; ratio can be predicted forward to assess future vulnerability to liquidity crises

Indicator	Evaluation/Use
Ratio of short-term debt to total outstanding debt	Indicates relative reliance on short-term financing; together with indicators of maturity structure allows monitoring of future repayment risk
Public sector indicators	
Public sector debt service over exports	Useful indicator of willingness to pay and transfer risk
Public debt over GDP or tax revenues	Solvency indicator of public sector; can be defined for total debt or for external debt
Average maturity of non-concessional debt	Measure of maturity that is not biased by long repayment terms for concessional debt
Foreign currency debt over total debt	Foreign currency debt including foreign currency indexed debt; indicator of the impact of a change in the exchange rate on debt
Financial sector indicators	
Open foreign exchange position	Foreign currency assets minus liabilities plus net long positions in foreign currency stemming from off-balance-sheet items; indicator for foreign exchange risk, but normally small because of banking regulations
Foreign currency maturity mismatch	Foreign currency liabilities minus foreign currency assets as percent of these foreign currency assets at given maturities; indicator for pressure on central bank reserves in case of a cutoff of financial sector from foreign currency funding
Gross foreign currency liabilities	Useful to the extent that assets are not usable to offset withdrawals in liquidity

Indicator	Evaluation/Use
Corporate sector indicators	
Leverage	Nominal (book) value of debt over equity (assets minus debt and derivatives liabilities); key indicator of sound financial structure; high leverage aggravates vulnerability to other risks (for example, low profitability, high ratio of short-term debt/total debt)
Interest over cash flow	Total prospective interest payments over operational cash flow (before interest and taxes); key cash flow indicator for general financial soundness
Short-term debt over total term debt (both total and for foreign currency only)	In combination with leverage, indicator of vulnerability to temporary cutoff from financing
Return on assets (before tax and interest)	Profit before tax and interest payments over total assets; indicator of general profitability
Net foreign currency cash flow over total cash flow	Net foreign currency cash flow is defined as prospective cash inflows in foreign currency minus prospective cash outflows in foreign currency; key indicator for unhedged foreign currency exposure
Net foreign currency debt over equity	Net foreign currency debt is defined as the difference between foreign currency debt liabilities and assets; equity is assets minus debt and net derivatives liabilities; indicator for balance sheet effect of exchange rate changes

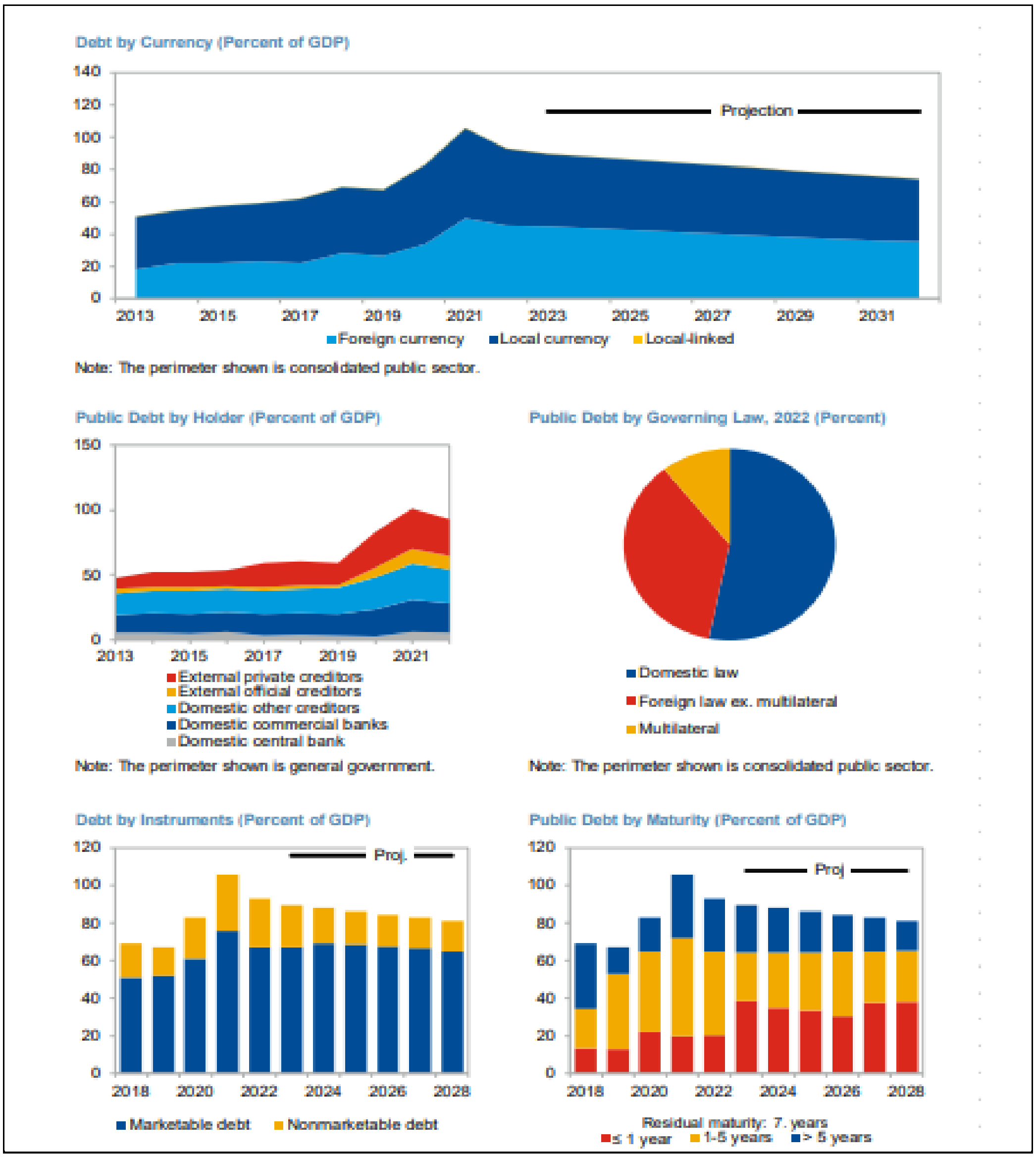
Source: IMF, I., 2003. External Debt Statistics: Guide for Compilers and Users-Appendix III. *Washington DC.: IMF*.

Figure A.1 Antigua and Barbuda Public Debt Structure Indicators (2023)



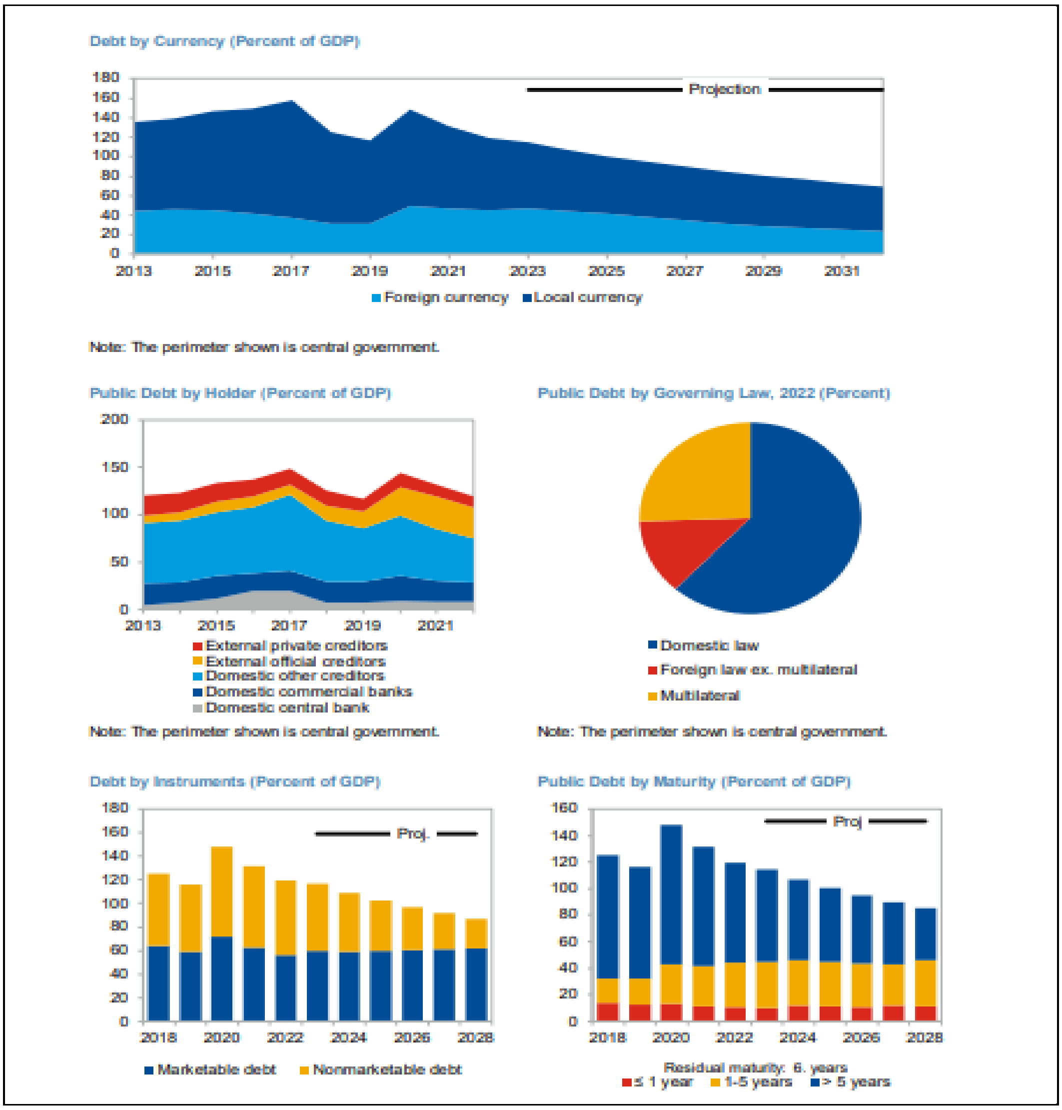
Source: IMF Article IV 2023, Antigua and Barbuda, pg. 47.

Figure A.2 Bahamas Public Debt Structure Indicators



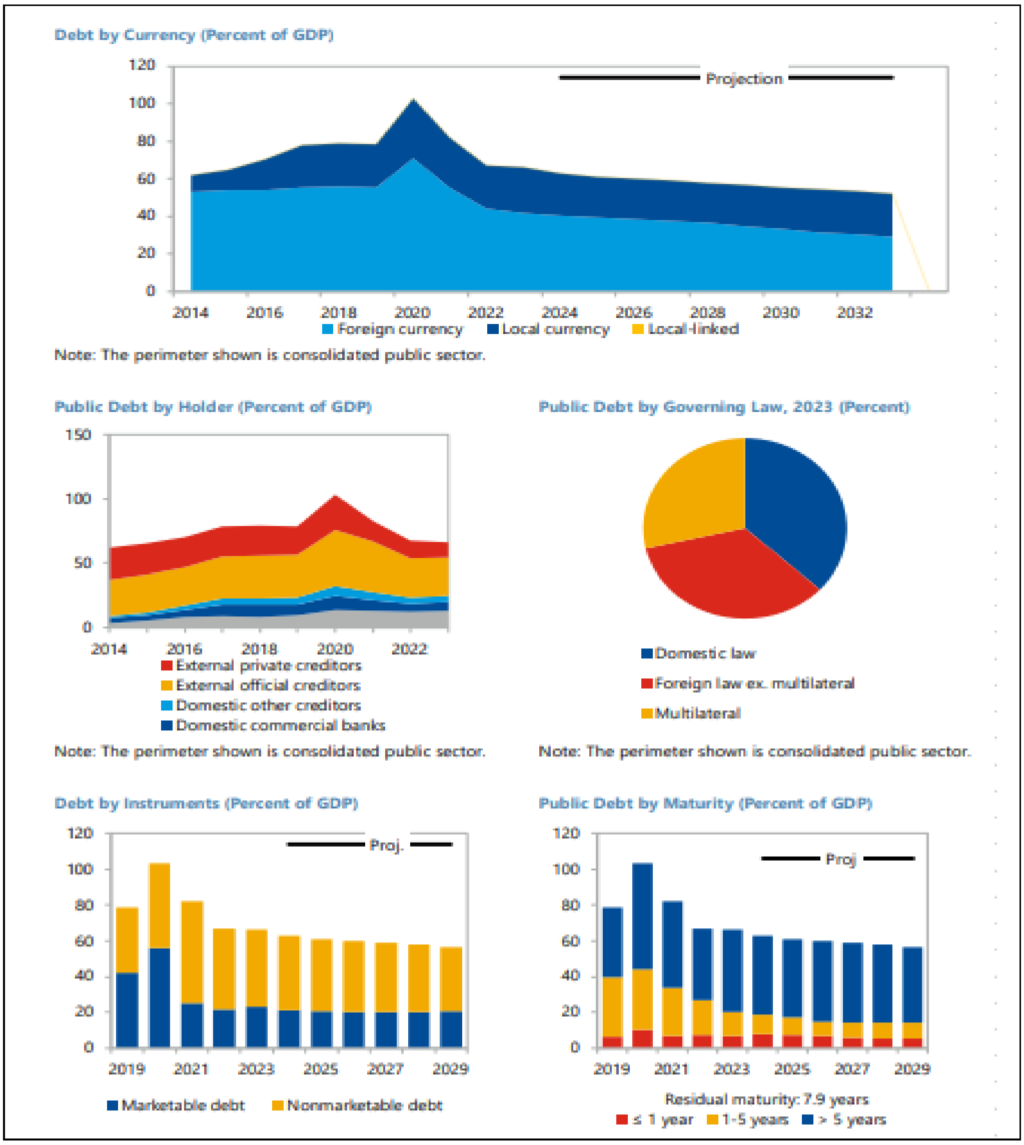
Source: IMF Article IV 2023, Bahamas, pg. 52.

Figure A.3 Barbados Public Debt Structure Indicators



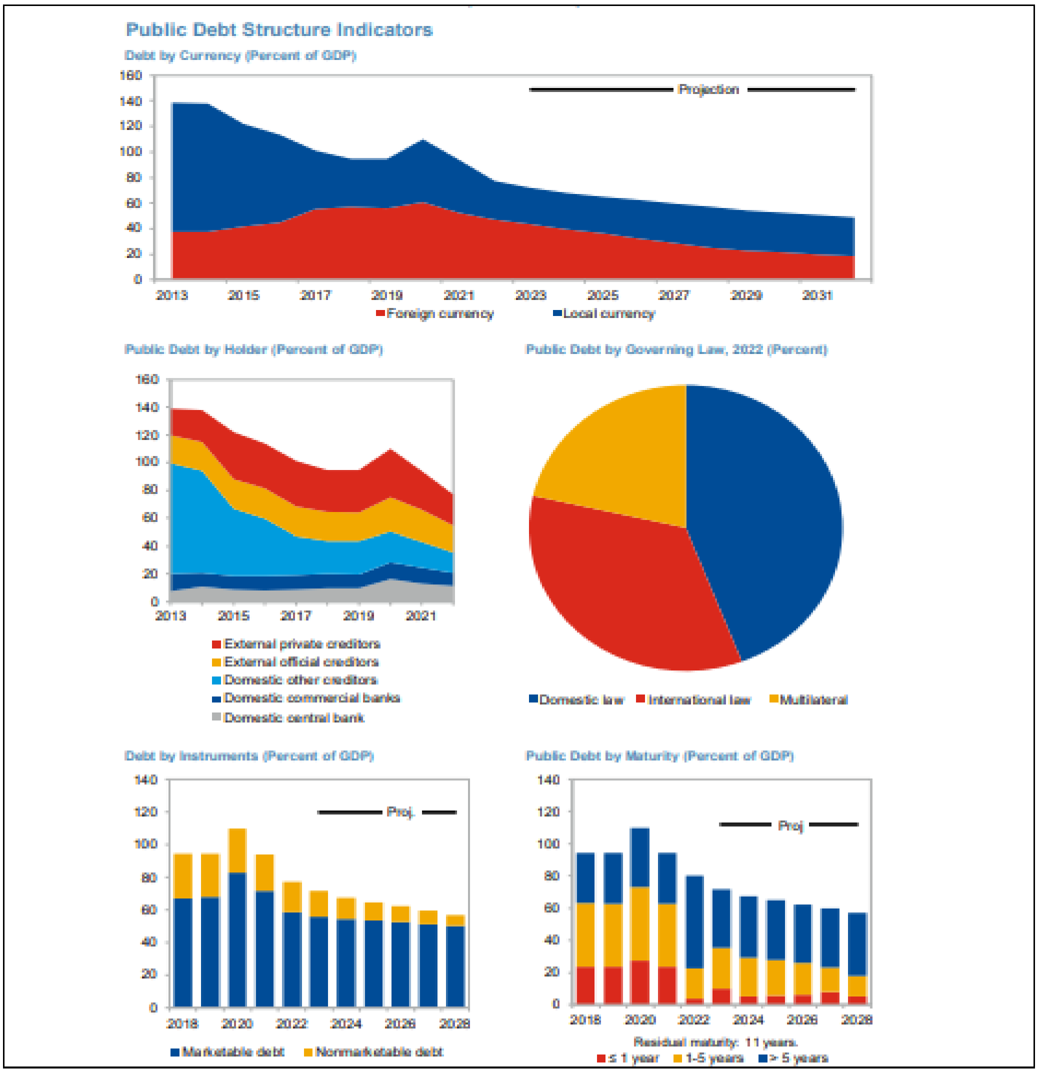
Source: IMF Article IV 2023, Barbados, pg. 67.

Figure A.4 Belize Public Debt Structure Indicators



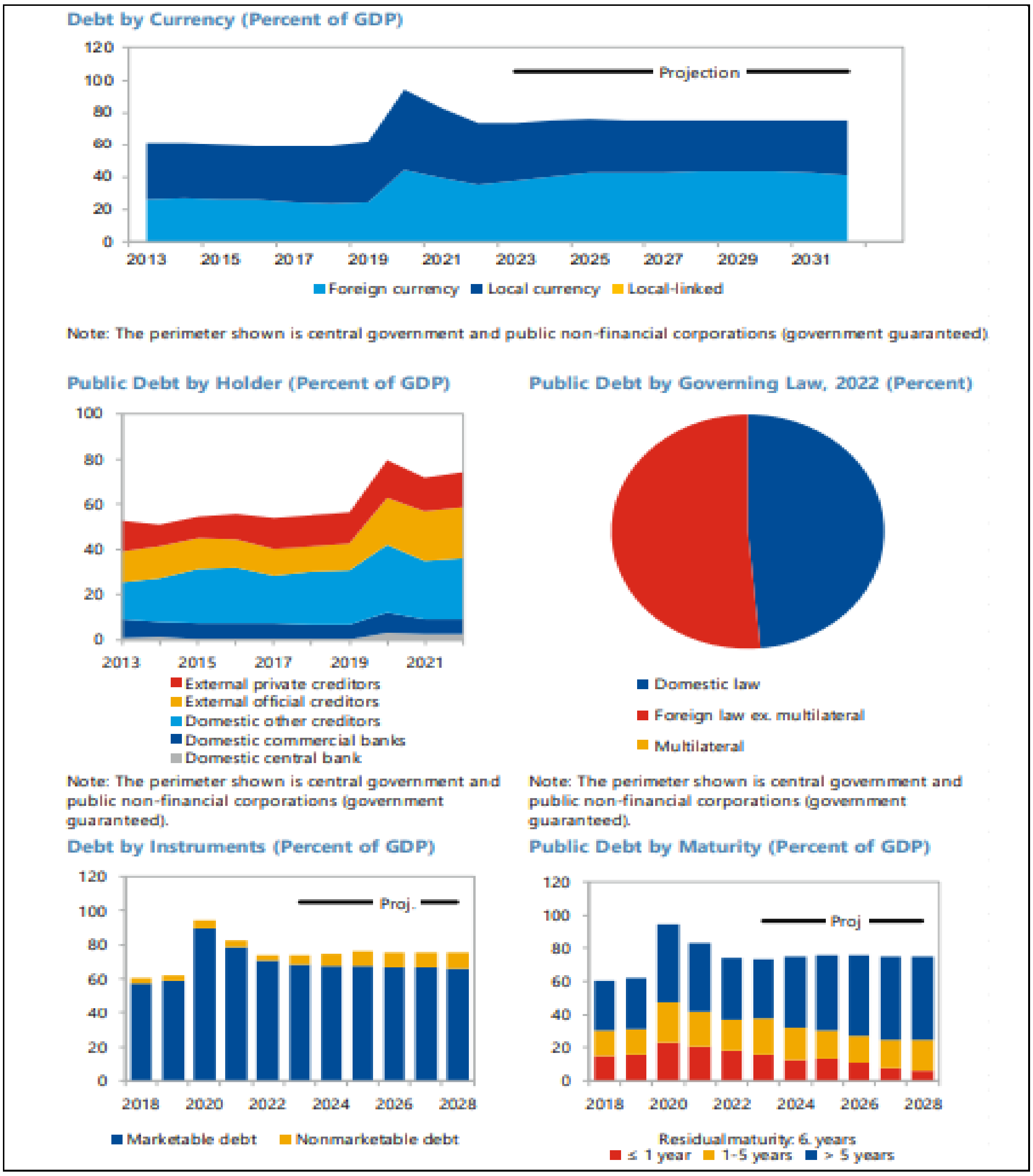
Source: IMF Article IV 2023, Belize, pg. 45.

Figure A.5 Jamaica Public Debt Structure Indictors



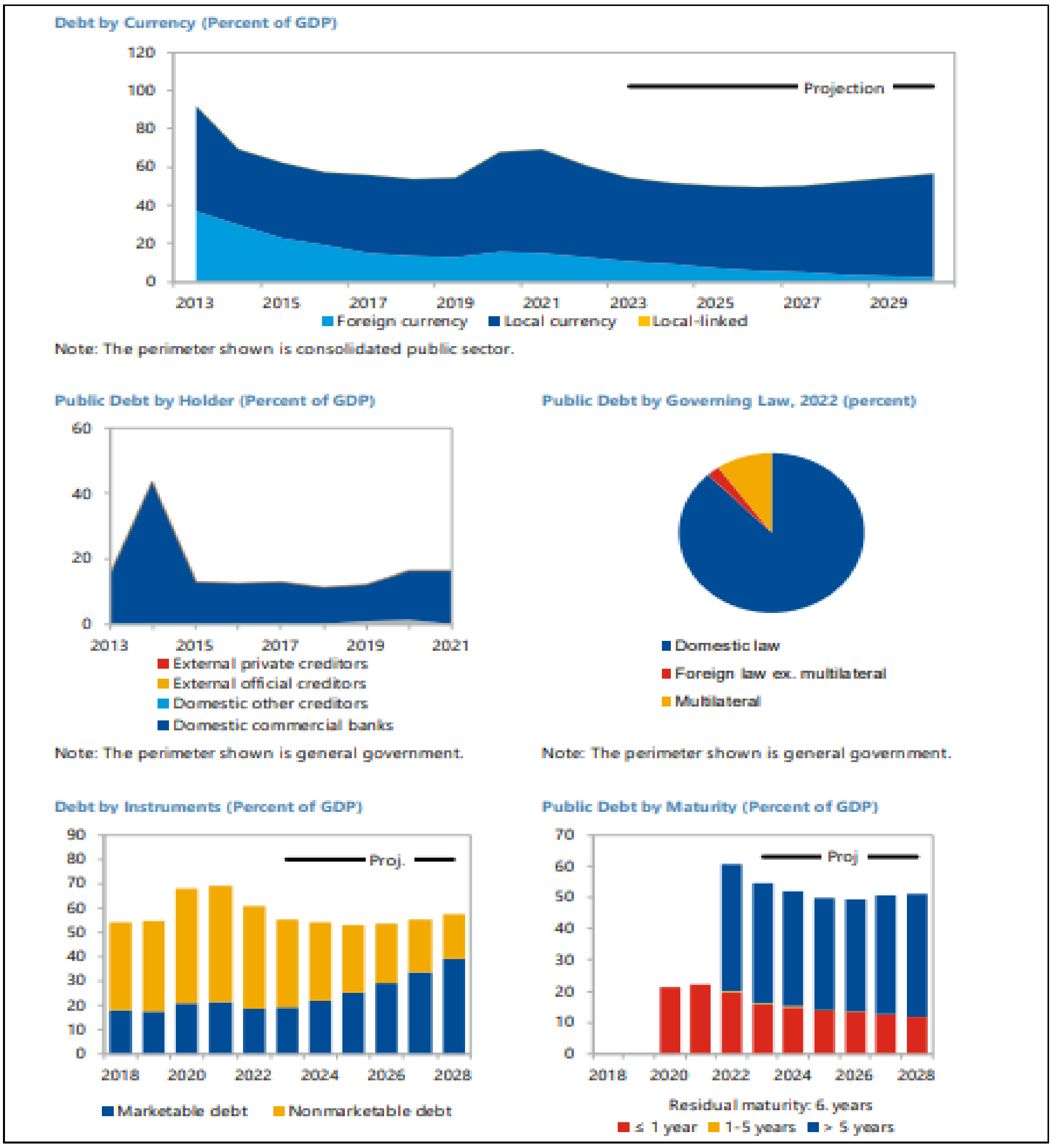
Source: IMF Article IV 2023, Jamaica, pg. 57.

Figure A 6 St Lucia Public Debt Structure Indicators



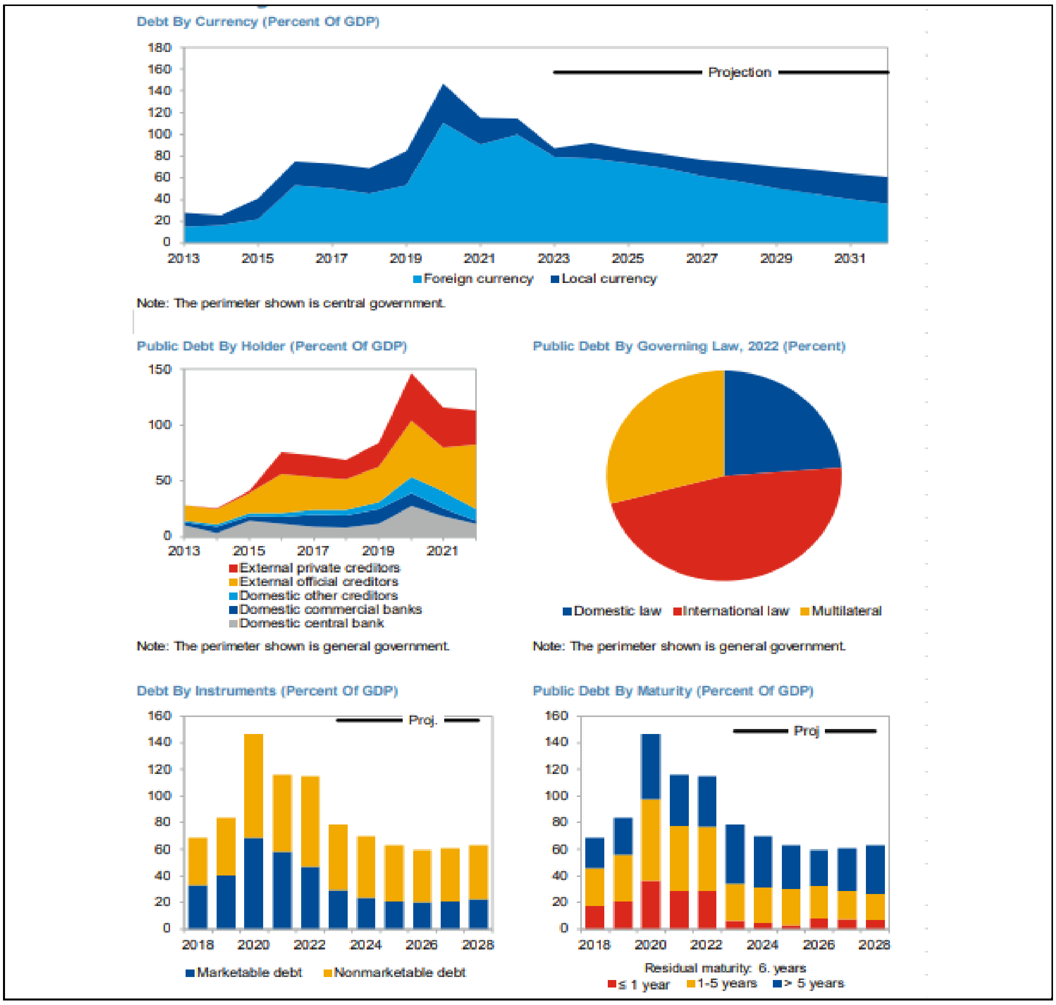
Source: IMF Article IV 2023, St Lucia, pg. 40.

Figure A 7 St Kitts and Nevis Public Debt Structure Indicators



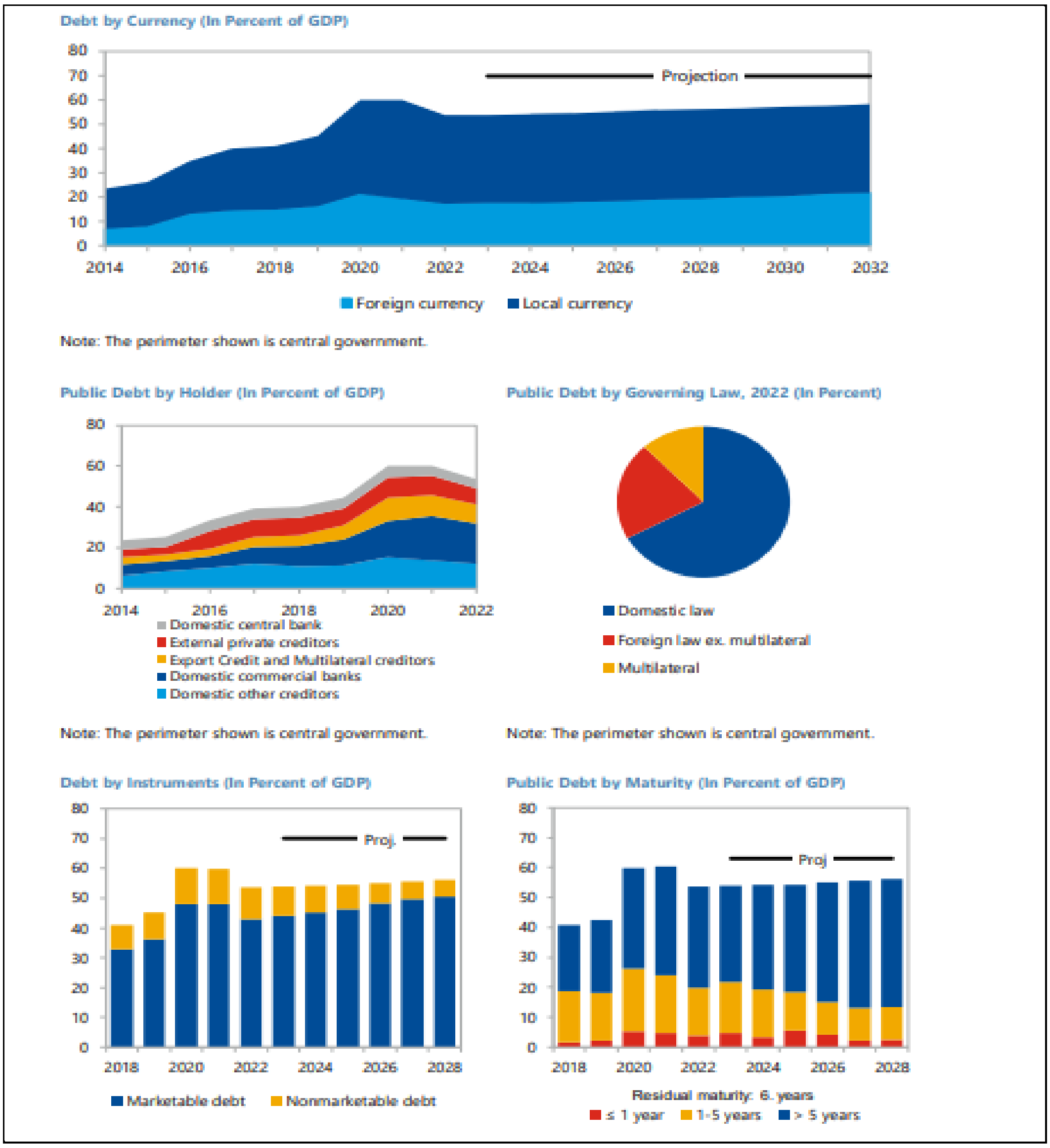
Source: IMF Article IV 2023, St Kitts and Nevis, pg. 39.

Figure A 8 Suriname Public Debt Structure Indicators



Source: IMF Article IV 2023, Suriname, pg. 49.

Figure A 9 Trinidad and Tobago Public Debt Structure



Source: IMF Article IV 2023, Suriname, pg. 66.

Chapter 3 An Empirical Assessment of Fiscal Sustainability in the Caribbean

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Abstract

The study conducts an empirical test for fiscal sustainability in the Caribbean using a debt sustainability cointegration approach. This approach helps to overcome existing data issues and adds to the limited debt sustainability literature for the region. Adopting an ARDL Bounds Testing procedure, the study concludes the presence of sustainable debt in 6 of the 9 Caribbean countries covered in the research.

Keywords: Debt Sustainability; ARDL; Co-Integration.

3.1 Introduction

The English-speaking Caribbean consists of 13 small island independent nations, 9 of which are in the Eastern Caribbean Currency Union (ECCU)[15]. These countries subscribe to fiscal and monetary benchmarks, like those of Europe's Maastricht Criteria (Polasek and Amplatz, 2003). In terms of the fiscal benchmarks, ECCU countries target debt and fiscal balances of 60 percent and 5 percent of GDP, respectively (Schipke *et al*., 2013). The remaining Caribbean countries though not part of the monetary union, do likewise but in a more informal manner.

The importance of fiscal policy in the Caribbean is heightened by these countries fixed or quasi-fixed exchange rate regimes (Mitchell, 2016) and liberalised capital accounts, which together nullifies Caribbean monetary policy (Cevik and Zhu, 2019), leaving fiscal policy as the main channel to address issues of growth, shocks, inflation, and economic stabilisation.

As small island developing states (SIDS), maintaining fiscal policy targets is complicated by these islands' small size, diseconomies of scale, export concentration,

[15] Information on the ECCU can be found here: https://www.imf.org/en/Countries/ResRep/ECC-Region.

and vulnerability to natural disasters. Owing to these and other impediments, Caribbean countries face constrained domestic resource mobilization, which is compounded by an absence of abundant natural resource (Acevedo *et al*., 2013).

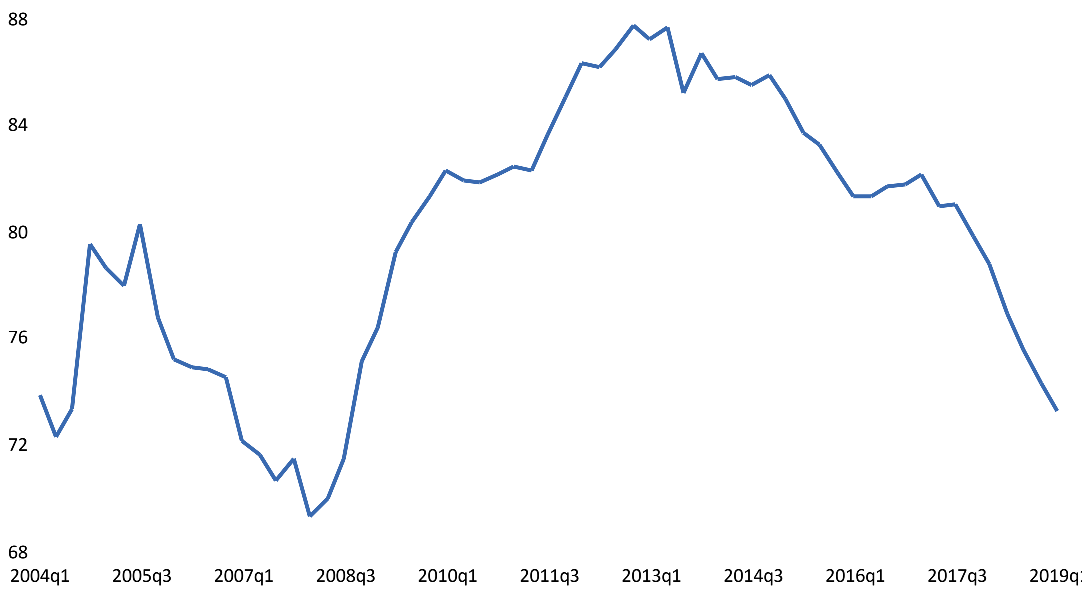
Tourism is the major and often sole engine of growth for most of the Caribbean region (Acevedo *et al*., 2013), accounting for up to 60 percent of GDP in some cases, for example in Antigua and Barbuda. Trinidad and Tobago, Suriname and now Guyana are the only commodity driven economies in the region, benefiting from their endowments of oil and natural gas, but broadly all Caribbean economies have concentrated productive and trade sectors. Caribbean governments' revenues are therefore generated from a narrow and volatile tax base, whilst expenditure tends to be pro-cyclical (Samuel, 2009).

The region's fiscal policy is also influenced by its politics. Since the Caribbean pre-independence labour movements, political mandates in the Caribbean have been aimed at achieving mainly social objectives (Bishop *et al*., 2020). Election cycles therefore tend to align with spikes in expenditures.

The importance of fiscal policy against such development challenges imply that regular monitoring of the region's fiscal policy sustainability is critical. However, assessments of Caribbean fiscal sustainability are scant, despite an environment of persistently high debt and chronically low GDP growth (Acevedo *et al*., 2013). Whether policy makers in the region are implementing a sustainable fiscal policy is, therefore, constantly in question.

For the decades spanning 2000-2019, for example, the Caribbean's average debt to GDP ratio – a key barometer of fiscal policy sustainability - was consistently above 70 percent of GDP, peaking at 87.8 percent of GDP, and earning the region a spot as one of the most indebted in the world (Buermann *et al*., 2021). At its lowest point the average Caribbean debt to GDP ratio was 69.4 percent in 2008q1.

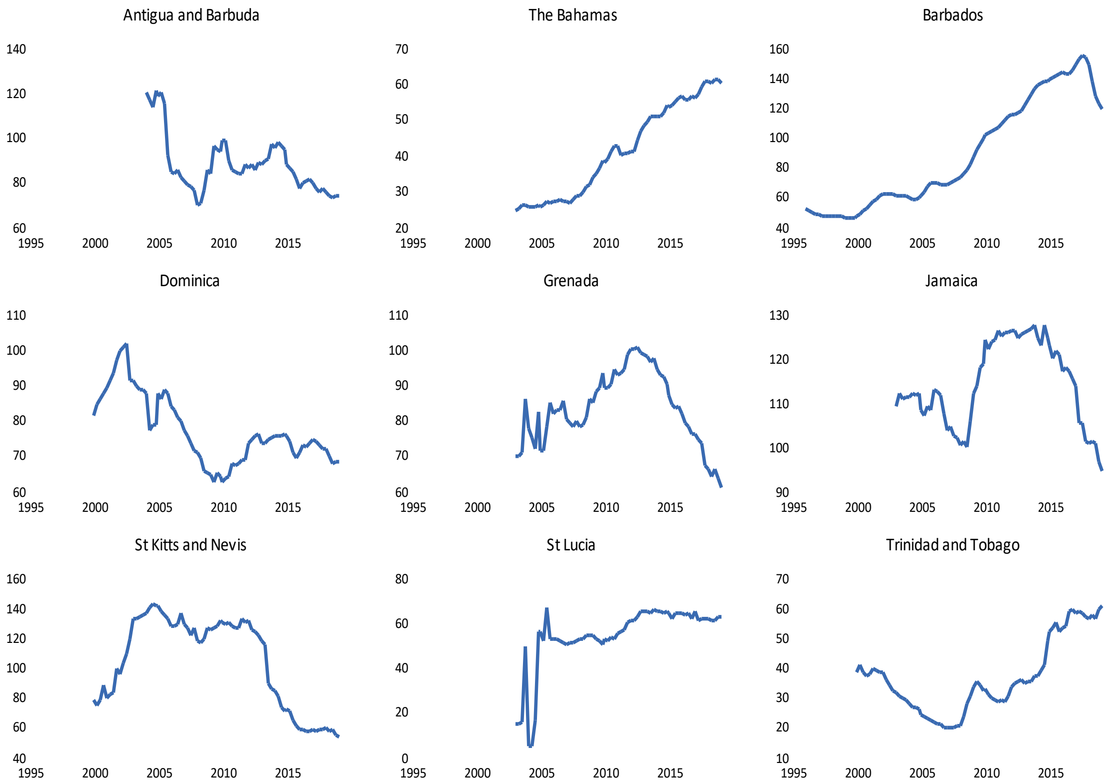
Figure 3.1 Average Caribbean Debt to GDP Ratio (Percent)



Source: IMF World Economic Outlook (WEO)

Since 2013, the region's debt although still high, has been trending downward, underpinned by contractions in the debt ratios of Jamaica, Grenada, St Kitts and Nevis, Antigua and Barbuda, and Dominica (Figure 3.2).

Figure 3.2 Trends in Caribbean Countries Debt to GDP Ratios (Percent)



Source: IMF World Economic Outlook (WEO)

Against this backdrop, this study undertakes an empirical assessment of the Caribbean's fiscal sustainability using an adjusted assessment procedure. It draws on Afonso (2005) (hereafter AF) cointegration approach to debt sustainability assessment and apply Pesaran and Shin (2000) (hereafter PS) ARDL Bounds Test. AF's approach to debt sustainability assessment provides the advantage of minimising data requirements, and therefore helps to side-step, somewhat, the region's severe data constraints. PS Bounds Test on the other hand helps to overcome traditional criticisms of tests for unit roots and cointegration and allows for the adaptation of AF's approach to include possible cases of sustainability where the key variables are integrated of different orders.

In undertaking the assessment, the study makes a substantial contribution to the literature on debt sustainability through offering an innovative approach that could make such analyses more viable, and debt sustainability assessment more attainable for data starved regions like the Caribbean. Further, it provides fresh impetus for cointegration approaches to assessing debt sustainability by avoiding contentious unit root problems.

Applying the adjusted cointegration assessment procedure with quarterly data, the study finds that between 2000q1 and 2019q4, debt in 6 of the 9 Caribbean countries included in this study was sustainable.

The rest of the study is organized as follows. Section 2 discusses the literature on debt sustainability tests, the challenges and rationale for the adjusted approach to assessing Caribbean debt sustainability is discussed in Section 3. In Section 4 the ARDL Co-

Integration Bounds Testing procedure is presented, whilst data and unit root tests are discussed in Section 5. The study ends with sections 6 and 7 that details the cointegration results and conclusions, respectively.

3.2 Testing debt sustainability

In this study, the approach to testing fiscal sustainability is selected to help circumvent data and other empirical issues encountered when trying to assess fiscal sustainability in the Caribbean. A brief review of the main approaches to assessing the sustainability of fiscal policy provide the justifications for the selected method.

According to Scott-Joseph (2008) sustainability indicators such as those popularised by Blanchard *et al*. (1991), Mendoza and Oviedo (2009) and Uctum and Wickens (2000) are the most appropriate for assessing debt sustainability in the Caribbean. This she argues is because they are simple and easy to implement, where "easy" is potentially also referring to the fact that they carry low data requirements, particularly as it relates to time series. Sustainability indicators assume that variables are in steady state, and therefore do not require a long series of historical data, as would time series approaches.

However, assuming steady state poses significant weaknesses as variables vary over time, and in the fiscal space, often considerably. The results from sustainability indicators though convenient to obtain may therefore not aptly capture long-run fiscal relationships. This is an important caveat as fiscal sustainability is a long-run phenomenon.

The work of Hamilton and Flavin (1986); Trehan and Walsh (1988); Wilcox (1989); Hakkio and Rush (1991); Quintos (1995), among others, are important contributions in this regard. They derive from theory approaches which allow for the application of econometric techniques, and specifically, cointegration to test for the existence of fiscal sustainability. They show that the government's intertemporal budget constraint (IBC) which implies a long-run relationship between debt and the primary balance, can be tested via unit roots and cointegration. In this approach, a credible long-run relationship implies debt sustainability.

Afonso (2005) (hereafter AF) and before him Hamilton and Flavin (1986); Trehan and Walsh (1991); and Hakkio and Rush (1991)) adapted the IBC such that the cointegration test is instead assessing the long-run relationship between revenues and expenditures. AF's approach is as a result, particularly useful for testing fiscal sustainability in the Caribbean where time series data on the primary balance and debt to GDP ratio are limited (IMF, 2023), but where data on expenditures and revenues are widely available at high frequency (ECCB, 2023).

Focusing on the role of revenues and expenditures, as opposed to the total primary balance, the government's IBC, assuming again that the no-Ponzi game condition $\lim_{j\to\infty} E_t \frac{1}{(1+r)^j} d_{t+j}$ goes to zero in the limit, equates to:

(3.1)

$$d_t = \sum_{j=1}^{\infty} \frac{R_{t+j} - G_{t+j}}{(1+r)^j}$$

Further, introducing the auxillary variables without-interest expenditure $E_t = G_t + (r_t - r)d_{t-1}$ and with-interest expenditure $GG_t = G_t + r_t d_{t-1}$, allows the IBC to be rewritten in present value terms as follows:

(3.2)

$$GG_t - R_t = \sum_{j=0}^{\infty} \frac{1}{(1+r)^{j-1}} \left(\Delta R_{t+j} - \Delta E_{t+j}\right)$$

Equation (3.2) implies that if both government revenues R_t and with-interest expenditures GG_t are I(1) and cointegrated, then the debt to GDP ratio does not violate government's IBC (Afonso, 2005).

The fiscal reaction function (FRF), a model-based test developed in Bohn (1998) is now the more popular method in the literature for assessing fiscal sustainability, but also equates to a test on the IBC. The FRF overtook unit root and cointegration tests of the IBC following critiques of these approaches in Bohn (2005, 2008), where he argues that cointegration tests reveal only weak sustainability because finding stationarity and cointegration can always be achieved once variables are differenced up to I(d) times. The cointegration method also lost its popularity given the issues with unit root testing, which were at the core of several debates on the sustainability of U.S fiscal policy (See for example Quintos, 1995; Bohn, 1998).

Apart from PS (2001) Co-Integration Bounds Testing procedure, unit root tests are a prerequisite for establishing the order of integration of variables, and for confirming cointegration. This has made cointegration assessment problematic as unit root tests suffer several challenges. Apart from different testing methodologies that can often bare conflicting results, there is the near unit root problem which can lead investigators to reject the presence of unit roots when unit roots are present, fostering erroneous cointegration conclusions.

FRFs on the other hand, only require simple OLS estimation, and are quite intuitive. A positive and significant FRF coefficient establishes sustainability. Nevertheless, the FRF also pose practical challenges for testing fiscal sustainability in the Caribbean. Time series data on the primary balance and debt to GDP ratios – the principal FRF variables - comprise less than thirty years of observations for the most part, making OLS regression of FRFs for several Caribbean countries infeasible. Panel data could help overcome such shortcomings (Khadan, 2019; Cevik and Nanda, 2020) but to the detriment of country-level assessment. Additionally, with such short data, unit root tests at the country-level to establish the order of integration of variables would still be necessary if one wants to avoid spurious regression. Bohn (2005) argues in his study that contrary to earlier findings, the US debt to GDP ratio is stationary. While this may be the case for U.S data originating in the 1770s, such is highly unlikely to hold for the Caribbean, where fiscal data only goes as far back as 1980, at least according to the IMF database (IMF, 2023).

3.3 Methodology

Pesaran and Shin (2000) Autoregressive Distributed Lag (ARDL) Co-Integration Bounds Test avoids the need to test for unit roots and can help to establish cointegration even if variables are of different orders of integration, namely I(I) and I(0). Consequently, in the context of the AF sustainability assessment procedure, application of the ARDL Bounds Test allows for an adaptation of the procedure to include additional paths to cointegration and conclusions on fiscal sustainability.

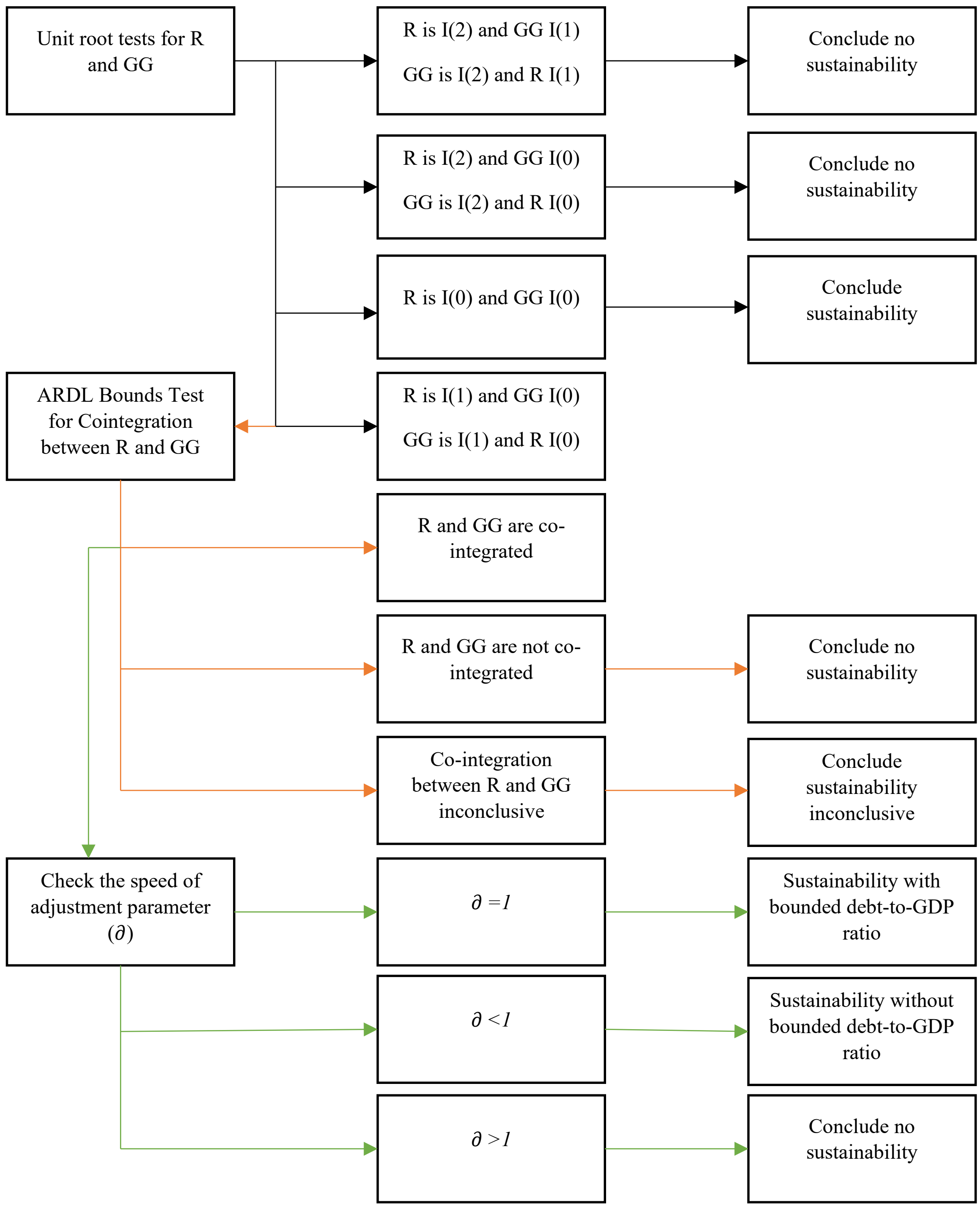
3.3.1 An Adjusted AF Sustainability Assessment Procedure

In AF's sustainability assessment, the first step is to test for unit roots in expenditures and revenues. If the variables are of different orders of integration, AF advises to stop and conclude no sustainability. If they are both integrated of order zero I(0) then one should conclude sustainability, and if they are both integrated of order one I(1), the researcher should proceed to test for cointegration (Appendix Figure A 3.1).

In step one of the adjusted assessment the procedure is like the original AF procedure, but one does not conclude unsustainability if the variables are of different orders of integration, and there is need to verify that the variables are not second order integrated. If they are second order integrated conclude no sustainability. This does not need to be done via unit root testing. I(2) variables exhibit strong persistence and can be picked up graphically. If the variables are not I(2) then the researcher proceeds to step two, the ARDL bounds test for cointegration. In this step, once cointegration is not detected one can conclude that there is no sustainability, but if there is evidence of cointegration the researcher moves on to step three. This last step is about verifying sustainability as in the original procedure and in the same way, is classified according to the size and sign of the speed of adjustment parameter. If the speed of adjustment parameter $\partial = 1$, the conclusion is that there is sustainability with a bounded debt-to-GDP ratio. If $\partial < 1$

there is sustainability with an unbounded debt-to-GDP ratio and if $\partial > 1$ there is no sustainability (Figure 3.3).

Figure 3.3 Adjusted AF Debt Sustainability Assessment Procedure



Note: In the assessment procedure above, step 1 is identified by the black arrows; step 2 by the orange arrows; and step 3 by the green arrows, respectively.

3.3.2 ARDL Bounds Test for Co-Integration

Testing for cointegration in the AF procedure involves the empirical estimation of (3.2), which begins with a levels-regression of within-expenditure GG_t on revenue R_t:

(3.3)

$$GG_t = \alpha + \beta R_t + \varepsilon_t$$

This is expressed in (3.3), where α is a constant and ε_t a white noise error term. β is a coefficient representing the long-run expenditure-revenue relationship. Cointegration between GG_t and $R_t$will be consistent with a cointegrating vector [1, -1].

Under classical cointegration approaches (including the two-step residual approaches of Engle and Granger (1987); Phillips and Ouliaris (1990); Park (1990); Shin (1994); systems approach of Stock and Watson (1998); and Johansen (1991; 1995), all variables usually have to be integrated of order 1, or I(1), before proceeding to test for cointegration. Unit root tests are the mechanism used to establish the integration properties. However, such tests are known to mislead by way of false positives and false negatives, causing much disagreement in the cointegration and debt sustainability literatures.

Pesaran and Shin (2001) provide a solution through their ARDL Bounds Testing approach that allows one to be agnostic about whether variables are truly I(1) or I(0). In particular, PS provide a table of asymptotic critical values for the range of purely I(0) and I(1) variables. The ARDL Bounds Testing approach is by consequence robust to cases of near/fractional unit roots or the misclassification of variables. Other noteworthy features of the ARDL Bounds Testing methodology are its simple single-equation structure; the super consistency of the ARDL estimator; and with the adequate lag structure, control of serial correlation.

A basic ARDL formulation of (3.3) is depicted in (3.4), where GG_t is regressed on its lagged values, and the contemporaneous and lagged values of R_t (see PS,1998):

(3.4)

$$GG_t = \alpha_0 + \sum_{p=1}^{n} \beta_{1p} GG_{t-p} + \beta_{20} R_t + \sum_{q=1}^{n} \beta_{2q} R_{t-q} + \varepsilon_t$$

Lagged values p =1,2…n and q = 1,2…n capture time series dynamics. Applying the traditional Engle and Granger cointegration approach, the ARDL (p,q) equation is converted into an Error Correction Model (ECM) by expressing the regression in first differences and introducing the error correction term $z_{t-1} = GG_{t-1} - \alpha - \partial_{t-1} R_{t-1}$, which are the residuals from the long-run equation:

$$\Delta GG_t = a_0 + \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t + \sum_{q=1}^{n} b_{2q}\Delta R_{t-q} + \theta z_{t-1} + e_t \tag{3.5}$$

Here the coefficient θ in (3.5) is the error correction parameter reflecting the speed of adjustment to equilibrium, and ∂_{t-1}contained in the residuals z_{t-1} is the estimated long-run revenue coefficient, derived post-estimation through solving for GG_t in terms of R_t. The main difference at this point between the traditional ECM and ARDL-ECM is that the long-run coefficients in the ARDL-ECM are unrestricted, such that:

$$\Delta GG_t = a_0 + \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t + \sum_{q=1}^{n} b_{2q}\Delta R_{t-q} + \theta_1 GG_{t-1} + \theta_2 R_{t-1} + e_t \tag{3.6}$$

PS (2001) refers to (3.6) as the Conditional Error Correction (CEC) model. In this setup, testing for cointegration involves an F-test of the null hypothesis $H_0: \theta_1 = \theta_2 = 0$ against the alternative hypothesis $H_1: \theta_1 = \theta_2 \neq 0$. However, note that the distribution of the test statistic is non-standard, so a standard F-test of this form would yield spurious results. Instead, in the ARDL Bounds Testing approach, the F-statistic is compared to the lower and upper bounds of critical values generated by PS for the asymptotic distribution of F-statistics, based on the assumption that all variables are I(0) or I(1), respectively.

The null hypotheses cannot be rejected if the test statistic falls below the lower critical value. In contrast, if the test statistic is greater than the upper critical value, the null can be rejected and cointegration amongst the variables concluded. In the situation where the test statistic lies in the middle of the lower and upper critical values, testing is deemed inconclusive. Confirmation of cointegration following rejection of the null from the F-Bounds test is undertaken through a Bounds Test using T statistics. Under the T-Bounds test, cointegration is confirmed if the test statistic is more negative than the upper bound critical values for I(1) variables and cannot be rejected if the test statistic is greater than the lower-bound critical values corresponding to I(0) variables.

The test procedure is summarized below:

F-Bounds Test

Fail to reject H_0 if F-stat < critical value for I(0) regressors

Reject H_0 if F-stat > critical value for I(1) regressors

Conclude inconclusive if critical value for I(0) <F-stat<critical value for I(1) regressors

T-Bounds Test

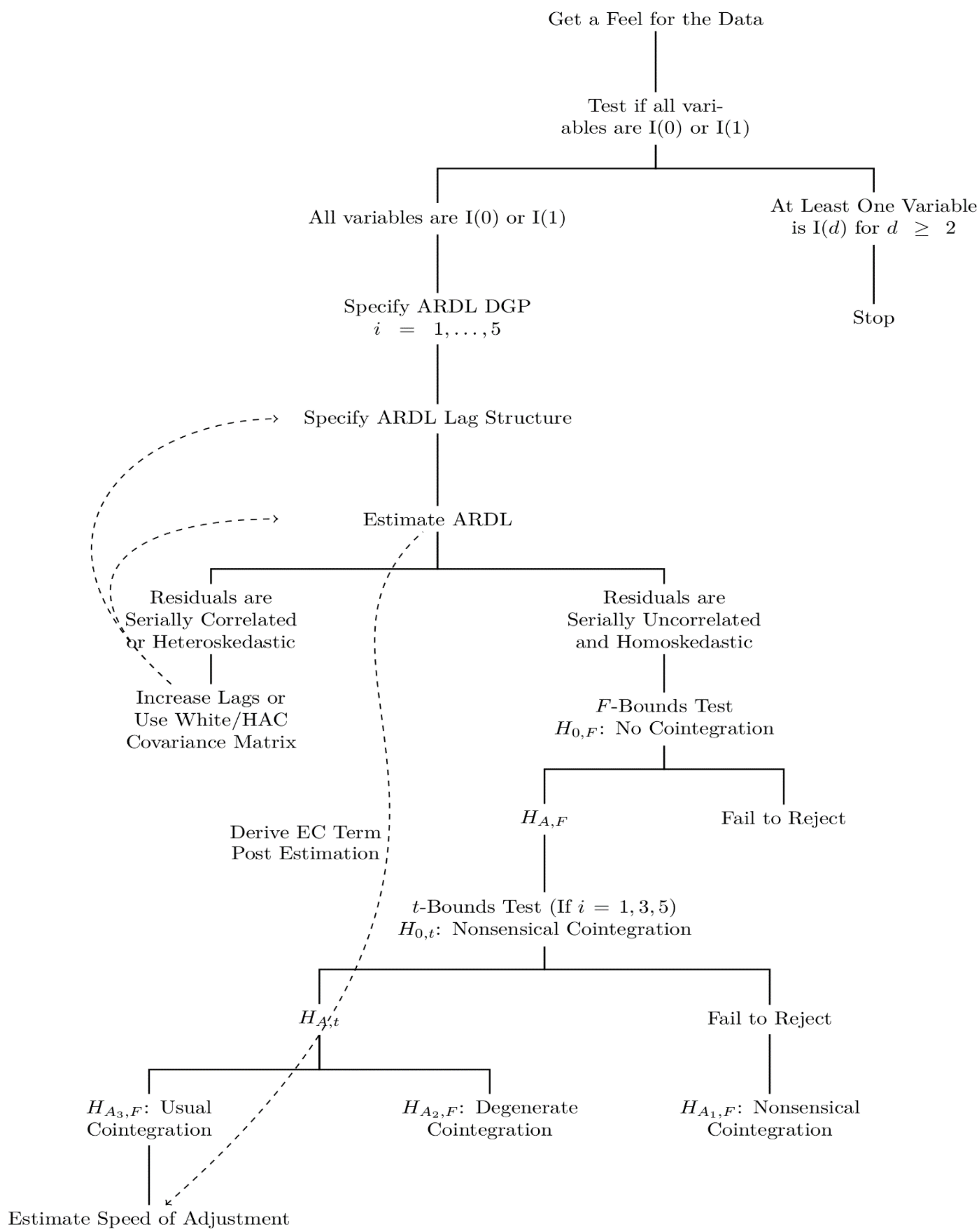
Fail to confirm H_0 if T-stat > critical value for I(0) regressors

Confirm H_0 if T-stat < critical value for I(1) regressors

Before moving on to the ARDL Bounds Test and estimation, it is critical to establish whether any of the variables are second order integrated I(2). This is because PS do not produce critical values for second order variables. Another important step is to determine the lag structure of the ARDL(p,q) model. This can be done by way of some lag selection criteria including the Akaike Information Criterion (AIC) and the Schwarz-Bayesian Information Criterion (BIC). Finally, a choice must be made between the five alternative interpretations of the CEC model derived by PS (2001). These models are differentiated by whether a constant and/or trend (a_0 and a_1t) enter the cointegrating vector (Appendix Box A 3.1 for details).

A good summary of the ARDL Bounds Testing process is illustrated in Figure 3.4 below. Note that it is also important to verify the absence of serial correlation and heteroscedasticity, as well as to assess the stability of parameters.

Figure 3.4 The ARDL Bounds Testing Procedure



Source: https://blog.eviews.com/2017/05/autoregressive-distributed-lag-ARDL.html

3.4 Data and unit root tests

3.4.1 Data

The scarcity of fiscal data for the Caribbean is a significant motivation for the empirical approach taken in this study. Annual time series for government finance variables in the Caribbean are highly discontinuous, making time series regressions for country level debt sustainability assessments difficult, at least at this stage.

As discussed in Chapter 1 and illustrated further via Table A1.1, the issues with Caribbean time series in the fiscal space are most prevalent for the primary balance, debt to GDP ratio, and real GDP. A fiscal reaction function based on time series data for Caribbean countries would therefore not be viable.

Focusing on AF's revenue-expenditure approach to sustainability assessment, however, significantly reduces the data burden and makes a Caribbean country level assessment possible, albeit at quarterly frequency.

AF's method is, by consequence, extremely useful and handy for the Caribbean context, but is surely not a panacea for the Caribbean's data problems. Missing data for revenue and expenditure variables in the Caribbean are still notable challenges which have limited the scope of countries covered in the study.

Data employed in this study are of quarterly frequency in the range 1995 to 2019 for 9 Caribbean countries, including Barbados, the Bahamas, Jamaica, Trinidad and Tobago, and from the Eastern Caribbean Currency Union (ECCU) - Antigua and Barbuda, Dominica, Grenada, St Kitts and Nevis and St Lucia. Data at this frequency allows for inclusion of the maximum number of country regressions.

Specifically, data for ECCU countries are from the year 2000q1 when this data series begins, until 2019q4. For Barbados, data is for the period 1995q1 to 2019q4; Bahamas and Jamaica 2003q1 to 2019q4, respectively; and for Trinidad and Tobago 2000q1 to 2019q4, all based on availability.

Among the ECCU countries, St Vincent and the Grenadines is excluded as missing data for the country were too significant. According to the Eastern Caribbean Central Bank (ECCB) database, from where the ECCU data were obtained, capital expenditure and capital revenue data for St Vincent and the Grenadines are only available from 2000m1 to 2013m12. The time series is discontinuous thereafter, rendering the series' length insufficient for time series regression. Note that the data for the ECCU in original form are monthly series. These were summed across three consecutive months and converted to quarters per year, whilst aggregate revenue and expenditure values were calculated by summing current and capital expenditure, and current and capital revenue for each country, respectively.

At the monthly or quarterly frequency, revenue and expenditure data for Belize, Guyana and Suriname are not attainable. Annual data for these variables are however available from 1996; 1997; and 1990 from the IMF WEO database, respectively. Using these data, different temporal disaggregation methods[16] were attempted to estimate quarterly revenue and expenditure, but the results were highly dubious and as a result these countries could not be included in the study.

On the other hand, time series data on government revenues and expenditures for Barbados and Bahamas are available at quarterly frequency from their respective Central Banks. Whereas data is for Barbados is drawn from the Central Bank's online database, for the Bahamas data is extracted from various Central Bank of Bahamas Economic Review Reports. Like the ECCU countries, the original data for Jamaica and Trinidad and Tobago are in monthly form and these are also converted to quarterly data. Data for Jamaica is from its Ministry of Finance database, and for Trinidad and Tobago from its Central Bank online data portal.

[16] These included simple linear and exponential disaggregation as well as disaggregation through extrapolating trends from key seasonal variables for respective countries, mostly quarterly tourism arrivals.

All variables are transformed to millions of dollars and are in local currencies (Table 3.1).

Table 3.1 Data Sources

Countries	Variables	Currency	Original Units	Sources	Original Frequency	Data Coverage
ECCU	Total Revenue Total Expenditure	$EC	Millions	Eastern Caribbean Central bank	Monthly	2000q1 - 2019q4
Barbados	Total Revenue Total Expenditure	BDS$	Millions	Central bank of Barbados (CBB)	Quarterly	1995q1 - 2019q4
Bahamas	Total Revenue Total Expenditure	BH$	Thousands	Central bank of Bahamas	Quarterly	2003q1 - 2019q4
Jamaica	Total Revenue Total Expenditure	JM$	Millions	Ministry of Finance Jamaica	Monthly	2003q1 - 2019q4
Trinidad & Tobago	Total Revenue Total Expenditure	TT$	Millions	Central bank of Trinidad & Tobago	Monthly	2000q1 2019q4

3.4.2 Unit Root Tests

Figures A 3.2 – A 3.10 graph expenditures and revenues for the 9 Caribbean countries. All figures, except for Antigua and Barbuda and Dominica, exhibit an upward trend in expenditures and revenues. Some co-movement between the two series is visible, however, there are also signs of divergence. As most variables exhibit a trend, it is difficult to ascertain from visual inspection whether the variables are integrated I(0) or I(1), but none appear to be I(2).

Unit root tests can help determine the integration properties of these data, but they are not a pre-requisite for the ARDL cointegration approach. The results from unit root tests are useful particularly for ensuring that none of the variables are I(2). PS (2001) only generate critical values for purely I(0) and I(1) variables and as such the ARDL Bounds Test is not valid for I(2) variables.

Table 3.2 Unit Root Tests on Caribbean Revenues and Expenditures (levels)

	Unit root tests	**Antigua & Barbuda**	**Barbados**	**Bahamas**	**Dominica**	**Grenada**	**Jamaica**	**St Kitts & Nevis**	**St Lucia**	**Trinidad & Tobago**
Revenues	1	-2.74	0.32	-1.29	-2.72	-1.85	0.09	-3.65*	-1.91	0.81
	2	-2.74	-2.25	-1.48	-1.57	-1.89	-1.08	-3.70**	-1.58	-1.08
	3	-6.82**	-7.68**	-5.91**	-5.66**	-2.63	-7.24**	-6.87**	-7.30**	-6.74**
	4	-37.80**	0.19	-4.23	-5.90	-6.60	-9.85	-18.02*	-0.44	-0.59
	5	0.11	0.20*	0.23**	0.15*	0.21*	0.27**	0.05	0.10	0.28**
Expenditure	1	-1.65	0.32	-8.44**	-0.37	-8.43**	-2.19	-2.04	-2.04	-1.05
	2	-1.33	-0.65	-8.55**	-1.18	-2.01	-2.18	-1.58	-1.36	-0.59
	3	-5.73**	-7.68**	-8.44**	-7.59**	-8.44**	-8.40**	-7.53**	-10.61**	-3.85*
	4	-2.70	0.19	-33.40**	-3.55	-3.72	-5.41	4.81	-0.73	-2.85
	5	0.14	0.20*	0.13	0.18*	0.10	0.11*	0.13	0.18*	0.26**

Note: Variables are in us dollars. Values are test statistics for the five-unit root tests 1. Augmented dickey fuller 2.adf-gls 3. Phillps perron and 4. Ng-perron and 5. Kpss. All unit root tests are run with a constant and trend in the regression following visual inspection of the variables. The significance levels 1% and 5% are represented by ***, **, respectively.

Table 3.2 presents the results from the Augmented Dickey Fuller (ADF) (as well as ADF-General Least Squares (GLS)), Phillips Perron (PP) (as well as Nyblom-Giles-Perron (NG-Perron)), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests. These tests are conducted for revenues and expenditures. There is a mixed bag of results across the five-unit root tests for all variables and countries, confirming the difficulty in establishing orders of integration with such tests, as well as the issues with data quality. The only cross-unit root agreement is for Bahamas' expenditure, which is estimated to be stationary; Grenada revenues estimated to be non-stationary; and St Kitts and Nevis' revenue estimated stationary.

Table 3.3 Group Unit Root Tests on Caribbean Revenues and Expenditures
(first difference)

Method	Statistic	Cross Sections	Observations
H_0: Unit Root (assumes common unit root process)			
Levin, Lin & Chut*	-43.41**	18	1273
Breitung T-Statistic	-6.70**	18	1255
H_0: Unit Root (assumes individual unit root process)			
IM, Pesaran and Shin W-Stat	-59.18**	18	1273
ADF-Fisher Chi-Square	452.36**	18	1273
PP - Fisher Chi-Square	331.57**	18	1316

** Note: probabilities for fisher tests are computed using an asymptotic chi-square distribution. All other tests assume asymptotic normality. Exogenous variables: individual effects, individual linear trends.

Joint unit root tests are performed on the group of variables for all countries to determine whether they are potentially I(2). These results are presented in Table 3.3. The two null hypotheses are for common and individual unit root processes. The hypotheses for a unit root in the first difference of the expenditure and revenue variables are tested against the alternative of no unit roots for both hypotheses. All tests, including the levin, Lin and Chu; Breitung T-Stat; IM, Pesaran and Shin; ADF-Fisher Chi-square; and the PP-Fisher Chi-square, confirm that all variables are at least first difference stationary.

3.5 ARDL Bounds Test and Co-Integration Results

Results from the PS (2001) ARDL Bounds Tests are presented in Tables 3.4-3.12 for all 9 Caribbean countries. Only key information is recorded and presented, including the ARDL structure; long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation $\chi2(s)$ and heteroscedasticity $\chi2(h)$; the Bounds Tests statistics F^b and T^b, as well as associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

Parameter stability tests are conducted using Cumulative Sum of Squares (CUSUM). The Schwarz-Bayesian Information Criterion (BIC) is employed for selection of the ARDL lag structure given its superiority over the Akaike Information Criterion (AIC) in exercises with small samples (Schwarz, 1978). Increased lags of the dependent and independent variables and/or employment of Newey West white noise errors are used to address issues of serial correlation (Newey and West, 1987). Moreover, for problems with heteroscedasticity, the variables are transformed into logarithms (Greene, 2012). Tests for serial correlation and homoscedasticity are undertaken by way of the LaGrange Multiplier and Breusch Pagan-Godfrey tests, respectively (Godfrey, 1978; Breusch and Pagan, 1979).

Normally, the PS Bounds Test require selection of one of the five cointegration cases as discussed earlier. This choice can be based on theoretical or empirical intuition. However, rather than selecting a model, the study is agnostic about case selection and presents results for all 5 cases. The results are then discussed, and the selected case is chosen based on the totality of the evidence. Note that for all models, parameter stability was achieved (Appendix Figures A 3.11-3.19).

Recall that in the ARDL Bounds Testing procedure, the null of no cointegration is accepted if the F-statistic is less than the PS critical values for I(0) regressors and rejected if the F-statistic is greater than the PS critical values for I(1) regressors. Should the F-statistic indicate rejection of the null hypothesis, this is confirmed by the T-test, whose statistic must be less than the PS critical values for I(1) variables, or else accepted if the statistic is greater than the PS critical values for I(0) regressors.

For Antigua and Barbuda, cointegration is therefore confirmed for cases 1 and 2 (no constant and no trend; restricted constant and no trend), indicating the absence of a constant and trend in the short and long-run dynamics of the model, as the constant

72.06 is insignificant. The irrelevance of the trend term is confirmed by the statistical insignificance of the trend variable in case 4.

Both the speed of adjustment and the long-run revenue coefficient are highly significant. On average, for each dollar of revenue raised in Antigua and Barbuda, the government spends 0.27 cents more in expenditure. This disequilibrium is adjusted at a speed of - 31% of expenditure per quarter, with case 1 suggested as the most relevant model (Table 3.4). The results suggest sustainability with a debt-to-GDP ratio that is not bounded.

There is also confirmed presence of ARDL cointegration between expenditures and revenues in cases 1-3 for Dominica. The F-statistic and T-statistic satisfy the rejection criteria, and both the error correction term and long-run revenue coefficient are highly significant. Issues of serial correlation and heteroscedasticity are not present, though the model had to be log-transformed to remove initial unequal error variance. Again, since the constant 0.09 in model 2 is insignificant, the most parsimonious model appears to be one without intercept or trend in the dynamics and cointegrating equation.

In logarithms, the interpretation is that on average, for every one percent increase in revenues per quarter, the government of Dominica increases expenditure by 1.07 percent. Nonetheless, the speed of adjustment to equilibrium in the long run is marginally higher than in Antigua and Barbuda at around -37.5 percent (Table 3.5).

These results also suggest fiscal sustainability for Dominica but with a debt-to-GDP ratio that is not bounded.

Table 3.4 Antigua and Barbuda ARDL Bounds Test

Cases	**1**	**2**	**3**	**4**	**5**
ARDL Structure	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)
Long-Run Coefficients					
a_0		72.06			
a_1				-0.96	
θ_2	1.27**	0.84**	0.84**	1.13**	1.13**
Speed of Adjustment					
ECT_{-1}	-0.31**	-0.43**	-0.43**	-0.41**	-0.41**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.41	0.41	0.41	0.42	0.42
Adj. R^2 - ECM	0.57	0.60	0.57	0.57	0.57
χ^2(s)	2.79	4.31	4.31	2.94	2.94
χ^2(h);	4.01	4.95	4.95	6.95	6.95
Bounds Test					
F^b	6.42	4.65	6.28	4.87	7.29
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.3
T^b	-3.62		-2.87		-2.72
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.60		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation χ2(s) and heteroscedasticity χ2(h); the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

Table 3.5 Dominica ARDL Bounds Test (log-log model)

Cases	**1**	**2**	**3**	**4**	**5**
ARDL structure	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)
Long-run coefficients					
a_0		0.09			
a_1				-0.01	
θ_2	1.07**	1.05**	1.05**	1.74	1.73
Speed of adjustment					
ECT_{-1}	-0.37**	-0.38**	-0.38**	-0.26**	-0.26**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.87	0.87	0.86	0.87	0.87
Adj. R^2 - ECM	0.78	0.78	0.76	0.77	0.78
χ^2(s)	8.64	8.62	8.62	8.51	8.51
χ^2(h);	8.50	8.68	8.68	13.47	13.47
Bounds Test					
Fb	19.86	13.06	15.16	10.58	14.99
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.30
Tb	-5.36		-4.25		-1.94
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.60		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation $\chi 2$(s) and heteroscedasticity $\chi 2$(h); the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

For the Grenada regressions, the BIC, like in the Antigua and Barbuda and Dominica estimations, selected ARDL (4,0) models for cases 1 through 5. There were no issues with serial correlation or heteroscedasticity for any of the cases, but the Bounds Tests did not find any evidence of cointegration.

Table 3.6 Grenada ARDL-Bounds Test

Cases	**1**	**2**	**3**	**4**	**5**
ARDL structure	(4,0)	(4,0)	(4,0)	(2,0)	
Long-run coefficients					
a_0		93.1**			
a_1				0.66	
θ_2	1.62	0.5**	0.5**	0.20	
Speed of adjustment					
ECT_{-1}	-0.04	-0.37**	-0.36	-0.80**	
ARDL Diagnostics					
Adj.R^2 - ARDL	0.57	0.56	0.56	0.5	
Adj. R^2 - ECM	0.59	0.59	0.59	0.57	
χ^2(s)	2.57681	3.34	3.34	7.53	
χ^2(h);	2.65332	5.15	5.15	7.12	
Bounds Test					
Fb	0.74664	1.6577	1.74315	6.71598	
Cv(f)I(0)	3.15	3.62	5.13	4.68	
Cv(f)I(1)	4.11	4.16	5.98	5.15	
Tb	-0.4625		-1.8662		
Cv(t)I(0)	-1.95		-2.86		
Cv(t)I(1)	-2.6		-3.22		

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation $\chi2$(s) and heteroscedasticity $\chi2$(h); the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

While the F-statistic rejects absence of a cointegrating relationship in case 4 with trend in the cointegrating vector, the error correction coefficient -.80 is significant. However, the long-run coefficient 0.20 is insignificant, thus invalidating an equilibrium long-run relationship (Table 3.6).

The relatively better performance of the model without trend is continued in the regressions for St Kitts and Nevis, which finds cointegration for cases 1-3 according to the F and T bounds statistics and corresponding critical values. Here serial correlation in case 2 is omitted through an increase in lags, and homoscedasticity through log transformation. Also worthy of note is the fact that in case 2 (restricted constant and no trend), the constant term is significant, in addition to the significance of the long-run coefficient and error correction term. Case 2 is as a result, selected as the regression of choice. In this model, the speed of adjustment is -57 percent compared to -20 percent in case 1 (no constant and no trend). Case 3 on the other hand, except for the constant term, provides similar results to case 2.

However, given the higher adjusted R^2 and with the significance of the constant term, case 2 is the preferred model, implying that for every 1 percent increase in revenues, expenditure rises by 0.57 percent in St Kitts and Nevis (Table 3.7).

For Barbados, though cointegration was found to be possible in case 2 with the model including a restricted constant and no trend, the issues with serial correlation, heteroscedasticity and parameter stability, cast huge doubt over this single result. To rid the model of heteroscedasticity 12 lags of the dependent and independent variables are included in the model and the model is transformed to a log-log variation to address non-zero error variance. Nonetheless, in cases 2-5 the Breusch Pagan-Goddfrey test for homoscedasticity continuously reject the null hypothesis. Further, a glance at the parameter stability charts in Figure A 3.15 for Barbados, clearly shows some parameter stability issues (Table 3.8).

Table 3.7 St Kitts and Nevis ARDL-Bounds Test (log-log model)

Cases	**1**	**2**	**3**	**4**	**5**
ARDL structure	(4,0)	(5,0)	(4,0)	(4,0)	(4,0)
Long-run coefficients					
a_0		2.05**			
a_1				0.002	
θ_2	1.05**	0.6**	0.64**	0.52**	0.50**
Speed of adjustment					
ECT_{-1}	-0.2**	-0.57**	-0.53**	-0.60**	-0.60**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.77	0.78	0.78	0.8	0.78
Adj. R^2 - ECM	0.72	0.75	0.72	0.72	0.72
χ^2(s)	8.99	4.79	7.09	7.8	7.8
χ^2(h);	2.27	7.74	4.37	5.82	5.82
Bounds Test					
Fb	6.84852	6.28997	6.49844	4.36622	6.3333
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.3
Tb	-3.7269		-3.2902		-2.7475
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.6		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics –

including serial correlation $\chi2(s)$ and heteroscedasticity $\chi2(h)$; the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

Table 3.8 Barbados ARDL-Bounds Test (log-log model)

Cases	1	2	3	4	5
ARDL structure	(6,0)	(4,0)	(4,0)	(4,0)	(4,0)
Long-run coefficients					
a_0		2.98**			
a_1				-0.02	
θ_2	1.04**	0.55**	0.55**	1.81	1.81
Speed of adjustment					
ECT_{-1}	-0.189**	-0.27**	-0.27**	-0.13**	-0.12**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.92	0.91	0.92	0.92	0.93
Adj. R^2 - ECM	0.82	0.8	0.8	0.82	0.82
$\chi^2(s)$	8.39	20.73	20.73	16.54	16.54
$\chi^2(h)$;	13.9	11.83**	11.83**	16.22**	16.22**
Bounds Test					
Fb	6.41377	12.1479	5.64088	6.78541	4.43891
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.3
Tb	-2.5088		-3.3382		-1.3468
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.6		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation $\chi2(s)$ and heteroscedasticity $\chi2(h)$; the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

All the necessary adjustments were made to take care of model parsimony for St Lucia, including lag extension (12 lags) and log transformation, but the Bounds Tests does not find evidence of cointegration across any of the cases 1-5 (Table 3.9).

Table 3.9 St Lucia ARDL-Bounds Test (log-log model)

Cases	**1**	**2**	**3**	**4**	**5**
ARDL structure	(5,0)	(5,0)	(5,0)	(5,0)	(5,0)
Long-run coefficients					
a_0		0.34			
a_1				0.01**	
θ_2	1.05**	0.98**	0.98**	0.25	0.26
Speed of adjustment					
ECT_{-1}	-0.21**	-0.22**	-0.22	-0.40**	-0.40**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.89	0.88	0.88	0.88	0.88
Adj. R^2 - ECM	0.85	0.85	0.84	0.85	0.85
$\chi^2(s)$	20.64	20.78	20.78	20.96	20.96
$\chi^2(h)$;	4.19	4.01	4.01	4.11	4.11
Bounds Test					
Fb	5.13	3.38	1.88	1.55	2.33
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.30
Tb	-1.92		-1.92		-1.85
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.60		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation $\chi2(s)$ and heteroscedasticity $\chi2(h)$; the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

In contrast, there is strong evidence of a long-run relationship between expenditures and revenues for Trinidad and Tobago. In all cases 1-5, the Bounds Tests conclude cointegration, and the relevant error correction term and long-run coefficients all possess significance and expected magnitude and signs. The adjusted R^2 for the Trinidad and Tobago regressions are also the largest of all the country estimates, indicating the superiority of the model for this country. Noticeable though is the absence of the constant and trend, both of which are cast out by the model results. Against their omission, the appropriate model appears to be case 1 with no constant and no trend in the dynamic and cointegrating relationship.

Table 3.10 Trinidad and Tobago ARD-Bounds Test (log-log model)

Cases	**1**	**2**	**3**	**4**	**5**
ARDL structure	(4,0)	(4,0)	(4,0)	(4,0)	(4,0)
Long-run coefficients					
a_0		0.38			
a_1				-0.001	
θ_2	1.01**	0.97**	0.97**	1.01**	1.01**
Speed of adjustment					
ECT_{-1}	-0.42**	-0.42**	-0.42**	-0.39**	-0.39**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.96	0.96	0.96	0.96	0.96
Adj. R^2 - ECM	0.89	0.89	0.89	0.89	0.89
χ^2(s)	7.23	7.02	7.02	6.63	6.63
χ^2(h);	2.73	2.78	2.76	2.87	2.87
Bounds Test					
Fb	50.80	33.73	38.65	25.52	21.14
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.30
Tb	-8.82		-8.78		-4.56
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.60		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation $\chi 2$(s) and heteroscedasticity $\chi 2$(h); the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

That accepted, the increase of expenditure given a 1 percent increase in revenue differs by only 0.01 percent, and the speed of adjustment to equilibrium is high at -42 percent per quarter for Trinidad and Tobago (Table 3.10). Both Trinidad and Tobago and St Lucia exhibit fiscal sustainability but again without a bounded debt-to-GDP ratio.

The Bahamas regressions reflect similar results to Trinidad and Tobago. The absolute values of the F and T bounds statistics are fairly large relative to the I(1) critical values, strongly confirming the possibility of cointegration. These results are bolstered and affirmed by the high significance of the error correction terms and long-run coefficients for all cases.

Nonetheless, there are a few differences. For one, the BIC opted for more efficient lag structures ((2,0) and (1,0)) and the trend coefficient 0.01 in case 4 is statistically significant, making the Bahamas the only regression exercise where such is the case. Possibly, mainly because adding a trend in the cointegrating vector of the Trinidad and Tobago regression, coincides with a significant but slightly explosive error correction term (-1.04). Again, also with the insignificance of the constant term in case 2, the case 1 model is preferred. As like in the Trinidad and Tobago case, on average, expenditures in the long-run only exceed the increase in revenues by 0.03 percent, but the speed of adjustment back to equilibrium is much faster at -68 percent in the chosen model (Table 3.11).

Table 3.11 Bahamas ARDL-Bounds Test (log-log model)

Cases	**1**	**2**	**3**	**4**	**5**
ARDL Structure	(2,0)	(2,0)	(2,0)	(1,0)	(1,0)
Long-run coefficients					
a_0		0.45			
a_1				0.01**	
θ_2	1.03**	0.96**	0.96**	0.55**	0.55**
Speed of adjustment					
ECT_{-1}	-0.68**	-0.71**	-0.72**	-1.04**	-1.03**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.87	0.87	0.87	0.89	0.89
Adj. R^2 - ECM	0.77	0.77	0.77	0.79	0.79
χ^2(s)	2.86	3.02	3.02	1.69	1.69
χ^2(h);	4.70	4.04	4.04	2.32	2.32
Bounds Test					
Fb	55.78	37.63	56.01	72.89	108.97
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.30
Tb	-10.50		-9.88		-12.62
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.60		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation χ2(s) and heteroscedasticity χ2(h); the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

Following some slight adjustments, the study finds cointegration for expenditures and revenues in Jamaica. Specifically in cases 2-4, which indicate a large and significant constant 27414.73 but insignificant trend in the long-run relationship. Choosing the most appropriate model presents some difficulty. Case 1 with no constant and no trend seems to suggest a very slow speed of adjustment at -9 percent per quarter compared to case 2 which suggests an error correction of -38 percent per quarter, but with a constant term that is abnormally large.

Jamaica has embedded in its constitution that debt must be repaid first (Grigorian *et al*., 2012). This legislated policy condition could explain the large constant term since by law, there must always be a stock of revenues within government to meet increases in expenditure obligations, to curtail or settle debt payments. Going with case 2, for every dollar of revenue earned in Jamaica, the government increases its expenditure by 86 cents (Table 3.12). Debt is therefore sustainable without a bounded debt ratio.

Table 3.12 Jamaica ARDL-Bounds Test

Cases	**1**	**2**	**3**	**4**	**5**
ARDL structure	(2,1)	(2,0)	(2,0)	(2,0)	(2,0)
Long-run coefficients					
a_0		27414.73**			
a_1				26.78	
θ_2	1.30**	0.86**	0.86**	0.84**	0.84**
Speed of adjustment					
ECT_{-1}	-0.09**	-0.32**	-0.32**	-0.32**	-0.32**
ARDL Diagnostics					
Adj.R^2 - ARDL	0.94	0.95	0.94	0.94	0.94
Adj. R^2 - ECM	0.78	0.77	0.77	0.78	0.78
χ^2(s)	9.83	10.29	10.29	10.58	10.52
χ^2(h);	5.58	3.71	3.71	10.42	10.43
Bounds Test					
Fb	3.43	8.81	7.99	5.24	7.86
Cv(f)I(0)	3.15	3.62	4.94	4.68	6.56
Cv(f)I(1)	4.11	4.16	5.73	5.15	7.30
Tb	-1.15		-4.03		-2.81
Cv(t)I(0)	-1.95		-2.86		-3.41
Cv(t)I(1)	-2.60		-3.22		-3.69

**Note: Only key information is recorded and presented, including the ARDL structure (a,b); long-run coefficient θ_2, constant a_0 trend coefficient a_1; speed of adjustments EC_{t-1}; ARDL diagnostics – including serial correlation χ2(s) and heteroscedasticity χ2(h); the Bounds Tests statistics F^b and T^b, as well as their associated critical values (cv(f)I(0), cv(f)I(1), cv(t)I(0) and cv(t)I(1)).

Interestingly, the error correction coefficients for Barbados, Grenada and St. Lucia[17], were negative and significant as was for the remaining sample of countries. The study

[17] Only in case 3 was an error correction coefficient negative and insignificant for St. Lucia. All others were significant despite the F and t bounds tests not confirming cointegration.

therefore evidences the rigour of the ARDL cointegration bounds testing procedure, in the absence of which could have led to erroneous conclusions on Caribbean fiscal sustainability. For those countries where cointegration was established, the average long-run coefficient is -0.46, which implies a moderate speed of adjustment to equilibrium for Caribbean fiscal policy.

3.6 Policy Discussion

The results obtained in this study when juxtaposed against the trends in debt-to-GDP ratios for the region over the period 2000q1 – 2019q4 evidence why solely using the debt to GDP ratio to assess the sustainability of fiscal policy could lead to misleading conclusions, and ultimately, poor policy choices.

Most of the Caribbean countries in this study with a downwardly trending debt ratio were found to exhibit sustainability according to the PS Bounds Test. However, their debt ratios were still in the magnitude of 70 percent by 2019Q4, which is on the moderate to high end. Additionally, whilst Barbados has a debt ratio that is clearly unsustainable, such is not the case for Grenada or St Lucia. Grenada's debt ratio has been trending sharply downward recently, and St Lucia's, though moderately high, has been rising at a very slow pace (Figure 3.2). From eyeballing the trend in their debt ratios, these latter cases would not be assessed as unsustainable.

The sustainability model is capturing fiscal policy behaviour over time, and specifically, whether governments are honouring their intertemporal budget constraints. By correcting for the increases in non-interest expenditure, governments are implementing a prudent fiscal policy that is reducing primary deficits and slowing debt growth on average.

However, according to the newly developed adjusted AF assessment, Caribbean countries only exhibit weak fiscal policy sustainability as fiscal corrections do not adjust for the full excess of expenditure over revenue ($b<1$), such that average debt to GDP ratio is unbounded. It is reflecting in large part the expansionary fiscal policy in the earlier part of the review period, which was counterbalanced by more fiscal consolidation in the period post 2013q1.

The weak sustainability result implies room for fiscal policy adjustment. If Caribbean governments are to keep debt ratios on a downward path, then the current fiscal effort must be maintained. Caribbean debt exposure to more comfortable levels would allow these countries room to respond to shocks, while continuing to target growth and other social objectives. Caribbean countries are in the top 10 most vulnerable countries in the world to natural disasters (IMF, 2013), to which fiscal policy has been found to be a key lever of response.

Ultimately, for the debt level to continue its downward path, these governments will need to either increase revenue efficiency or reduce expenditures, where the latter is probably best achieved through a shift away from a pro-cyclical to a counter-cyclical fiscal policy. A counter-cyclical fiscal policy for the region is conducive to debt sustainability but may require the adoption of formal revenue and expenditure rules, which, except for in Jamaica do not currently exist in the region (Grenade *et al.,* 2015).

Setting up fiscal rules for the Caribbean would benefit from further research on the possible bi-directional and non-linear interactions between revenues and expenditures to assess how such rules should be designed. One of the three questions motivating Legrenzi and Milas' (2012) research on non-linearities and the sustainability of fiscal sustainability in Italy is particularly relevant in this context. They ask whether the process of fiscal adjustment is equally shared by changes in revenues and by changes in expenditure and find that expenditure in Italy is downwardly rigid. The procyclicality of fiscal policy in the Caribbean warrants similar research.

Such could be tackled through a VAR error correction framework as did Legrenzi and Milas (2012) to allow for endogeneity and to test for asymmetries as well non-linearities between revenues and expenditures. Alternatively, future research could follow the route of Eberhardt and Presbitero (2015) and Bournakis and Ramírez-Rondán (2024) who employ non-linear dynamic models but with panel data. Though 1999a time series approach was preferred in this study to facilitate country-level analysis, Eberhardt and Presbitero (2015) show that this can also be achieved in the panel setting by introducing heterogenous panel techniques (also see Pesaran et al.,1999).

On introducing revenue and expenditure rules in the region, it would also be helpful to interrogate the short-run relationships. This study focused on the sustainability question only, and additionally, remained mindful of the overall length of the analyses, thus short-run results of the ARDL bounds tests were neither assessed nor reported. However, understanding the short-run dynamics is as important as the long-run relationship for design of effective revenue or expenditure rules, especially in Caribbean countries which are known to have short planning horizons and face multiple shocks. The same VAR approach by Bournakis and Ramírez-Rondán (2024) would be useful for a more concise short-run analysis.

3.7 Conclusions

This study employed an adjusted AF (2005) debt sustainability assessment procedure with PS (2001) ARDL Bounds Test for an empirical assessment of fiscal sustainability in the Caribbean, a region which has historically carried very high ratios of debt, and where there is a disproportionate susceptibility to shocks, especially natural hazards.

Using the adjusted method, it finds that between 2000q1 and 2019q4, debt sustainability was present in 6 of the 9 Caribbean countries included in the study. Fiscal sustainability was statistically confirmed for Antigua and Barbuda; Dominica; St Kitts and Nevis; Trinidad and Tobago; the Bahamas; and Jamaica. Sustainability could, however, not be confirmed for Grenada, Barbados, or St Lucia.

Largely, the results align with that of Grenade (2011); Wright *et al*. (2009); Thacker and Acevedo (2011); Cevik and Nanda (2020) and Khadan (2019) who conclude that Caribbean debt is weakly sustainable.

The evidence also broadly supports Caribbean fiscal policy performance, particularly within the last six years since the spike in the average debt to GDP ratio in 2013q1. Two of the countries that had recent debt restructurings (Grenada and Barbados) failed the sustainability test.

To strengthen fiscal sustainability in the region, the study recommends introducing formal revenue and expenditure rules and to this end makes recommendations for future research.

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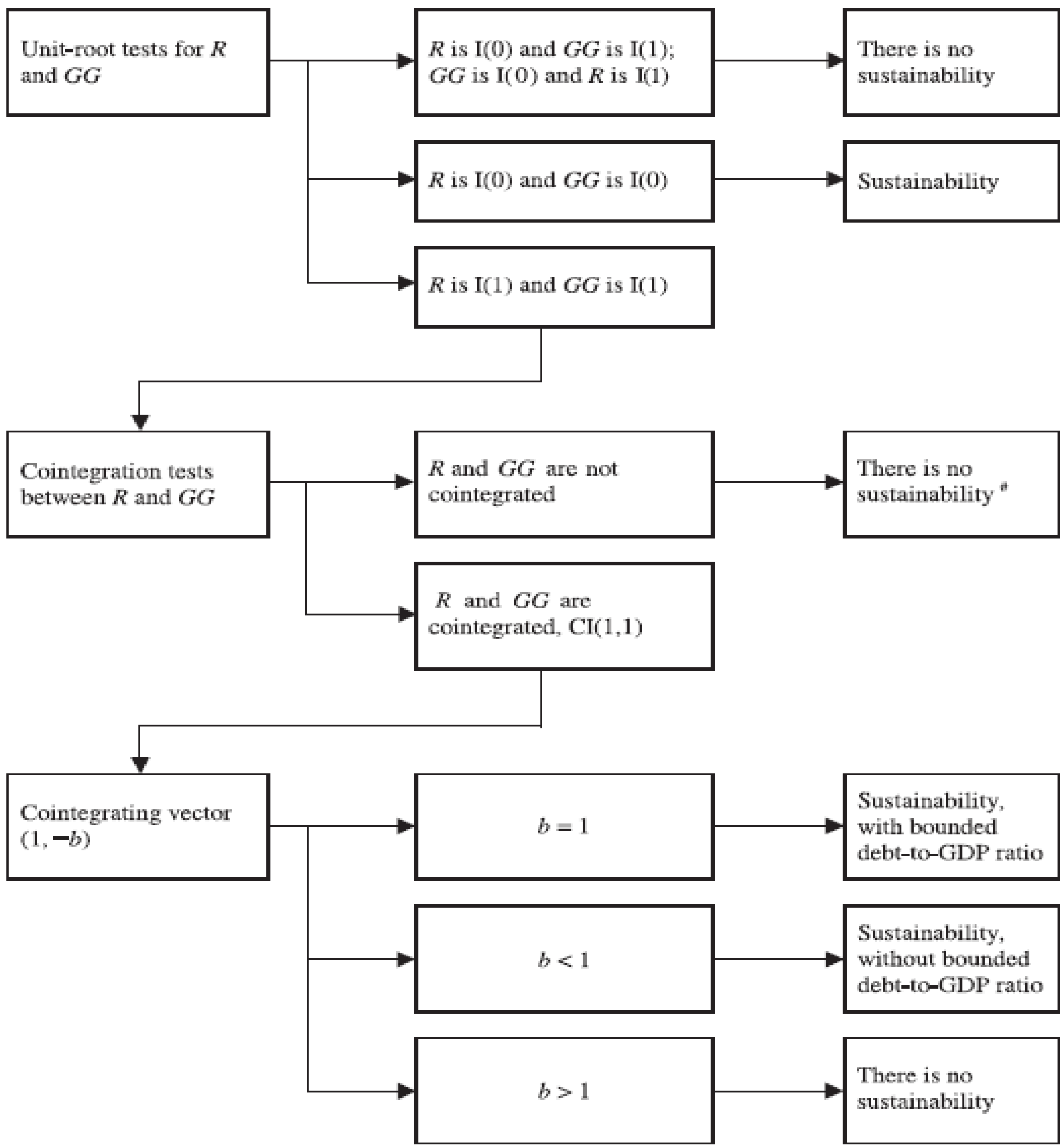
Appendix

Figure A 10 AF Fiscal Sustainability Testing Procedure



Source: AF (2005)

Box A 3.1 Options in ARDL Bounds Test for Co-Integration

Case 1: (no constant and no trend)

$$\Delta GG_t = \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t + \sum_{q=1}^{n} b_{2q}\Delta R_{t-q} - \theta_1\left(GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1}\right) + e_t$$

Omitting the constant and trend terms from the ARDL-ECM (3.6) and rewriting the long-run relationship as in (3.5), the data generating process for case 1 is (14). The error correction term becomes: $EC = GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1}$ and the null hypothesis to be tested H_0: $\theta_1 = \theta_2 = 0$.

Case 2: (restricted constant and no trend)

A restricted constant implies that the constant term enters the cointegrating vector.

$$\Delta GG_t = \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t + \sum_{q=1}^{n} b_{2q}\Delta R_{t-q}$$

$$- \theta_1\left(GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1} - \frac{a_0}{\theta_1}\right) + e_t$$

The error correction term in this case is therefore $EC = GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1} - \frac{a_0}{\theta_1}$, while the null is H_0: $a_0 = \theta_1 = \theta_2 = 0$.

Case 3: (unrestricted constant and no trend)

$$\Delta GG_t = a_0 + \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t + \sum_{q=1}^{n} b_{2q}\Delta R_{t-q} - \theta_1\left(GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1}\right) + e_t \qquad (16)$$

In case 3, the constant term enters the dynamic regression, and the error correction term and null hypothesis remains as in case 1.

Case 4: (unrestricted constant and restricted trend)

$$\Delta GG_t = a_0 + \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t + \sum_{q=1}^{n} b_{2q}\Delta R_{t-q}$$

$$-\theta_1\left(GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1} - \frac{a_1 t}{\theta_1}\right) + e_t$$

like in case 3 the constant enters the dynamic equation but not the cointegrating vector. However, the trend is restricted to enter only the cointegrating equation. The corresponding error correction term $EC = GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1} - \frac{a_1 t}{\theta_1}$, and H_0: $a_1 = \theta_1 = \theta_2 = 0$.

Case 5: (unrestricted constant and unrestricted trend)

$$\Delta GG_t = a_0 + a_1 t + \sum_{p=1}^{n} b_{1p}\Delta GG_{t-p} + b_{20}\Delta R_t +$$

$$\sum_{q=1}^{n} b_{2q}\Delta R_{t-q} - \theta_1\left(GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1}\right) + e_t$$

And finally, in case 5 both the constant and trend terms enter unrestricted such that the error correction and null hypothesis are $EC = GG_{t-1} - \frac{\theta_2 R_{t-1}}{\theta_1}$ and H_0: $\theta_1 = \theta_2 = 0$, respectively.

Figure A 11 Trends in Antigua and Barbuda Revenue and Expenditure

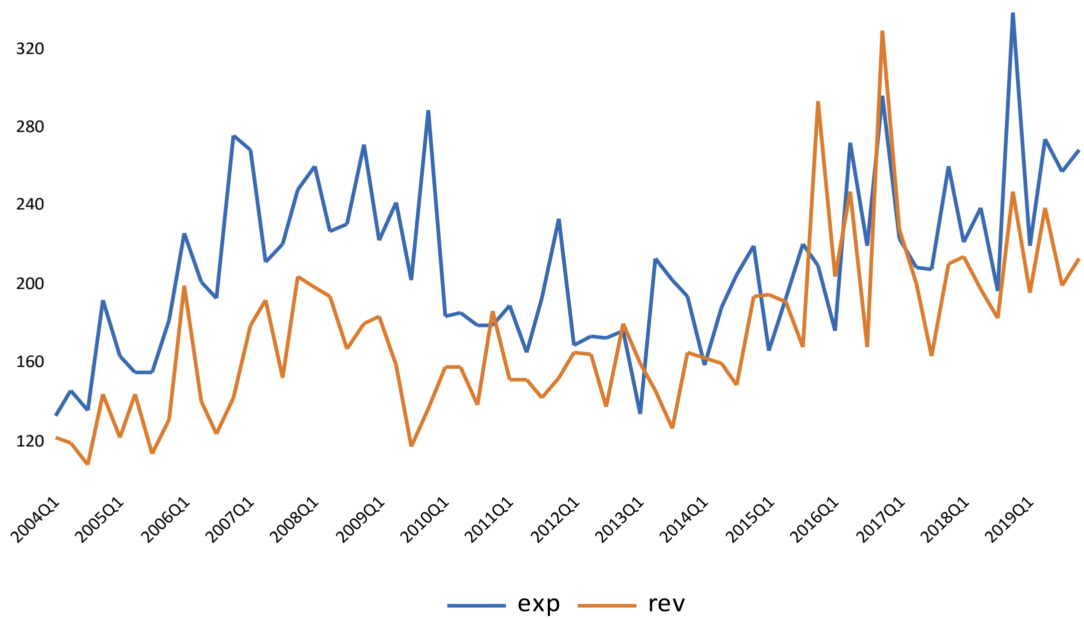


Figure A 12 Trends in Dominica Revenue and Expenditure

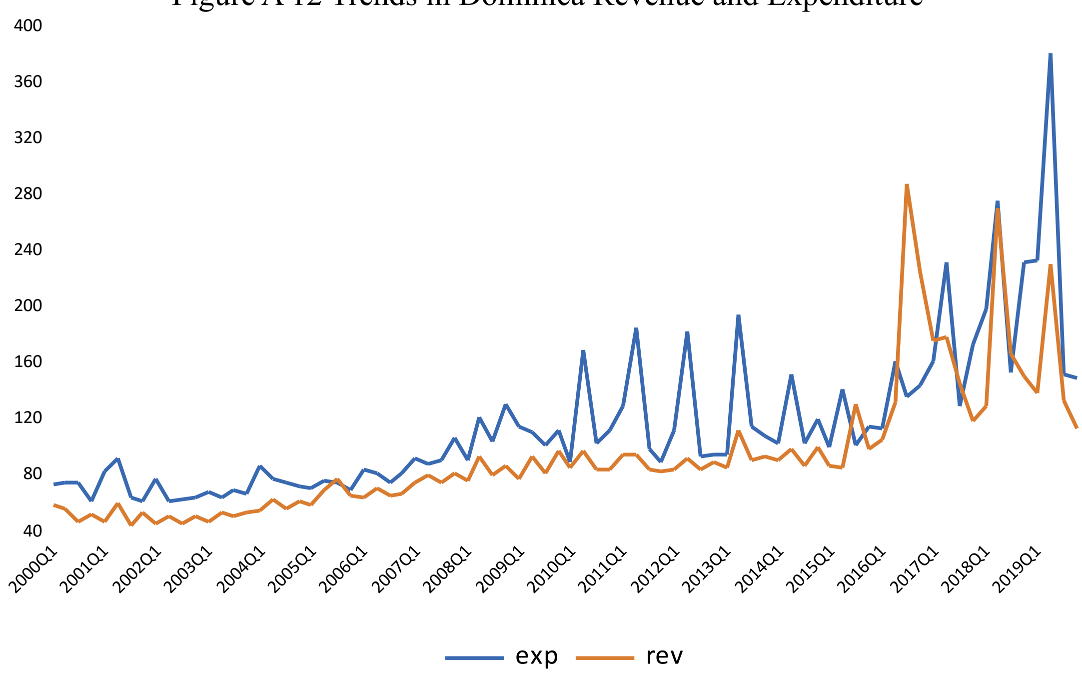


Figure A 13 Trends in Grenada Revenue and Expenditure

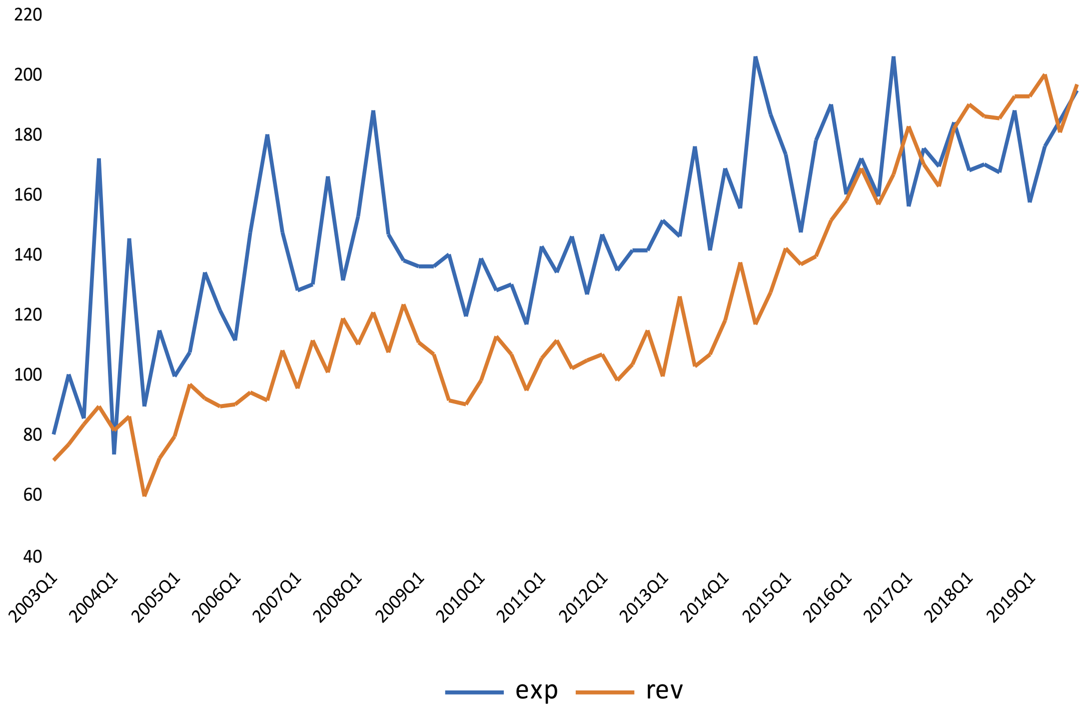


Figure A 14 Trends in St Kitts and Nevis Revenue and Expenditure

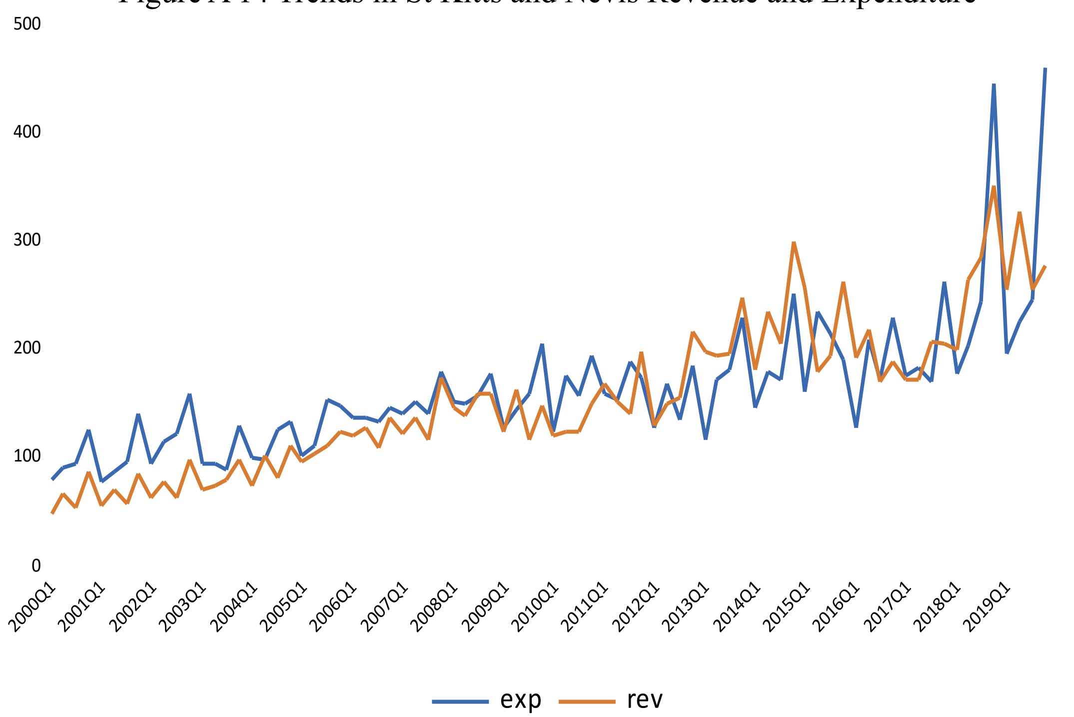


Figure A 15 Trends in Barbados Revenue and Expenditure

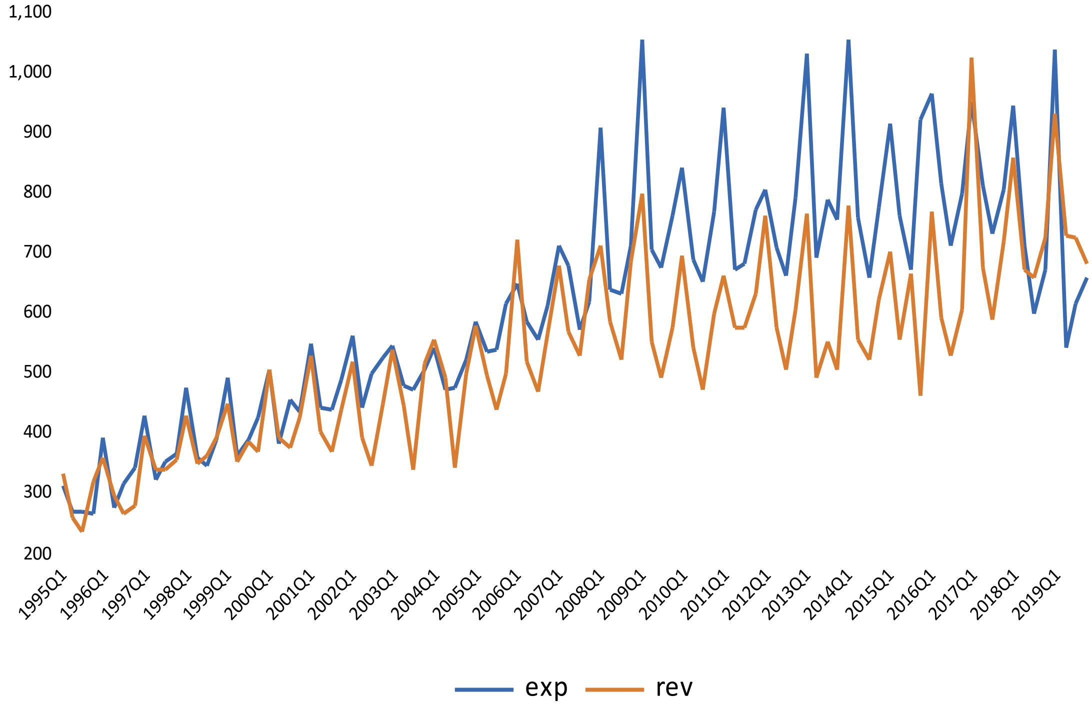


Figure A 16 Trends in St Lucia Revenue and Expenditure

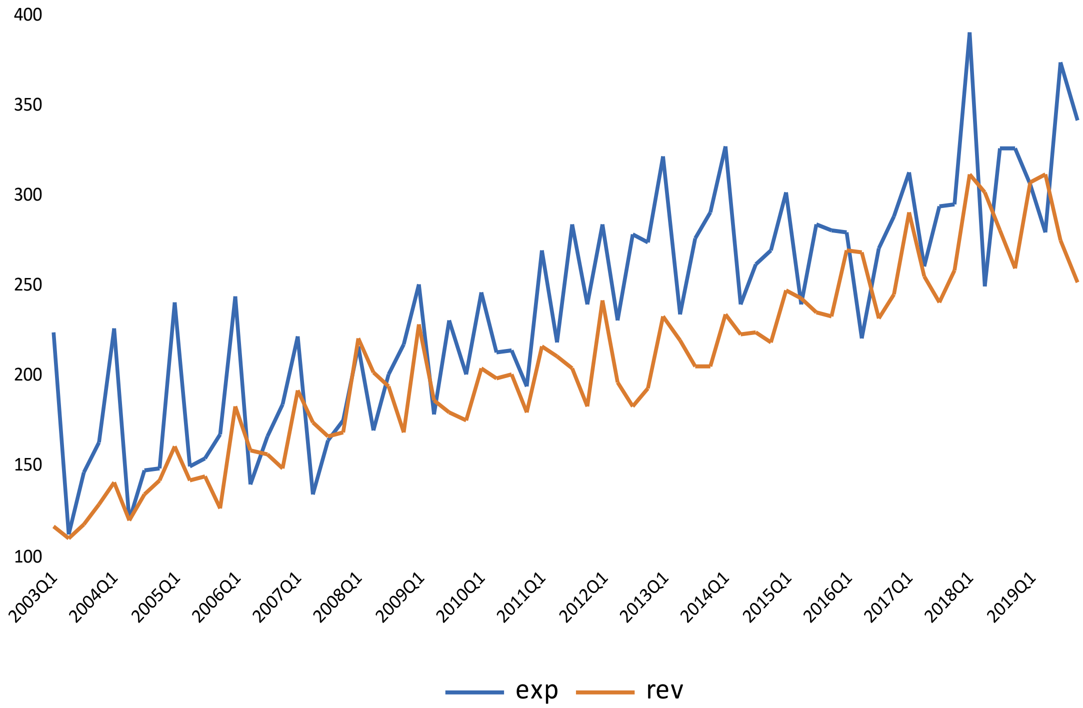


Figure A 17 Trends in Trinidad and Tobago Revenue and Expenditure

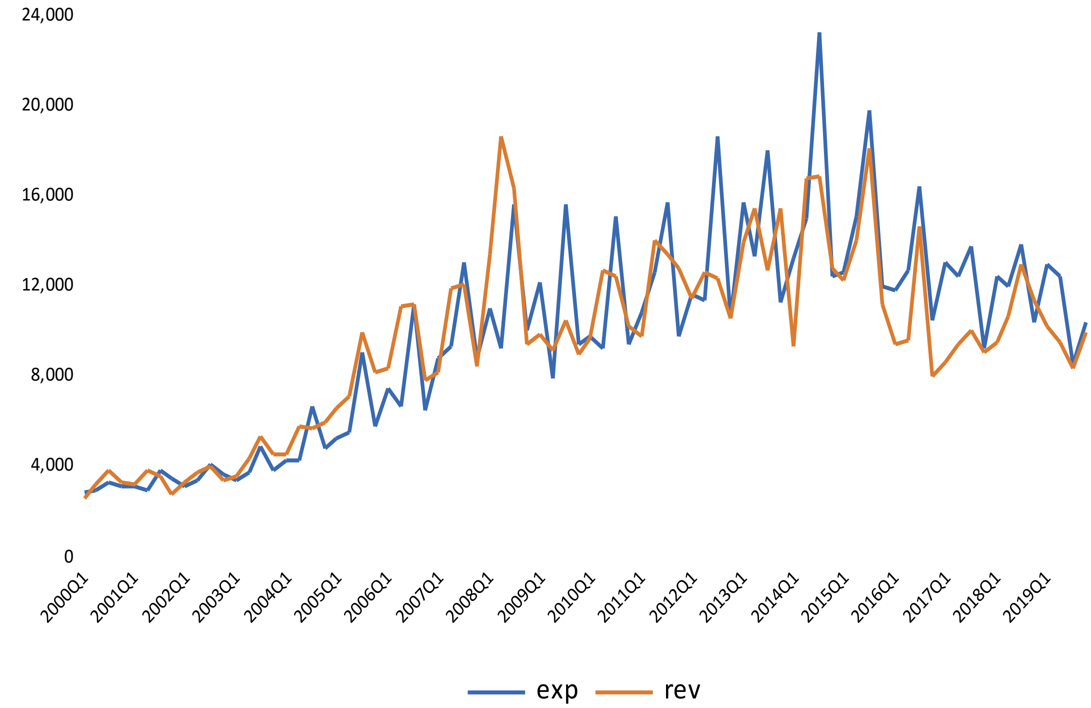


Figure A 18 Trends in Bahamas Revenue and Expenditure

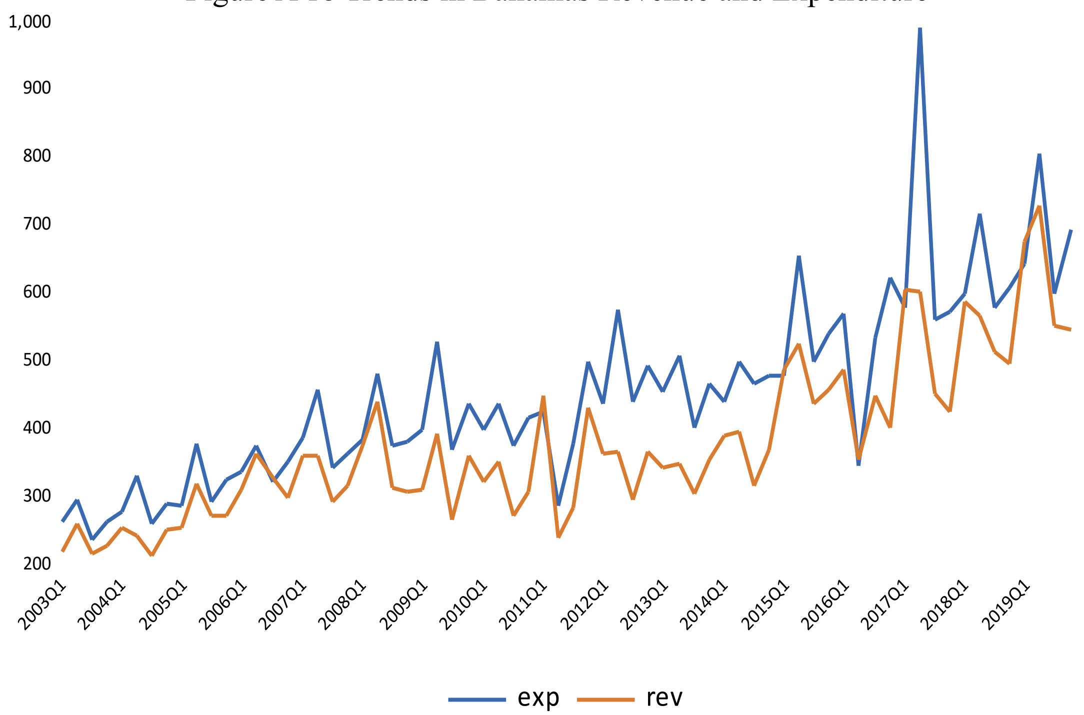


Figure A 19 Trends in Jamaica Revenue and Expenditure

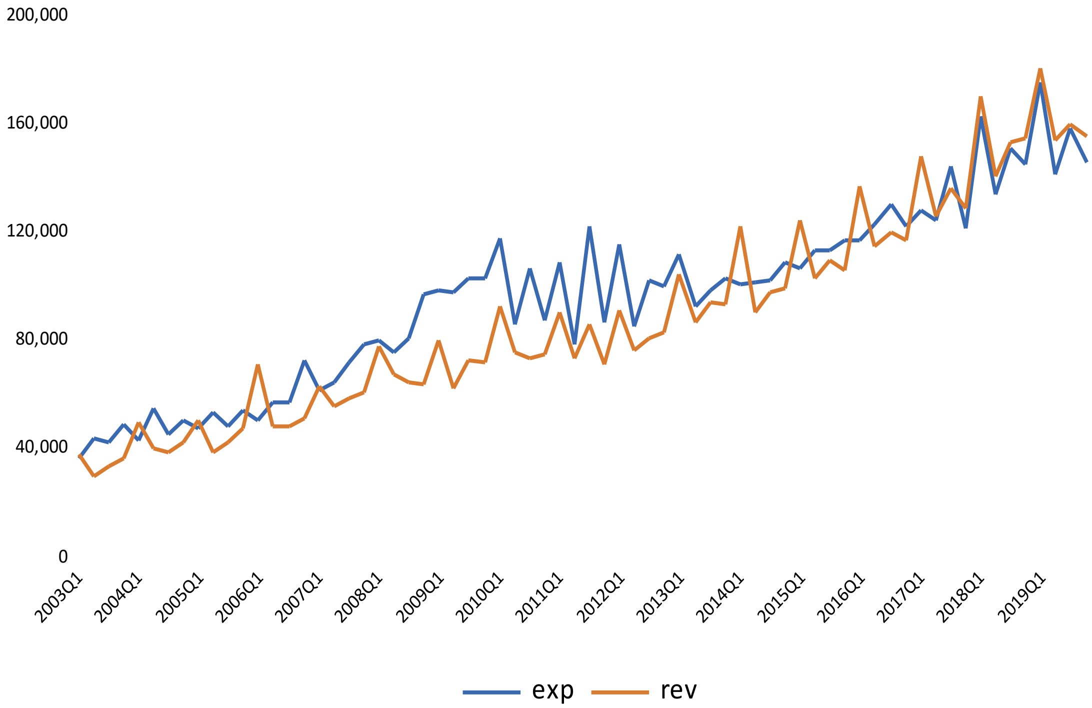


Figure A 20 ARDL Parameter Stability Antigua and Barbuda Regressions (Cases 1-5)
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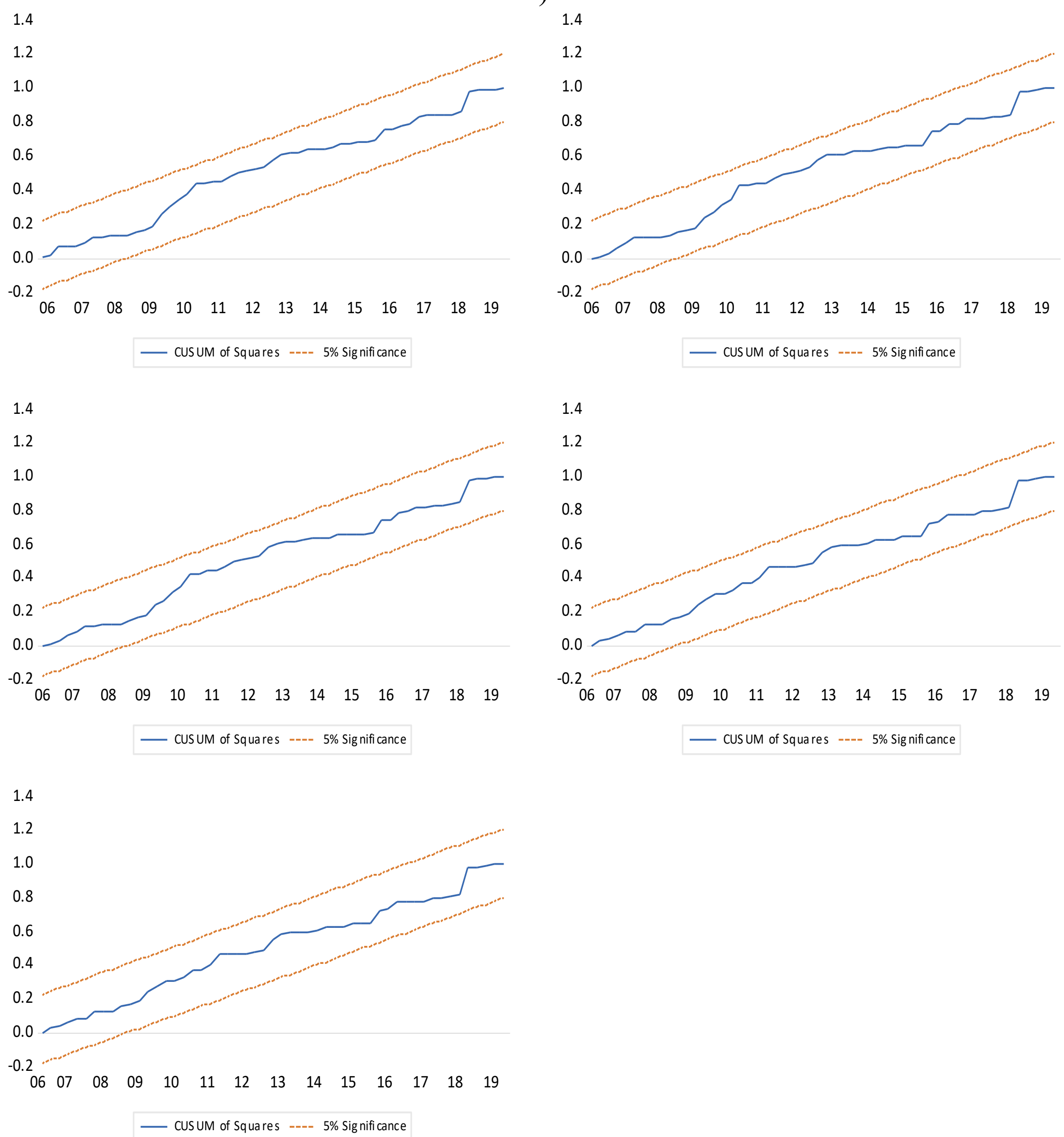


Figure A 21 ARDL Parameter Stability Dominica Regressions (Cases 1-5)

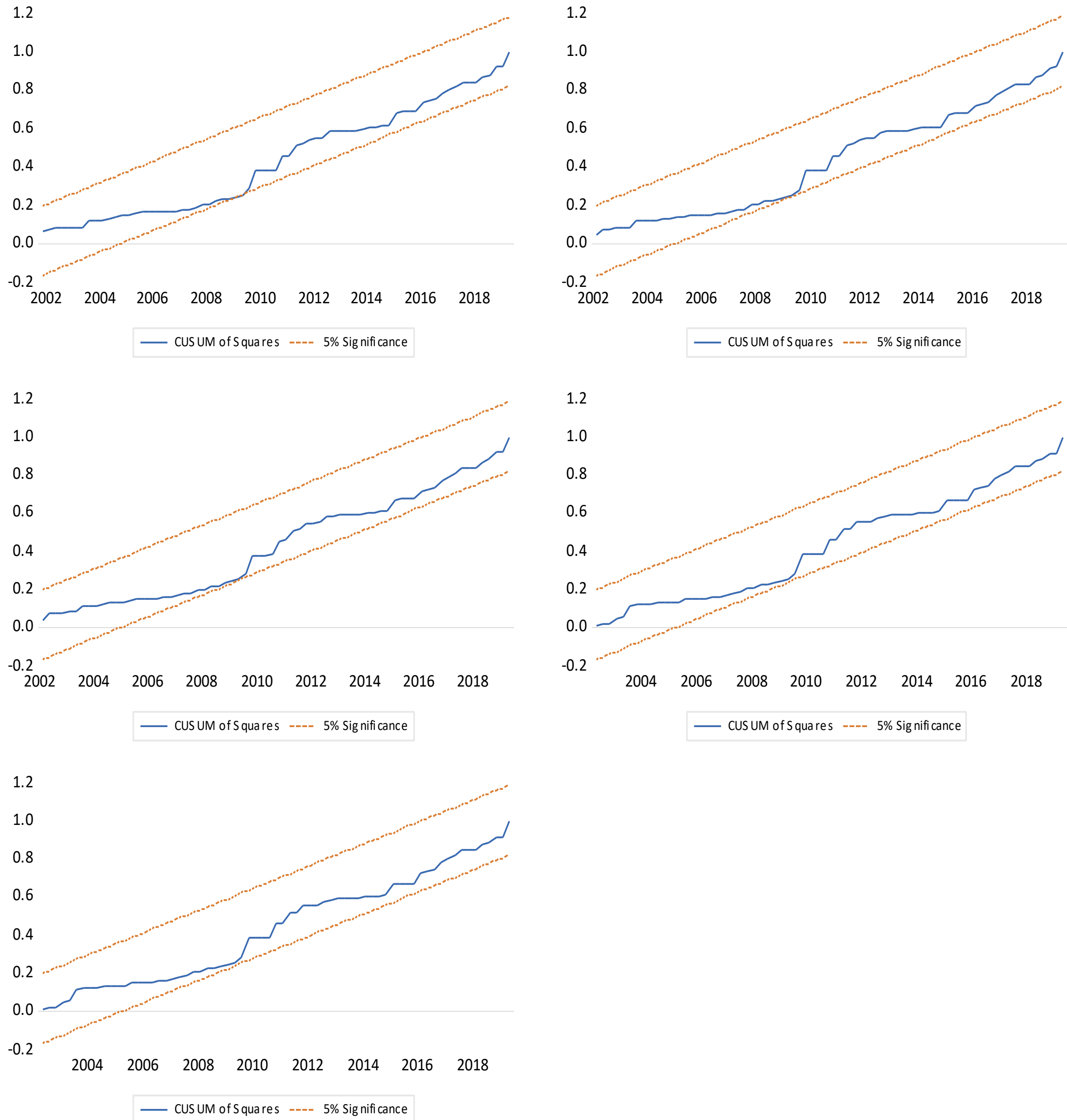


Figure A 22 Parameter Stability Grenada Regressions (Cases 1-5)

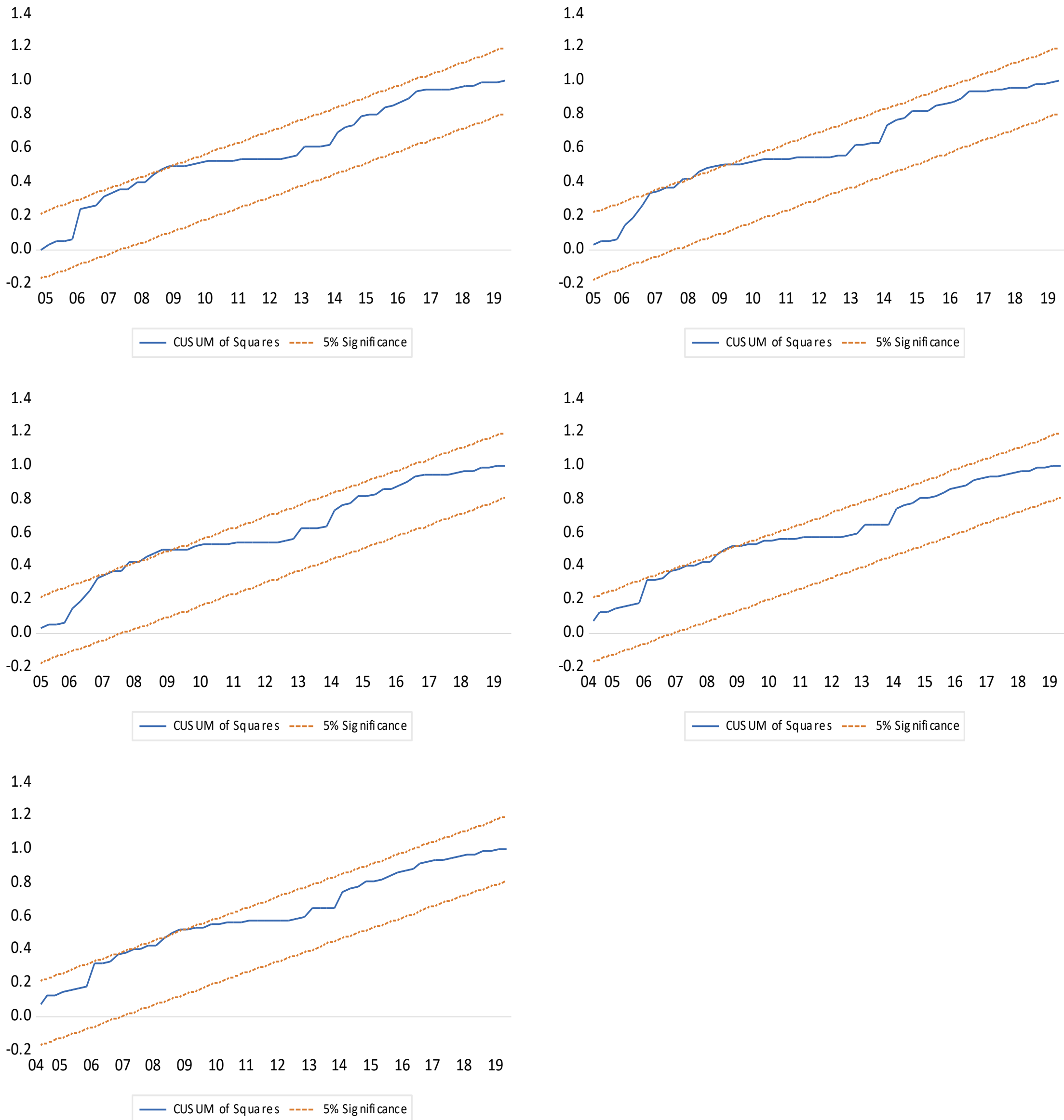


Figure A 23 ARDL Parameter Stability St Kitts and Nevis Regressions (Cases 1-5)

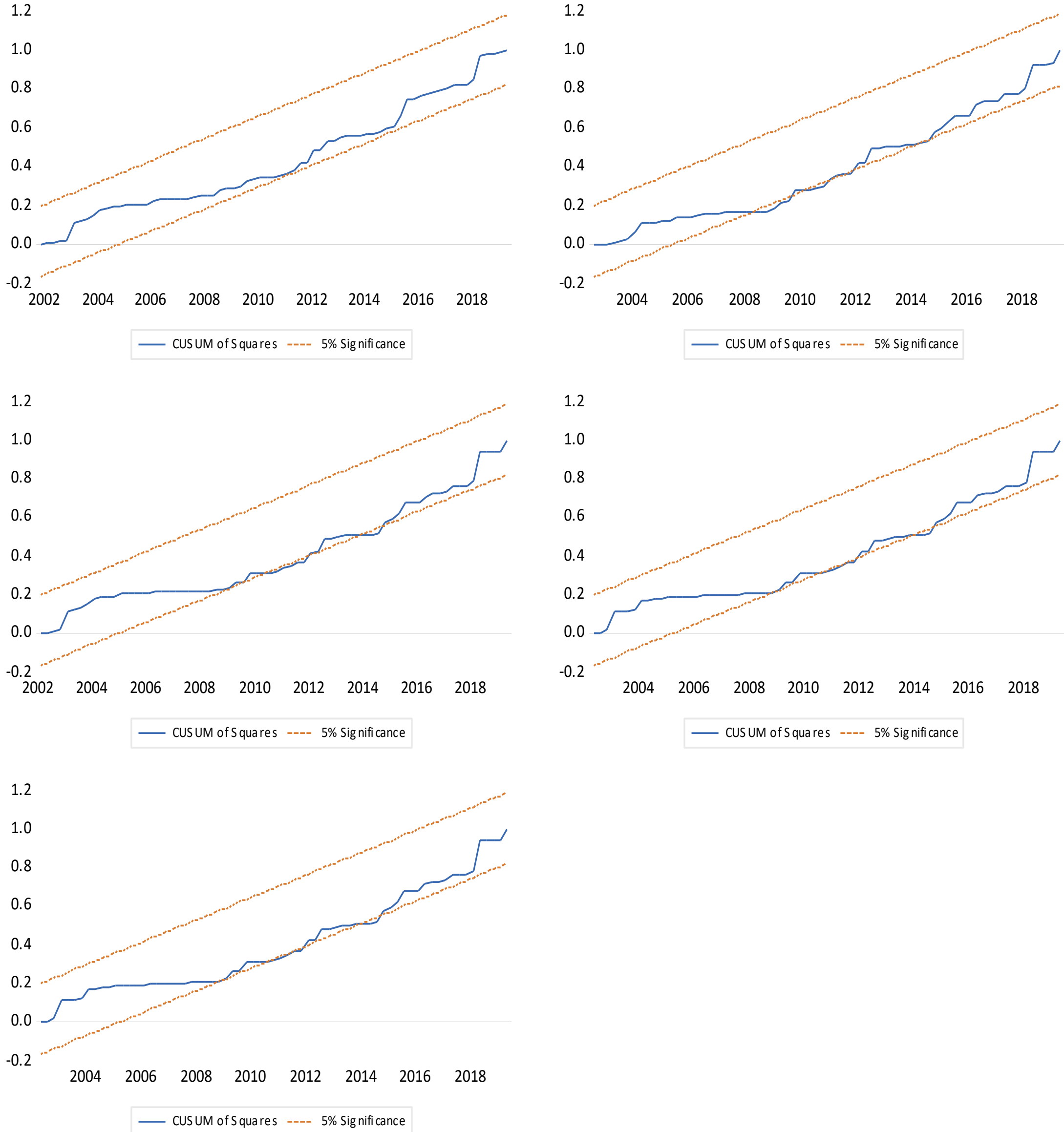


Figure A 24 ARDL Parameter Stability Barbados Regressions (Cases 1-5)

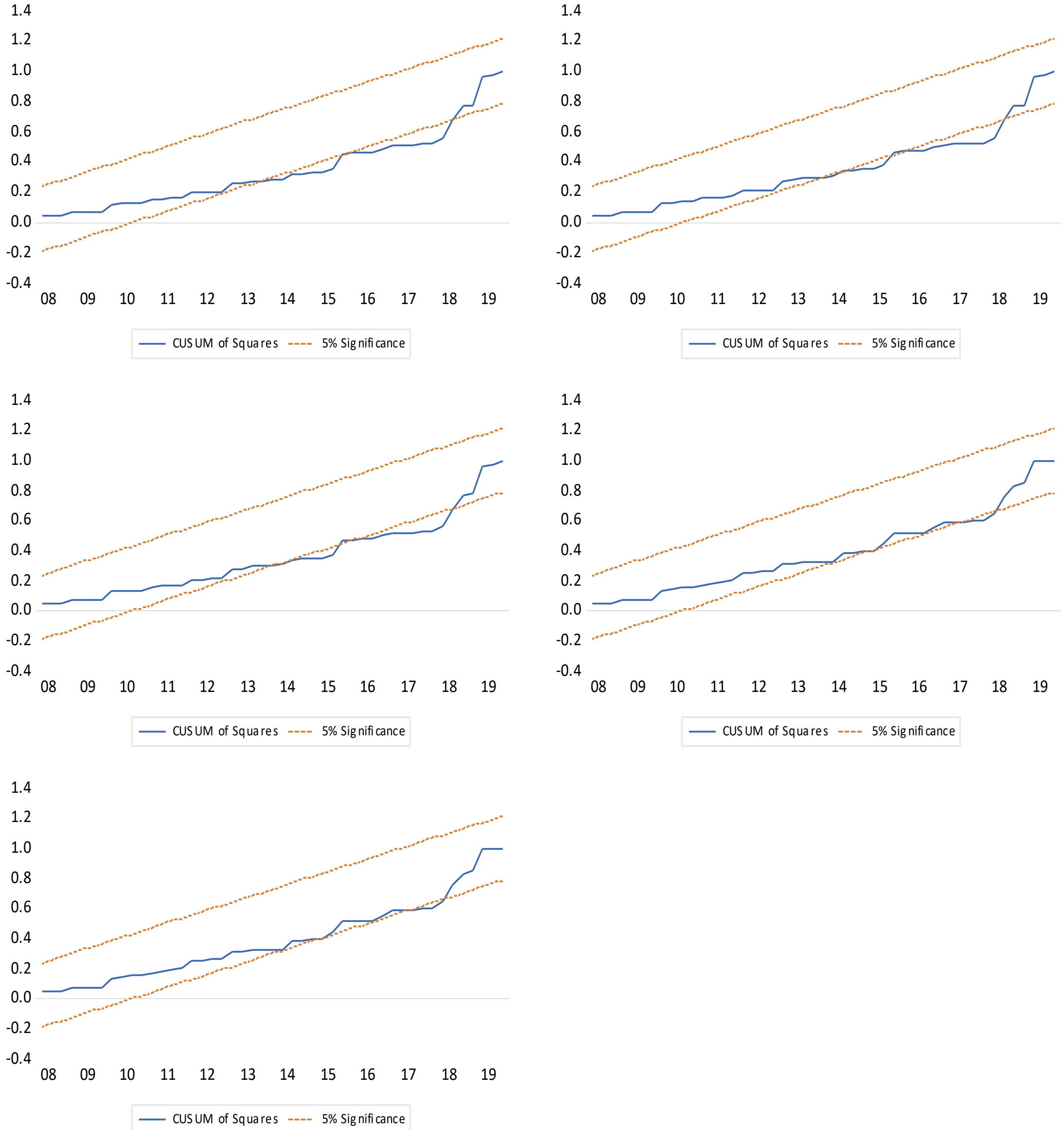


Figure A 25 ARDL Parameter Stability St Lucia Regressions (Cases 1-5)

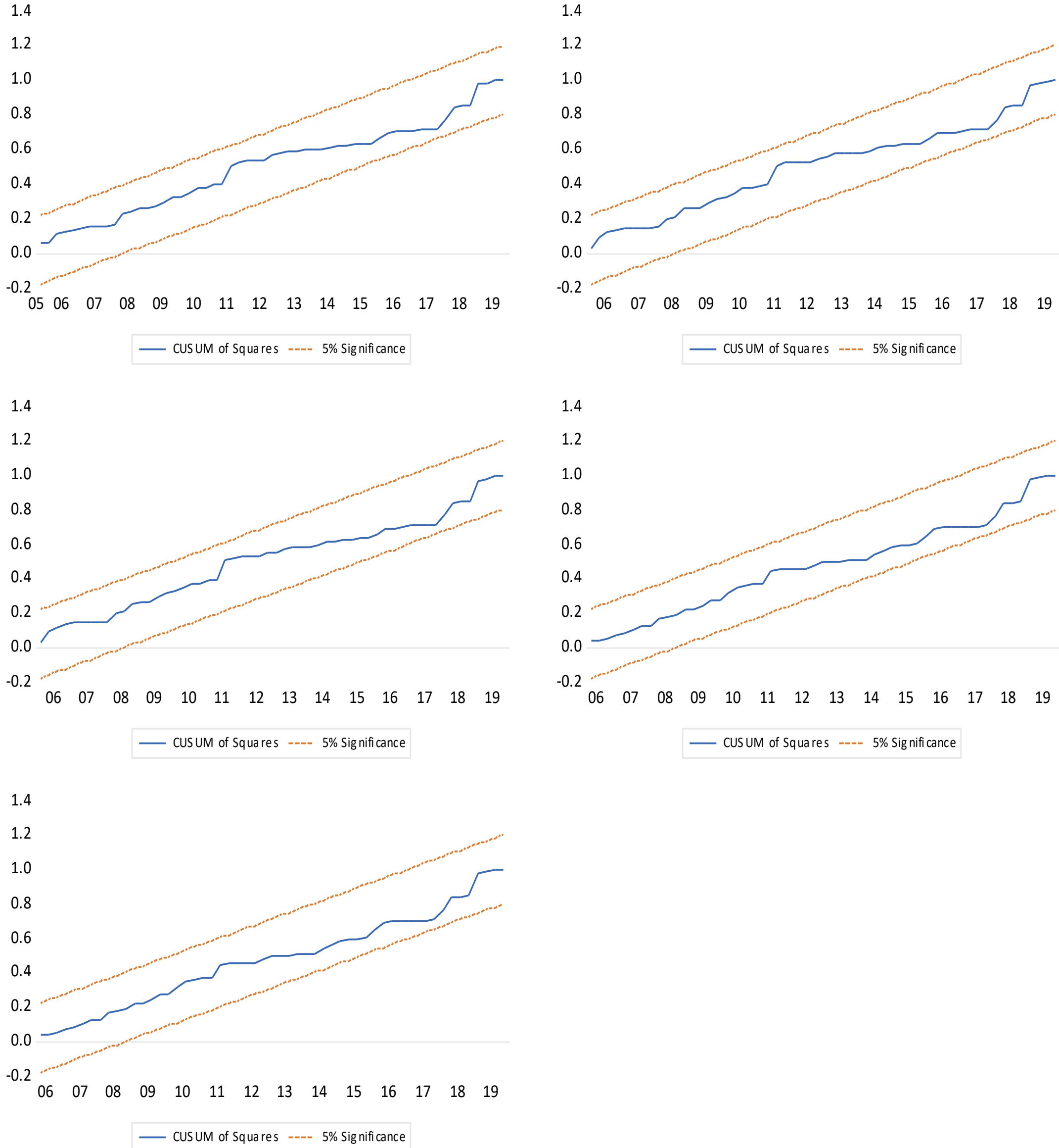


Figure A 26 ARDL Parameter Stability Trinidad and Tobago Regressions (Cases 1-5)

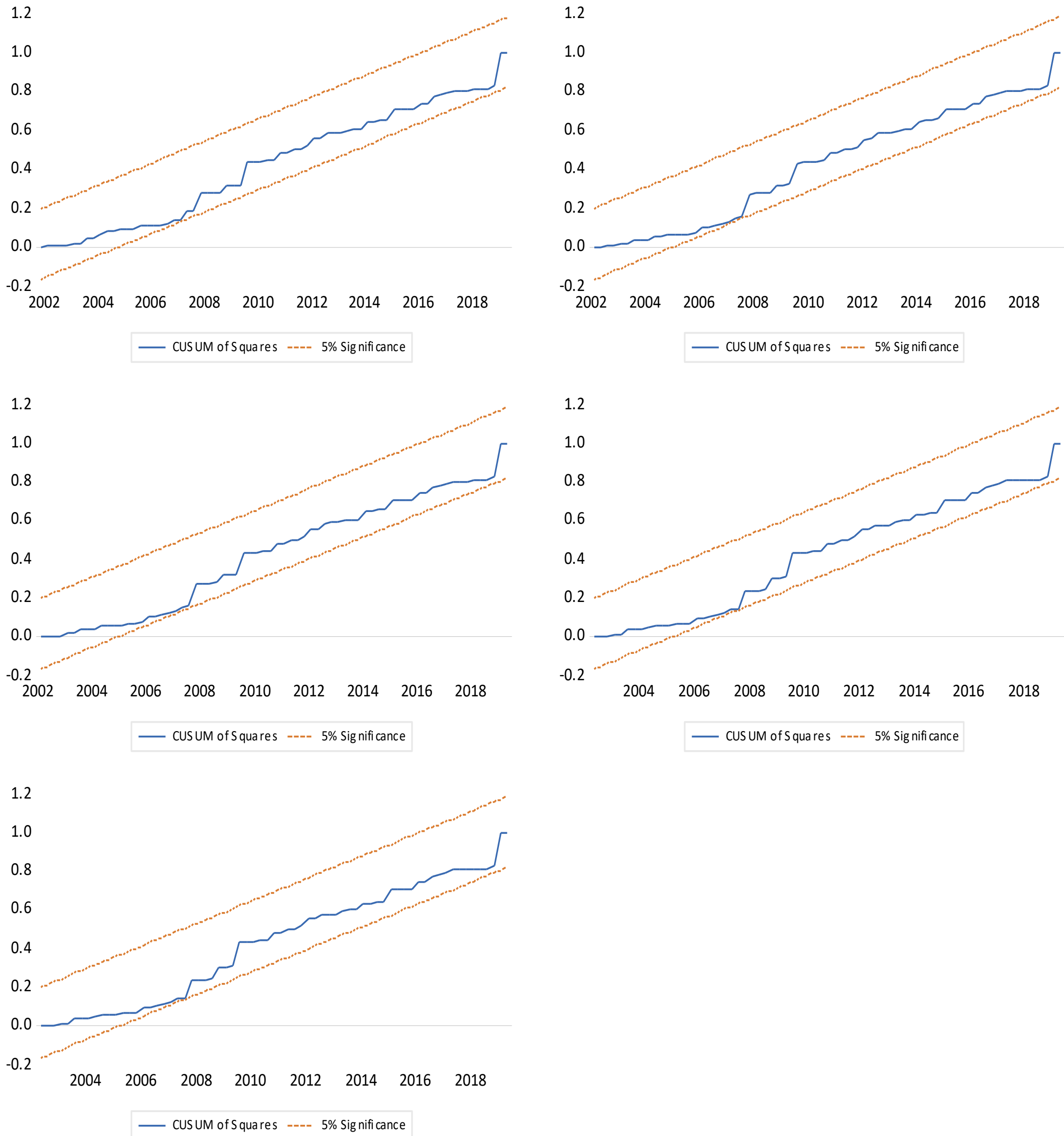


Figure A 27 ARDL Parameter Stability Bahamas Regressions (Cases 1-5)

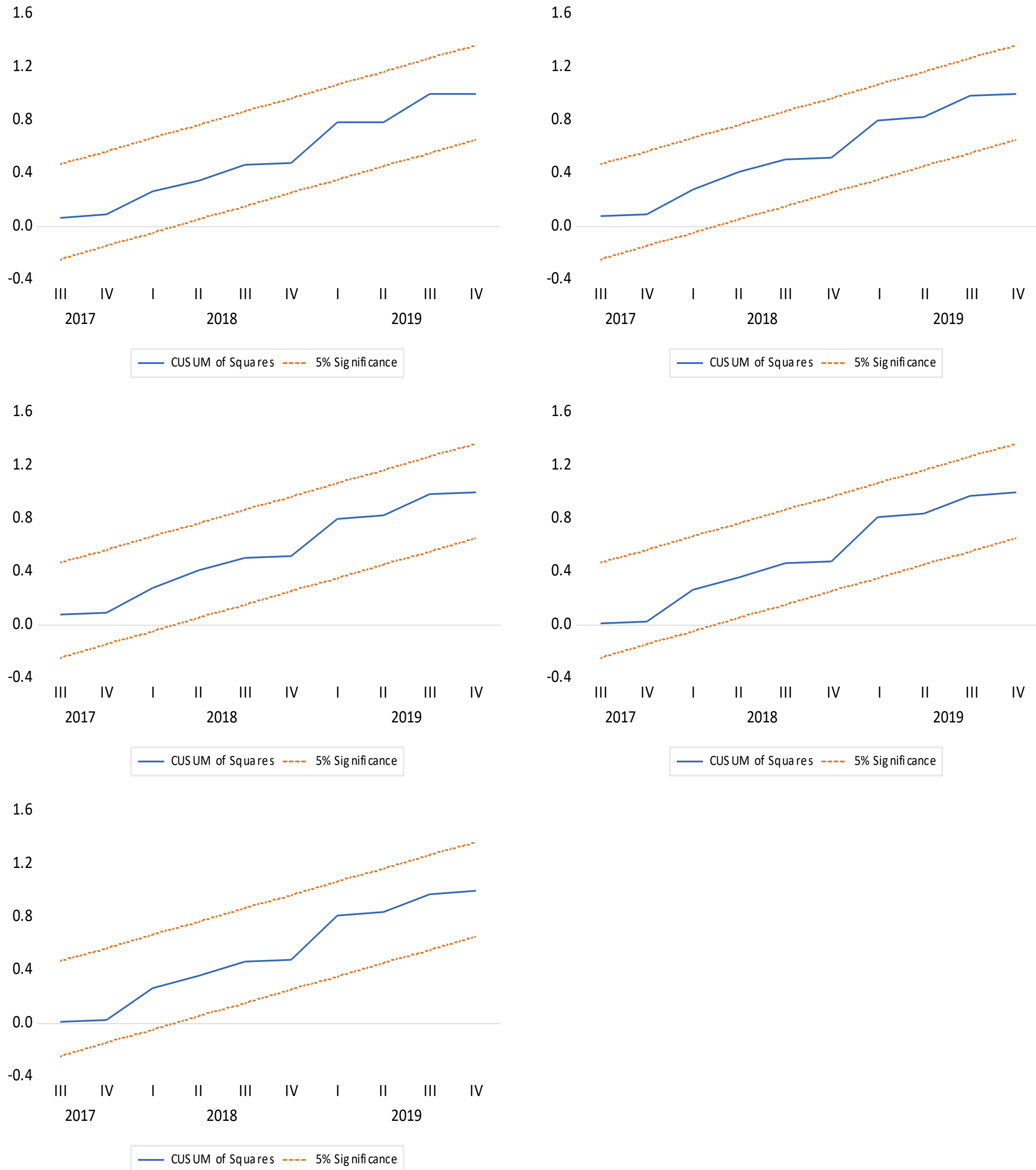
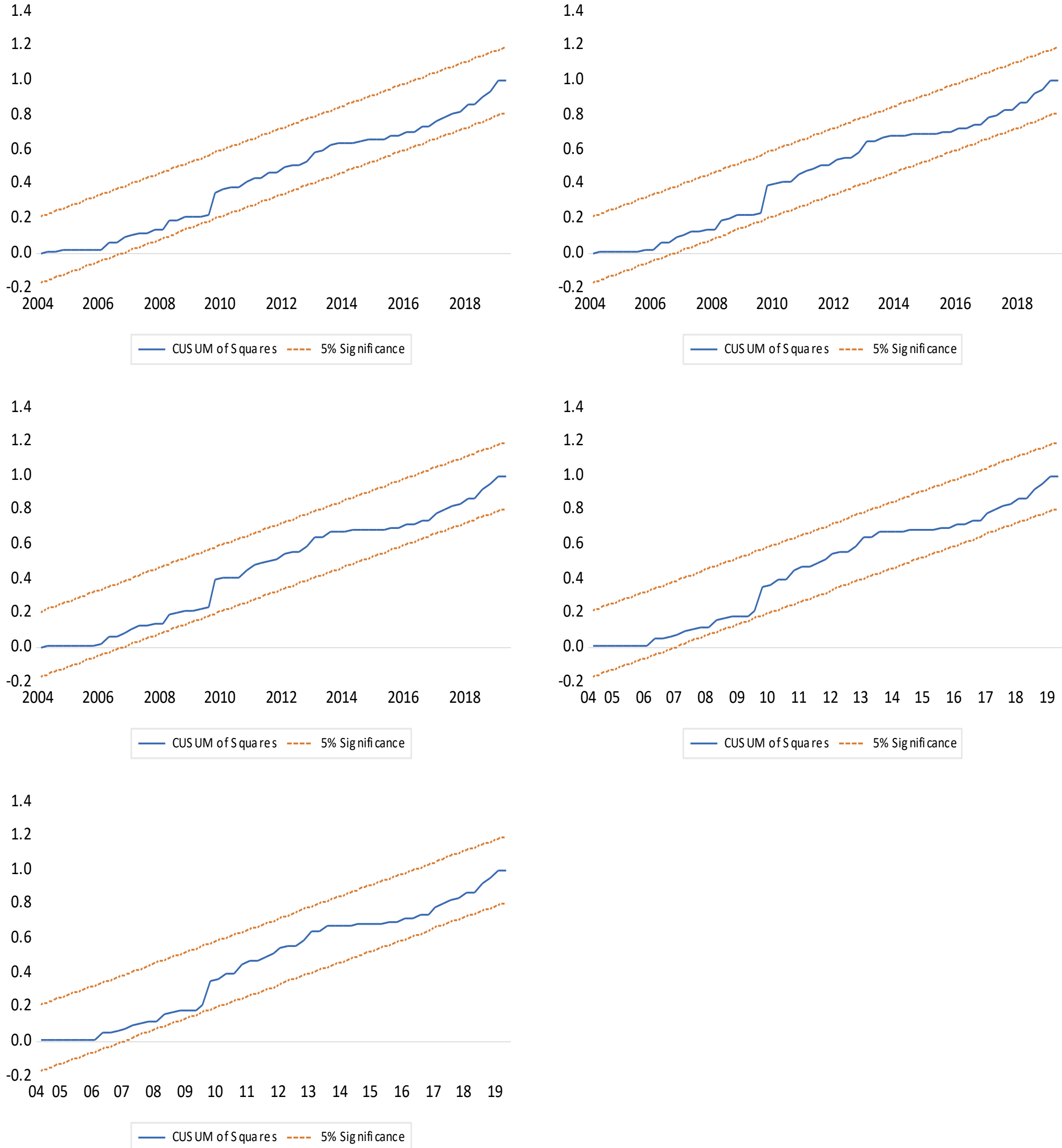


Figure A 28 ARDL Parameter Stability Jamaica Regressions (Cases 1-5)



Chapter 4 Estimating a Fiscal Reaction Function for the Caribbean

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Abstract

Despite fairly high levels of indebtedness measured as a percentage of GDP, countries' debt positions can be sustainable if governments fiscal policy reacts positively to debt expansions on a consistent basis. A key consequence of this empirical realization is that debt ratios above the conventional 60 percent rule of thumb cannot conclusively be regarded as unsustainable, neither can the attendant fiscal policy.

The Caribbean's average debt to GDP ratio has been consistently above this threshold for the past two decades but two recent studies have found that debt in the region is sustainable, increasing academic curiosity about the region's fiscal sustainability. With the use of panel data, the study conducts a fiscal reaction test on the sustainability of the Caribbean region's fiscal policy. However, as opposed to the most recent studies, the estimation procedure is selected by way of Monte-Carlo simulations and policy implications are drawn from the results to guide the region's policy makers.

The study confirms the region's weak fiscal sustainability and finds that improving the perception of corruption is a key policy initiative for improving the primary balance and the region's fiscal sustainability going forward.

Keywords: Debt Sustainability; Panel Data; Fiscal Reaction Functions.

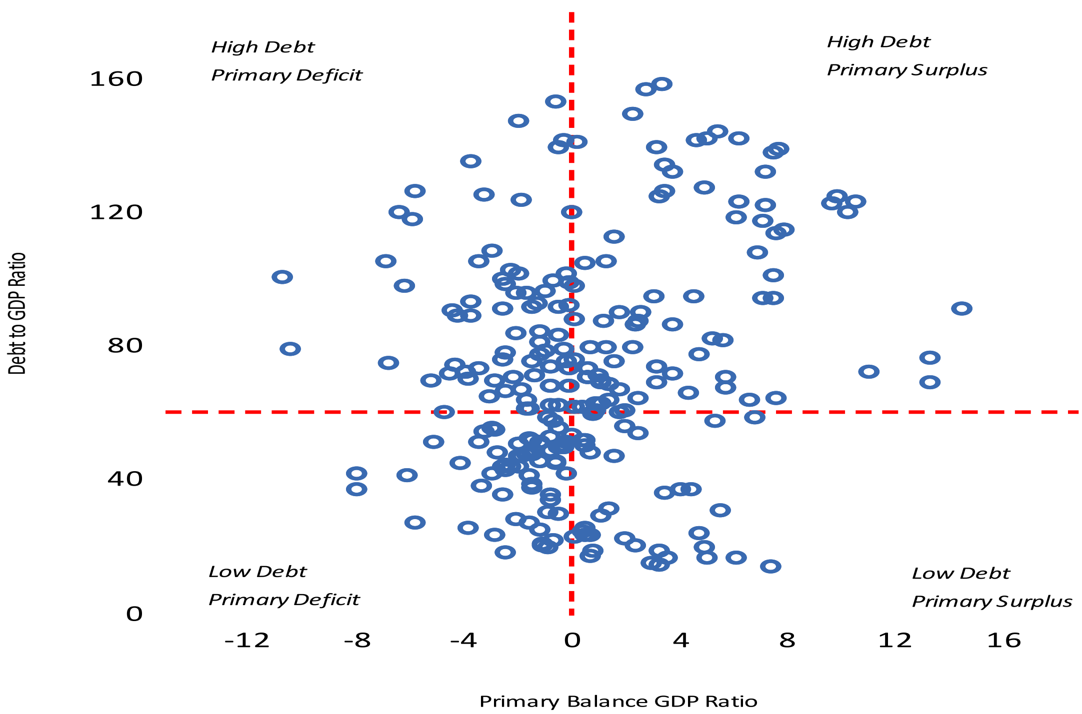
4.1 Introduction

According to two recent studies, the sustainability of Caribbean fiscal policy is but hanging by a thread. Khadan (2019) and Cevik and Nanda (2020) find a near zero (0.02) but highly significant Fiscal Reaction Function (FRF) coefficient for Caribbean data using panel IV and GMM methods, respectively, indicating a small fiscal surplus response to debt, just narrowly satisfying Bohn's (1998; 2005; 2007) conditions for fiscal sustainability.

A scatter plot of Caribbean debt against the primary balance over 2001-2019, does reflect a seesaw pattern of loose and tight policy measures along the upper axis of debt (> 60 percent of GDP), continuing even as the Caribbean debt ratio surpasses 120 percent of GDP (Figure 4.1), and corroborating the authors' findings.

The evidence from these studies stimulates academic curiosity for two main reasons. For one, the Caribbean region is highly indebted and has been so for the past four decades. And though theory shows (Bohn, 1998) that even with high and increasing debt, fiscal policy can be sustainable, the very weak sustainability coefficient implies that the region's sustainability could easily collapse at any moment. Secondly, the econometric methods used in the two most recent studies raise questions due to the Caribbean's data limitations.

Figure 4.1: Association between Caribbean Debt and Primary Balance to GDP Ratios (2001-2019)



Source: IMF World Economic Outlook Database (2023)

Influenced by the work of Lucas *et al*. (2019), Roodman (2008), Mammi (2015), and Celasun and Kang (2006) on testing estimator bias, this study delves further into the issue of Caribbean fiscal policy sustainability. In this updated assessment, the estimator for the Caribbean FRF is chosen by way of Monte-Carlo simulations. This serves to rule out and/or to minimise the possibility of small sample bias and/or invalid statistical inference (Bun and Sarafidis, 2015; Dang *et al*., 2015; Lucas *et al*., 2019; Windmeijer, 2015) in the most recent works.

The Caribbean region comprises just 13 English speaking countries, and fiscal data is available only from 1980 (IMF, 2023), providing a maximum of 40 observations per variable up to the year 2019. In the panel data setting, this translates to a dataset of N=13 cross sections and T=40 time series observations from which to draw inference. In contrast, the system GMM estimator employed by Cevic and Nanda (2020), requires a dataset with large N dimension, or at least N=20 cross sections, and some finite time series to guarantee consistent and unbiased estimation (Roodman 2008, 2009; Lucas *et al*, 2019; Mammi, 2015).

This discord, in addition to the problems encountered with small sample panel IV estimation (Baum, 2009), raises the prospect of estimator bias in the recent estimations of the Caribbean FRF, and underlines the key motivation for the current study.

In line with convention, the study also undertakes robustness checks, as did both Khadan (2019) and Cevic and Nanda (2020) on their selected estimators. However, it is important to note that whilst robustness checks are good litmus tests for estimator consistency, they are not the most useful for identifying estimator bias. Estimator bias can only be truly verified with knowledge of population parameters. Hence, even in this case where the authors find identical FRF coefficients, it does not necessarily rule out the possibility that their estimators are biased. Monte Carlo simulation, on the other hand, is helpful in this regard, as it can measure estimator bias ex-ante, through knowledge of true population parameters.

In undertaking the assessment, the study makes the following contributions:

1. Updates the assessment of the Caribbean's fiscal sustainability and provide comparative evidence.

2. For the first time in this region, adds to knowledge on the appropriateness of different panel estimators (Panel Instrumental Variable (IV), Least Square Dummy Variable (LSDV), OLS-Panel Corrected Standard Error (PCSE), OLS-O'Driscoll, and Feasible General Least Square (FGLS) in the context of small samples and fiscal reaction functions.

3. Augments the Caribbean FRF, and in doing so, provides original evidence as to the drivers of Caribbean fiscal policy. In particular, the study sheds light on whether the Caribbean marginal primary balance response is stronger in countries with marketable or non-marketable debt, or in highly indebted versus lower indebted Caribbean countries. It also tests for the relevance of

institutional variables such as corruption, political stability, government effectiveness, and governance.

Using a randomised sample with a panel data structure identical to that of the Caribbean, the study finds that OLS with Panel Corrected Standard Errors (PSCE) is most suitable for estimating FRFs for the Caribbean. The study further finds that recent results are valid, and indeed, the Caribbean's fiscal policy is weakly sustainable. Moreover, with regards fiscal reactions, the research implies that the levels of debt matter, but not whether countries hold marketable debt. Whilst there is not much evidence to support the importance of policy effectiveness and political stability, the study finds strong evidence of the importance of improving the region's perception of corruption and reducing election spending, as regards influencing positively, discretionary fiscal policy and sustainability.

The study proceeds in Section 2 with a review of literature. It then moves to Section 3, where the study discusses specification of the fiscal reaction function, continuing to Section 4 which delves into choosing the estimator via a Monte-Carlo exercise. The data and relevant diagnostic checks feature in Section 5. The model is then estimated, and the empirical results are discussed in Section 6. In Section 7, the study turns its attention to robustness checks and concludes in Section 8.

4.2 Literature Review

4.2.1 Caribbean Fiscal Sustainability Research and Related Challenges

In the Caribbean, despite a higher average ratio of debt and extreme vulnerability to shocks, the discussions on the region's fiscal sustainability have generally been constrained to the policy space, with various international and regional bodies (World Bank; International Monetary Fund (IMF); United Nations (UN); Caribbean Development Bank (CDB); Caribbean Community (CARICOM)) leading calls to address Caribbean fiscal imbalances and debt to GDP ratios, given the risks to these already highly vulnerable, low-growth economies (Acevedo, Cebotari, and Turner Jones, 2013; Alleyne, Otker, Ramakrishnan, and Srinivasan, 2017).

Formal research on the sustainability of Caribbean fiscal policy is limited, with the IMF serving as the prime source of empirical investigation into possible violations of Caribbean governments' intemporal budget constraints (See for example IMF, 2022a; and IMF; 2022b)). The IMF's analysis, however, derives from the debt sustainability analysis (DSA) framework, which has been well criticized for its overzealous growth forecasts and highly subjective results, among other things (Wyploz 2011).

Limited availability of data, which from a fiscal perspective, begins 1980 and is sketchy at best until the early 2000s (WEO, 2023) is a major impediment to fiscal sustainability research in the Caribbean. The data issues have allowed for mainly indicator type approaches to answering questions on the long-run sustainability of the Caribbean's debt, but these are unable to provide a robust perspective. Debt sustainability is a long-run phenomenon, and the satisfaction of the IBC must therefore be assessed over time. The indicator approach imposes steady state assumptions that are unrealistic especially considering the region's volatility.

Panel data approaches have seen more long-run debt sustainability analyses include the Caribbean, and particularly those of Latin America, which neighbours the region. See for example, Alberola and Montero (2006); SELA (2013); Campo-Robledo and melo-Velandia (2015); kemoe and Lonkeng (2020); and Gonzalez and Hernandez (2023). Nevertheless, another challenge is that Latin America is much larger in terms of economies and numbers of countries, so joint Latin America and Caribbean (LAC) research does not necessarily lead to any meaningful conclusions for the Caribbean (Cevik and Nanda, 2020).

4.2.2 Specific Evidence on Fiscal Sustainability in the Caribbean

Gonzalez and Hernandez (2023), Cevik and Nanda (2020) and Khadan (2019) are the most recent examples of Caribbean specific research examining the state of the region's long-run fiscal sustainability.

Motivated by the lack of focus on Caribbean countries in the recent debt literature, Cevik and Nanda (2020) investigate the cyclicality and sustainability of fiscal policy for 16 Caribbean countries between 1980 and 2018 using system GMM to estimate a Caribbean panel FRF. They depart from the convention of using the primary balance to GDP ratio as the dependent variable and introduce a cyclically adjusted primary balance to GDP ratio, with control variables reflecting not only the business cycle but also economic, institutional, and financial development.

Moreover, Khadan (2019) compares the results from a revenue-expenditure panel cointegration approach for testing debt sustainability with that of a FRF using panel data for 10 Caribbean countries over the period 1991 to 2017. His model is estimated using Panel-IV fixed effects and includes the primary balance to GDP ratio, output gap and current account balance.

Khadan (2019) finds that the primary balance for Caribbean countries improves by a modest 0.02 percentage points for every 1 percentage point increase in the debt ratio. Interestingly, he also finds similar results using the revenue-expenditure panel cointegration approach (based on tests of the intertemporal budget constraint following approaches of Hamilton and Flavin, 1986; Quintos, 1995; Hakkio and Rush, 1991; Afonso, 2005; Kirchgaessner and Prohi, 2008). Cevik and Nanda (2020) find the same magnitude of fiscal response as did Khadan (2019). On this basis, the Caribbean findings lend to the conclusion that the region's debt is at best weakly sustainable. The significant controls that appear in these Caribbean models include, the output gap, inflation, credit to the private sector and per capita GDP.

4.2.3 Comparison with Evidence from Other Regions

Emerging market countries suffer from high debt burdens and growth volatility. They also have the experience of the Argentina debt crisis that caused ripple effects across Latin America, prompting keen interest by researchers in monitoring the sustainability of that region's debt (Celasun, Debrun and ostry, 2007; Mendoza and Ostry, 2008; and Gonzalez and Hernandez, 2023). Similarly, researchers in the EU (for example Everaert and Jansen 2017) given the central importance of the group's Maastricht criteria, including that linked to its fiscal regime, keep a watchful eye on the EU's fiscal sustainability, especially considering the 2015 Greek debt crisis, the scourges of which are still visible across European economies. For these reasons, emerging markets and the EU continue to be rich areas for fiscal sustainability research.

Largely, the fiscal reaction function has been the workhorse in assessing Emerging Market and EU governments' ability to tame debt expansion, and the findings from this research suggest that the marginal response of primary balances to rises in debt appears to be larger in Latin America and Europe, when compared to the Caribbean.

According to Khadan (2019), the average fiscal reaction coefficient lies between 0.03 – 0.05 for the Euro Area. For Latin America, Gonzalez and Hernandez (2023) reflect an average marginal response of primary balances of around 0.05 percentage points for every 1 percentage point increase in debt since the 1990s, whilst Checherita-Westphal and Zdarek (2017) who review the wider empirical evidence on FRFs suggests debt coefficients ranging between 0.01 and 0.10 for the world.

4.3 Specification of the Fiscal Reaction Function

The FRF is a model-based test of debt sustainability. Bohn (1998) show that a FRF is equivalent to the traditional test on the satisfaction of government's intertemporal budget constraint, but without the need to establish cointegration. The focus of the

FRF is β, which captures fiscal policy responses to changes in the debt to GDP ratio. A positive and significant β implies debt sustainability since for every increase in debt, government is reacting responsibly through raising the primary surplus.

The panel data approach to FRFs presents several practical opportunities for testing debt sustainability in the Caribbean. Time series data on the government's budget for Caribbean countries, including the primary balance and debt, are short, and in most countries in the region, available for less than 30 years (IMF, 2023). The Panel data FRF helps overcome such shortcomings through the pooling of country data for increased observations and variability.

The static FRF with panel data, assuming fixed and time effects is as follows:

(4.1)

$$p_{it} = \alpha_i + d'_{it-1}\beta + X'_{kit}\gamma_k + \delta_t + \epsilon_{it}$$

For the set of $i = 1, \dots, N$ cross sections and $t = 1, \dots, T_i$ time periods, the primary balance to GDP ratio p_{it} is regressed on the previous period's debt to GDP ratio d_{it-1} , a set of k = 1,2…K control variables X_{kit} which at the most basic level include the output gap and an expenditure gap following Bohn (1998) and Barro (1979). In addition, fixed effects α_i, time effects δ_t, together with ϵ_{it}, well-behaved error terms satisfying the classical assumptions. Essentially assumptions A1 – A4 below apply (Greene, 2006):

(A1) The data generating process is linear.

(A2) $E[\boldsymbol{\varepsilon}^{*}|\boldsymbol{X}] = 0$

(A3) $E[\boldsymbol{\varepsilon}^{*}\boldsymbol{\varepsilon}^{*\prime}|\boldsymbol{X}] = Var[\boldsymbol{\varepsilon}^{*}|\boldsymbol{X}] = \sigma^{2}\boldsymbol{I}$

(A3.1) $E[\varepsilon_{i}^{2}|\boldsymbol{X}] = \sigma^{2}$

(A3.2) $E[\varepsilon_{it}\varepsilon_{is}|\boldsymbol{X}] = 0 \qquad (t \neq s)$

(A3.3) $E\left[\varepsilon_{it}\varepsilon_{jt}|\boldsymbol{X}\right] = 0 \qquad (i \neq j)$

(A3.4) $E\left[\varepsilon_{it}\varepsilon_{js}|\boldsymbol{X}\right] = 0 \qquad (i \neq j)$

(A4) Rank ($\boldsymbol{X}$)= full rank

Explanatory variables are purely exogenous, and the errors follow a multinomial distribution N(0, σ^{2}) as expressed in (A2) and (A3). The errors are also assumed homoscedastic (A3-A3.1) with no correlation across groups, contemporaneously or temporally (A3.2 – A3.4). Finally, as in the normal OLS Gauss Markov assumptions, the explanatory variables are assumed orthogonal (A4).

Several regional studies on debt sustainability have employed this type of specification (See Celasun *et al*.,2006; Abiad and Baig, 2005; Daniel *et al*., 2003; Leonce and Hope;2013). However, Gosh *et al*. (2013) recently introduced the dynamic form of the FRF through inclusion of the lagged primary balance p_{it-1}, noting the possibility of persistence in fiscal policy, especially in developing countries where governments are not able to respond immediately to fiscal shocks.

In this study, the dynamic specification of the FRF is preferred. The dynamic FRF with panel data, assuming fixed and time effects is as follows:

$$p_{it} = \alpha_i + p_{it-1}\beta_0 + d'_{it1-1}\beta_1 + X'_{kit}\gamma_k\delta_t + \epsilon_{it} \tag{4.2}$$

Studies, including on the Caribbean (Khadan (2019) and Cervic and Nanda (2020)) have found a significant coefficient on the lagged primary balance, confirming the legitimacy of the dynamic FRF specification.

4.4 Selection of the FRF Estimator – Monte Carlo Simulations

4.4.1 Problems in Choosing a Suitable Estimator and Possible Options

Most authors tend to resolve the problem of estimator selection by including a range of different estimators in robustness checks. This reduces to choosing that which delivers the most significant results, possibly leading to erroneous findings and conclusions. This is because there are several factors to consider in estimator selection, including the appropriateness of the estimator for the size and structure of data; and the econometric issues presented by the data generating process, including violations of important classical assumptions.

Thankfully, there are several options to deal with these issues. The Feasible GLS (FGLS) estimator can produce consistent, unbiased, and efficient coefficient estimates when the errors are potentially heteroscedastic and autocorrelated (Beck and Katz, 2001). The FGLS estimator $\hat{\beta} = \left[X'\Omega^{-\frac{1}{2}}X\right]^{-1}\left[X'\Omega^{-\frac{1}{2}}y\right]$ is a weighted ($\Omega^{-\frac{1}{2}}$) least square procedure that transforms the unknown and heteroscedastic error variance ($Var[\boldsymbol{\varepsilon_i}|\boldsymbol{X},\boldsymbol{z}] = \sigma^2\boldsymbol{\Omega}$) to that in A3 using the sample errors to estimate the covariance matrix $\boldsymbol{\Omega}$. Researchers can also employ robust standard errors, which include White Standard Errors (WSE) and Newey West Standard Errors (NWSE).

White's standard errors $S_0 = (1/T)\sum_i e_i^2 x_i x_i{}'$ corrects for heteroscedasticity, while NWSE $S_T = S_0 + (1/T)\sum_l w_L(l)\sum_{t=l+1,..,T}(x_{t-l}e_{t-l}e_t x_t' + x_t e_{t-l}e_{t-l}x_{t-l}')$ are applied to correct for both heteroscedasticity and serial correlation.[19] In the presence of cross-sectional dependence, White or NW SE need to be adjusted to achieve consistent and efficient estimators (Greene, 2006). Driscoll and Kraay (1998) standard errors correction and Panel Corrected Standard Errors (PCSE) are extensions to estimate robust standard errors in panels with cross-sectional dependence. The transformations remove cross-sectional dependence by assuming correlation within a cluster – i.e a group that shares common characteristics – but of dependence across clusters (See Table 4.1 for a summary). They are therefore robust to cross-sectional and temporal dependence in the data.

[19] Prais Winsten transformations of the variables can also correct for autocorrelation in the residuals.

Table 4.1: Panel Data Tests and Corrections for Violations of the CLM Assumptions

CLM Assumption Violation	Tests	Corrective Measures	Comments
Heteroscedasticity	Breusch Pagan (1979) LM White (1980) LM	For pooled and Fixed Effects Models (FEMs): OLS with White or NW SEs (cross sectional independence)	On pooled model without Fixed Effects (FE). `
	Greene (2000) Modified Wald Statistic	For pooled and FEMs: FGLS or PCSE (cross section dependence)	On model with FE
Autocorrelation	Durbin Watson (1950,71) Statistic	For pooled and FEMs: OLS with NW SE or Prais Winsten transformation and Cochrane Orcutt procedure (cross sectional independence)	On pooled model without FE.
	Woolridge (2002) Bhargava *et al.* (1982) modified Durbin Watson Statistic	For pooled and FEMs: FGLS or PCSE (cross section dependence)	For pooled and FEMs: FGLS or PCSE
Cross Sectional Correlation	Pesaran (2004) LM adjusted and CD	For pooled and FEMs: FGLS or PCSE	For pooled and FEMs Assumption: $N \rightarrow \infty$ and T sufficiently large
	Breusch and Pagan (1980) LM		Assumption: N fixed and $T \rightarrow \infty$

**Note: Adapted from Hoechle (2007), page (4).

In addition to the challenges posed by heteroscedasticity, autocorrelation and cross-sectional dependence, the dynamic specification of the FRF introduces another significant issue – endogeneity. Both debt and the output gap are potentially endogenous given their possible simultaneous determination. While previous increases in debt can cause fiscal policy reactions through the primary balance, previous debt may also be determined by changes in that period's fiscal policy. Additionally, whereas the output gap influence on changes in fiscal policy is well documented, it is also known that the fiscal multiplier can determine the output gap by way of its GDP effects. Endogeneity issues can further arise due to omitted variables, feedback effects and correlation between the regressors and unobserved heterogeneity (fixed effects) (Lucas *et al.* (2019). The latter is most problematic when T<20 but disappears when T is large (Nickell, 1981).

In this case, the researcher can either choose to ignore the potential endogeneity as has been done in earlier estimations (Bohn, 1998; Bohn, 2005; Medoza and Ostry, 2008); Leonce and Hope (2013), or seek to remove the potential endogeneity from the model. The panel instrumental variable estimator is a two stage least square estimator that instruments for the potentially endogenous variables. Instruments can ideally be variables correlated with the regressors but uncorrelated with the errors and fixed effects, but given the difficulties in identifying such instruments, the recent tradition has been to use variables that are sequentially exogenous (Lucas *et al*. (2019)). These are simply appropriate lags of the potentially endogenous variables. However, Wang and Bellemare (2019) show that using lagged instruments could be problematic and even make matters worse, particularly when the source of endogeneity is linked to violation of both the independence and omitted variable assumptions.

The more complex option to deal with endogeneity is General Method of Moments (GMM), which are of two main types - the difference GMM and system GMM approaches. The difference GMM estimator by Holt-Eakin, Newey, and Rosen (1988) and Arellano and Bond (1991) is constructed like the fixed-effects first difference estimator. Differencing removes some of the endogeneity, but some differenced variables are possibly still related to differenced errors. Hence the difference GMM uses lags of the variables in levels as instruments for the differenced variables to rectify. Arellano and Bover (1995) and Blundell and Bond (1998) system GMM estimator is built on the recognition that lags of the differenced variables in levels may not be the most appropriate instruments if the variables are close to a random walk. The system GMM estimator instead adds to the first differenced model, the model in levels and instruments the potentially endogenous variables in levels with lags of their first differences.

GMM improves on IV panel regression of the FRF by bringing more instruments to bare. However, with small data sets it can pose serious challenges. The GMM approach can produce hundreds of instruments which grow exponentially with T, and while the Hansen test for over identification can help to determine instrument suitability, this test also suffers a weak instrument detection problem, and reducing the instrument count by collapsing the instrument matrix can still be problematic particularly with small samples (Roodman, 2009).

4.4.2 Evaluations of Estimators

The key question is therefore when to employ which specification, error correction and/or estimator, and which combination is likely to produce the most consistent and unbiased results. This challenge is central to a lack of consensus on several empirical findings including in debt sustainability research. Often, different model specifications or econometric techniques will yield varied results. Even if different specifications yield similar coefficients, they frequently reveal different conclusions with regards their significance.

To provide guidance on the choice of GMM specifications for estimation of fiscal rules in advanced economies, Mammi (2015) used Monte Carlo experiments and empirical tests. In the study, different GMM specifications of FRFs with the cyclically adjusted primary balance and primary balance are estimated with simulated data, and then tests checked for robustness against alternative settings of the parameters. Results N=15 countries and T=15 time periods with 1000 repetitions indicated that amongst the estimators tested (OLS, Random Effects (RE), FE, GMM-dif and GMM-sys), the system GMM estimator is best performing, and the high instrument count turns out not to be problematic.

Similarly, Lucas *et al* (2019) focused on evaluating methods for overcoming endogeneity in corporate finance models and concluded that the system GMM was most robust. The structure of their simulations was for N=500 firms and T=8 periods ran with 1000 repetitions of the model. They tested for various forms of endogeneity including from omitted variables, measurement errors, and simultaneity between dependent and independent variables.

Deriving the expected bias of the Least Square Dummy Variable (LSDV) estimator for FRFs in static and dynamic specifications of the model, and running simulations on data with N=100 and T=5 for 1000 repetitions, Celasun and Kang (2006) find that the use of the LSDV estimator to model FRFs would lead to negative and positive biases, and opposite biases, respectively, on the estimates of the debt coefficient in estimating the AR(1) form of the FRF. On the size of the biases, they find that the biases are smaller in the static estimation of the FRF with a LSDV estimator compared to a GMM estimator. However, if there is endogeneity posed by the output gap for example, the GMM estimators and particularly the GMM-diff estimator performs best. Likewise, Kiviet (1995) and Judson and Owen (1999) find the LSDV to be large when estimating FRFs in dynamic form.

4.4.3 A Monte-Carlo Evaluation of the Caribbean FRF Estimator

The study employs Monte-Carlo simulation with a data generating process designed to mimic the major characteristics of Caribbean data, as a means of selecting the most appropriate estimator for the Caribbean dynamic FRF.

A population sample is generated for N=13 countries and T=40 time periods (1980-2019). Noting the possible econometric issues as detailed in Section 4.6.1, the population parameters and data generating process are constructed to reflect the presence of endogeneity, cross sectional dependence, heteroscedasticity, and autocorrelation.

The baseline simulation model is as follows:

(4.3)

$$y_{it} = \alpha y_{it-1} + x'_{1it}\beta_1 + x'_{2it}\beta_2 + \eta_i + \lambda_t + v_{it}$$

Where,

$$x_{1it} = \rho x_{1it-1} + \lambda_t + \delta_{it}$$

$$x_{2it} = \tau\eta_i + \phi\lambda_t + \theta_1 v_{it} + \epsilon_{it}$$

y_{it}, x_{1it} and x_{2it} represent the primary balance, debt to GDP ratio and output gap, respectively.

The parameters are assumed to have the following values:

$$\sigma_\eta^2 = \sigma_\lambda^2 = \sigma_\varepsilon^2 = \sigma_\delta^2 = 1$$

$$\rho = 0.2$$

$$\alpha = 0.5$$

$$\beta = 1$$

$$\tau = 0.6$$

$$\phi = 0.3$$

$$\theta_1 = 0.5$$

$$\theta_2 = 0.6$$

Note that $\eta_i \sim N(0, \sigma_\eta^2)$ and $\lambda_t \sim N(0, \sigma_\eta^2)$ are fixed and time effects, respectively, distributed with mean zero and white noise errors. $\varepsilon_{it} \sim N(0, \sigma_\eta^2)$, $z_{it} \sim N(0, \sigma_\eta^2)$ and $\delta_{it} \sim N(0, \sigma_\eta^2)$ are pure white noise disturbances, while $v_{it} \sim N(0, \sigma_i^2)$ is a heteroscedastic, autocorrelated and cross-sectionally dependent error term.

Autocorrelation in the simulation model arise from temporal correlation of the error term $v_{it} = \theta_2 v_{it-1} + z\gamma_i$, and heteroscedasticity through some factor $\gamma_i = 1, \ldots, 13$ (See Baum, 2017), representing the cross section of countries for $i \neq j$, where i signifies country i and j. In other words, $E\left[v_{it}v_{jt}|\boldsymbol{X}\right] = \sigma_i^2$.

Unobserved heterogeneity or measurement error is assumed omitted by inclusion of fixed and time effects. Endogeneity by simultaneous determination of the regressor and regressand violates the pure exogeneity assumption. It is generated through the output gap variable $x_{2it} = \theta_1 v_{it} + \epsilon_{it}$, so that the output gap ratio is correlated with the errors and simultaneously connected with the primary balance.

The model in (4.3) is estimated over 1000 repetitions for several estimators including: the OLS estimator; FGLS estimator; OLS estimator with PCSEs; OLS estimator with O'Driscoll and Kraay corrected standard errors; panel-IV regressions with robust standard errors; and GMM-sys estimators, the latter with collapsed instruments. Note that all estimators contain fixed and time effects.

4.4.4 Performance of Estimators under Violations of Gauss Markov Assumptions

Table 4.2 Simulation Results

Estimator	Coefficient	Mean	Std. Dev	RMSE	Min	Max
LSDV	Beta1	1.03	0.04	0.00	0.92	1.14
FGLS	Beta1	1.03	0.03	0.00	0.92	1.14
PCSE	Beta1	1.03	0.04	0.00	0.92	1.14
O'Driscoll	Beta1	1.03	0.03	0.00	0.93	1.14
IV	Beta1	1.00	0.85	0.32	-3.05	8.15
GMM-sys	Beta1	1.28	0.45	0.38	-0.46	3.13

**Note: The populations parameters are $\rho = 0.2$, $\alpha = 0.5$, $\beta_1 = 1$, $\beta_2 = 1.5$, $\tau = 0.6$, $\phi = 0.3$, $\theta_1 = 0.5$ and $\theta_2 = 0.6$ and the regressions are simulated with S=1000 repetitions under assumption of Gauss Markov violations. N=13 and T=40.

In view of the assumed GM assumption violations, the simulations show that, except for the dynamic panel IV fixed effects model, the FRF estimators are positively biased. The bias appears larger for the dynamic GMM-sys estimator, compared to the dynamic OLS estimators – LSDV, FGLS, PSCE, and O'Driscoll. This is likely underpinned by a mismatch between the underlying assumptions of the GMM-sys and the structure of the Caribbean data. As Roodman (2009) explains, GMM estimators are constructed under the asymptotic assumption of $N \rightarrow \infty$ and T small. He further adds that for $N < 20$, post- GMM estimation should be viewed with caution.

The least biased estimator according to the Monte Carlo simulations is the dynamic panel IV estimator. Based on the simulations, the panel IV mean value is 1.00. However, it carries a coefficient Standard Error (SE) of 0.85, and Root Mean Squared

Error (RMSE) of 32 percent with quite a wide interval (-3.05 – 8.15). Note that the panel IV RMSE is larger than for that of the OLS estimators, for which the RMSEs are all 0. This is possibly due to the wider confidence intervals around the IV estimator.

The choice is therefore between a very marginal bias (0.03) in the OLS estimators and a moderate RMSE (0.32) from the Panel IV estimator, of which living with the marginal bias appears the obvious and wiser option.

4.5 Data Sources

4.5.1 Description of Data

The data are for 13 Caribbean countries - Antigua and Barbuda, Barbados, Bahamas, Belize, Dominica, Grenada, Guyana, Jamaica, St Kitts and Nevis, St Lucia, Suriname, St Vincent and the Grenadines and Trinidad and Tobago - come from the World Bank Economic Outlook (WEO), World Development Indicators (WDI) and World Governance Indicators (WGI) databases for the period 1980 to 2019.

The primary balance is the WEO's primary net lending variable expressed in ratio to nominal GDP. As per the output and expenditure gaps, they are taken as the difference between actual and trend values, and by convention the cyclical components of real GDP (constant 2018 dollars) and nominal total government expenditures are separated from the data using the Hodrick Prescott filter.[20]

In terms of other regressors, the study follows Caribbean literature and introduces the current account balance, implicit interest rate, elections, and inflation. The elections variable is a dummy with 1 in the year prior and during elections as in Khadan (2019). The average implicit interest rate on Caribbean debt is calculated from IMF WEO data on the primary balance to GDP ratio, fiscal balance to GDP ratio, and debt to GDP ratio. It is calculated as interest payments relative to previous period's debt. Inflation is represented by the percentage change in the consumer price index and disasters by a binary variable with 1 representing the occurrence of a disaster. The data on disasters are from the Emergency Management Database (EM-DAT).

The model is further augmented with variables reflecting institutional strength and political economy. From the World Governance Index are variables reflecting government effectiveness, political stability, and perception of corruption. These indices vary between -2 and 2, where positive values indicate more favourable levels. Table 4.3 provides a summary of the main data.

[20] Using lamda = 100 as recommended for annual data.

As can be seen, Caribbean data issues pertaining to FRFs are primarily concerning the key variables – primary balance, gross debt, and the implicit interest rate. These are missing 1/3 of observations on average. Another observation is outliers, as represented by the large differences between means and medians across the variables. For example, the output gap carries a mean of 0 and a median of 259, whilst the debt ratio reflects a mean of 66.2 and a median of 33.5. Such differences are also visible in differences between means and medians for credit to the private sector, and per capita GDP variables. These differences characterise a set of countries that are at two ends of the spectrum as pertains their debt exposure and development. This point is further illustrated in the large standard deviations and very wide data intervals.

Table 4.3 Summary Statistics

Variables	Observations	Mean	Median	Standard Deviation	Minimum	Maximum
Primary Balance	386.0	0.6	4.2	-19.0	14.4	386.0
Gross Debt	354.0	66.2	33.5	11.8	158.3	354.0
Output Gap	520.0	0.0	259.0	-1250.0	1720.0	520.0
Expenditure Gap	520.0	0.0	4.0	-24.8	36.4	520.0
Inflation	520.0	6.7	12.3	-3.1	142.8	520.0
Implicit Interest Rate	337.0	0.1	0.2	0.0	1.5	337.0
Credit to the Private Sector	518.0	42.3	16.1	6.6	93.5	518.0
Current Account Balance	520.0	-8.5	10.1	-52.5	38.8	520.0
Per Capita GDP	520.0	10102.6	7393.5	2386.1	33672.9	520.0

Note: The primary balance, gross debt, credit to the private sector, and current account are all as a ratio to GDP. The output gap and expenditure gap are reported here are calculated as actual GDP/expenditure less trend GDP/expenditure (cyclical component). The elections and disaster variables are omitted as they are dummy variables.

4.6 Estimation and Results

4.6.1 Econometric Tests

The existence of cross-sectional dependence can lead to erroneous statistical inference. For example, the Caribbean sample includes 6 Eastern Caribbean Countries which follow common policies and rules. Therefore, any shocks that hit the sub-region will have cross-sectional effects either through policy coherence or temporally by virtue of spill-over effects. Testing for the presence of cross-sectional dependence before proceeding to full estimation is therefore recommended (Baltagi, Feng and Kao 2012).

Breusch and Pagan (1980) and Pesaran (2004) provide tests to detect cross sectional dependence. The Breusch Pagan (1980) LM test is valid for fixed N and $T \rightarrow \infty$, which seem to fit the Caribbean dataset, at least according to guidance from Wooldridge (2002), who notes that the assumption of N fixed is suitable for example in cases where N = U.S states, and where T can grow.

For the other diagnostic tests, the study employs the modified Wald Statistic to detect groupwise heteroscedasticity[21] (Greene, 2000) and Woolridge (2002) tests for serial correlation in panel data.[22]

The Caribbean data exhibits all the ills of econometric panel estimation. Breusch and Pagan (1979) Lagrange Multiplier (LM) test statistic for cross-sectional dependence has Chi-squared distribution (78) = 259.39 with p-value = 0, strongly rejecting the null hypothesis of cross-sectional independence. Pesaran CD (38, 156) = 2.797 with p-value = 0.01 and fails also to reject the null hypothesis, providing strong evidence against cross sectional independence for the Caribbean FRF data.

The modified Wald Test for groupwise heteroscedasticity has a Chi-squared distribution (13) = 962.18 with p-value = 0, and the Woolridge test statistic for first order auto correlation in the data F(1, 12) = 22.21 with p-value = 0, both strongly rejecting the null hypotheses of homoscedasticity and no serial correlation, respectively. It is also prudent to assume that the Caribbean output gap in the FRF framework is potentially endogenous.

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[21] Tests (A3.1) $E[\varepsilon_i^2|\boldsymbol{X}] = \sigma^2 = \sigma_i^2$ for $i = 1, .., N_g$, where N_g. Test statistic is distributed Chi-squared (N_g) under the null hypothesis of homoskedasticity (Baum, 2001).
[22] The test is robust to heteroscedasticity.

4.6.2 Baseline Model

Based on the Monte-Carlo simulations and econometric tests, the preferred estimator is the dynamic OLS estimator with PSCE. Although there is no real distinction between the OLS estimators' simulation results, the OLS-PSCE is preferred due to the positive test for cross-sectional dependence in 4.6.1, and the corresponding guidance in Table 4.1.

Table 4.4 – models 1-5 presents the results from the chosen estimator and dynamic FRF in equation (4.2), regressed with different combinations of control variables. In all models, the FRF coefficients are positive and significant. Except for in model 1, the value of the FRF coefficient is consistent. For the FRF coefficient, the results suggests that for every one percent increase in the debt to GDP ratio, the average Caribbean primary surplus rises by 0.04 percent of GDP.

Across all models, the output (-) and expenditure (+) gaps have the expected signs, which suggests a pro-cyclical Caribbean fiscal policy (See also Araujo (2009); Daude, Melguizo and Neut (2011); Klemm (2014); Aberlo *et al.* (2016); Samuel (2009); Khadan (2019)). However, the significance of these variables fluctuates in the presence of other control variables. Only in model 3 are both the output and expenditure gaps jointly significant. In model 1 without any other control variables, the significance of the output and expenditure gaps disappears. Likewise, in model 2 with the full set of control variables; in model 3 with the parsimonious control set and model 4 with only the output gap and the parsimonious control set, only the output gap appears significant. In model 5 with only the expenditure gap, and parsimonious controls, the expenditure gap loses its significance. This is likely because the influence of both variables on the primary balance is weak, with the output gap having slightly larger relevance. For instance, the output gap though significant, has a coefficient very near zero.

Amongst the other controls, only the election dummy, credit to the private sector and the current account balance show statistical significance (model 3). The results suggest elections in the Caribbean are associated with an expansion in the average primary deficit of between 0.78 and 0.83 percent of GDP. The current account balance is similarly significant and reflects an increase in the primary surplus of between 0.10 and 0.11 percent of GDP for every unit expansion in the external ratio. On the contrary, the private sector credit coefficient range (-0.05 and -0.06) suggests that at higher levels of financial development (deeper domestic capital markets) the government is likely to run higher primary deficits.

Against these results, model 4 is the preferred baseline specification of the Caribbean FRF, mainly due to the slightly larger relevance of the output gap over the expenditure gap in the regressions.

Table 4.4 Specifications and Results of the Baseline Model

Dynamic OLS-PSCE					
Dependent Variable: Primary Balance Ratio	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
Constant	0.39	2.35	2.64**	2.72**	2.74*
	[3.00]	[1.97]	[1.08]	[1.07]	[1.26]
Lagged Primary Balance	0.64***	0.58***	0.58***	0.58***	0.58***
	[0.08]	[0.09]	[0.09]	[0.09]	[0.09]
Lagged Debt	0.16*	0.04***	0.04***	0.04***	0.04***
	[0.01]	[0.01]	[0.01]	[0.01]	[0.01]
Output Gap	-0.00	-0.00*	-0.00**	-0.00*	
	[0.00]	[0.00]	[0.00]	[0.00]	
Expenditure Gap	0.06	0.06	0.06*		0.03
	[0.04]	[0.03]	[0.03]		[0.03]
Elections		-0.78**	-0.78**	-0.82***	-0.83***
		[0.25]	[0.26]	[0.27]	[0.25]
Credit to Private Sector		-0.05**	-0.06**	-0.05**	-0.05**
		[0.02]	[0.02]	[0.02]	[0.02]
Current Account Balance		0.11**	0.11**	0.11**	0.10**
		[0.04]	[0.04]	[0.04]	[0.04]
Per Capita GDP		0.00			
		[0.00]			
Implicit Interest Rate		-0.01			
		[0.10]			
Disasters		0.09			
		[0.37]			
Observations	341	317	326	326	326
Groups	13	13	13	13	13
Periodsǂ	26.2	24.4	25.1	25.1	25.1
R-Squared	0.55	0.58	0.56	0.56	0.56
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes

Note: The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses. The Dynamic LSDV model is regressed with panel clustered (cross sections) standard errors.ǂ Refer to average observations per group.

4.7 Robustness Checks

The dynamic FRF is regressed with the Panel IV, GMM-sys and GMM-diff estimators to test the sensitivity of the results, and to ascertain whether the results corroborate those from the Monte-Carlo simulations. The coefficient on the lagged debt to GDP ratio (0.01) in the Dynamic Panel IV regression is lower than for the OLS-PSCE, GMM-sys and GMM-diff estimators (0.02). These results therefore seem to align with the Monte-Carlo conclusions, which suggest that the OLS and GMM estimators are more positively biased than the Dynamic Panel IV estimator (Table 4.5).

Nonetheless, in all regressions the FRF coefficients are positive and significant. The major difference between the results from the Panel IV, GMM-sys and GMM-diff and the baseline results is that the output gap becomes insignificant with GMM, and the elections dummy is rendered insignificant under GMM-sys estimation. Otherwise, the OLS-PSCE and the Dynamic Panel IV reveal similar significance of explanatory and control variables. Notably, whereas the Dynamic Panel IV estimation uses 45 instruments, the GMM-sys and GMM-diff estimators employ 115 and 419 instruments, respectively.

Robustness of the results to country selection is illustrated in Table 4.6, where the country sample is reduced by one country at a time and results of the regressions presented for comparison. In all 13 estimations, except for the regressions with the exclusion of St Kitts and Nevis and Trinidad and Tobago, the FRF coefficient maintains its sign, magnitude, and significance, indicating that the results are robust to the sample of countries. In the regressions with exclusion of St Kitts and Nevis and Trinidad and Tobago, the FRF coefficient dips only slightly to 0.03 but is significant. The other results are not reported but apart from the output gap, all the control variables in all regressions maintain their signs and significance. The constant term and the output gap magnitude and significance varies depending on the countries excluded, reflecting differences in fiscal policy as relates responses to the business cycle and the impact of country fixed effects.

In Table 4.4, the results for the model augmented with institutional control variables is presented. The FRF coefficient maintains its sign and significance, and the findings suggest that the only institutional or political economy variable with an impact on the Caribbean's primary balance is perception of corruption.

From the associated signs of the insignificant determinants, we can however deduce that greater government effectiveness can lead to improved primary balances, whereas countries with higher levels of political stability are likely to run primary deficits. Though the latter finding is not immediately obvious, it is intuitive. Governments with higher levels of political stability are likely to attract lower risk premiums and higher levels for foreign investment and credit. Therefore, their ability to run primary deficits increases with political stability.

On the other hand, the results indicate a positive association (1.55) between improvements in the perception of corruption and increases in the primary surplus. This is likely since lower levels of corruption should naturally be associated with higher spending efficiency and less revenue wastage.

Only 5 Caribbean governments (The Bahamas, Barbados, Belize, Jamaica and Trinidad and Tobago) have ready access to global capital markets. These are what the IMF refer to as market access countries. The other 8 countries in the region borrow mainly from the multilateral development banks, bilateral and commercial creditors. In Table 4.8 is presented regressions for the Caribbean group with countries separated into market and non-market access countries. These regressions aim to increase understanding as to whether countries exposed to market pressures show more fiscal discipline than those that are not. In both regressions, the FRF coefficients remain positive and significant and are of the same magnitude - 0.03 percent of GDP. Implying that whether countries have or do not have access to capital markets does not determine their fiscal effort as relates maintaining debt sustainability.

Further separating the Caribbean group into high and low debt countries, where high debt countries are those with debt to GDP ratios surpassing 60 percent of GDP on average over the past 10 years, the FRF coefficient shows significance for the former but not for the latter in line with Bohn (2008) FRF theory. At higher levels of average debt, Caribbean countries marginal primary balance response is significant, but loses that significance once debt falls below that higher debt threshold. Note though that at the lower levels of debt to GDP ratios, the average Caribbean FRF coefficient is larger at 0.13. This finding implies that a threshold effect of debt on the primary balance lies somewhere above 60 percent of GDP.

Table 4.5 Results of Baseline Model with Different Estimators

Dependent Variable: Primary Balance Ratio	**Dynamic Panel IV-FE**	**GMM-Sys**	**GMM-Diff**
Constant	1.40***	1.57**	1.71***
	[0.38]	[0.55]	[0.41]
Lagged Primary Balance	0.66***	0.62***	0.57***
	[0.06]	[0.09]	[0.04]
Lagged Debt	0.01***	0.02*	0.02***
	[0.00]	[0.01]	[0.01]
Output Gap	-0.00***	-0.00	-0.00
	[0.00]	[0.00]	[0.00]
Elections	-0.69***	-0.54	-0.65***
	[0.25]	[0.33]	[0.20]
Credit to Private Sector	-0.02***	-0.03**	-0.02**
	[0.01]	[0.02]	[0.01]
Current Account Balance	0.04**	0.06***	0.08***
	[0.19]	[0.02]	[0.01]
Observations	481	494	481
Groups	13	13	13
Periods	37	38	37
R-Squared	0.58		
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes
Sargan Test (Prob Chi2)		0.01	
Hansen Test (Prob Chi2)		1.00	
Instruments	45	115	419

Note: The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses. The Dynamic Panel-IV FE model is regressed with clustered (cross sections) standard errors. The GMM-sys regression is with robust standard errors and collapsed instruments to reduce instrument count.

Table 4.6 Results Sensitivity to Exclusion of Specific Countries

Dynamic OLS-PSCE			
Excluded Countries	**Constant**	**Lagged Debt Ratio**	**Controls**
Antigua and Barbuda	3.02**	0.04***	Yes
	[1.07]	[0.01]	
Bahamas, The	2.54**	0.04***	Yes
	[1.11]	[0.01]	
Barbados	2.11*	0.04***	Yes
	[1.08]	[0.01]	
Belize	2.70**	0.04***	Yes
	[1.08]	[0.01]	
Dominica	2.45**	0.04***	Yes
	[0.74]	[0.01]	
Grenada	2.30**	0.04***	Yes
	[0.98]	[0.01]	
Guyana	2.95	0.04***	Yes
	[1.77]	[0.01]	
Jamaica	2.44*	0.04***	Yes
	[1.14]	[0.01]	
St Kitts and Nevis	2.29*	0.03**	Yes
	[1.05]	[0.13]	
St Lucia	2.74**	0.04***	Yes
	[1.13]	[0.01]	
St Vincent and the Grenadines	2.63**	0.04***	Yes
	[1.08]	[0.01]	
Suriname	2.41*	0.04***	Yes
	[1.14]	[0.01]	
Trinidad and Tobago	1.06	0.03***	Yes
	[1.35]	[0.01]	
Observations[ǂ]	300.9		
Groups[ǂ]	12		
Periods[ǂ]	25.1		
R-Squared[ǂ]	0.56		
Fixed Effects	Yes		
Time Effects	Yes		

Note: The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses. The Dynamic LSDV model is regressed with panel clustered (cross sections) standard errors. Note that the model includes the lagged primary balance but not reported. Excluded countries are dropped from the regressions one country at a time.
[ǂ]These figures are averages.

Table 4.7 Results of Augmented Model

Dynamic OLS-PSCE			
Model	**Government Effectiveness**	**Political Stability**	**Corruption**
Constant	2.20	2.83**	2.40*
	[1.46]	[1.14]	[1.27]
Lagged Debt Ratio	0.03**	0.02**	0.02**
	[0.01]	[0.01]	[0.01]
Output Gap	-0.00	-0.00*	-0.00*
	[0.00]	[0.00]	[0.00]
Added Control	0.25	-0.61	1.55**
	[1.38]	[0.81]	[0.65]
Other Controls	Yes	Yes	Yes
Observations	239	244	239
Groups	13	13	13
Periods	18.4	18.8	18.4
R-Squared	0.55	0.51	0.56
0.56Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes

Note: The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses. The Dynamic Panel-IV FE model is regressed with clustered (cross sections) standard errors. Note that the model includes the lagged primary balance but not reported. The additional controls are treated as strictly exogenous.

Table 4.8 Results for Different Country Groups

	Dynamic OLS-PSCE			
Model	**Market Access Countries**	**Non-Market Access Countries**	**High Debt Countries**	**Low Debt Countries**
Constant	1.86*	1.07	4.08	1.94*
	[1.99]	[2.14]	[2.58]	[0.81]
Lagged Debt Ratio	0.03*	0.03***	0.03**	0.13
	[0.01]	[0.01]	[0.01]	[0.02]
Output Gap	0.00*	0.00	0.00	0.00**
	[0.00]	[0.00]	[0.00]	[0.00]
Other Controls	Yes	Yes	Yes	Yes
Observations	127	199	191	135
Groups	5	8	8	5
Periods	25.4	24.9	23.9	27
R-Squared	0.75	0.46	0.62	0.60
Fixed Effects	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	No	Yes

Note: The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses. The other control variables are added to the regression but not reported and are mostly significant. Note that the model includes the lagged primary balance but not reported. The market access countries are those that have traditionally had access to global financial markets and include: The Bahamas, Barbados, Belize, Jamaica, Suriname and Trinidad and Tobago. High debt countries are those whose average debt in the past 10 years has exceeded 60 percent of GDP. The high debt countries are Antigua and Barbuda (91.3%), Barbados (132.3%), Belize (69.6%), Dominica (76.9%), Grenada (87%), Jamaica (122.7%), St. Kitts and Nevis (84.2%) and St Vincent and the Grenadines (69.9%).

4.8 Policy Discussion

The scatter plot in 4.1 as well as the results reveal that Caribbean countries appear tardy in their fiscal response to increasing debt, particularly those with moderate but not high debt levels. These Caribbean governments have an opportunity to course correct and should resist complacency.

While the results satisfy Bohn (2008) FRF criteria for debt sustainability, it should be borne in mind that the Caribbean's marginal response is comparably weak, and maybe amongst the weakest in the world (Section 4.2, Khadan (2019)). Immediate action to strengthen the Caribbean fiscal response is needed to achieve a more comfortable fiscal position, to improve opportunities for investment, and to lower the impact from unexpected shocks.

Such would include a shift to a counter-cyclical fiscal approach. The results imply, for example, that automatic stabilization is non-existent in the region. Caribbean governments do not seem to adjust their fiscal policy to movements in the business cycle.

In this vein, Caribbean efforts to diversify trade and especially trade in services should be expanded. As has been revealed, a positive current account balance can produce primary surplus gains of around 0.11 percent of GDP. The Caribbean depends heavily on tourism given its very limited resources. However, the concentrated dependence on tourism leaves the region highly susceptible to shocks (Acevedo *et al.,* 2017). The Caribbean should expand into other services' areas, which can raise net trade, reduce their exposure to shocks, and improve the primary balance. Alternatively, or conjointly, the region could continue to search for areas of diversification within the tourism industry, such as nature, health, sports, and business tourism. Business tourism has taken off since the COVID-19 pandemic and may prove a viable niche sector.

Though the government effectiveness index was not significant, its positive relationship implies mileage to be gained from strengthening institutions, through for example improved tax administration, to increase the potency of Caribbean fiscal policy. The same is true for gains in reducing corruption, which could be had through increased efforts at improving public financial management and particularly fiscal transparency, a task which the region has been focused on for some time with the assistance of the IMF and World Bank (see for example PEFA, 2010). Reducing corruption has the largest projected average impact on the primary balance of 1.55 percent of GDP, reflecting the importance of improving the perception of corruption to the fiscal sustainability agenda.

The Caribbean regions' median scores on the perceptions of corruption index are in the moderately weak to moderately strong range at around 0.53 (World Bank, 2022), meaning that there is significant room for improvement.

As regards elections, the results imply a need for Caribbean governments to limit excess spending in future campaigns, especially with these countries current weak state of fiscal sustainability. The negative impact on the primary balance could just be enough to tilt sustainability in the opposite direction. Whilst Caribbean countries respond to debt in an amount equivalent to 0.04 percent of their GDP on average, they spend on average 0.78 to 0.83 percent of GDP during elections. A counter measure to protect spending during election campaigns and to secure fiscal sustainability could be the implementation of expenditure rules, which have flexibility during crises, but which are entrenched in the constitution to prevent incumbent governments changing them at a whim to facilitate campaign ambitions.

4.9 Conclusions

The study set out to investigate fiscal sustainability in the Caribbean with the aid of fiscal reaction functions and confirmed that debt in the region is weakly sustainable. The fiscal reaction function has an average coefficient of 0.04 across most specifications and is significant. This finding is arrived at by way of a well-specified model-based test using Dynamic OLS-PSCE. The estimator was deemed superior to the Panel IV, GMM-sys and GMM-diff by way of Monte-Carlo simulations, at least in the context of the Caribbean, and the results from this estimator are robust to estimator choice and country exclusion.

The results though similar in nature to that of Cevik and Nanda (2020) and Khadan (2019) offer different insights and help to expand on the very narrow Caribbean fiscal sustainability literature. For example, it proposes that the Dynamic OLS-PSCE is superior to the GMM-sys and Panel IV used by the two authors above. This evidence contrasts with the findings of Mammi (2015) who find the GMM-sys superior in advanced countries and Lucas (2019), who also supports the GMM-sys for dynamic estimation at the micro level. It is however in support of the evidence by Celasun and Kang (2006); Kiviet (1995), and Judson and Owen (1995) who find that the LSDV produces a larger coefficient bias. As per the bias, this study argued that the marginal estimator bias of the OLS-PSCE is a smaller ill to live with than the larger RMSE and estimate intervals of the Panel IV and GMM regressions, which increase the probability of type II errors or parameter insignificance in the results.

The smaller positive bias of the OLS-PSCE regressions manifested in the results but all FRF coefficients across the Panel IV, GMM-sys and GMM-diff were of similar magnitude and significance, confirming continued weak fiscal sustainability in the region.

As regards other primary balance effects, the key determinants in the Caribbean are the business cycle, level of financial development (proxied by credit to the private sector), and the health of the external sector. It should be said, however, that influence of these on the direction of fiscal policy is small. Only improvement in the perception of corruption has more than a 1 percentage point impact on the primary balance ratio.

Interestingly, despite the region's susceptibility to natural disaster shocks, natural disasters are not found to affect significantly, the direction of the primary balance. Neither does the average price of debt (proxied by the implicit interest rate) or the level of economic development (proxied by per capita GDP). Based on the finding that natural disasters have a positive and significant income effect (Acevedo, 2014) future research could look at whether the lagged natural disaster variable affects the current primary balance ratio, through the income transmission mechanism. Further, as regards the relevance of the implicit interest rate as a determinant of the primary balance, it is possible that the measurement of the variable could be playing a part in the insignificant result. It is well known that the implicit interest rate may not be a good proxy for the average interest rate on debt (Blanchard, 2019).

Of note is the finding that improving the perception of corruption in the Caribbean could have a substantial effect on the primary balance, and in turn, on the region's fiscal sustainability. This, in combination with trade in services expansion, reduced election spending, and more proactive fiscal policy even when debt is not yet at high levels, are policy initiatives to secure and improve the region's fiscal sustainability going forward. Specifically, the study recommends that Caribbean governments continue to strengthen their public financial management and consider implementing expenditure rules to restrict election spending.

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Chapter 5 Tests for a Caribbean Debt Threshold

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Abstract

The rise in Caribbean debt post COVID-19 reignites interest in establishing a debt threshold for the region. A debt threshold is an important anchor for fiscal policy as it provides the basis for debt reduction targeting and for assessing risks around the debt trajectory. As a region highly susceptible to shocks, Caribbean countries are at higher risk of debt instability. A clearly agreed debt threshold either at the regional or country level would help to shape fiscal policy through providing appropriate boundaries on debt expansion. The study employs Gosh *et al*. (2013) fiscal fatigue theory to establish the Caribbean's debt threshold but finds that for many Caribbean countries, such may not exist, at least as defined by fiscal fatigue.

5.1 Introduction

Rises in the Caribbean average debt ratio following the COVID-19 pandemic (Figure 5.1) provides fresh ground for research on the region's debt sustainability. The Caribbean is comfortably one of the most indebted regions of the world having been saddled with elevated debt levels for decades (Acevedo *et al*., 2013; CDB, 2013). Of main concern is the risk that persistent high debt ratios pose to the economic development of the Caribbean, and the countries' ability to sustain future shocks (McClean and Charles, 2018).

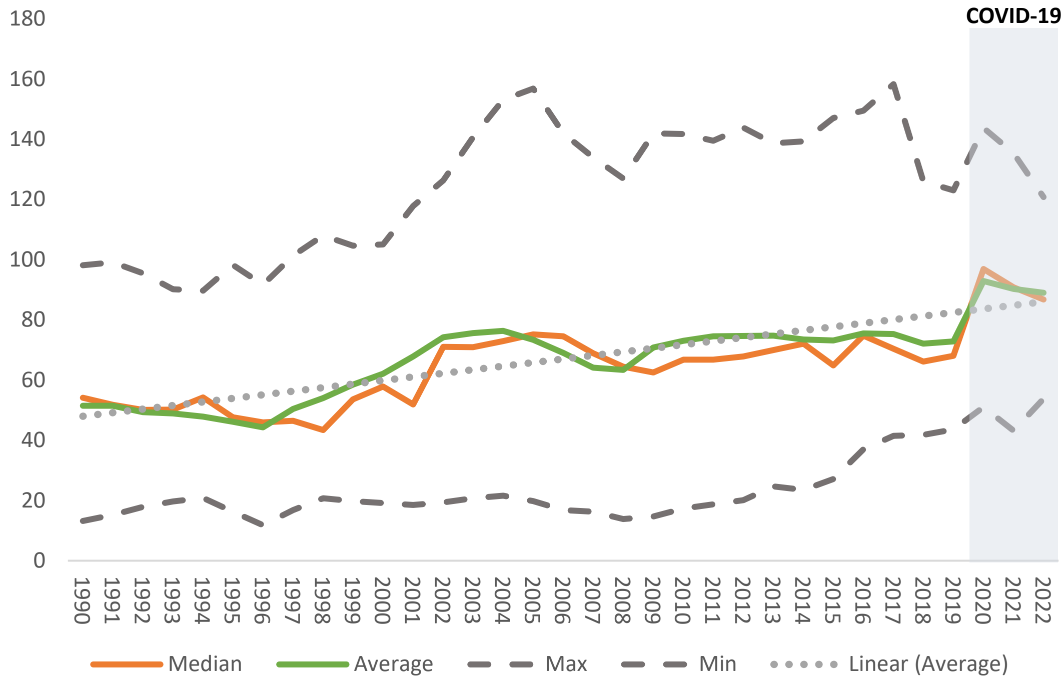
Apart from its status as one of the most indebted regions, the Caribbean also ranks highly with regards economic, environmental, and social vulnerability. High debt exacerbates these vulnerabilities as it weakens the government's purse and puts significant constraints on fiscal levers. With shocks, particularly climatic shocks, expected to increase rapidly in frequency, the Caribbean is at risk of severe debt issues if it is not able to reduce its exposure in the near to medium term (Otker and Loyola, 2017).

This need for debt reduction is known (Yartey *et al*., 2012), but by how much – there is no consensus. That is partly because the desired level of debt reduction will vary depending on economic circumstances of individual countries, level of international financial assistance, and changing policy priorities. However, it is also largely because there are different perspectives on what constitutes an acceptable level of debt, and that apart from the IMF's rule of thumb there is no agreed debt threshold for developing countries or indeed for the Caribbean. A debt threshold or generally agreed cut-off point is needed for effective debt reduction targeting, and for assessing the risks around the debt trajectory (Tran, 2018). A fiscal adjustment that is too onerous would have deleterious effects on the economy, whilst one which is inadequate simply kicks the unsustainability can further down the road but fails to address the core issue.

Most governments in the Caribbean adopt the IMF rule of thumb of 60 percent of debt to GDP (Schipke *et al.,* 2013), which contrasts with Rogoff and Reinhart's (2003) estimation of a 90 percent global debt to GDP threshold. The IMF rule of thumb follows from the observation that although debt crises have occurred at lower debt to GDP ratios, roughly two-thirds of debt crises transpire at ratios below 60 percent of GDP (Finger *et al*., 2007; IMF, 2003a; IMF, 2003b; Reinhart *et al*., 2003).

Considering the IMF benchmark, the median and average rises in the Caribbean's debt during COVID-19 would put the region approximately 20 percentage points above its debt limit, and based on the latter, about 10 percentage points below, respectively. Further, with peak debt ratios rising as high as 143.8 percent in 2020, 135.4 percent in 2021, and to 120.8 percent in 2022, at least one Caribbean country should be at serious risk of debt default.

Figure 5.1: Trends in the Caribbean Debt Ratio



Data source: IMF World Economic Outlook (WEO), 2023.

According to Gosh *et al*. (2003) theory of fiscal fatigue, governments will generally run primary deficits at low levels of debt, but as the debt burden rises, they will consolidate and initiate a primary surplus. However, as debt grows larger and larger, governments will eventually reach a point where they are no longer able to raise a primary surplus, at which point they've reached their debt threshold. Surpassing the debt threshold should coincide with debt defaults, but none of the countries in the region have had debt restructurings because of the pandemic. Those with IMF restructuring programmes existed before the pandemic struck. Nonetheless, assuming the theory is credible, the natural conclusion would be that the debt threshold for the region is higher, and at least greater than 70 percent of GDP.

In the emerging market literature, however, studies have estimated thresholds for Latin America and the Caribbean of around 55 percent (Celasun *et al*., 2006), while for the Caribbean specifically, research focused on the debt-growth nexus for individual Caribbean countries have estimated debt thresholds ranging between 48-138 percent of GDP (Wright and Grenade, 2014; Wright and Love, 2014). This is quite a wide margin and a key motivation for the current research.[24]. Indeed, Rogoff and Reinhart (2003) show that countries in the Latin America and Caribbean regions have external debt to GDP default ratios ranging between 31 percent and 214.3 percent, based on default episodes from 1970 – 2001. This is because countries can be subject to debt intolerance, where legacy fiscal and debt management issues, and especially past debt defaults, cause investors to grow weary of rising debt, even at conventionally low levels.

Gosh et. al.'s theory supports this view of a conditional debt threshold, noting that a decrease in the economy's output, increase in a government's willingness to undertake fiscal adjustment, negative or positive shocks to the primary balance, both expected and unexpected, can shift the threshold value. Further, the authors assert that if current debt were close to its threshold value, a negative shock could

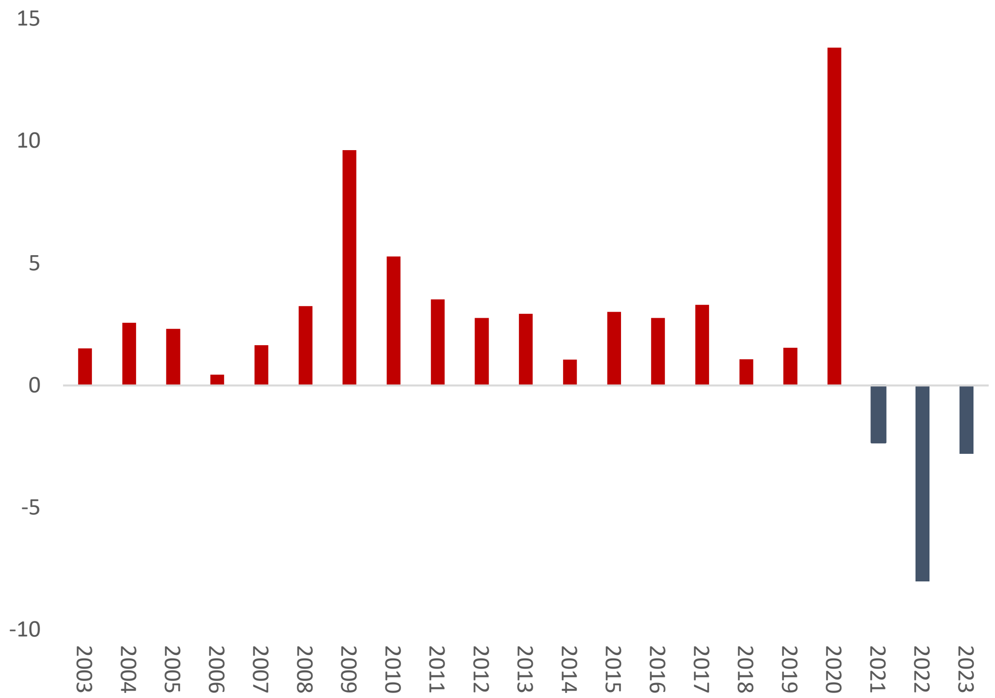
[24] However, note that Greenidge et al. (2012) estimate a debt-growth threshold of 56 percent for Barbados.

render a debt ratio that was formerly sustainable, unsustainable, especially since the threshold value is more sensitive to downside risks. Against this backdrop and given the negative shift in the region's debt dynamics during COVID-19 (Figure 5.2), the current study of the Caribbean's debt threshold is both novel and interesting.

Moreover, this study is the first to test for a Caribbean debt threshold using a Caribbean Fiscal Reaction Function (FRF). Cevik and Nanda (2020) employ the FRF for studying debt sustainability and fiscal fatigue and find weak evidence of a non-linear fiscal reaction function for Caribbean countries using a quadratic model but do not establish a Caribbean debt threshold.

In addition to identifying thresholds for the region based on fiscal reaction functions and noting the wide margin of threshold estimates for the region, this study addresses the issue of possible heterogeneity in the non-linear fiscal reaction function as discussed in Everaert and Jansen (2018) for Organisation for Economic Co-operation and Development (OECD) countries. In the context of the narrow Caribbean literature, this study also marks an original contribution.

Figure 5.2 Average Interest-Growth Rate Differential for the Caribbean



Source: Author's calculations from data extracted from the World Economic Outlook (2003). Interest rates calculated as interest payments over previous period's debt. Interest payments measured by primary balance less fiscal balance. Some variables are estimated from 2020.

A further potential contribution of this study arises from the augmentation of the model to include an IMF programme variable, given the prominence of IMF programmes in the region in the past two decades. This is anticipated to help to tease out truly discretionary Caribbean fiscal reactions to debt not attributed to IMF conditionality. Caribbean governments have borrowed extensively from the IMF over the period, through IMF funding windows which come with macro-economic adjustment conditions attached. It is possible then that these conditionalities, which are primarily fiscal in nature, help determine the direction of governments' primary balance.[25] A glossary of the IMF funding windows and details of IMF lending to the Caribbean is provided in Appendix Table A 5.3 and Table A 5.4, respectively. Between 1963 and 2022, IMF data shows that the Caribbean had 54 lending arrangements with the IMF to the tune of Special Drawing Rights (SDR) 8 billion.

The results from dynamic panel cubic FRF indicate that the Caribbean's debt threshold is undefined, at least by fiscal fatigue. Countries in the region do not necessarily follow the theorised non-linear debt rule proposed by Gosh *et al*. (2013), with the implication that the fiscal fatigue hypothesis does not generally hold. At the country level there is some evidence of a significant cubic fiscal reaction, but the coefficient signs are not consistent with fiscal fatigue. Nonetheless, basic data analysis and data visualisation still point to the possibility of a non-linear FRF model, which when tested with Seo and Shin (2016) dynamic panel threshold model reveals a significant debt threshold of 106.2 percent for the Caribbean region. These results show that the Caribbean's debt-primary balance relationship is not curvilinear (or smooth) as theorised by Gosh *et al*. but rather aligning with a sharp change in the primary balance after reaching extremely high levels of debt.

The study continues with a brief review of the literature on debt thresholds in Section 2, and then conducts a statistical analysis of debt thresholds in Section 3,

[25] "The IMF lends under concessional and non-concessional arrangements or can provide outright loans. A lending arrangement, which is similar to a line of credit, is approved by the IMF Executive Board to support a country's economic and financial program. The arrangement requires the member to observe specific terms and subject to periodic reviews in order to continue to draw upon it. An outright loan is also approved by the IMF Executive Board, however, it does not require a member to observe specific terms."

termed basic threshold analysis. It discusses the chosen methodology – nonlinear FRFs, data and results in Sections 4, 5 and 6, respectively. The study concludes in Section 7.

5.2 Literature Review

There are three broad types of debt threshold approaches, each following from the hypothesis that beyond a certain point, debt induces a negative threshold effect. One focuses on the debt threshold beyond which economic growth turns negative (Rogoff and Reinhart, 2010)). Another focuses on the market reaction to rising government debt to predict when government is likely to default on its obligations, given prohibitive increases in interest rates. The other stems from the research of Bond (1998) and Gosh *et al*. (2013), who introduce fiscal reaction functions and a methodology to measure fiscal fatigue, respectively. In this latter approach, the focus is on identifying the limits of fiscal policy, that is, the point at which government's fiscal policy becomes ineffective as a tool to address an ever-rising debt to GDP ratio.

The fiscal approach to debt threshold analysis is well aligned with the questions raised in the current study but research in this context is only recently emerging. Most studies investigate the threshold effects of debt on growth, and secondly, the threshold effects of debt on market sentiment (interest rates), in that order.

5.2.1 Theoretical Motivations Underlying Debt Thresholds Research

Several studies on the debt-growth nexus are motivated by debt overhang theory. Debt overhang theory posits that at a certain level of external debt, potential investors will begin to fear future tax rises, and as a result, will hold back on future investments, causing capital investment and economic growth to slow, until it eventually declines. This occurs because as debt rises, investors become increasingly worried about government's ability to honour its obligations, as illustrated by the debt Laffer curve (Claessens, 1990). With debt continuing to rise further, investors are more unwilling to incur costs today for the promise of return on output in the future, given the risk that government could face an increasing tax burden from existing creditors seeking to recover outstanding debt service (see Krugman, 1988; Calvo and Diaz-Alejandro, 1989).

The debt overhang theory does not explicitly link debt to growth, but the implication is that debt constrains growth by way of reduced investment (Patillo *et. al,* 2004; Greenidge *et al.,* 2012; Cordella *et al.,* 2005; Caner *et al.,* 2010). Other theoretical perspectives are that debt overhang causes increased uncertainty about government policies and actions, generally, and loss in productivity, leading to a fall in domestic and foreign investment (Clements *et al.,* 2003; Cordella *et al.,* 2010). At the same time, it is equally recognised that borrowing, particularly in resource constrained developing countries, once used for productive investments, can result in higher GDP growth rates (Burnside and Dollar, 2000; Barro, 1979).

On the interest rate reaction to rising debt, its foundations are debt sustainability theory (Diamond, 1965; Blanchard, 2004). The core concept is that borrowers are penalised for accumulating debt to restrain excessive borrowing, and to provide creditors with more compensation the more risk they undertake. Such is reflected in the no-Ponzi game condition and dynamic efficiency hypothesis (Barro 1988), also in Bohn (2005) articulation of fiscal reaction functions. Interest rates will increase with rising debt but non-linearly, reflecting market participants anxiety about government's ability to repay as the debt ratio rises. In other words, because bond holders will not continue to roll-over debt indefinitely, after some debt ratio, interest rates will rise sharply, creating a doom loop (Alcidi and Gros, 2019) and eventually causing government to default. A related theory is Reinhart, Rogoff and Savastano (2003) debt intolerance hypothesis, which also postulates default due to non-linear interest rates but with the additional argument that threshold effects can occur even at very low levels of debt, especially in emerging economies that have previously defaulted, mainly due to creditors' debt intolerance.

The idea of a debt threshold is also implied in Bohn (1998) theoretical elucidation of fiscal reaction functions, where debt sustainability exists only if, on average, government can maintain a positive reaction of the primary surplus to increasing debt. The foundations of this theory are Barro's (1988) tax smoothing hypothesis. More recently, studies investigating the threshold effects of debt on fiscal policy have been motivated by Gosh *et al.* (2013) fiscal fatigue hypothesis, which derives from fiscal reaction functions, and states that there is a non-linear relationship between debt and the primary balance. It posits that at low levels of debt, the primary balance can be negative, but as debt rises it becomes positive as governments seek to address the higher debt burden. However, at even higher levels of debt, the primary balance increase stalls or turns negative, reflecting government's fiscal fatigue.

5.2.2 Empirical Approaches for Tests on Debt Thresholds

Empirical tests for threshold effects on growth and market sentiment are in the majority bivariate models either regressing debt on growth, or on long-term interest rate spreads, respectively (Augustin *et al*., 2022; Karadam, 2018). On the threshold effects of debt on fiscal policy these models are multivariate, where the dependent variable is the primary balance regressed on lagged debt and several control variables (Fournier *et al*.,2015). On the latter, the control variables are the usually applied in fiscal reaction functions including the output gap, inflation etc.

Rogoff and Reinhart's (2010; 2012) influential studies and that of Pescatori *et al.* (2014), is based on simple arithmetic comparisons of average debt to GDP ratios at low, medium, and high levels, and GDP growth rates at 5-year horizons. Those studies have influenced a large body of research seeking to improve the robustness of threshold analysis, as discussed below.

In this regard, the most popular empirical approach for threshold analysis is Hansen (1996) threshold estimation. Its popularity stems from its rigour and unbiasedness in identifying the debt threshold. Rather than testing for the significance of a threshold exogenously, for example the 60 percent debt to GDP rule of thumb, the Hansen approach conducts a grid search and locates thresholds endogenously. Further, the method has been extended to panel data and the latest version provide the researcher the option of locating one or two possible endogenous thresholds (Hansen 1999; 2000). It can be applied both in bivariate and multivariate settings, although most threshold studies have used bivariate models.

In a critique of the lack of formal testing in the debt-growth threshold literature, Egert (2015) employed the Hansen's estimation on 10-year non-overlapping data for GDP growth and debt, while Karadam (2018) used a panel smooth transition framework, a model in the family of the threshold regression, to test for non-linear effects between debt and growth. Zaghdoudi (2020) introduced a dynamic panel formulation of the original threshold model.

The threshold estimation procedure has been utilised by Tran (2018) to search for threshold effects on EMBI spreads, and by Augustin *et al*. (2022) who tests whether there is a threshold effect of fiscal constraints on default risk. Similarly, Fournier *et al*. (2015) in their work to find Euro Area debt limits used the threshold model and fiscal reaction functions to investigate both the non-linear debt-interest rate relationship and the existence of a debt threshold, defined as the debt level at which a sovereign borrower loses market access and the inability to service its debt.

The debt threshold estimation in threshold effects of debt on fiscal policy has not been as widespread. Celasun *et al*. (2006) performed a direct test for threshold effects of debt on fiscal policy by way of a fiscal reaction function with kink at 50 percent debt to GDP. Gosh *et al*. (2013) and similarly Everaert and Jansen (2017) in testing their theory of fiscal fatigue use a cubic fiscal reaction function to first test for non-linearity of fiscal policy and then identify debt thresholds for individual OECD countries. Their study employed the Pesaran (2006) Common Correlated Effects (CCE) estimator to capture country specific coefficients and the corresponding debt thresholds.

Other methods for testing threshold effects have included the median regression model (Lee *et al*., 2017); meta-regression analysis (Heimberger, 2021); the value-at-risk approach (Andres *et al*., 2017; Lewis, 2004); event analysis (Bustillo *et al*., 2019); panel dynamic OLS (Wright and Grenade, 2014); and general equilibrium modelling (Wright and Leon, 2014).

5.2.3 Evidence on Debt Thresholds from Recent Studies

There is broad based support for the existence of debt thresholds in advanced countries, especially as relates non-linear market and fiscal policy effects. Nonetheless, as per evidence of a global debt threshold value, there is much dispute stemming from Rogoff and Reinhart (2010; 2012) 90 percent debt to GDP finding.

Evidence in support of the 90 percent global threshold comes largely from research on OECD countries as in Cecchetti *et al*. (2011), Padogan *et al*. (2012) and Madisson (2013); whilst evidence against is found in studies on both OECD and developing economies, for example Caner *et al* (2010), Elmeskov and Sutherland (2012), Baglan and Yoldas (2013), Minea, Parent (2012) and Egert (2015) from OECD research, and Leon (2004), Greenidge *et al*. (2013), Wright and Grenade (2014), and Wright and Leon (2014), for developing countries, particularly, the Caribbean.

The common argument against the 90 percent global debt threshold is that non-linear effects can occur much quicker and there is further disagreement as to the marginal impact on growth below and above that threshold. Egert (2015), for example, similar to Minea and Parent (2012) who find evidence of a 15 percent threshold, contest the global value, arguing that debt threshold effects on GDP growth can kick in as low as 20 percent of GDP. Additionally, whereas Egert (2015) finds that public debt is generally associated with low levels of economic performance, Zaghdoudi (2020) results imply that in middle-income countries, at low regimes (below the debt threshold), an additional 1 percent increase in debt raises growth by 36 percent, whilst above the threshold a 1 percent increase in debt reduces GDP growth by 3.8 percent. From meta-regression evidence Heimberger (2021) concurs with marginal negative effects on growth past the threshold, finding that a 10-percentage point increase in public debt leads to a growth decline of 0.14 percentage points. Panizza and Presbitero (2013) provide a comprehensive summary of evidence in threshold research.

Whether for OECD or developing countries, or the type of research, there seems to be consensus that debt thresholds for developing countries are lower than for OECD countries (Tran, 2018; Lewis, 2004). Further, the evidence on debt thresholds and the market seem to imply that threshold values are smaller than when derived from fiscal policy and growth theory. Tran (2018) in studying the threshold effects of debt and emerging market spreads in Latin America find a threshold value of 34 percent, asserting that other more advanced economies can sustain a higher level of debt up to 40-55 percent. Indeed, Lewis (2004) find a debt shock more than 12 percent of GDP can abruptly widen long-term market spreads in Jamaica. This contrasts with Alcidi and Gros (2019), and Andres and Rojas (2017) who find thresholds of 60 percent and 54 percent for the Euro Area and Spain, respectively.

As per the debt threshold effects on fiscal policy Fournier and Fall (2015) using data for 30 OECD countries between 1985 and 2013 find a large threshold value of 120 percent, whereas Wright and Leon (2014) find a range of values for the Caribbean, specifically: 138 percent for Trinidad and Tobago, 105 percent for Jamaica, 91 percent for Antigua and Barbuda, 61 percent for Barbados, 50 percent for Bahamas, and 43 percent for Dominican Republic, respectively.

5.2.4 Observed Limitations

Although made in the context of threshold effects of debt and growth, Pescatori and Simon (2014) remark that the results of these threshold analyses can be influenced by outliers, as in the case of Japan where debt increased from 133 percent to 204 percent with a – 50 percent decline in GDP growth. Likewise, Fournier and Fall (2015) finds that results are driven by countries that have experienced high debt.

Egert (2015) also highlights that in Hansen (1996, 1999) threshold regressions, findings are sensitive to set trimming percentages. He found in his research that setting a trim percent of 30 indicated a two-threshold regime and a 30 percent threshold, whereas when setting to a 4 percent and 1 percent trim, the results indicated a three-threshold regime with threshold values of 90 percent of GDP. Additionally, he warns that tackling endogeneity in these threshold models leads to adverse effects of public debt, in testing for non-linear effects.

For the Caribbean, there are limitations on the type of threshold research as interest rates are hard to measure (Nicholls and Peter, 2014). This is linked to the region's underdeveloped capital markets, which can lead to downward bias in the implicit interest rate. Moreover, EMBI spreads that are employed in several market threshold studies are only available for a few Caribbean countries.

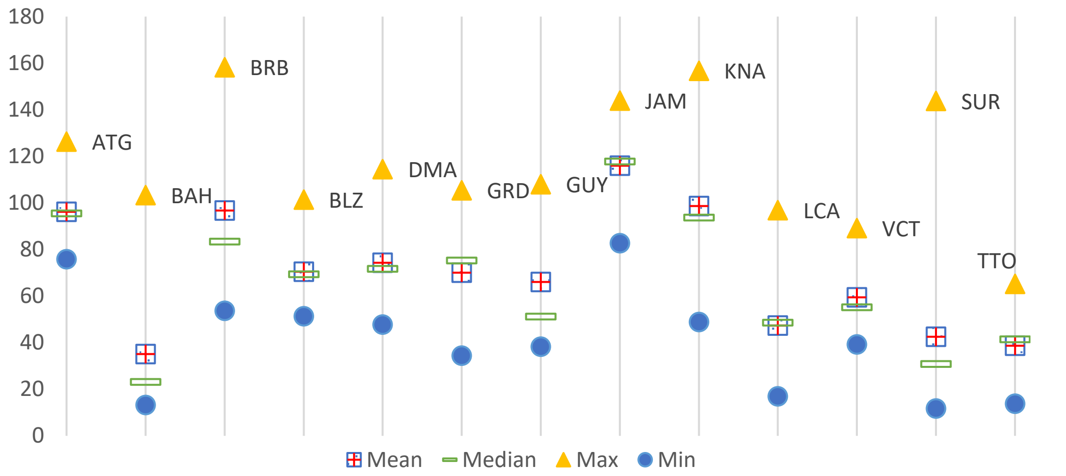
5.3 A Statistical Analysis of Debt Thresholds

5.3.1 An Overview of Trends

Summary statistics on the Caribbean's debt and primary balance ratios paint a picture of a region saddled with high debt, and weak fiscal policy reflected in a negligible average primary balance surplus. Between 1980 and 2022, the Caribbean region averaged a debt to GDP ratio of 70.1 percent, comprising a maximum of 116.4 percent and a low of 40.6 percent during the period. All but 3 countries – St Lucia, St Vincent and the Grenadines, and Trinidad and Tobago, surpassed the 100 percent of debt-to-GDP mark, and at the same time, most, apart from Antigua and Barbuda, and Jamaica saw debt ratios fall below 60 percent of GDP sometime during the period. The most drastic shifts in debt burden in the region was for Suriname, which at different points in these four decades held debt to GDP ratios of 11.8 percent and 143.8 percent, respectively (Figure 5.3).

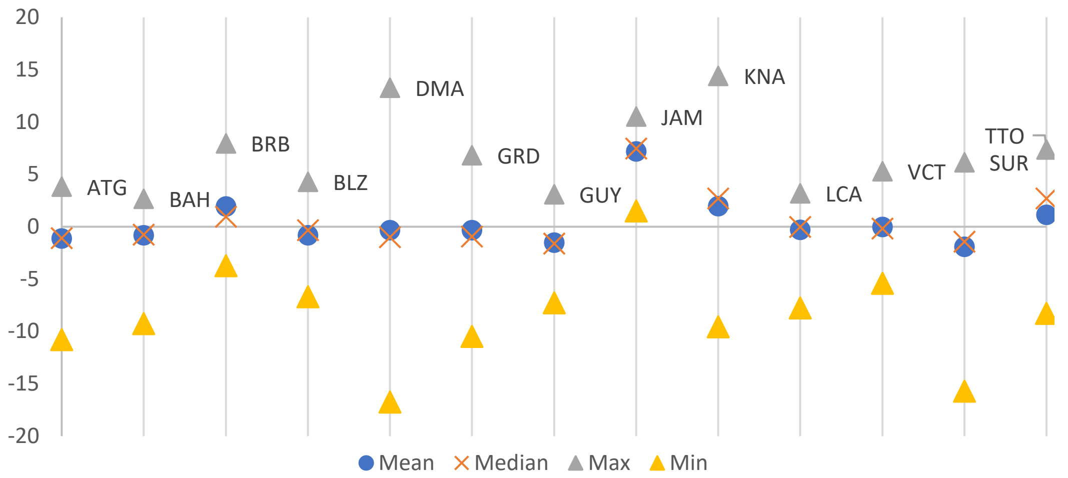
Caribbean fiscal policy appears to have been weakly countercyclical on average. In the preceding 40 years, many Caribbean countries averaged near zero primary balances. Barbados, St Kitts and Nevis, and Trinidad and Tobago's fiscal stance has tended to be more contractionary, and Antigua and Barbuda, Guyana, and Suriname slightly more expansionary when compared to the rest of the region, but not by huge margins. A key outlier in the Caribbean's fiscal policy space is Jamaica, which has averaged a primary balance ratio of around 7 percent of GDP (see Figure 5.4).

Figure 5.3: Statistical Summary of Caribbean Debt Ratios (1980-2022)



Note: Statistics are for the 13 Caribbean countries in alphabetical order where ATG=Antigua and Barbuda and TTO=Trinidad and Tobago. Data source is IMF World Economic Outlook (WEO), 2023.

Figure 5.4: Statistical Summary of Caribbean Primary Balance Ratios (1980-2022)



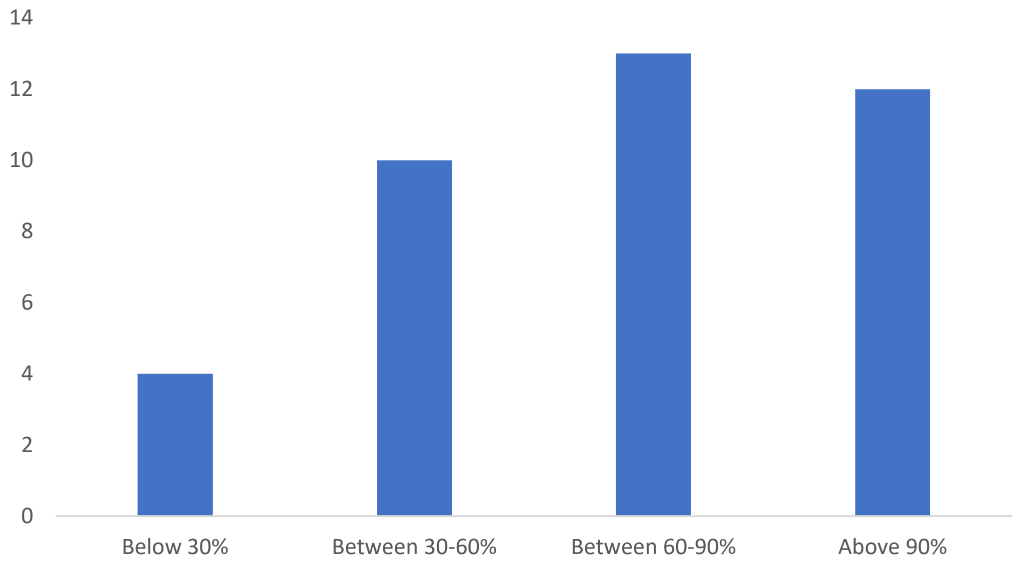
Note: Statistics are for the 13 Caribbean countries in alphabetical order where ATG=Antigua and Barbuda and TTO=Trinidad and Tobago. Data source is IMF World Economic Outlook (WEO), 2023.

5.3.2 A Statistical Analysis of the Caribbean Debt Threshold

There is a wide range of debt and primary balance ratios, and debt levels in the region have been sufficiently high as to initiate threshold effects (Figures 5.5).

Rogoff and Reinhart (2003) framework provide a decent precursor for threshold analysis. Using their exogenously determined debt threshold ranges – d <30%; 30%>d<60%; 60%>d<90%; and d>90%, corresponding Caribbean primary balance ratios can be assessed. As in the debt-growth literature, a threshold effect is determined if across countries, median or average primary balance ratios turn negative once surpassing a threshold range. In practical terms, this implies that if the debt threshold in the Caribbean was 70 percent of GDP, then at this debt range one would expect to witness a shift to mainly primary deficits across the region, as primary deficits are interpreted as the government's inability to respond when faced with high levels of debt. The conventional wisdom has been to use the median ratios given possible outliers, and this will be the basis for the analysis, although as can be seen in the first two figures, the average is very representative of central tendencies, both for Caribbean debt and primary balance ratios (averages presented in Tables A1-A2 and in Figure A1). The analysis is presented in Figures 5.6-5.7.

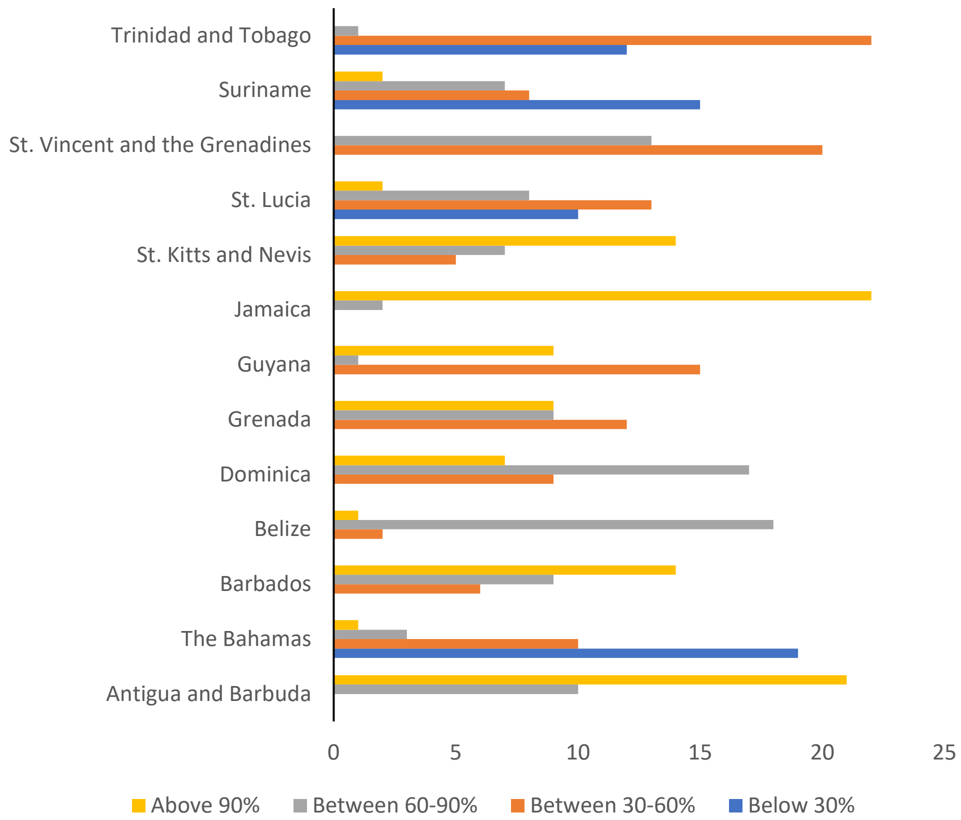
Figure 5.5 Frequency of Caribbean Debt Ratios by Selected Debt Thresholds (1980-2022)



Data source is IMF World Economic Outlook (WEO), 2023.

At the regional level, Figure 5.5 illustrates that most of the debt to GDP ratios fall within the 60-90 percent range. There are less instances of debt at ratios below 30 percent of GDP, substantiating the earlier point about the figures depicting a highly indebted region. Indeed, only The Bahamas, St Lucia, Suriname, and Trinidad and Tobago have posted low debt ratios in this period. All Caribbean countries have experienced debt ratios between 60 and 90 percent, and all but one – Trinidad and Tobago, have experienced debt ratios exceeding 90 percent. In addition, all except for Antigua and Barbuda, and Jamaica have held debt ratios between 30 and 60 percent of GDP during the period (Figure 5.6).

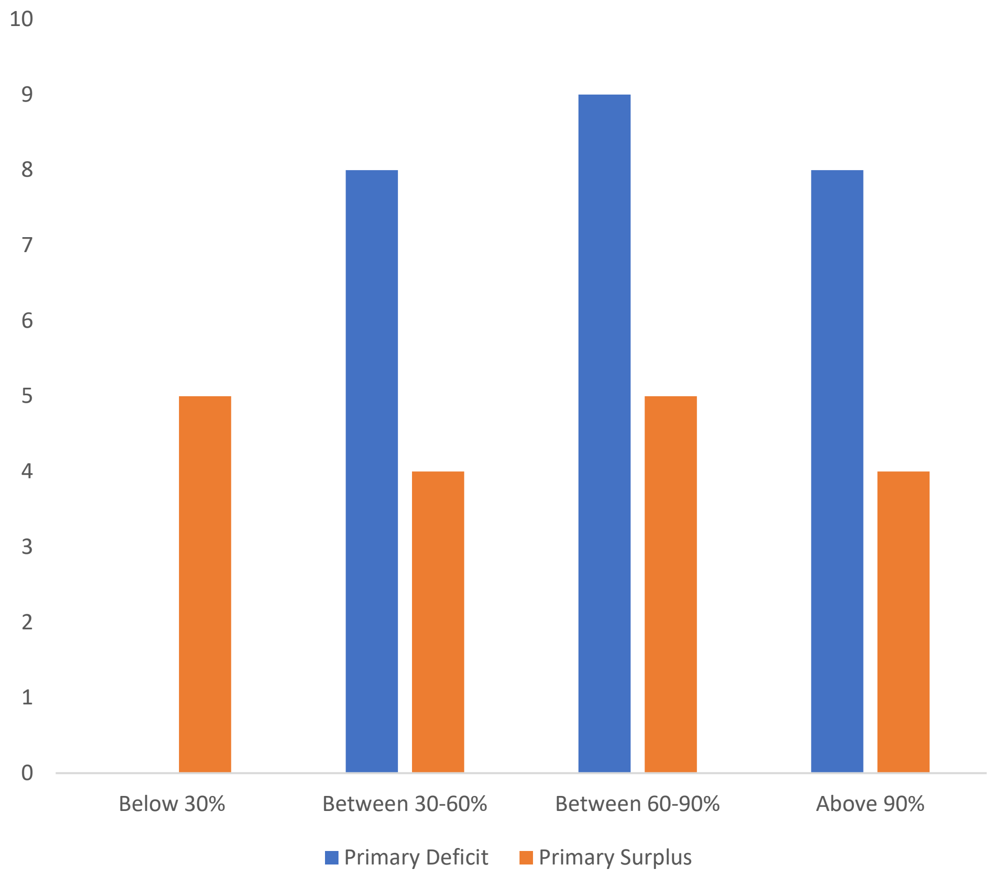
Figure 5.6 Frequency of Debt Ratios at Selected Debt Thresholds



Data source is IMF World Economic Outlook (WEO), 2023.

However, there is no clear-cut shift to positive and then negative primary balances at higher levels of debt. For example, whereas the number of primary deficits is highest between 30 and 60 percent debt-to-GDP, the frequency of a primary surplus is also highest in that same range (Figure 5.7).

Figure 5.7 Frequency of Caribbean Primary Deficit and Surplus at Selected Debt Thresholds

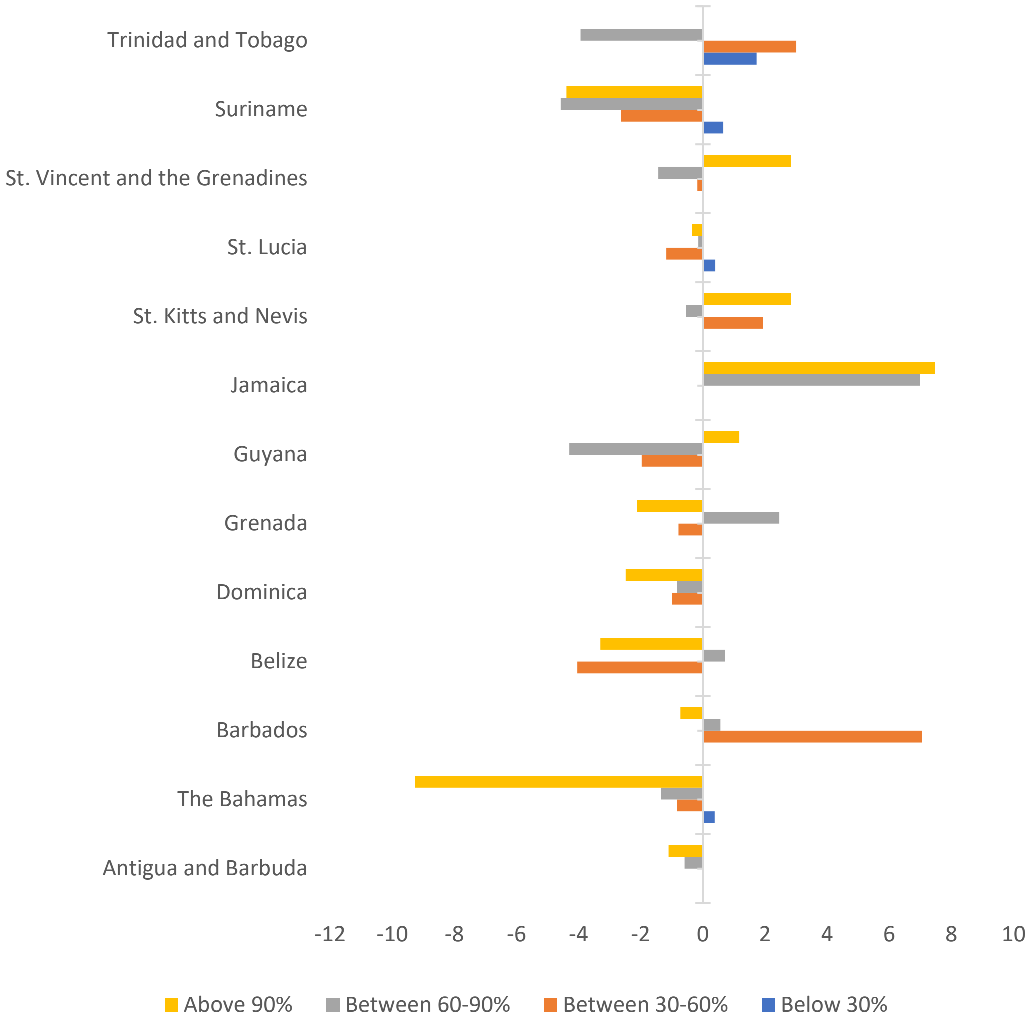


Data source is IMF World Economic Outlook (WEO), 2023.

The country level analysis is presented in Figure 5.7. It further illustrates the heterogeneity in the Caribbean fiscal response at higher ranges of debt to GDP ratios. Antigua and Barbuda's government has run consistent high debt and deficits. So even though the country's primary deficit is highest above debt exceeding 90 percent of GDP, one cannot clearly decipher from the analysis whether that debt ratio signifies threshold effects. The interpretation is somewhat similar for The Bahamas, where the median primary balance is only positive below 30 percent of GDP but negative at all other thresholds, though somewhat larger above the 90 percent of debt-to-GDP threshold. The case of Barbados appears in line with what one might expect of threshold effects. At the 30-60 percent threshold, the government responds sharply and positively to the increase in debt, but once debt surpasses 90 percent of GDP, there is a negative primary balance response. On the contrary, the Belize government has continued to run deficits when debt crosses the 30-60 percent debt range, only to respond positively when debt goes above the upper bound. Likewise, above 90 percent of GDP the fiscal response turns negative.

At this point, one could surmise that there is some evidence of fiscal fatigue and negative threshold effects beyond 90 percent of debt to GDP. This is reflected in the analysis for Dominica, Grenada and Suriname. However, this could ably be refuted in noting the experience of Jamaica, St Kitts and Nevis and St Vincent and the Grenadines, which have managed significant primary surpluses at debt to GDP ratios above that mark.

Figure 5.8 Primary Balances for Caribbean Countries by Selected Debt Thresholds
(Median, 1980-2022)



Data source is IMF World Economic Outlook (WEO), 2023

Hence, subject to further analysis, evidence of a Caribbean debt threshold is inconclusive. In addition, the statistical analysis raises the possibility that in some countries, threshold effects could occur earlier. This is observed for The Bahamas, St Lucia and Suriname, where primary balance ratios have turned negative after debt surpassing 30 percent of GDP (Figure 5.8).

5.4 Approach and Methodology

As outlined in the literature, threshold analysis has been dominated somewhat by application of the Hansen (1996) threshold model, given its unbiased and robust foundations. Zahgdoudi (2020) has extended the model to the dynamic setting, making it also useful for assessing threshold effects in dynamic fiscal reactions functions (FRFs). However, in this study Gosh *et al*. (2013) approach to uncovering debt thresholds is preferred, largely because of the Caribbean context, but also due to its theoretical and intuitive appeal.

5.4.1 Theory of Fiscal Fatigue

The fiscal fatigue approach aligns well with the reality of the Caribbean at least a priori. Interest rates are hard to calculate for the region given shallow financial markets and limited bonded debt (CDB, 2013). This effectively rules out market-based threshold approaches. On the other hand, whilst several of the works for the Caribbean have been in the debt-growth threshold space, analysing the bounds of fiscal policy and debt is more useful for policy makers as they have more direct control of the fiscal outcome. In this study, therefore, the fiscal fatigue theory takes precedence and is the preferred methodology.

Gosh *et al.* (2013) makes three critical assumptions, which define government's fiscal reaction to debt, outlines a default rule, and lenders investment behaviour. These assumptions together with specific sequences of interest rates and debt, guarantee satisfaction of government's budget constraint (rational expectations equilibrium) and the existence of a finite debt limit.

(1) Noting the government's budget constraint, which determines the dynamics of changes in debt (one period ahead) $d_{t+1} - d_t = (r_t - g)d_t - s_{t+1}$, and the fiscal reaction function (one period ahead) $s_{t+1} = \mu + f(d_t) + \varepsilon_{t+1}$ they postulate that there exists a debt ratio $d^m > \bar{\varepsilon}$ (shocks to the primary balance) such that as long as $r = r^*$ (risk free interest rate), for any primary balance shock, the primary balance is greater than the rise in debt: $\mu + f(d^m) - \bar{\varepsilon} \geq (r^* - g)d^m$, so that debt is non-increasing. That is, $d_{t+1} - d_t = (r_t - g)d_t - s_{t+1} \leq 0$. Additionally, for all debt d greater than d^m the government's fiscal response does not exceed the interest-growth rate differential, $f'(d) < (r^* - g)\ \forall d > d^m$.

(2) Government defaults if debt exceeds $\bar{d}$, the maximum debt level at which government can roll-over its maturing debt at a finite interest rate.

(3) Creditors are atomistic, risk neutral and are incentivised to hold government debt as the probability of default $p_{t+1} < 1$. Further, there is a finite interest rate at which creditors are compensated, defined by the endogenous risk of default or arbitrage condition $1 + r^* = (1 - p_{t+1})(1 + r_t) + p_{t+1}\theta(1 + r^*)$.

Gosh *et.al* shows by way of graphical illustration[26] that in the deterministic case (without primary balance shocks) there are generally two equilibria with the debt limit $\bar{d}$ defined by the intersection of $\mu + f(\bar{d})\ and\ (r^* - g)\bar{d}\ \forall d > d^m$, and at lower levels of debt, the conditional long-run level of debt d^*at the above intersection $\forall d < \bar{d}$, reflecting a non-linear relationship between the primary balance and debt to GDP ratios. Gosh *et al.* models this relationship with a cubic function to capture the two equilibria at $d^*$and $\bar{d}$.

5.4.2 Panel Dynamic Non-Linear Fiscal Reaction Function

Following Gosh *et al*. (2013) a panel dynamic specification of the FRF extended to include nonlinearities in the primary balance-debt to GDP ratio relationship is utilised. The dynamic FRF specification with panel data, assuming fixed and time effects is as follows:

(5.1)

$$p_{it} = \alpha_i + p_{it-1}\theta_1 + d'_{it1-1}\beta_1 + d^{2\prime}_{it1-1}\beta_2 + d^{3\prime}_{it1-1}\beta_3 + X'_{kit}\gamma_k\delta_t + \epsilon_{it}$$

As per the non-linear FRF, the set of $i = 1, \ldots., N$ cross sections and $t = 1, \ldots., T_i$ time periods, the primary balance to GDP ratio p_{it} is regressed on itself lagged one period p_{it-1}, the previous period's debt to GDP ratio d_{it-1} , and on a set of k =

[26] Gosh et al. (2013) Figure 2, pg. 11.

1,2…K control variables X_{kit}, which include the output gap and an expenditure gap following Bohn (1998) and Barro (1979).

Use of the primary balance rather than the cyclically adjusted primary balance (CAPB) as the main dependent variable follows the tradition of Bohn (1995; 1998) and others (Fournier *et al*.,2015 for example) in modelling fiscal reaction functions. Conceptually, the CAPB more accurately represents the governments discretionary fiscal policy. There is, however, no consensus in the literature on how to accurately measure cyclically adjusted primary balances due to well-known difficulties (see Mourre, G., Astarita, C., & Princen, S., 2014; Bornhorst, F., Dobrescu, G., Fedelino, A., Gottschalk, J., & Nakata, T., 2011) and so introduction of the CAPB carries the risk of measurement error[27]. Hence the primary balance is instead controlled for movements in fiscal policy due to the business cycle (output gap) and temporary expenditure shocks (expenditure gap) which parses out these influences from the errors, leaving the discretionary portion of fiscal policy.

In addition, fixed effects α_i, time effects δ_t, together with the errors ϵ_{it}, assumed heteroscedastic with correlation across groups, contemporaneously or temporally. Explanatory variables are, potentially, not all exogenous (e.g output gap) but following the wisdom of Wang and Bellmare (2019), rather than estimating the

[27] The estimation of potential output is a common challenge as well as sensitivity of estimates to underlying assumptions.

model via Panel IV, the study opts for the simple pooled OLS approach with clustered standard errors to control for cross-sectional dependence.

Wang and Bellmare find that controlling for endogeneity via lagged variables in the Panel IV, for example, is successful only if the endogeneity is from violation of the independence assumption. However, if endogeneity is stemming from both violation of independence and omitted variables assumptions, then such methods could make matters worse. Without knowing the exact potential source of endogeneity, this study takes the safer option and ignores it, as has been done by several other authors (Bohn, 1998; Bohn, 2005; Medoza and Ostry, 2008; Leonce and Hope, 2013). In addition, it is well known that finding actual instruments (correlated with the endogenous variables but not with the errors) for endogenous variables is notoriously difficult.

Nonlinear effects are by way of $d_{it1-1}^{2\prime}$ and $d_{it1-1}^{3\prime}$, the lagged square and cubic debt to GDP ratios, respectively. According to Gosh (2013), if $\beta_1 < 0, \beta_2 > 0$ and $\beta_3 < 0$ there is evidence of fiscal fatigue. At low levels of debt, fiscal policy is pro-cyclical but as debt starts to rise beyond a certain point the government reacts positively to the increase in debt. However, if debt continues to rise, creditors begin to charge a premium above the risk-free interest rate, until they eventually require an infinite interest rate. This causes government fiscal fatigue and eventually default. It is at the higher debt threshold represented by $\beta_3 < 0$ where government reaches fiscal fatigue and its debt limit.

Cevik and Nanda (2020) employ a quadratic specification for the Caribbean. This is in line with Bohn (1998, 2008), Abiad and Ostry (2005), and Mendoza and Ostry (2008) who find a non-linear response of the primary balance to debt. Note, however, that with the quadratic specification, evidence of fiscal fatigue correlates with $\beta_1 > 0, \beta_2 < 0$.

5.4.3 Heterogenous Panel Dynamic Non-Linear Fiscal Reaction Function

Everaert and Jansen (2017) raise attention to the possibility that the fiscal fatigue observation is not homogenous but could rather be heterogenous across countries. This implies that debt thresholds can also be heterogenous, and there isn't necessarily an average Caribbean debt threshold.

(5.2)

$$p_{it} = \alpha_i + p_{it-1}\theta_1 + d'_{it-1}\beta_{1i} + d^{2\prime}_{it-1}\beta_{2i} + d^{3\prime}_{it-1}\beta_{3i} + X'_{kit}\gamma_k\delta_t + \sum_{l=0}^{\pi_T} \omega'_{il}\bar{z}_{t-l} + \epsilon_{it}$$

The model is therefore adjusted as in (5.2) to allow for country specific debt coefficients estimated by Pesaran's (2006) Dynamic Common Correlated Effects (DCCE). In such panels with heterogeneous coefficients, the error term $\epsilon_{it} = \tau'_i \boldsymbol{f}_t + e_{it}$, where $\boldsymbol{f}_t$ are unobserved factors common to individual cross sections,

τ_i heterogeneous factor loadings, and e_{it} a cross-section specific idiosyncratic error term. The factor loadings imply cross-sectional dependence and thus inconsistent estimation of the model. Pesaran (2006) show that in static form the CCE model can be consistently estimated by approximating common factors with cross-sectional averages $\bar{z}_t = (\bar{d}_t,\ \bar{X}_t)$. However, in the dynamic case (5.2), due to the endogeneity of the lagged dependent variable, consistent estimation requires also adding cross sectional averages $\bar{\rho}_{t-1}$, with lags of all cross-sectional averages up to the floor of $\sqrt[3]{T}$ to maintain appropriate degrees of freedom. The cross-sectional lags are represented by $\pi_T = \left|\sqrt[3]{T}\right|$. In the case of weak cross-sectional dependence $\lim\limits_{N\to\infty} \frac{1}{N}\sum_{i=1}^{N}|\tau_i| = 0$, such that equation (5.2) can be consistently estimated. Only strong cross-sectional dependence is problematic (Dizten, 2018; Pesaran, 2015).

5.4.4 Estimating the Fiscal Reaction Function Debt Threshold

Recall that fiscal fatigue occurs when $\beta_1 < 0, \beta_2 > 0$ and $\beta_3 < 0$, where β_3 captures reaction of government's discretional fiscal policy (primary balance) at the highest levels of debt. In other words, when there is statistical evidence that government can no longer continue to respond positively to higher levels of debt ratios. At this point, government has reached its debt threshold.

Considering the equilibrium condition:

$$\mu + f(\bar{d}) = (r^* - g)\bar{d} \tag{5.3}$$

Solving for the debt threshold requires FRF coefficients θ_1, β_{1i}, β_{2i}, β_{3i}, and γ_k from (5.1) for substitution in $\mu + f(\bar{d})$ in (5.3)[28], where μ is the sum of primary balance effects except from changes in debt, and $f(\bar{d})$ the primary balance response evaluated at $\bar{d}$. It also requires data on the long-run interest rate-growth rate differential $(r^* - g)$, which Gosh *et al*. (2013) estimates using the previous 10-year average.

The above estimation of $\bar{d}$ is for the regional debt threshold. Country specific debt thresholds $\bar{d}_i$ is estimated using the heterogeneous coefficients from 5.2 and country specific long-run interest-growth rate differentials.

5.5 Data

Data on the primary balance to GDP ratio, debt to GDP ratio, and control variables are mainly from the World Bank Economic Outlook (WEO) for the period 1980 to 2019.

[28] This is assuming that the output and expenditure gaps are closed as in Gosh et al. (2013).

The primary balance ratio is the WEO's primary net lending variable, while the debt to GDP ratio is general government gross national debt, both expressed in ratio to nominal GDP, respectively.

As is commonly found in FRF models, the control variables are primarily the output gap, representing the business cycle, where the output gap is calculated as the difference between actual and trend values, and by convention the cyclical components of real GDP (constant 2018 dollars) is separated from the data using the Hodrick Prescott filter.[29] Judging from the studies of Cevik and Nanda (2020) and Khadan (2019) the expenditure gap does not seem relevant for the Caribbean fiscal reaction function.
Additional controls included are the current account balance to GDP ratio; credit to government, elections dummy, and a dummy representing IMF programmes deduced from the IMF database on historical lending commitments[30].

Inclusion of the current account balance is in recognition of the twin-deficit problem, where high primary deficits lead to current account imbalances. The credit to government variable accounts for financial deepening and its impact on government primary deficits, while the elections dummy variable follows from evidence that governments tend to expand expenditure before and during elections.

[29] Using lamda = 100 as recommended for annual data.
[30] Found athttps://www.imf.org/external/np/fin/tad/extarr1.aspx.

As such, the elections variable is a dummy with 1 in the year prior and during elections as in Khadan (2019).

Caribbean governments have borrowed extensively from the IMF over the period, through IMF funding windows which come with macro-economic adjustment conditions attached. It is possible then that these conditionalities, which are primarily fiscal in nature would help determine the direction of governments' primary balance.[31] A glossary of the IMF funding windows and details of IMF lending to the Caribbean is provided in Appendix Table A 5.3 and Table A 5.4, respectively. Between 1963 and 2022, IMF data shows that the Caribbean had 54 lending arrangements with the IMF to the tune of SDR 8 billion. IMF programmes are represented by a dummy variable which takes on the value 1 in the years of IMF lending and 0 otherwise.

For calculation of the debt thresholds, note that GDP growth is calculated from constant GDP at 2015 prices, whereas the interest rate is the implicit interest rate calculated as interest payments relative to previous period's debt. A summary of the data is presented in Table 5.1.

[31] "The IMF lends under concessional and non-concessional arrangements or can provide outright loans. A lending arrangement, which is similar to a line of credit, is approved by the IMF Executive Board to support a country's economic and financial program. The arrangement requires the member to observe specific terms and subject to periodic reviews in order to continue to draw upon it. An outright loan is also approved by the IMF Executive Board, however, it does not require a member to observe specific terms."

Table 5.1: Data Descriptions and Sources

Variable	Description	Period	Source	Comments
Primary Balance Ratio	General government primary net lending/borrowing (percent of GDP)	1980 - 2022	IMF World Economic Outlook (WEO), 2023.	
Debt Ratio	General government gross debt (percent of GDP)			
Real GDP growth	Gross domestic product, constant prices (100=2015, U.S dollars)			Converted into percentage changes
Real Interest Rate	Interest payments relative to previous period's debt less inflation (percent)			Interest expense calculated as Primary balance less fiscal balance
Current Account Balance Ratio	Current Account Balance (percent of GDP)			
Credit to Private Sector	Domestic credit to the private sector (percent of GDP)			
Elections	Dummy variable (1=election and pre-election years 0 =no elections or pre-election year)			Defined as in Khadan (2019)
IMF Programmes	Dummy variable (1=year of IMF programme 0=no IMF programme year)		IMF History of Lending Commitments (August 2023)	https://www.imf.org/external/np/fin/tad/extarr1.aspx

5.6 Results

The baseline model is estimated using OLS with PSCE, fixed and time effects. Table 5.2 presents the results from the estimation. Model (1) is the generic fiscal reaction function, whilst model (2) and (3) test for the existence of non-linear effects between debt and the primary balance, through introducing the lagged square and cubic debt variables, respectively.

The results show evidence of a Caribbean fiscal reaction function or debt rule. For every 1 percentage point rise in the debt to GDP ratio, primary balances in the region rise on average by around 0.03 percent. Caribbean fiscal policy is persistent as represented by the highly significant lagged primary balance, and there are other significant auxiliary effects including from the business cycle, twin deficit phenomenon, private sector crowding out, and elections expenditure, which all help determine the Caribbean's fiscal policy stance.

Despite evidence of an underlying fiscal rule, the findings do not reflect significant non-linearity in the Caribbean's fiscal reaction function or Caribbean fiscal fatigue. Both the lagged square and lagged cubic debt terms are insignificant in their respective models, though the quadratic model appears to have signs ($\beta_1 > 0, \beta_2 < 0$) in line with the fiscal fatigue hypothesis and similarly sized coefficients as in Cervic and Nanda (2020).

In model (2) the lagged primary balance is highly significant at 0.58, whilst the lagged debt (0.05) and lagged square debt coefficients are insignificant, with the latter exhibiting a negative and very near zero coefficient. In contrast, in model (3) the coefficients on the lagged debt and non-linear debt variables are 0.08, -0.00 and 0.00, and are all insignificant. The control variables in models 2 and 3, on the other hand, maintain their significance and have very similarly sized coefficients.

As earlier highlighted and confirmed in Everaert and Jansen (2018) for OECD countries, such regressions could be masking heterogeneity at the country level. Fiscal fatigue at the regional level or lack thereof is not necessarily unanimously representative. Table 4 presents the tests for heterogeneity in Caribbean fiscal fatigue by way of DCCE regressions. Mean group estimations are not reported. The interest is only in establishing whether there is evidence of a debt limit in any of the 13 individual Caribbean countries, as represented by the fiscal fatigue hypothesis.

Before delving into these findings, it is worth noting that the results of the DCCE regressions displayed in Table 4 model (4) highlight heterogeneity in the fiscal reaction function for the Caribbean as well. Though not all country equations could be estimated due to degrees of freedom issues, those that are estimable show that whilst fiscal reaction coefficients are significant for Barbados (0.05*), St. Kitts and Nevis (0.09**) and St Vincent and the Grenadines (0.21*), they are insignificant for Antigua and Barbuda, Bahamas, Dominica, Grenada, and Guyana, raising questions about the homogeneity of the Caribbean fiscal reaction function.

Model (5) shows a coefficient of 0.02 on the square debt term for Dominica, which is significant at the 5 percent level. The result does not align with the theory of fiscal fatigue, however, as it suggests that Dominica keeps increasing its primary surplus in line with rising debt.

According to the cubic regressions in model (6), Antigua and Barbuda and St Vincent and the Grenadines have cubic debt coefficients that are very near zero and significant at least at the 5 percent level but with different signs. Antigua and Barbuda's cubic debt coefficient is positive whereas St Vincent and Grenadines' is negative. As with Dominica, the former results suggest that as debt rises, Antigua and Barbuda's primary balance response becomes more positive as opposed to exhibiting fiscal fatigue. Generally, over the past 40 years, Antigua and Barbuda's debt to GDP ratio has ranged between 70 and 126 percent of GDP, reflecting persistent debt overhang. This could explain, as is the case with Japan in Everaert and Jansen (2018), why the fiscal fatigue hypothesis does not hold in the context. Antigua and Barbuda is living with high average debt ratios and only initiates a positive fiscal response at very high levels of debt. This may be possible for Antigua and Barbuda since the country has mostly non-marketable debt and is thus not at full risk of the doom loop. On the other hand, St Vincent and Grenadines' negative coefficient on the cubic debt variable imply relevance of fiscal fatigue.

However, the finding of a zero average primary balance and the corresponding interest-growth rate differential in Table 5.6 suggests that a debt threshold for St Vincent and the Grenadines does not exist, but that the debt ratio continues to rise without bound.

Gosh *et al*. observed similar for Greece, Iceland, Italy, Japan, and Portugal, where the assumed interest-growth rate differential, and estimated primary balance reaction suggested that public debt would not converge to a finite steady-state debt ratio.

Table 5.2: Tests for Fiscal Fatigue and a Caribbean Debt Threshold

OLS-PSCE			
Dependent Variable: Primary Balance to GDP Ratio	**(1)**	**(2)**	**(3)**
Constant	2.19*	2.12	1.57
	[1.17]	[1.78]	[2.62]
Lagged Primary Balance	0.56**	0.58***	0.58***
	[0.01]	[0.09]	[0.09]
Lagged Debt	0.03**	0.05	0.08
	[0.01]	[0.04]	[0.09]
Lagged Debt Squared		-0.00	-0.00
		[0.00]	[0.00]
Lagged Debt Cubed			0.00
			[0.00]
Output Gap	-0.00	-0.00*	-0.00*
	[0.00]	[0.00]	[0.00]
Elections	-0.81**	-0.81**	-0.80**
	[0.28]	[0.27]	[0.27]
Credit to Government	-0.06**	-0.05**	-0.05**
	[0.02]	[0.02]	[0.02]
Current Account Balance	0.11**	0.11**	0.12**
	[0.04]	[0.04]	[0.04]
IMF Programme	1.58		
	[0.92]		
Observations	326	326	326
Groups	13	13	13
Periods	25.1	25.1	25.1
R-Squared	0.56	0.56	0.56
Fixed Effects	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes

Note: model (1) refers to the panel IV FE with $d'_{it1-1}\beta_{1i}$ and (2) is the quadratic model $d'_{it1-1}\beta_{1i} + d^{2\prime}_{it1-1}\beta_{2i}$. Model (3) is the cubic model $d'_{it1-1}\beta_{1i} + d^{2\prime}_{it1-1}\beta_{2i} + d^{3\prime}_{it1-1}\beta_{3i}$. The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses.

Table 5.3: Tests for Heterogeneity in Fiscal Fatigue and Caribbean Debt Thresholds

	Dynamic Common Correlated Effects (DCEE)			
	Dependent Variable: Primary Balance to GDP Ratio	**(4)**	**(5)**	**(6)**
1.	Antigua and Barbuda	0.09	-0.01	0.00**
		[0.08]	[0.01]	[0.00]
2.	Bahamas, The	0.01	0.00	0.00
		[0.07]	[0.01]	[0.00]
3.	Barbados	0.05*	-0.01	
		[0.03]	[0.01]	
5.	Dominica	0.08	0.02***	
		[0.08]	[0.01]	
6.	Grenada	0.20	0.00	
		[0.16]	[0.00]	
7.	Guyana	- 0.09		
		[0.08]		
9.	St Kitts and Nevis	0.09**		
		[0.03]		
10.	St Lucia	0.16		0.00
		[0.22]		[0.00]
11.	St Vincent and the Grenadines	0.21*		- 0.00**
		[0.12]		[0.00]
	Controls	Yes	Yes	Yes
	Fixed Effects	Yes	Yes	Yes
	Time Effects	Yes	Yes	Yes
	CD Statistic (p-value)	0.36	0.0084	0.179

Note: models (4), (5) and (6) are the DCCE regressions relevant to models (1), (2) and (3) respectively. For the purposes of this study, results for the other heterogenous coefficients or the mean group estimates are not reported. Regressions are run with cross-section averages of the primary balance, debt and elections dummy with 3 lags. However, results for countries 4, 8,9 and 13 in model (4); countries 4, 7,8, and 9 in model (5); and countries 3, 4, 5, 6 7, 8, 9, 12 and 13 in model (6) were eliminated because of insufficient observations. The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses.

5.7 Robustness Checks

5.7.1 Dynamic Panel Non-Linear Fiscal Reaction Function with Cyclically Adjusted Primary Balance

This section further employs the cyclically adjusted primary balance (CAPB) with dynamic non-linear OLS-PSCE*, Panel IV* and GMM-sys*, and compare the results from these regressions (Table 5.4) with the results in Table 5.3. The CAPB follows the IMF aggregate approach as articulated in Hlivnjak and Laco (2018), where:

(0.4)

$$CAPB = R^{CA} - G^{CA}$$

$$R^{CA} = E\left(\frac{Y^*}{Y}\right)^{e_R}$$

$$G^{CA} = G\left(\frac{Y^*}{Y}\right)^{e_G}$$

The CAPB is calculated as cyclically adjusted revenue R^{CA} less cyclically adjusted non-interest expenditure G^{CA}. Here Y^* is potential GDP and Y actual GDP. Elasticities e_R and e_G are assumed 1 and 0, respectively, for revenues and expenditure (Cevik and Nanda, 2020).

Additionally, the model is run with panel IV and system GMM for the baseline model with the primary balance as the dependent variable, respectively.

The results using the CAPB in model (7), (9) and (11) regressed with OLS-PSCE*, Panel-IV* and GMM-sys* with fixed and time effects do not show markedly different results when compared to the baseline model, other than for signs of the debt coefficients and significance of other primary balance effects. The CAPB models though not possessing significant debt coefficients, reflect a non-linear CAPB-debt relationship that aligns with fiscal fatigue.

Changing the estimation procedure to Panel-IV and GMM-sys for the baseline model with the primary balance as the dependent variable, as in models (8) and (10), apart from differences in significance of the control variables, these estimators also do not yield any different results from the baseline model regressed with OLS-PSCE. That is, the debt coefficients do not exhibit the signs associated with fiscal fatigue and are not significant.

As with the primary balance model, it is useful to check whether there is heterogeneity at the country level in terms of the non-linearity of the CAPB-fiscal reaction function. The results from the DCCE model with the CAPB as the dependent variable are presented in Table 5.5, models (12-14). Notably, none of the models show significant coefficients either for the linear or non-linear specifications of the baseline model. All debt and control variables are insignificant, but like the primary balance-FRF, the coefficient signs are not consistent across countries and suggest different patterns of non-linearity.

However, what is consistent across the models (7-14) is that the debt coefficients' (β_{1i}, β_{2i} and β_{3i}) all hover around zero irrespective of their significance or sign, implying a weakening of the CAPB and primary balance response at very high levels of debt. Of course, a major limitation of the results is the scarcity of data. The DCCE model normally require large N and T for accurate inference, so the results from those regressions are not taken likely.

Nonetheless, there seems to be some evidence of non-linearity in the relationship between the Caribbean primary balance and debt to GDP ratios. This is evidenced in Figures A 5.2-5.4. The scatter plot of the primary balance against lagged debt in raw data form suggests a strictly linear relationship. However, while the quadratic and cubic models are not highly representative of the data generating process for the primary balance, there are visible changes in the relationship between the variables when transforming the data into averages and medians, as was done in Gosh *et al*. Specifically, as was alluded to in Section 5.3 on basic threshold analysis, there is a dip in the primary balance at debt to GDP ratios exceeding 90 percent, which warrants further investigation.

5.7.2 Dynamic Panel Fiscal Reaction Function with Kink

To test for the existence of a threshold in a dynamic FRF, one can define a dynamic model with kink. Following on from equation (5.1), a dynamic fiscal reaction function with kink can be expressed as below:

(5.5)

$$p_{it} = \alpha_i + p_{it-1}\theta_1 + d'_{it1-1}\beta_1 + d'^{\tau}_{it1-1}[\leq \tau]\beta_2 + X'_{kit}\gamma_k\delta_t + \epsilon_{it}$$

Where all variables are defined as before and there is a debt threshold or kink at some threshold value $\tau = 30, 31 \dots \dots .120$. The values of the threshold variable d'^{τ}_{it1-1} signify that the interest is in testing the threshold range $30 \leq \tau \leq 120$, which is quite a wide search range but applicable considering the broad evidence (Wright and Grenade, 2014; Wright and Leon, 2014; Greenidge *et al*., 2012; Celasun *et al*., 2006) on a Caribbean threshold. The test range is also informed by the revelations of Figure 5.4, which shows that most of the debt to GDP ratios are in the range 30 percent of GDP to 90 percent of GDP and above.

Table 5.4 Alternative Tests for a Caribbean Debt Threshold

	OLS-PSCE*	**Panel IV-FE**	**Panel IV-FE***	**GMM -Sys**	**GMM-Sys***
Dependent Variable: Primary Balance Ratio	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
Constant	-2.18	0.84	0.31	0.95	0.56
	[6.22]	[2.73]	[9.04]	[2.87]	[4.82]
Lagged Primary Balance	1.09***	0.60***	1.09***	0.54***	1.09***
	[0.01]	[0.09]	[0.14]	[0.12]	[0.02]
Lagged Debt	-0.04	0.13	-0.16	0.01	-0.19
	[0.22]	[0.12]	[0.47]	[0.13]	[0.29]
Lagged Debt Squared	0.00	-0.00	0.00	0.00	0.00
	[0.00]	[0.00]	[0.01]	[0.00]	[0.00]
Lagged Debt Cubed	-0.00	0.00	-0.00	0.00	-0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Output Gap	0.00	-0.00**	-0.00	-0.00	0.00
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Elections	0.90	-0.89***	0.78	-0.26	0.05
	[0.70]	[0.29]	[0.65]	[0.31]	[0.31]
Credit to Private Sector	0.13*	-0.06**	0.20**	-0.03	0.02
	[0.06]	[0.03]	[0.08]	[0.02]	[0.03]
Current Account Balance	0.08	0.08***	1.09***	0.09*	-0.03
	[0.10]	[0.04]	[0.14]	[0.04]	[0.08]
R-Squared	0.99	0.57	0.58		
Fixed Effects	Yes	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes
Sargan Test (Prob Chi2)				0.01	
Hansen Test (Prob Chi2)				1.00	
Instruments				115	419

Note: model (7) and (9) refers to the panel IV FE and system GMM regressions with the CAPB as dependent variable and $d'_{it1-1}\beta_{1i} + d^{2\prime}_{it1-1}\beta_{2i} + d^{3\prime}_{it1-1}\beta_{3i}$ as regressors of interest. Model (8) is the system GMM regressions with primary balance and same regressors of interest. The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses.

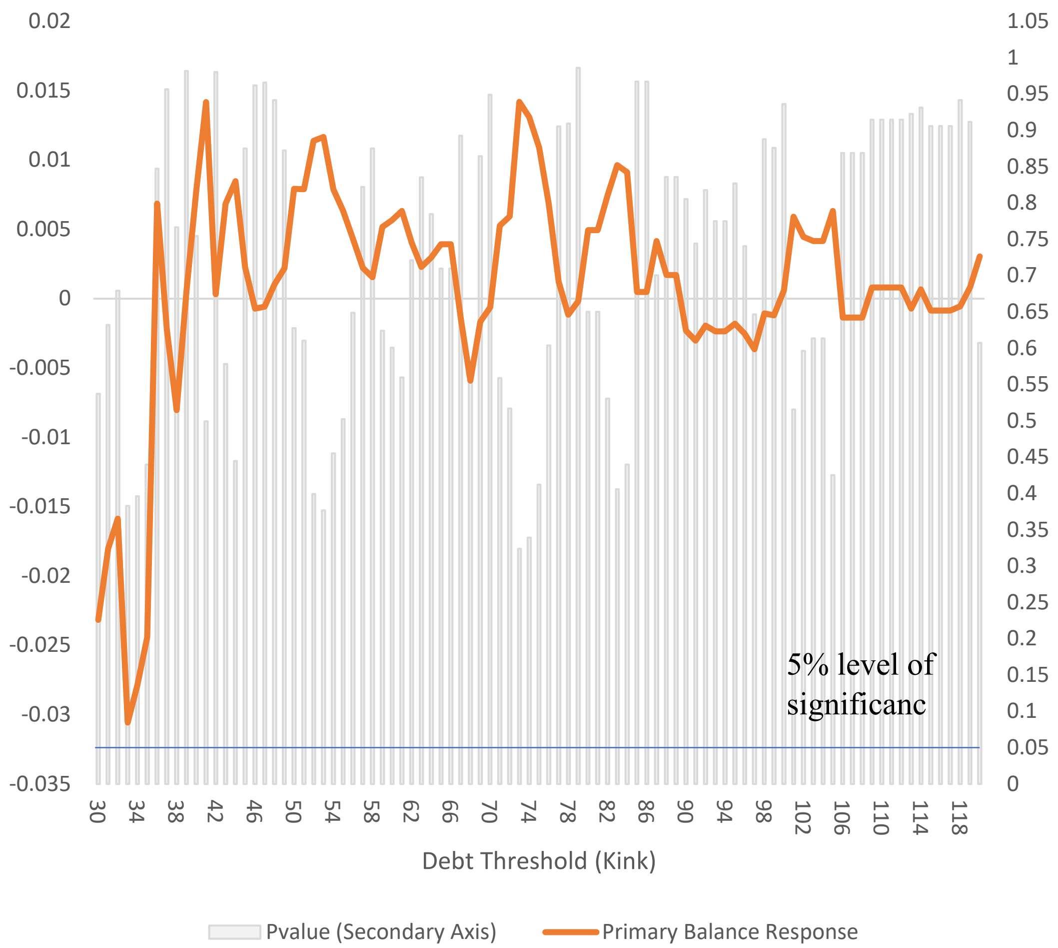
Table 5.5 Alternative Tests for Heterogeneity in Fiscal Fatigue and Caribbean Debt Thresholds

	Dynamic Common Correlated Effects (DCEE)			
	Dependent Variable: Primary Balance Ratio	**(12)**	**(13)**	**(14)**
1.	Antigua and Barbuda	-0.00	-0.00	-0.00
		[0.15]	[0.01]	[0.00]
2.	Bahamas, The	0.05	-0.00	-0.00
		[0.20]	[0.01]	[0.00]
3.	Barbados	0.01	0.00	
		[0.05]	[0.00]	
5.	Dominica	0.00	0.00	
		[0.14]	[0.01]	
6.	Grenada	0.01	0.00	
		[0.11]	[0.00]	
7.	Guyana	0.25		
		[0.16]		
9.	St Kitts and Nevis	0.00		
		[0.04]		
10.	St Lucia	0.01		0.00
		[0.82]		[0.00]
11.	St Vincent and the Grenadines	-0.00		0.00
		[0.14]		[0.00]
Controls		Yes	Yes	Yes
Fixed Effects		Yes	Yes	Yes
Time Effects		Yes	Yes	Yes
CD Statistic (p-value)		0.36	0.0084	0.179

Note: models (10), (11) and (12) are the DCCE regressions relevant to model (7). For the purposes of this study, results for the other heterogenous coefficients or the mean group estimates are not reported. However, results for countries 4, 8,9 and 13 in model (4); countries 4, 7,8, and 9 in model (5); and countries 3, 4, 5, 6 7, 8, 9, 12 and 13 in model (6) were eliminated because of insufficient observations. The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses.

The results from the dynamic FRF with kink are summarized in Figure 5.9. At all thresholds in the range, the FRF coefficient is highly insignificant, reflecting that such a model also does not describe the data generating process for the primary balance with a debt threshold.

Figure 5.9 Tests for a Dynamic Linear (with Kink) Caribbean Debt Threshold



Nonetheless, just focusing on the trends in the FRF coefficient, the model with kink despite its insignificance reflects some of the basic foundations of fiscal fatigue to which Gosh *et al*. refers. For instance, at low levels of debt and particularly below 33 percent of debt to GDP, the average Caribbean primary balance is negative. It turns positive above 33 percent of debt to GDP (though declining) and falls negative at debt ratios greater than 72 percent prior to a brief negative decline. After 72 percent of debt to GDP, the primary balance is on a positive but declining trend with only a brief positive upshot at around 99 percent before eventually plateauing post 105 percent of debt to GDP.

5.7.3 Dynamic Panel Threshold (without kink)

Another method for testing dynamic threshold effects is Seo and Shin's (2016) dynamic panel threshold regression, which extends Hansen's (1999) static threshold model to the dynamic case, allowing for endogenous variables and consistent and asymptotically normal estimates (Seo *et al*., 2019). The threshold variable acts as the lever or switch from one regime to another, defined at certain threshold values.

Letting the threshold value be represented again by τ, Seo and Shin's dynamic panel FRF threshold model can be expressed as follows:

(5.6)

$$p_{it} = x_{it}\beta + q_{it}\delta_1 + \epsilon_{it} \qquad \text{if} \qquad -\infty < q_{it} \leq \tau$$

$$p_{it} = x_{it}\beta + q_{it}\delta_2 + \epsilon_{it} \qquad \text{if} \qquad \tau < q_{it} < \infty$$

The debt threshold or transition variable q_{it} is the debt to GDP ratio whose coefficient δ varies depending on whether the threshold variable is above or below (two-regimes) a particular threshold τ. The variable x_{it} is a kxk matrix including the lagged primary balance p_{it}, lagged debt GDP ratio, constant term α_i, and control variables both exogenous and endogenous[32], as included earlier, whilst β is a $1xk$ vector of coefficients. The errors ϵ_{it} are as defined in equation 5.5 and 5.2.

The model is first-differenced to eliminate fixed effects and the parameters β, δ and τ are estimated via generalized method of moments (GMM). One important caveat here is that the dynamic threshold procedure requires fully balanced data. Hence the model is only estimable for the period 2012 – 2018, where there are no missing observations across all Caribbean countries and periods.[33]

The results from Seo and Shin's dynamic panel threshold regression in Table 5.6 indicate a Caribbean debt threshold of 106.2 percent, conditional on the primary balance to GDP ratio. The estimated debt threshold is highly significant, and the model shows varying significance of the control variables in different regimes. Note that the debt threshold estimate is consistent with the observations from Section 5.3 and 5.7.2, where it was found that a debt to GDP ratio of above 90 percent seems to be associated with a negative or plateauing primary balance.

[32] Note that the output gap is specified as endogenous in the model.
[33] Also note that the grid number is left at default = 100, and the trim rate is set to 0.01. The low trim rate is used to ensure that we maximise the use of extreme values given limited data and time period, and also considering the objective, which is to understand whether there is a significant non-linear effect of very high debt on the primary balance.

Table 5.6 Tests for a Dynamic Linear Caribbean Debt Threshold (Two-Regime)

Dependent Variable: Primary Balance Ratio	**Below Threshold**	**Above Threshold**
Lagged Primary Balance	-0.69*	11.25*
	[0.38]	[6.13]
Output Gap	0.00**	-0.00
	[0.00]	[0.00]
Credit to Private Sector	0.22	15.9
	[0.43]	[16.13]
Current Account Balance	0.40***	-2.26**
	[0.10]	[1.01]
Threshold	106.62***	
	[2.25]	
Groups	13	
Periods	7	
Bootstrap Linearity Test [pvalue]	0	

Note: The significance levels 1%, 5% and 10% are represented by ***, **, and *respectively. Standard errors for the coefficient estimates are in square parentheses. The constant term is not reported.

Below the threshold, the primary balance shows negative persistence and is significant at the 10 percent level. Above the threshold there is evidence of a strong and persistent fiscal effort (11.25 percent of GDP) also significant at the 10 percent level. When the debt to GDP ratio is below its threshold, the results indicate a positive and significant response to the business cycle, though negligible, implying procyclicality of fiscal policy. On the other hand, fiscal policy appears to become countercyclical above the threshold as the output gap coefficient turns negative.

Note however that the coefficient on the output gap is insignificant. The influence of private sector credit is insignificant both above and below the threshold, but the current account balance coefficient is highly significant in both regimes. Specifically, in the lower regime a 1 percent increase in the current account balance raises the primary balance by 0.4 percent. On the contrary, in the upper regime, such a rise in the current account balance will lead to a decrease in the primary balance of 2.26 percent. The non-linear reaction of the primary balance to the current account implies that below the debt limit, a trade surplus contributes positively to the primary balance. This could be reflective of a build-up in foreign reserves. Above the threshold, say when the government is facing extremely high external debt payments, surplus foreign exchange from a positive trade balance is used to finance the high external debt service.

The bootstrap linearity tests reject the null hypothesis H_0: $\delta = 0$ and confirms non-linearity in the Caribbean FRF.

5.8 Policy Discussion

The empirical evidence does not support the existence of a Caribbean debt threshold defined by the theory of fiscal policy fatigue.

On the contrary, it seems that a fiscally derived debt threshold is better defined by a dynamic panel threshold model, which shows a debt threshold value of 106.2

percent of GDP for the region. This high threshold value implies that Caribbean governments can live with high debt to GDP ratios for some time, defying not only the fiscal fatigue hypothesis but also that related to market interest-debt theory or the so-called doom loop.

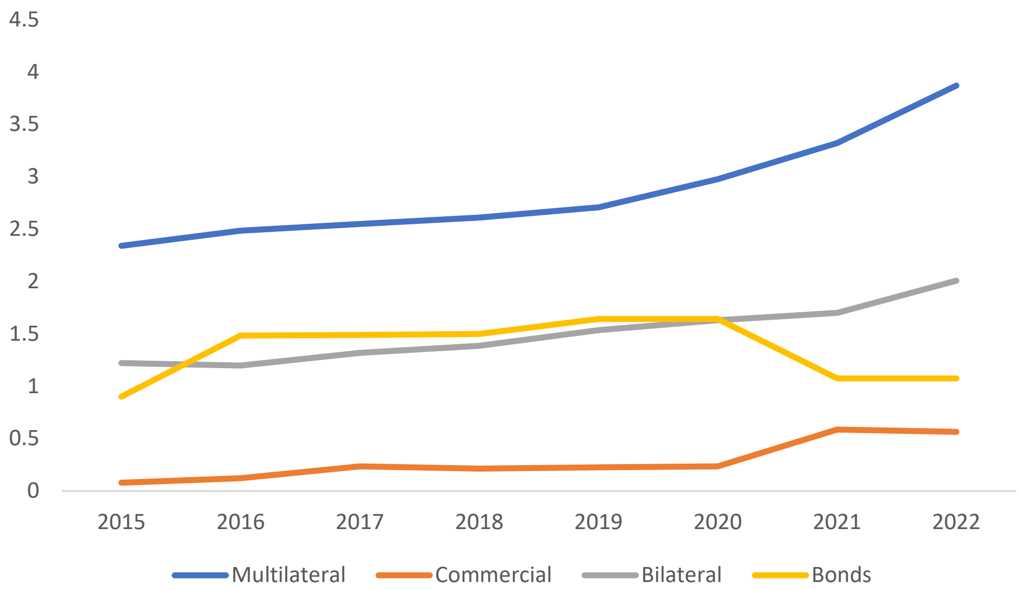
A plausible explanation for the absence of fiscal fatigue might be linked to the composition of the Caribbean debt portfolio, and the inapplicability of Gosh *et al.*'s interest rate assumption, embedded in the arbitrage condition.

Much of the Caribbean, except for Barbados, Belize, Jamaica and Trinidad and Tobago, mainly hold non-marketable debt. Caribbean debt portfolios comprise in the majority, concessional and fixed term liabilities, borrowed from multilateral and bilateral creditors. There is only a small portion of commercial bank debt provided mainly by the Paris Club (Figure 5.10).

Since multilateral, and bilateral creditors don't behave in the same way as pure credit market participants, that is, raising interest rates in line with fiscal policy laxity and against the corresponding risk of default, it might explain why some Caribbean governments can continue to run primary deficits or respond positively to debt (as indicated by the non-linear results), even in the face of an ever-rising debt level (as indicated in the linear FRF model).

The Caribbean's multilateral and bilateral creditors are primarily the IMF and World Bank, with the IMF lending for balance of payment needs and the World Bank for growth and structural reform, generally. Though these creditors do lend for profit, their non-concessional interest rates are set mainly for replenishment of their capital budgets, and concessional rates are determined by the grant element. Therefore, Gosh *et. al's* arbitrage condition that theorises creditor's behaviour doesn't necessarily hold for the region.

Figure 5.10: Composition of Caribbean Debt ($US billions)



Data source: World Bank International Debt Statistics

As debt dynamics worsen, the penalty for poor fiscal policy reaction over time, as mandated by multilateral creditors, is a reduction in the scale of resources that can be accessed by debtor countries. However, the reduced resources are provided at more concessional rates to increase the probability of countries returning to debt sustainability. Examples of such facilities are the World Bank's International Bank for Reconstruction and Development (IBRD) and OECD-DAC concessional loan windows.

In hindsight then, as opposed to being defined by fiscal fatigue, the debt threshold for developing countries of the Caribbean could possibly be determined by social-political factors, which force governments to introduce stringent fiscal consolidation and reforms to maintain access to concessional resources at scale, and to avoid the opportunity for social and political unrest. In this context, the Caribbean's debt threshold will not show up as a curvilinear[34] type non-linear primary balance response to debt because Caribbean governments seem to only make drastic shifts in the primary balance when there are no options but to.

Additionally, note that as alerted to by Gosh *et. al* (2013), the estimated debt threshold is contingent on the existing fundamentals. In this period of review 2012-2018, the Caribbean debt to GDP ratio was on a downward path, owing to a less positive interest-growth rate differential. With COVID-19, as highlighted in the introduction, the debt fundamentals have shifted negatively, and the region has

[34] When the relationship follows a curve such as a quadratic or cubic curve.

experienced a severe negative primary balance shock. Gosh *et al*. shows that such negative primary balance shocks would lower the threshold value, so it is highly likely that the current Caribbean debt threshold is lower today as compared to the period 2012-2018.

The policy implications of these results are several. Firstly, as a region subject to persistent shocks, the Caribbean needs a well-defined debt threshold model to constantly review their debt limits, and to help govern fiscal policy behaviour. Without a well-defined debt threshold method of assessment, Caribbean governments are likely to continue to run persistent high debt balances, with adverse effects to their debt sustainability and growth.

Next, the Caribbean's debt threshold contingent on the primary balance likely represents the upper bound of the Caribbean's debt limit. The lower bound is most likely defined by growth and not by a fiscal reaction function. When debt surpasses a particular threshold (on average between 56-62 percent of GDP), the studies by Greenidge *et al.* (2012) and by Wright and Grenade (2014) etc. show that there is a negative effect on growth. This is likely the first stage of threshold effects. This negative growth affects the interest-growth rate differential, debt to GDP and primary balance ratios, which in turn determines future risk premiums and the primary balance reaction to debt, the final stage of the debt threshold effect. Hence knowledge of both the lower and upper bounds of the debt threshold are important for fiscal policy. This reasoning could also explain why the Caribbean after surpassing higher levels of debt, and beyond the IMF rule of thumb, for example, could continue to raise debt without default.

The interpretation also suggests that governments have two choices, either to begin to adjust their fiscal policy prior to the lower debt limit to arrest any negative effects on growth or to make those adjustments once in the region between the lower and upper debt limits. The disadvantage of the former is that implementing fiscal consolidation may increase the drag on growth if done prematurely. Debt used for investment, for example to develop infrastructure, will take time to bear fruit and could translate into higher growth. However, if government puts the brake on investments too early then such future growth will be stymied. On the other hand, waiting until the debt to GDP ratio reaches say 90 percent of GDP, though not yet past the upper debt limit, will increase the country's vulnerability to shocks and could result in the debt ratio breaching the debt limit if the country is suddenly struck by an external event like COVID-19, with very harmful effects on the economy and society.

Lastly, owing to the Caribbean's stage of economic development and social focus, these governments should consider introducing a fiscal or debt rule (threshold) linked to economic growth and achievable primary balances ratios. This would better help to guide fiscal policy in line with economic, social, and political objectives, especially if enshrined in the constitution. Grenade *et al*. (2015) provides a set of arguments and recommendations for individual Caribbean countries as pertains adoption of fiscal rules. In their study the authors also emphasize the embedding of rules in the constitutions. This study provides evidence supporting that recommendation as the insignificance of the IMF programme variable, which ultimately reflects the introduction of fiscal rules, implies Caribbean governments' non-compliance with such rules, and by consequence, the need for strong enforcement via the constitution.

Taking averages of the interest-growth rate differentials for the period 2015-2019 against the region's 2019 debt ratios, the average debt stabilising primary balances for the region is 1.7 percent of GDP. Except for Jamaica, this is a ratio much larger than the average primary balances generated by most Caribbean countries and the average fiscal reaction to increases in debt. Jamaica has managed to generate an average primary surplus of around 7 percent of GDP over the period 1980-2019. Information on the debt limit together with achievable primary balances would help to establish a feasible debt rule for the Caribbean.

5.9 Conclusions

Despite the intuitive appeal of the fiscal fatigue hypothesis and the evidence to support it in OECD countries, the results from this study cast doubt over the relevance of the theory for the Caribbean, and by consequence, the existence of a corresponding debt threshold as defined by Gosh *et al*.'s (2013) hypothesis.

Through dynamic non-linear FRFs the study concludes, subject to data limitations, that whilst there is evidence of heterogeneity, the paucity of support in favour of a well-defined non-linear cubic fiscal reaction function suggests that debt thresholds could be better defined elsewhere.

It turns out that a FRF threshold of the non-curvilinear type exists. The study finds using Seo and Shin (2016) dynamic panel threshold model, that the Caribbean FRF indicates a debt threshold of 106.2 percent, corroborating the statistical analysis done using Rogoff and Reinhart (2013) basic threshold methodology. Such a high debt ratio defies the IMF rule of thumb of 60 percent of GDP and the research on Caribbean debt thresholds based on the debt-growth nexus.

A key factor is thought to be the composition of Caribbean creditors, which are mostly multilateral and bilateral, as opposed to bondholders that are characteristic of developed markets and that are primary actors in debt theory, including in the fiscal fatigue hypothesis. In particular, the definition of creditors and their behaviour is key to Gosh *et al*.'s assumption about the behaviour of interest rates, and consequently, the relationship between debt and the primary balance. The study concludes that for the Caribbean, Gosh *et al*'s. interest rate assumption – and specifically the arbitrage condition - does not hold.

Creditors to the Caribbean lend for development objectives and to replenish their capital budgets. Additionally, most Caribbean debtor countries are hardly cut-off from concessional credit lines but merely face reduced access to concessional credit at scale. Therefore, the dynamics of a debt threshold for the Caribbean are possibly not defined by market forces nor fiscal fatigue, but rather social-political considerations linked to the performance of the economy.

As debt grows higher and higher, such countries have less resources to advance social objectives owing to the impact on growth and begin to suffer politically. This then incentivises fiscal restraint, which has the main aim of ensuring the continuation of concessional debt flows at scale. Threshold analysis based on the debt-growth nexus may therefore be describing the lower bound of the debt thresholds, whilst the debt-primary balance relation maybe reflective of the upper threshold bound for the region.

The study provides the incentive for more research particularly bringing together debt threshold analysis based on the debt-growth and debt-primary balance relationships.

Based on the study's conclusions, Caribbean countries are encouraged to establish a method for assessing their debt limits and to constantly review these as debt limits are not set in stone but shift with macroeconomic fundamentals. Assuming that the thresholds from the debt-primary balance reaction and the debt-growth nexus represent the upper and lower bounds of the Caribbean debt threshold, respectively, then governments in the region are advised to use these to make a choice on fiscal adjustment, armed with knowledge that adjusting prior to reaching the lower threshold could risk a premature slowdown in growth whilst waiting to adjust between the lower and upper threshold range could heighten vulnerability and risk debt default if unexpected negative primary balance shocks act to reduce their debt thresholds. Governments in the region are also advised to consider implementing fiscal rules and enshrining them in the constitution to ensure enforcement.

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Appendix

Table A 5.1 Median Primary Balances by Selected Debt Thresholds in the Caribbean (1980-2022)

Country	Below 30%	Between 30-60%	Between 60-90%	Above 90%
Antigua and Barbuda			-0.594	-1.11
The Bahamas	0.38	-0.84	-1.347	-9.27
Barbados		7.04	0.56	-0.73
Belize		-4.04	0.715	-3.3
Dominica		-1	-0.84	-2.49
Grenada		-0.785	2.46	-2.13
Guyana		-1.97	-4.3	1.17
Jamaica			6.98	7.46
St. Kitts and Nevis		1.93	-0.54	2.84
St. Lucia	0.395	-1.18	-0.15	-0.34
St. Vincent and the Grenadines		-0.185	-1.44	2.835
Suriname	0.65	-2.64	-4.58	-4.39
Trinidad and Tobago	1.73	3	-3.94	

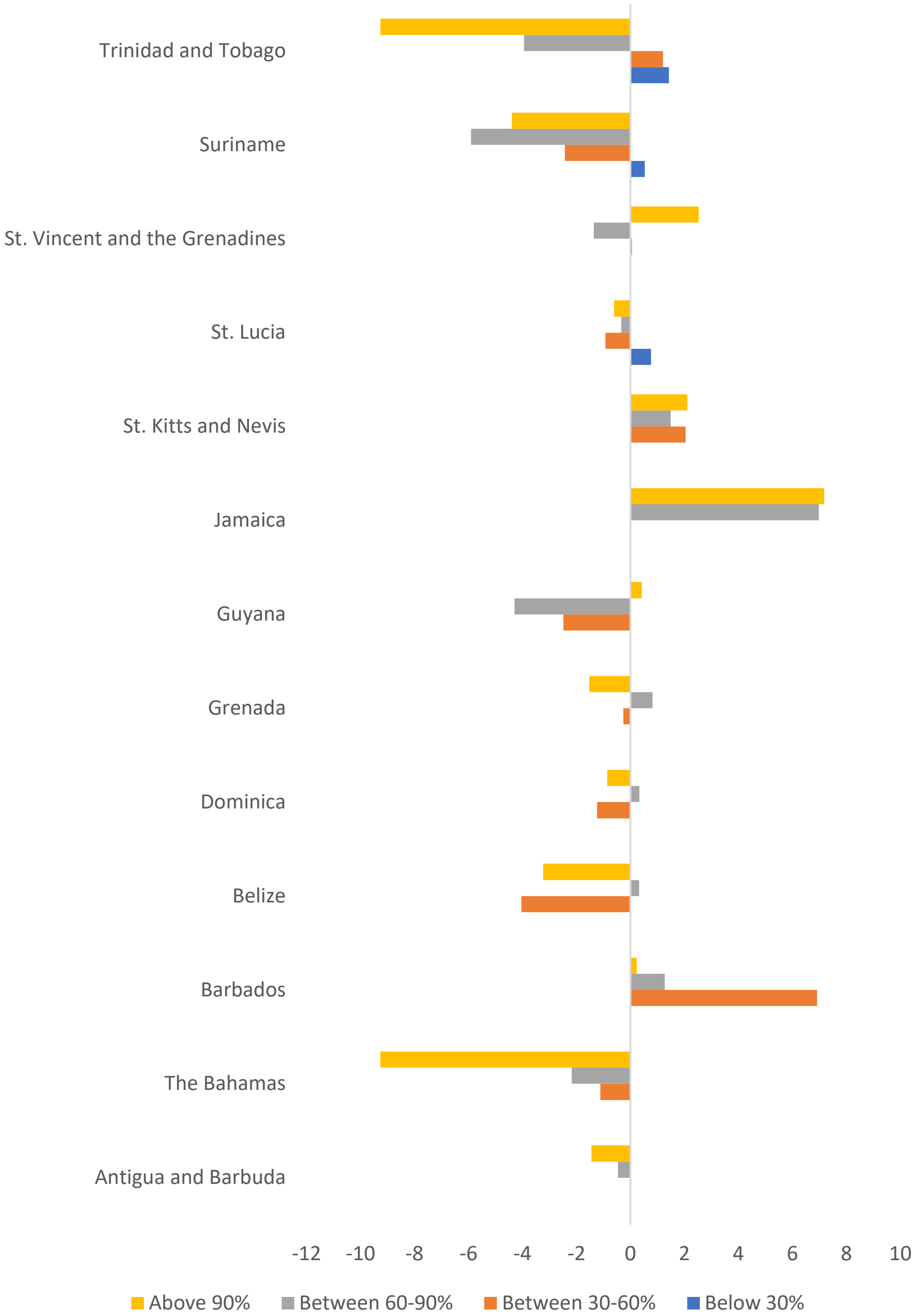
Data source is IMF World Economic Outlook (WEO), 2023.

Table A 5.2 Mean Primary Balances by Selected Debt Thresholds in the Caribbean (1980-2022)

Country	Below 30%	Between 30-60%	Between 60-90%	Above 90%
Antigua and Barbuda	-		-0.46	-1.45
The Bahamas	-0.001	-1.11	-2.17	-9.27
Barbados	-	6.91	1.27	0.23
Belize	-	-4.04	0.32	-3.23
Dominica	-	-1.24	0.33	-0.86
Grenada	-	-0.26	0.82	-1.52
Guyana	-	-2.49	-4.3	0.42
Jamaica	-		6.98	7.18
St. Kitts and Nevis	-	2.04	1.49	2.11
St. Lucia	0.76	-0.93	-0.34	-0.61
St. Vincent and the Grenadines	-	0.06	-1.36	2.53
Suriname	0.53	-2.43	-5.91	-4.39
Trinidad and Tobago	1.43	1.2	-3.94	-9.27

Data source is IMF World Economic Outlook (WEO), 2023.

Figure A 29 Caribbean Primary Balances by Selected Debt Thresholds (Mean, 1980-2022)



Data source is IMF World Economic Outlook (WEO), 2023.

Table A 5.3 Glossary of IMF Lending Facilities and Selected Terms

Term (Glossary)	Description (Glossary)
Adjustment Program	A detailed economic program, usually supported by use of IMF resources, that is based on an analysis of the economic problems of the member country and specifies the policies being implemented or that will be implemented by the country in the monetary, fiscal, external, and structural areas, as necessary, to achieve economic stabilization and set the basis for self-sustained economic growth.
Conditionality	Economic policies that members intend to follow as a condition for the use of IMF resources. These are often expressed as performance criteria (for example, monetary and budgetary targets) or benchmarks, and are intended to ensure that the use of IMF credit is temporary and consistent with the adjustment program designed to correct a member's external payments imbalance.
Enhanced Structural Adjustment Facility (ESAF)	Facility established in December 1987 to provide assistance on concessional terms to low-income member countries facing protracted balance of payments problems. (Changed to the Poverty Reduction and Growth Facility in 1999.)
Enhanced Surveillance Procedure	Policy introduced in 1985 to help members make progress in addressing their debt problems and improving relations with their creditors. During the enhanced surveillance period, economic developments in the member country are monitored by the IMF. The staff prepares an assessment of the member's economic program, which may be presented by the member to official and private creditors for consideration. The policy was broadened in 1993 to cover any situation in which a member would find this enhanced monitoring by the IMF helpful.
Extended Arrangement	A decision of the IMF under the Extended Fund Facility that gives a member the assurance of being able to purchase (draw) resources from the General Resources Account (GRA) in accordance with the terms of the decision during a specified period, usually three years, and up to a particular amount.
Extended Fund Facility	A financing facility (window) under which the IMF supports economic programs that generally run for three years and are aimed at overcoming balance of payments difficulties resulting from macroeconomic and structural problems. Typically, the member's economic program states the general objectives for the three-year period and the specific policies for the first year; policies for subsequent years are spelled out at the time of program reviews (see Extended Arrangement).

Term (Glossary)	Description (Glossary)
Poverty Reduction and Growth Facility (PRGF)	Established as the Enhanced Structural Adjustment Facility (ESAF) in 1987, enlarged and extended in 1994, and further strengthened in 1999 to make poverty reduction a key and more explicit element. The purpose of the facility is to support programs to strengthen substantially and in a sustainable manner balance of payments positions, and to foster durable growth, leading to higher living standards and a reduction in poverty. Eighty low-income countries are currently PRGF-eligible. Loans are disbursed under three-year arrangements, subject to observance of performance criteria and the completion of program reviews. Loans carry an annual interest rate of 0.5 percent, with a 5 - 1/2-year grace period and a 10-year maturity.
Precautionary Arrangement	A Stand-By or an Extended Arrangement under which the member agrees to meet specific conditions for use of IMF resources although it has indicated to the Executive Board its intention not to make purchases (drawings).
Precautionary Balances	Balances held in the form of General and Special Reserves, and the Special Contingent Accounts that were established in the context of the arrears strategy.
Program Monitoring	Monitoring by the IMF to determine whether the performance criteria specified, and policy commitments made in the context of a Stand-By or an Extended Arrangement are being observed by the member receiving resources (see Conditionality).
Stand-By Arrangement	A decision of the IMF by which a member is assured that it will be able to make purchases (drawings) from the General Resources Account (GRA) up to a specified amount and during a specified period, usually one to two years, provided that the member observes the terms set out in the supporting arrangement.
Structural Adjustment Facility (SAF)	A financial facility of the Fund established in 1986 to provide concessional loans to low-income Fund member countries. It recycled resources lent under the IMF's Trust Fund. It was superseded by the Enhanced Structural Adjustment Facility (ESAF) which was established in 1987 to promote stronger adjustment and reform measures than those under the SAF. The ESAF was replaced by the Poverty Reduction and Growth Facility in 1999.

Source: https://www.imf.org/en/About/glossary.

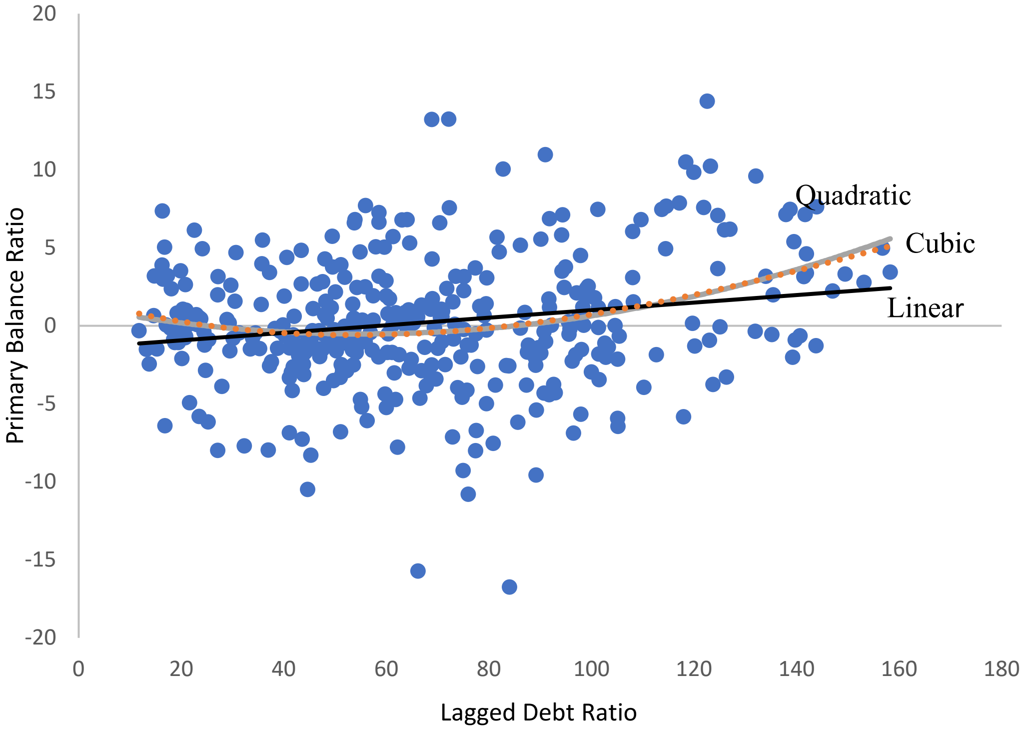
Table A 5.4 IMF Lending to Caribbean Countries

Country	Facility	Date of Arrangement	Expiration Date	Amount Agreed
Antigua and Barbuda	Standby Arrangement	Jun 07, 2010	Jun 06, 2013	67,500
Bahamas	Rapid Financing Instrument	Jun 01, 2020	Jun 03, 2020	182,400
Barbados	Resilience and Sustainability Facility	Dec 07, 2022	Dec 06, 2025	141,750
	Extended Fund Facility	Dec 07, 2022	Dec 06, 2025	85,050
	Extended Fund Facility	Oct 01, 2018	Jun 17, 2022	322,000
	Standby Arrangement	Feb 07, 1992	May 31, 1993	23,890
	Standby Arrangement	Oct 01, 1982	May 31, 1984	31,875
Belize	Standby Arrangement	Dec 03, 1984	Jun 01, 1986	7,125
Dominica	Rapid Credit Facility	Apr 28, 2020	Apr 30, 2020	10,280
	Rapid Credit Facility	Oct 28, 2015	Nov 05, 2015	6,150
	Rapid Credit Facility	Jan 11, 2012	Jan 18, 2012	2,050
	Extended Credit Facility	Dec 29, 2003	Dec 28, 2006	7,688
	Standby Arrangement	Aug 28, 2002	Jan 02, 2004	3,280
	Structural Adjustment Facility Commitment	Nov 26, 1986	Nov 25, 1989	2,800
	Standby Arrangement	Jul 18, 1984	Jul 17, 1985	1,400
	Extended Fund Facility	Feb 06, 1981	Feb 05, 1984	8,550
Grenada	Rapid Credit Facility	Apr 28, 2020	Apr 30, 2020	16,400
	Extended Credit Facility	Jun 26, 2014	May 26, 2017	14,040
	Extended Credit Facility	Apr 18, 2010	Apr 17, 2013	8,775

Country	Facility	Date of Arrangement	Expiration Date	Amount Agreed
	Extended Credit Facility	Apr 17, 2006	Apr 13, 2010	16,380
	Extended Fund Facility	Aug 24, 1983	Jan 23, 1984	13,500
	Standby Arrangement	May 11, 1981	May 10, 1982	3,425
	Standby Arrangement	Nov 06, 1979	Dec 31, 1980	651
	Standby Arrangement	Jun 30, 1976	Dec 31, 1976	225
	Standby Arrangement	Sep 29, 1975	Jun 30, 1976	500
Jamaica	Resilience and Sustainability Facility	Mar 01, 2023	Feb 28, 2025	574,350
	Precautionary and Liquidity Line	Mar 01, 2023	Feb 28, 2025	727,510
	Rapid Financing Instrument	May 15, 2020	May 19, 2020	382,900
	Standby Arrangement	Nov 11, 2016	Nov 10, 2019	1,195,300
	Extended Fund Facility	May 01, 2013	Nov 10, 2016	615,380
	Standby Arrangement	Feb 04, 2010	May 03, 2012	820,500
	Extended Fund Facility	Dec 11, 1992	Mar 16, 1996	109,125
	Standby Arrangement	Jun 28, 1991	Sep 30, 1992	43,650
	Standby Arrangement	Mar 23, 1990	May 31, 1991	82,000
	Standby Arrangement	Sep 19, 1988	Mar 23, 1990	82,000
	Standby Arrangement	Mar 02, 1987	May 31, 1988	85,000
	Standby Arrangement	Jul 17, 1985	Jul 16, 1986	115,000
	Standby Arrangement	Jun 22, 1984	Jun 21, 1985	64,000
	Extended Fund Facility	Apr 13, 1981	Apr 12, 1984	477,700
	Extended Fund Facility	Jun 11, 1979	Apr 12, 1981	260,000

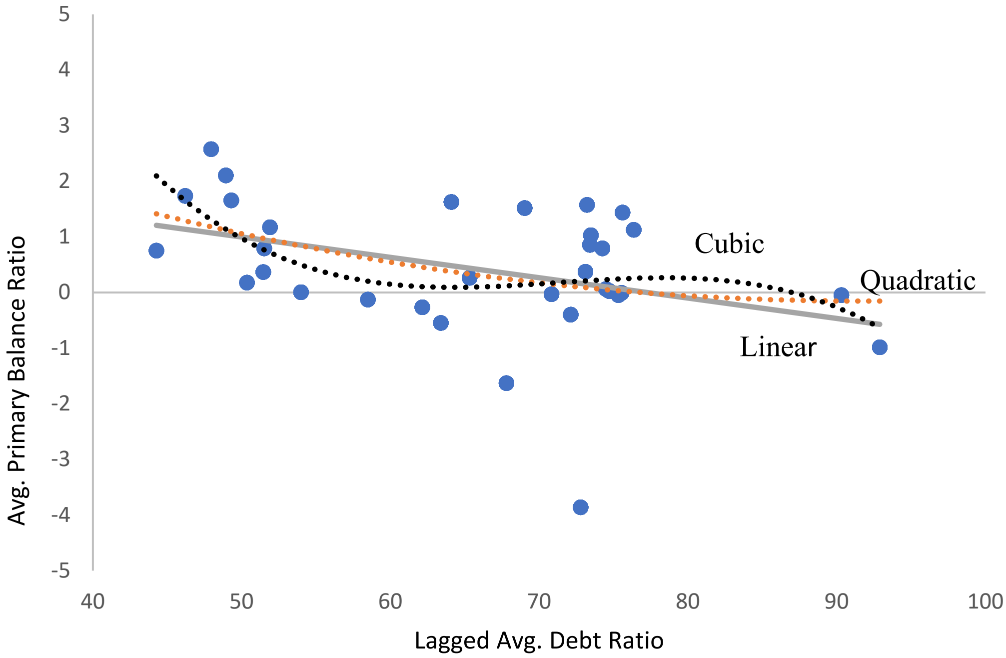
Country	Facility	Date of Arrangement	Expiration Date	Amount Agreed
	Extended Fund Facility	Jun 09, 1978	Jun 10, 1979	200,000
	Standby Arrangement	Aug 11, 1977	Jun 09, 1978	64,000
	Standby Arrangement	Jun 01, 1973	May 31, 1974	26,500
	Standby Arrangement	Jun 13, 1963	Jun 12, 1964	10,000
St Kitts and Nevis	Standby Arrangement	Jul 27, 2011	Jul 26, 2014	52,510
St Lucia	Rapid Credit Facility	Apr 28, 2020	Apr 30, 2020	21,400
St Vincent and the Grenadines	Rapid Credit Facility	Jul 01, 2021	Jul 07, 2021	8,172
	Rapid Credit Facility	May 20, 2020	May 22, 2020	11,700
	Rapid Credit Facility	Aug 01, 2014	Aug 12, 2014	2,075
	Rapid Credit Facility	Jul 25, 2011	Aug 02, 2011	1,245
Suriname	Extended Fund Facility	Dec 22, 2021	Mar 31, 2025	430,700
	Standby Arrangement	May 27, 2016	Apr 16, 2017	342,000
	Standby Arrangement	Apr 20, 1990	Mar 31, 1991	85,000
	Standby Arrangement	Jan 13, 1989	Feb 28, 1990	99,000

Figure A 30 Linear and Non-Linear Predicted Primary Balance



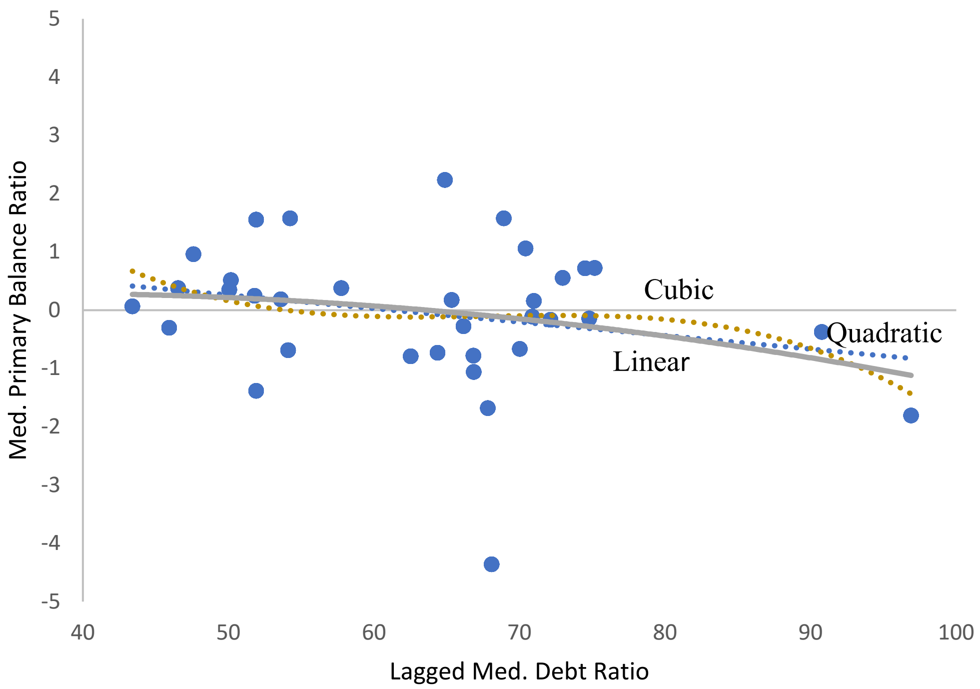
Data source: World Economic Outlook (2023)

Figure A 31 Linear and Non-Linear Predicted Primary Balance (Average)



Data source: World Economic Outlook (2023).

Figure A 32 Linear and Non-Linear Predicted Primary Balance (Median)



Data source: World Economic Outlook (2023).

Chapter 6 Conclusions

6.1 Introduction

This PhD thesis set out to empirically assess the state of fiscal sustainability in the Caribbean region and to strengthen the slim evidence base, for the purpose of contributing to a sustainable Caribbean fiscal policy and to establish a Caribbean debt threshold. It has been motivated by the Caribbean region's high and prolonged indebtedness, its implications for the region's already high vulnerability and social-economic development, and in tandem, the lack of Caribbean specific research on the topic.

The studies presented in Chapters 3 to 5 make valued contributions to a literature comprising roughly 15 studies written over the past four decades. In Chapter 3 the thesis relooks old debates on cointegration as a method of assessing debt sustainability, motivated by cointegration approaches' relevance to the Caribbean due to data limitations involved in the estimation of fiscal reaction functions, the mainstream method of sustainability estimation in the literature.

The approach to the thesis involved combining different methodological interpretations of debt sustainability theory, and the application of various econometric approaches designed to tackle common hurdles including estimator bias and cross sectional dependence, noting as highlighted in the literature that although most sustainability assessments are underlined by debt sustainability theory, results can differ largely depending on methodological interpretation and on the application of different estimation procedures (Segura-Ubiergo and Oomes, 2005).

The contrast of methods and application of empirics provided for a collective view on fiscal sustainability in the Caribbean, both at the regional and country levels. Bohn's (2008) theory of Fiscal Reaction Functions (FRF) estimated via dynamic panel fixed effects, formed the key methodology for the research. The intuitive appeal of the FRF theory and its touted superiority when compared to traditional cointegration methods (Bohn, 2007), underlined its central application.

6.2 The Sustainability of Fiscal Policy in the Caribbean

On the question of whether fiscal policy in the Caribbean is sustainable, the conclusion of the thesis is that fiscal policy in the Caribbean is weakly sustainable. This is established both in Chapters 3 and 4. Further, and a more important point is that the regions' weak sustainability is not broad-based but heterogenous with some countries found not to be leading sustainable fiscal policies. As such if the region's fiscal sustainability is assessed only at the regional level as in Chapter 4, and as in the study of Cevik and Nanda (2020), the results could lead to misguided findings and ill-advised policy recommendations at the country level.

This is one of the most significant constraints posed by data scarcity, which normally is remedied by aggregation of data at the regional level and the application of panel data analysis. In the thesis, the Caribbean's limited fiscal data was overcome through application of the Afonso (2005) revenue-expenditure cointegration approach which only requires revenue and expenditure data, as opposed to primary balance and debt data that is difficult to come by on a consistent annual basis for the Caribbean.

The insights from the thesis are therefore relevant for other studies undertaking fiscal sustainability assessments at the aggregate level in other regions. Even if the data does not allow for heterogenous panel estimation, researchers are strongly advised to review basic debt sustainability indicators at the country level and debt trends to assess whether the homogenous results from panel estimation are credible. This type of reconciliation is important before moving to policy recommendations.

The contrast between the findings from the homogenous and heterogenous FRFs supports use of the revenue-expenditure cointegration based sustainability assessment for the Caribbean as employed in Chapter 3, since it allows for time series analysis.

Note that the available time series data on primary balances and debt to GDP ratios required for estimation of Caribbean FRFs do not allow for pure time series analysis, but sufficient time series data for the Caribbean on revenue and expenditure is available to run the revenue-expenditure cointegration sustainability approach, at least at a quarterly frequency. Ran with the ARDL Bounds Test, the approach also does not require unit root testing, circumventing many of the traditional challenges that saw FRFs as the preferred method of choice.

Further, the panel data formulation of the FRF whilst powerful given its ability to estimate models consistently and unbiasedly with unbalanced data, is found to be suboptimal in the context of Caribbean fiscal sustainability research when compared to the revenue-expenditure ARDL Bounds Test assessment, also because of the degrees of freedom required for heterogenous panel data FRF estimation, and the absence of such data volumes in the Caribbean.

Nonetheless, the FRF offers some advantages, a key one being that it enables wider fiscal policy analysis. Using the revenue-expenditure approach provides only a yes or no response to fiscal sustainability, but the surrounding fiscal policy analysis is limited by the bivariate nature of the regressions. In this vein, the thesis found that expenditure rules to ensure stronger cointegration between revenue and expenditures was a natural policy choice in view of the results. On the other hand, by way of the FRFs, there was richer policy discussion leading to valuable recommendations.

For example, the thesis finds that in the Caribbean, the primary balance is more readily explained by the output gap and not necessarily the expenditure gap; the current account balance; credit to the private sector; and elections. It also establishes the relevance of the perception of corruption to fiscal policy, and by extension fiscal sustainability.

In this regard, Caribbean policy makers are advised that a shift to a counter-cyclical approach could improve debt sustainability. At current, the response of fiscal policy to the business cycle confirms the region's fiscal policy procyclicality, which has underpinned excess expenditure, a lack of resilience during crisis, and a build-up of debt. They are also advised to progress with a diversification of trade in services, from which the region could gain increases in the primary surplus. The COVID-19 pandemic, for example, has revealed the potential gains from business tourism. Like the recommendations provided in Chapter III, the evidence showing a tendency to increase deficits the higher the region's financial development, merits looking into the introduction of fiscal rules to tame such fiscal behaviour. And of course, given the strong evidence that Caribbean policy makers increase deficits during their election campaigns, the thesis has recommended control of election spending, which can also be achieved by way of fiscal rules. Caribbean policy makers must also introduce greater measures to control corruption. There is room for improvement according to the World Governance Indicators and according to the thesis' results, there is significant gain as regards others' perception of corruption in the region and the positive externalities as regards fiscal sustainability. This is one of the thesis' most notable results and insights from the research.

6.3 The Caribbean Debt Sustainability Threshold

As relates the second research question: what is the Caribbean's debt sustainability threshold? the thesis concludes that the non-linear extension of the FRF stemming from Gosh *et al.* (2003) fiscal fatigue theory and articulated in Chapter 5, is unsuitable for the establishment of debt thresholds in the Caribbean. The experience contrasts with application of the non-linear FRF to assess fiscal fatigue in OECD countries where there was clear evidence of fiscal fatigue, and by extension debt thresholds.

In contrast, following a relook of the raw data through graphical analysis and introduction of other non-linear threshold approaches, the thesis reaches the alternative conclusion that the region's debt-primary balance threshold relationship is not curvilinear but of the traditional threshold type, where there is a sudden shift in the primary balance at extremely high levels of debt. Using the Seo and Shin (2016) dynamic panel threshold model the conclusion is that the Caribbean's debt threshold is 106.2 percent, above and below which the control variables show varying responses to the primary balance at different levels of significance.

The explanation for the finding is provided in Chapter 5. In short, most Caribbean countries do not follow a non-linear fiscal rule as they are not bounded by market forces in the same way as OECD countries owing to their large portfolio of multilateral debt. Caribbean countries can instead live with high debt until socio-political considerations force them to make corrective measures. This is why even at very high levels of debt to GDP ratios, Caribbean governments are found to be still running primary deficits, as opposed to increasing their fiscal surplus as purported by the fiscal fatigue theory.

These nuances are important. OECD countries' fiscal policy behaviour diverge from that of small developing countries, such as those in the Caribbean, and for two main reasons. One of those being that the composition of debt liabilities in OECD countries differ. OECD country debt liabilities are mainly market-based, whereas the Caribbean's is primarily concessional or non-concessional and multilateral in nature. Hence, whereas OECD countries' fiscal policy is tamed by the potential of a doom loop, causing them to follow a non-linear FRF rule, small developing countries do not as multilateral banks act in a dissimilar way to normal market participants.

The second is that policy makers in the Caribbean as alluded to above are not necessarily at the mercy of market creditors and are only persuaded to shift their expansionary policy stance once the socio-political consequences raise their head. This conclusion is supported by the consistent significance of elections as a key determinant of Caribbean fiscal policy, relative to a very weak influence from the output gap.

6.4 Contributions to the Debt Sustainability Literature

All these insights have been made possible through the thesis' nuanced treatment of the topic, which has allowed it to make several valuable contributions. In summary, the thesis makes a valuable contribution to the existing body of work on debt sustainability broadly, but more crucially, in the space of the Caribbean debt sustainability literature where prior Caribbean specific studies are extremely limited.

The thesis is the first in the region to apply Gosh *et al*. (2013) fiscal fatigue theory to the establishment of debt thresholds in the Caribbean, and although it was shown that the theory does not apply, the application unveiled very noteworthy results including the nature and magnitude of the Caribbean's debt threshold, which is estimated at 106.2 percent.

Application of the heterogenous coefficient model to the Caribbean debt sustainability case is another major contribution to previous work. Only two very recent studies have paid specific attention to Caribbean debt sustainability, both of which rely on panel data to enable application of FRFs and to assess sustainability over the available time horizon. However, both conclude on sustainability based on results obtained at the regional level. And as has been flagged in this thesis, those results can be misleading. Drilling down to the country level is necessary before one can conclude sustainability and is a key message from this research. Further, despite wide application of the FRF for assessing debt sustainability, the thesis provides evidence in support of the traditional revenue-expenditure cointegration approach as a more feasible option for data starved regions like the Caribbean. Such contrasts markedly with the direction of the literature following Bohn (2007; 2008), which set off a revolution in debt sustainability assessment that opposes cointegration modelling as a method for assessing debt sustainability. Showing that in some special cases, as with the Caribbean and application of special estimation procedures, that cointegration can be a more useful method is an additional valuable contribution of the PhD thesis.

The reflections on the assessment methods can be useful for governments and could help Caribbean countries move beyond static and very basic sustainability assessments, and substantially improve their dialogue on debt sustainability issues with key stakeholders, notably with the IMF and World Bank who are the key interlocuters. Due to its simplicity, the revenue-expenditure application would compensate for low developing country capacity and data limitations.

The various findings from the PhD research, especially those differing from mainstream applications, also contributes to the body of knowledge on debt sustainability by motivating inquiry into the applicability of debt theory to developing countries, given debt theory's foundations that are based on market dynamics of advanced countries. In a nutshell, key underlying assumptions of debt theory don't apply to the Caribbean. Caribbean governments don't necessarily follow a non-linear primary balance rule because they can afford to live with high debt, which is mostly of the bilateral and multilateral composition. As such, fiscal policy often remains accommodative even when debt is continually rising.

Governments, and particularly the ten Caribbean countries with no extensive commercial or capital markets debt, will not experience fiscal fatigue. Caribbean countries on average will only experience fiscal incapacity, particularly when debt reaches so high as to constrain the government's ability to address socio-economic challenges and experience subsequent political fall-out.

6.5 Limitations of the Thesis

Of course, these conclusions are based on data with relatively short time spans, narrow cross-sections, and highly unbalanced frames, especially prior to the 2000s. It is likely therefore that the results are influenced by this data paucity, particularly the findings from the heterogenous FRF model that requires large cross-section and time dimensions. This data scarcity is without doubt, the primary limitation of the thesis. Data constraints affect not only the type of methods that can be applied but the confidence the reader might place in the findings and conclusions, despite the robust efforts to circumvent these challenges.

Another important limitation of this research on the Caribbean is these countries' nascent stages of development. With most only becoming independent nations in the 1960s and 70s, there are still young countries and so, even if data were available from the time of inception the data would still be limited in what it could enable and reveal. Debt sustainability is a long-run concept, and so making pronouncements about the Caribbean's debt sustainability given the short historical context just described could be premature.

6.6 Recommendations for Future Research

These issues raise old and new and important questions, serving as motives for future research. On the penultimate point above, how long is the long run? What length of data does one need to make an informed assessment about a country's fiscal sustainability if fiscal sustainability is defined as whether the government's fiscal policies of the past, extended into the future, is likely to maintain a sustainable debt to GDP ratio?

And as has been frequently raised, should one be reflecting on past policy behaviour, or on current and planned fiscal policy against probable macroeconomic conditions? In this era of a highly uncertain macroeconomic environment, countries cannot take for granted that past prudent fiscal policy behaviour even if extended into the future, will guarantee fiscal sustainability. This is primarily because shocks are now ubiquitous, especially climatic shocks, to which the Caribbean is acutely exposed. The latter is why the IMF Debt Sustainability Analysis (DSA) aims to estimate whether a country's expected fiscal policy and income growth will be sufficient to mitigate the trend in interest rates and changes in the debt level. Future research could focus counterfactually on whether the historical or horizon methods yield drastically different conclusions.

Of major note as well is the lingering question on whether debt-growth models are the true basis for establishing debt thresholds for the Caribbean, and if so, what does it imply for Caribbean fiscal policy? Should Caribbean fiscal policy be drawn up based on a debt-growth rule or debt-primary balance rule, as articulated in FRFs?

The convention in the literature investigating fiscal sustainability issues is to model gross public debt, and to a lesser extent external debt. However, Reinhart and Rogoff (2011) remind us that domestic debt has also played a significant role in sovereign default and financial crisis, globally. The Caribbean has not yet turned attention to this issue despite domestic debt comprising between 60-70% on average of their debt portfolios.[35]

Lastly, the finding in Chapter 4 that natural disasters do not play a significant role in shaping Caribbean fiscal policy given the vulnerability of the region to such

[35] Rough estimate based on IMF Article IV excerpts on the composition of Caribbean debt in Chapter 2, Appendix.

shocks merits further and deeper research. The study by Nikolopoulos (2010) which discusses the impact of special events on time series data would be helpful in undertaking such an endeavour.

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