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Constructing Country-Specific Debt Indices for Developing Countries

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ABSTRACT

Contemporary crises continue to keep governments in protracted periods of borrowing, increasing the stock and flow of sovereign indebtedness. Especially for developing economies and small states, singular metrics of public debt such as the debt-to-GDP ratio may not reflect the country's true debt position. We consolidate various indicators of public debt to construct a novel composite debt index and its companion debt volatility index. We demonstrate our approach, based on principal component analysis, using a natural resource-rich but relatively data-poor country, Trinidad and Tobago, where debt management is a recurring macroeconomic concern, but comprehensive debt indices remain unavailable. The movements in our indices align with historical episodes that would influence country-specific public debt levels. Our approach is straightforward to adapt and apply to developing countries, where a uniform measure of debt is either unavailable or provides an incomplete perspective of fiscal stress when such a measure exists. We further illustrate the usefulness of the constructed indices by investigating the debt-growth nexus. Consistent with several empirical studies, our novel debt indices for this country provide evidence of a negative, significant, and robust impact of debt on growth when the traditional debt-to-GDP measure suggests none.

JEL Classification: C38, C43, H63

1 | Introduction

THE COVID-19 pandemic resulted in increased government borrowing to fund extraordinary stimulus packages to cushion its impact. Inevitably, this led to higher public debt levels in the last few years and debt is expected to remain elevated in the short to medium term (IMF 2023). Rising debt was also a concern in the aftermath of the 2008 Global Financial Crisis and it served as a principal pre-crisis risk factor for the sovereign debt crisis in Europe (Lane 2012). Indeed, fiscal actions in the aftermath of crises renews the interest of macroeconomic research on the debt-growth nexus, debt sustainability and fiscal discipline, and the pathway for returning sovereign debt to sustainable levels. Prior to contemporary crises like the pandemic and the European sovereign debt crisis, studies on debt sustainability were less frequent, especially relative to research

in other macroeconomic areas such as monetary policy. In what empirical research exists, much of the literature investigating government debt cites the debt-to-GDP ratio as the most common metric.

However, debt-to-GDP may not capture the complete debt profile of an economy since it suffers from several limitations. For instance, gross debt-to-GDP does not separate debt into short-term and long-term debt, and this has implications for macroeconomic volatility as short-term debt can exacerbate fiscal stress when compared to long-term debt (see, e.g., Brunnermeier 2009). Furthermore, short-term debt can face sudden reversal of capital flows in market access countries (Chowdhury and Sundaram 2023). Additionally, debt-to-GDP does not capture the cost of debt or the interest rate which has implications for the interest-growth differential. In fact, interest expense has been a

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primary factor contributing to fiscal deficits in Latin American countries (Vera 2009) and can adversely impact economic growth up to 10-times more compared to debt-to-GDP (Afonso and Alves 2015). Moreover, hidden debt is now endemic, especially in developing economies and small states that intentionally conceal debt from international financial institutions (Brown 2023) and thus, it is not reflected in the debt-to-GDP ratio. However, due to the audited nature of the government's budget and the explicit nature of foreign interest payments by the Central Bank on behalf of the government, the debt-service ratio or interest expense will capture the cost associated with the hidden debt. Finally, it ignores potentially more realistic repayment variables such as government revenue or exports (see, e.g., Amegashie 2023).

In light of this, we propose a novel composite debt index (CDI) that ultimately captures a more inclusive list of indicators and overcome several shortcomings in the sole use of the debt-to-GDP ratio. For instance, it captures multiple repayment capacity variables, implicitly incorporates duration and hidden debt with interest expense, and explicitly accounts for short-term debt which has severe implications for macroeconomic volatility. Furthermore, we recognize that developing economies and small states face frequent shocks including export revenue shocks and natural disaster shocks that may impact macroeconomic performance and debt indicators. As such, we again propose a novel debt volatility index (DVI) as a companion to the CDI that captures the volatility of debt indicators in turbulent macroeconomic environments. The significant contribution of our paper is that we provide an easy to adapt and apply approach for constructing the country-specific CDI and DVI for developing countries and small states, where uniform measures of debt tend to be either unavailable or unreliable and insignificant when undertaking policy analysis.

Indices are not uncommon in economics and finance, and studies often construct indices to capture and communicate multiple indicators in a simple way (see, e.g., Afonso et al. 2005; Felice 2016). Even within the fiscal and debt literature, there are several indices such as the fiscal stress index, the external debt vulnerability index, and the fiscal distress index but the scope of such indices remains limited. To this end, we draw on a similar approach by Afonso et al. (2014) to construct the CDI and DVI with application to Trinidad and Tobago (T&T)—a small open petroleum-exporting economy that is prone to procyclicality of fiscal policy with international commodity price cycles. Although we limit our application to T&T, it is straightforward to adapt and apply the CDI and DVI construction steps we identify to any developing country. We follow this with an application of the CDI and DVI to assess the debt-growth nexus in T&T.

The remainder of this paper is structured as follows: in Section 2, we review the literature on related debt indices. In Section 3, we identify the steps to develop the CDI and DVI, and we use T&T as a case study to construct the novel indices. We use the CDI and DVI to investigate the debt-growth nexus of this country in Section 4 and conclude in Section 5.

2 | Indices in Fiscal and Debt Issues

Indices relating to issues of debt and fiscal vulnerabilities and stresses are marked by limited literature. Indeed, there are few

available indices and there is a consensus that they provide signals or early warning indicators, and guides government policy decision making. However, their methodologies and focus are quite diverse. Baldacci et al. (2011) presents one of the earlier index which focuses on fiscal stress. It is designed as an early warning signal of debt issues for both developing and developed countries. Broadly speaking, the authors describe fiscal stress as a situation where an event endangers government debt solvency, necessitating fiscal policy adjustments. In a similar vein, Doemeland et al. (2022) adopts a default view of debt vulnerabilities but for market assess countries only. Notably, their view of debt vulnerability is panoramic, and they propose that overall debt vulnerability is multi-faceted, which includes four sub-indices including the fundamental index, probability of default index, the count index, and the theory index, with probability of default index conspicuously similar to the fiscal stress index by Baldacci et al. (2011).

In contrast, Blanchard and Das (2017) narrow their focus to external debt and create an index of external debt sustainability. Contrary to the fiscal stress index and the debt vulnerability index which underscores overall solvency, they describe external debt sustainability as a situation where net debt does not exceed the present value of net exports. This study by Blanchard and Das (2017) addresses a notable gap in the literature which gives inadequate consideration for exchange rate movements, and they go on to explicitly incorporate the uncertainty of the exchange rate through a distribution of exchange rates generated from the variance-covariance matrix of a Vector Autoregression (VAR). In addition to the academic literature, multi-lateral lending institutions such as the Caribbean Development Bank (CDB) explore the use of debt indices in their assessment of borrowing member countries access to funding. Quite similar to the fiscal stress index from Baldacci et al. (2011) and the probability of default sub-index from Doemeland et al. (2022), the CDB define fiscal distress as “any form of fiscal and debt unsustainability” where the country cannot repay, or the country is having difficulty in repaying its debt.

As expected, a common theme exists across the choice of indicators for constructing the indices. For example, the CDB (2012) constructs a fiscal distress index using standard debt indicators that capture both liquidity and solvency. These include debt-to-GDP, the primary balance, real GDP growth rates, and the interest rates. Baldacci et al. (2011) focus on fiscal indicators such as the interest-growth differential, debt-to-GDP, and the cyclically adjusted primary balance. However, the indicators then diverge based on the focus on each index. For instance, the Caribbean suffers from fiscal and debt issues due to structural inefficiencies, susceptibility to natural disasters, and slow growth, which results in the CDB including a fiscal adjustment variable that captures the difference between the primary balance required to achieve debt reduction and the actual primary balance. Since Baldacci et al. (2011) include developed countries in their study, they incorporate indicators that capture asset and liability management and long-term fiscal trends. Blanchard and Das (2017) did the same, with the addition of exchange rates distribution. Similarly, Doemeland et al. (2022) include credit default swaps and emphasize thresholds in their analysis as they aim to assess the probability of defaults.

Methodological approaches, particularly weighting, are of paramount importance as inaccurate weights can distort results. Surprisingly, the choice of weights varies substantially. For example, the CDB adopts a simple equal-weight approach while Baldacci et al. (2011) adopt a more complex approach and derive weights from the signaling power of each indicator. Borrowing from other fields such as finance and social research, Doemeland et al. (2022) opt for a neutral approach, letting the indicators themselves determine the weights using Principal Component Analysis (PCA). Perhaps the most complex method, relative to the other approaches, is adopted by Blanchard and Das (2017) as they use a VAR with a vector of endogenous variables and take the joint distributions from the estimation of the VAR equations and its associated variance–covariance matrix to create stochastic simulations to obtain the exchange rate distribution and hence capture uncertainty.

Each index, despite deferring methodologies and indicators, performs well and successfully serves its intended purpose. For example, Baldacci et al. (2011) find that gross financing needs and fiscal solvency risks were the primary contributors to fiscal stress in developed countries while public debt structure and spillovers from the global financial market were the main contributors of fiscal stress for developing countries. In their case study of Chile and the U.S., Blanchard and Das (2017) find robust evidence that the sustainability of external debt is heavily dependent on the capital account as opposed to the current account since adjustments in the capital account can easily offset any adjustment in the trade balance.

Conclusively, the literature illustrates that indices are constructed for different purposes, including capturing the current debt situation, providing an early warning system, or predicting the probability of crises. In this contribution, we aim to construct the novel CDI and DVI that ultimately capture a more comprehensive list of indicators and overcome several shortcomings in the sole use of the debt-to-GDP ratio. Our CDI and DVI are particularly suited for developing countries and small states using low-frequency (annual) data that capture both liquidity (short-term debt dynamics) and solvency (long-term debt dynamics). We present a structured comparison of the methodology, indicators, tools, and policy relevance across our approach and key existing studies in Appendix 1.

3 | Constructing A Country-Specific Composite Debt Index (CDI)

In this section, we identify the steps to construct a composite index and apply it to T&T. While there are several definitions of a composite index, Freudenberg (2003) provides one of the simplest definitions which states that “composite indicators are synthetic indices of individual indicators.” Using the OECD (2008) framework for constructing indices, we construct the CDI using the six steps outlined in Figure 1¹.

The primary purpose of the CDI is to provide a more comprehensive measure that captures the debt position of a country, identifies the trends in government debt, and ultimately assesses the fiscal relationship with other macroeconomic variables. We select variables not only based on their availability from sources such

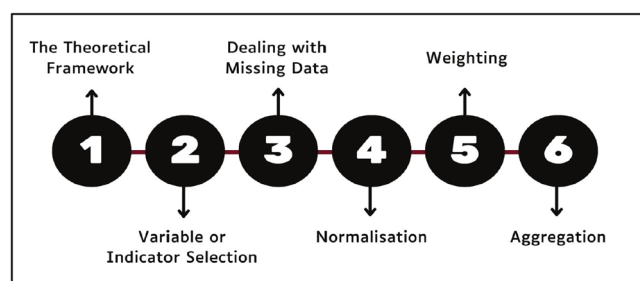


FIGURE 1 | Steps in constructing an index. *Source:* adopted from OECD (2008). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/ode.70003)]

as the IMF's World Economic Outlook, the World Bank's World Development Indicators, and, where applicable, national Central Banks and Ministries of Finance, but also based on their relevance in previous research and their ability to capture both liquidity and solvency risks. For example, Baldacci et al. (2011) use fiscal monitoring indicators such as gross debt-to-GDP, which reflects the size of the debt burden, and the proportion of debt held in foreign currencies, which signals exposure to exchange rate fluctuations. This type of risk is particularly relevant for developing economies that may lack diversified sources of foreign exchange. In addition, many developing countries face structural challenges, including limited revenue collection capacity and reliance on a few commodities. To account for this, we include indicators that reflect export earnings and government revenue performance. In the case of T&T, where the energy sector is a major contributor to economic activity, we include a country-specific indicator that compares external debt to energy-export revenues. This approach may be adapted for other countries by using equivalent indicators tied to tourism, trade, or other dominant economic sectors.

Other variables we include, such as interest payments to government revenue, are also common to established frameworks including the CDB (2012) fiscal distress index and Doemeland et al. (2022) multi-angle approach to debt vulnerability. These variables are presented in a similar form to the real interest rate, which captures the cost of borrowing and can be a critical factor in assessing default risk. In developing countries such as T&T, common debt-related variables are shown in Table 1. We intentionally exclude variables such as the primary balance or gross financing needs to allow for application of the CDI using frameworks such as the Bohn (1998) fiscal reaction function which includes the primary balance as the dependent variable. As such, we use these variables from Table 1 to construct the CDI for T&T between 1971 and 2021, which represents just over five decades of economic history.

Following the work of Baldacci et al. (2011) and Sharaunga and Mudhara (2021), we use PCA to construct the CDI. To begin, we test for correlation between the variables from Table 1 using the Pearson correlation test, as well as its non-parametric equivalent—Spearman correlation—which is robust to the heteroskedasticity known to afflict economic and financial time series (see, e.g., Mahadeo et al. 2019 and references therein). We find a high degree of correlation between most of the variables, as shown in Table 2. As we expect, there is a high correlation (greater than 90.0%) between DTR, DTX, and DTG as they share a common indebtedness measure in gross debt, and the repayment variables (GDP, exports, and revenue) move in the same direction. Moderately high

correlation exists among the other variables, such as ITR given that interest payments are dependent on the outstanding debt stock. EDEE and EDE are highly correlated with DTX since they share a common measure of indebtedness, and total exports are largely driven by energy exports. EDRES is the outlier because the repayment variable is the stock of international reserves, which does not move with the current repayment variables, but it is accumulated over a period of time.

Then, we test for unit roots to ensure all variables are stationary. With the exception of EDRES, all variables have a unit root. As such, we first difference those variables to ensure that all seven indicators are stationary. PCA requires normalized data using standardization or the standard deviation approach, which assumes that the indicators are normally distributed through the imposition of the standard normal distribution. It is computed as:

$$Z_t = \frac{x_t - \mu}{\sigma} \quad (1)$$

where x_t is the indicator value at time t and μ and σ are the period mean and standard deviation respectively. In most instances, this is done within the statistical software or package. As such, we proceed to apply PCA to the seven indicators from Table 1 and we display the results in Table 3. Using the Kaiser criterion which states that components with eigenvalues of at least one should be included within the index, we select the first two components (PC1 and PC2) which accounts for 82.5% of

the cumulative variations in the seven indicators. As a measure of robustness, we use the Joliffe criterion which supports components once the eigenvalues are above 0.70. Furthermore, we visually inspect the scree plot which hints to two components (see Appendix 3). We proceed by scaling the contributions of PC1 (0.649) and PC2 (0.176) in Table 3 relative to the combined contribution of both components (0.825). This adjustment allows us to derive the index weights for each component, approximately 78.6% and 21.4%, respectively.

In Table 4, we show that each of the coefficients in PC1 has a positive and similar impact ranging from 0.30 to 0.44 except for EDRES with a coefficient of 0.13. In PC2, we find that EDRES and ITR have the largest coefficients of 0.77 and 0.52 respectively, while the other coefficients are smaller. We calculate the weights of each of the seven indicators within each component by squaring their eigenvalues. Subsequently, we scale each of the seven indicator weights using the weights assigned to each component (PC1 and PC2) to determine the weight of each indicator within the CDI. We find that each indicator carries a weight ranging from 12.0% to 15.8%, with DTG weighing less than other indicators such as DTX, EDTE, and EDTEE with weights exceeding 15%.

Finally, PCA uses linear aggregation to produce the CDI which is given as:

$$DSI = (0.786 \times PC1) + (0.214 \times PC2) \quad (2)$$

TABLE 1 | Debt indicators for T&T.

Indicator	Description
DTR (Debt-to-revenue)	Ratio of gross debt to total revenue.
DTX (Debt-to-exports)	Ratio of gross debt to total exports.
DTG (Debt-to-GDP)	Ratio of gross debt to GDP.
ITR (Interest payments to revenue)	Ratio of interest payments to total revenue.
EDEE (External debt to energy exports)	Ratio of external debt to energy exports.
EDE (External debt to exports)	Ratio of external debt to total exports.
EDRES (External debt to gross official reserves)	Ratio of external debt to gross international foreign exchange reserves.

TABLE 2 | Correlation matrix—debt indicators (with Spearman correlation in the upper triangle and Pearson correlation in the lower triangle).

	DTR	DTX	DTG	ITR	EDEE	EDE	EDRES
DTR	1.0000	0.9180	0.9664	0.9086	0.8691	0.8374	0.5883
DTX	0.9054	1.0000	0.9409	0.8257	0.9765	0.9646	0.5551
DTG	0.9630	0.9419	1.0000	0.8664	0.8911	0.8646	0.5421
ITR	0.8607	0.7694	0.8451	1.0000	0.8088	0.7740	0.5782
EDEE	0.7980	0.9326	0.8581	0.7684	1.0000	0.9941	0.5811
EDE	0.7655	0.9208	0.8312	0.7249	0.9938	1.0000	0.5744
EDRES	0.1021	0.0991	0.0097	0.1226	0.1557	0.1402	1.0000

Note: A precondition for PCA is strong correlation among the indicators. Darker shades show stronger levels of correlation between debt indicators.

A positive change in the CDI reflects an increase in indebtedness while a negative change represents a decrease in indebtedness. The results in Figure 2 illustrate that between 1971–1982 and 2000–2009, the CDI is typically below zero demonstrating that debt indicators are below the period average while the CDI is generally above zero showing that debt indicators are above the period average between

1982–1993 and 2014–2021. The movement in the CDI reflects key information content embedded in the seven indicators that would not have been captured if we use a single indicator and the fact that the CDI coincides with identifiable events (Figure 2) that affect T&T implies that we may be able to identify future movements and trends if other shocks occur.

TABLE 3 | Composite debt index—PCA.

Component	Eigenvalue	Difference	Proportion	Cumulative variance
1	4.5397	3.3061	0.6485	0.6485
2	1.2336	0.6806	0.1762	0.8247
3	0.5530	0.1163	0.0790	0.9037
4	0.4367	0.2885	0.0624	0.9661
5	0.1481	0.0692	0.0212	0.9873
6	0.0789	0.0689	0.0113	0.9986
7	0.0100	—	0.0014	1

Note: All variables are stationary, and we use the Kaiser criterion which states that components with eigenvalues of at least one should be included within the index. The weight of principal component 1 (PC1) is derived as a ratio of the proportion to the cumulative variance of two components. For example, $PC1 = \frac{0.6485}{0.8247} = 78.6\%$.

TABLE 4 | Weighting of each indicator for PC1 and PC2 in the CDI.

Variable	PC1 eigenvalue	Weight	PC2 eigenvalue	Weight	Combined weight
DTR	0.41	16.5%	0.28	8.0%	14.7%
DTX	0.44	19.7%	0.01	0.0%	15.5%
DTG	0.38	14.3%	0.18	3.4%	12.0%
ITR	0.30	9.0%	0.52	27.0%	12.9%
EDEE	0.44	19.4%	0.09	0.8%	15.4%
EDE	0.44	19.5%	0.14	2.0%	15.8%
EDRES	0.13	1.6%	0.77	58.7%	13.8%

Note: The weight of each variable in the respective components is derived by squaring the eigenvalues. For example, $0.41^2 \approx 16.5\%$. The combined weight of each variable is derived by scaling the weights of each variable from PC1 and PC2 by the overall component weights. For example, $(0.786 \times 16.5\%) + (0.214 \times 8.0\%) \approx 14.7\%$.

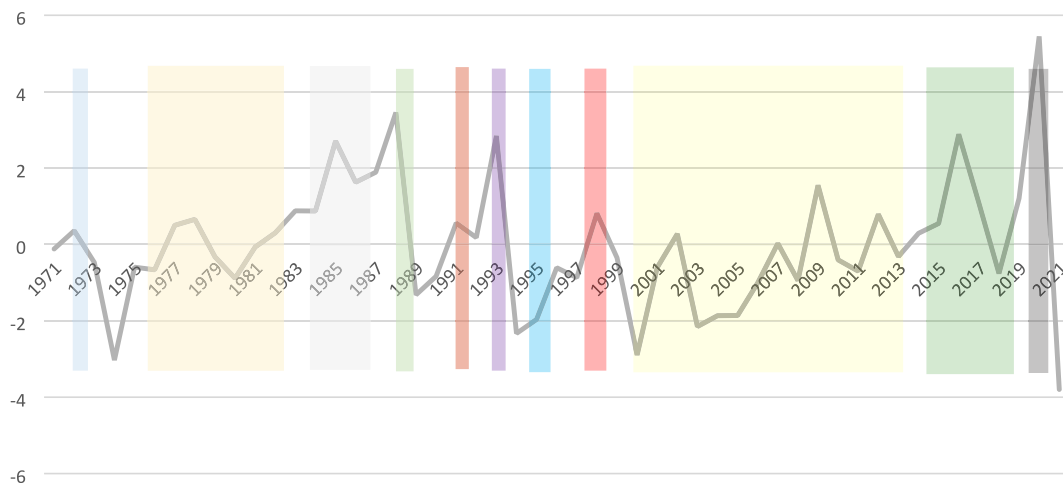


FIGURE 2 | Composite debt index (CDI). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

TABLE 5 | Debt volatility index—PCA.

PCA: 5-year rolling volatility				
Component	Eigenvalue	Difference	Proportion	Cumulative variance
1	4.0286	2.6604	0.5755	0.5755
2	1.3682	0.5346	0.1955	0.7710
3	0.8336	0.4177	0.1191	0.8901
4	0.4160	0.1876	0.0594	0.9495
5	0.2284	0.1399	0.0326	0.9821
6	0.0885	0.0517	0.0126	0.9948
7	0.0367	—	0.0052	1.0000

Note: We use the Kaiser criterion which states that components with eigenvalues of at least one should be included within the index.

Shading flows in chronological order	
	Macroeconomic performance is strong with significant infrastructural developments and rapid foreign exchange reserve accumulation.
	Favorable sugar and oil prices and production.
	1980s Oil Price War—Drastic fall in oil price with concurrent decrease in oil production.
	IMF structural adjustment program in 1988.
	Attempted Coup d'état and significant decline in capital expenditure.
	The exchange rate change from fixed to floating resulting in a sharp spike in the domestic dollar value of external debt.
	External debt decline as the IMF loan is repaid.
	Income tax rates are lowered which results in an increase in revenue collection.
	Large capital expenditure.
	Low external debt service with few debt maturities. Capital expenditure is high with mega construction projects, but it is accompanied by elevated energy and non-energy revenue. Largest LNG train in the world is operationalized.
	Treasury bill issuance increase by 135% to meet significant shortfall in revenue to continue to fund mega-projects.
	Stimulus funding for COVID-19.

In addition to comprehensively measuring government indebtedness, we investigate debt volatility by computing a companion debt volatility index (DVI). This measure is particularly important for economies that are relatively undiversified and largely dependent on concentrated sources of government revenue and economic activity such as oil or tourism exports. Given the susceptibility of these economies to external shocks, factors affecting repayment

capacity such as GDP, revenue, and exports can be quite volatile, leading to volatility in debt indicators. To begin, we examine the conditional volatility of the seven indicators in Table 1 by testing for Autoregressive Conditional Heteroscedasticity (ARCH) effects. Not surprisingly, given the low frequency of annual data, four out of the seven indicators had no ARCH effects up to five lags and the remaining three indicators had some ARCH effects (see Appendix 4). Still interested in the volatility of these indicators, we proceed to examine moving unconditional volatility by using the simple but common method of a rolling standard deviation (see, e.g., Yeh et al. 2013) as the rolling standard deviation approach to volatility can sometimes closely approximate more complex econometric models such as ARCH (Schwert 2002). Based on the literature, the size of the dataset, and the fact that political cycles are typically 5 years in T&T and fiscal expenditure is tied to election periods, a 5-year rolling window can illustrate the punctuations in government spending, so we use a 5-year window to calculate the rolling standard deviation. This results in a sample spanning 1975 to 2021.

We follow the same steps as the CDI, and we proceed to construct the DVI by applying PCA to the 5-year rolling standard deviation as a measure of volatility and display the results in Table 5. We conclude that the DVI with the 5-year rolling volatility has two principal components ($PC_{DVI\ 1}$ and $PC_{DVI\ 2}$) derived from the seven indicators.

From Table 5, we calculate the weights of each component resulting in weights of 74.6% and 25.4% for $PC_{DVI\ 1}$ and $PC_{DVI\ 2}$ respectively. Both components combined accounts for 77.1% of the variations. The DVI is given as:

$$DVI = (0.746 \times PC_{DVI\ 1}) + (0.254 \times PC_{DVI\ 2}) \quad (3)$$

Like the CDI, the movements in the DVI in Figure 3 follow several major events in the international oil markets as well as other national and global shocks. Consistent with the findings of Siddique et al. (2016) in their investigation of the impact of declining oil sales on HIPC countries in the 1980s, we find that the sharp rise in the DVI coincide with plummeting oil prices and domestic oil production between 1984 and 1989. This is especially so given T&T's high dependence on the energy

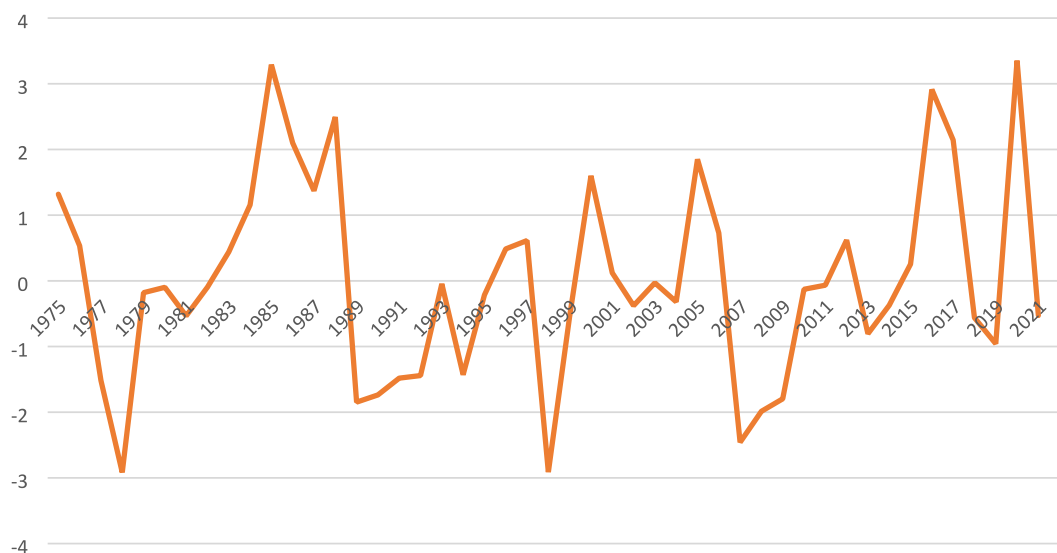


FIGURE 3 | Debt Volatility Index (DVI). Refer to Figure 2 and the main text for further details on annotated periods of historical global and country-specific significance. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/nhe.70003)]

sector which captures the positive correlation between current oil prices and current expenditure (see, e.g., El Anshasy and Bradley 2012). The conditions are reversed between 1990 and 1994 which result in a fall in the DVI. In the study of 17 Latin American countries, Ames (1977) find that governments respond to the needs of the electoral cycles which increases public expenditure and Alesina et al. (1992) refer to a similar notion as political budget cycles. This results in rising debt, and from 1998 to 2008 we see volatility levels remaining low with pungent changes which coincide with the follow up to general elections in 2000 and 2007. El Anshasy and Bradley (2012) find that previous oil price volatility induces greater fiscal prudence especially when the exchange rate is fixed, and we see this in the DVI where volatility remains fairly low between 2008 and 2015 as high revenue from the energy sector result in a decline in deficit financing and the rate of debt accumulation. We also see history from the 1980s repeating itself from 2016 onwards, resulting in debt volatility increasing as deficit financing, and the higher cost of borrowing result in higher interest payments. Previous issues of debt instruments are due and rollover risks are present. Finally, we see a spike in volatility as the government requires short-term financing to fund stimulus packages to cushion the effects of the COVID-19 pandemic. This is the largest spike in volatility since the 1980s oil price war.

4 | Index Application: The Debt-Growth Nexus

We continue by illustrating the applicability of our novel indices to investigate the debt-growth nexus in T&T. Indeed, the empirical literature on the debt-growth nexus is quite infrequent (Checherita-Westphal and Rother 2012) but its importance resurfaces after major shocks such as the global financial crisis or the COVID-19 pandemic, as elevated debt reignites the cause for concern. A popular departure point for investigating the nexus between debt and economic growth is Reinhart and Rogoff (2010) who study this relationship in 20 advanced economies and 24 emerging market economies.

Using simple correlation analysis on both groups of countries, they find that debt exceeding 90.0% (very high) results in lower growth. For emerging market economies with debt levels below 90.0%, median and average growth is approximately 4%–4.5%. Despite the timeliness, relevance, and importance of their work, the scope is limited since it relies on correlation analysis, and correlation does not imply causation. Additionally, they do not consider other determinants of growth.

Since then, authors such as Panizza and Presbitero (2014) and Kumar and Woo (2010) establish causal links between debt and growth by considering other determinants such as inflation, financial development, national savings, and gross capital formation to name a few. Another key consideration since the work of Reinhart and Rogoff (2010) is the linear and non-linear relationships between debt and economic growth as countries' debt levels move between different threshold (see, e.g., Cordella et al. 2010; Égert 2010). A consensus in the empirical literature is the variables used to assess the debt-growth nexus. The primary indicator of economic growth is real GDP growth and as expected, debt-to-GDP is the debt indicator of choice. The consensus extends to regressors or control variables as well. These include population growth, financial development, private savings, inflation, trade openness, unemployment, interest rate and gross fixed capital to name a few (see, e.g., Gómez-Puig et al. 2022). The most common estimation techniques are autoregressive distributed lag (ARDL) models (see, e.g., Makun 2021; Roy 2023) and IV estimation (see, e.g., Law et al. 2021 and references therein).

Yet, despite the harmony with methodologies and estimation techniques, estimated results remain diverse. For example, Panizza and Presbitero (2014) find no evidence of higher public debt adversely impacting economic growth across a sample of 17 OECD countries. Interestingly, their results differ from Cecchetti et al. (2011) in their study of 18 OECD countries as they take a multi-pronged approach to analyzing the relationship between

various forms of debt including government, corporation and household, and economic growth. They specifically find that when government debt exceeds 85.0%, it adversely affects growth. Cordella et al. (2010) takes a different perspective by including the quality of institutions and policies in their analysis of 79 developing countries. They find that in countries with good institutions and policies where debt rises above 20%–25.0%, debt overhang is present and there is a negative relationship between debt and growth. However, the relationship disappears with very high levels of debt (about 70%–80.0%). For countries with bad policies and institutions, the thresholds are much lower, but the relationship is insignificant.

Law et al. (2021) undertake a similar study of 71 developing countries and find a negative relationship between growth and debt when debt exceeds 51.7%. Below this threshold, however, the relationship disappears. Where developing countries have sound institutions above a threshold that can minimize or control the negative impact of rising debt, increasing debt can have a positive impact on growth. If institutions and policies are not sound, the relationship between debt and growth is negative above the 51.7% threshold but insignificant otherwise. Using World Bank’s country income group classifications, Ramos-Herrera and Sosvilla-Rivero (2017) find that from 115 countries, there is an inverse relationship between debt and economic growth. However, they find that low-income countries behave differently from the other classifications and that the heterogeneous relationship between debt and economic growth is quite complex. Mejia (2024) is agreeable and finds that debt dependence exerts a harmful impact on economic growth across 103 less-developed countries.

For developed economies such as the US, UK, Germany, and Italy, Afonso et al. (2018) examine the relationship between debt and economic activity while including a financial stress index as an endogenous variable. The authors find that increases in debt positively impact economic activity and, most notably, that deficit financing has a positive impact on economic activity during periods of financial stress. To investigate the short-run and long-run relationship between debt and economic growth in T&T, we adopt and augment the work of Nguyen et al. (2024) and Oyadeyi et al. (2024) to estimate the following ARDL:

$$\Delta RGDPG_t = \alpha_0 + \sum_{i=1}^p \gamma_i \Delta RGDPG_{t-i} + \sum_{j=0}^q \delta_j \Delta X_{t-j} + \varphi ECT_{t-1} + \varepsilon_t$$

(4)

where RGDPG is the real GDP growth rate, X is the vector of independent variables (see Appendix 5 for description) including the measure of debt (d), the inflation rate (INF), capital expenditure as a percent of GDP (CAP), the unemployment rate (U), and financial development (FD). With the exception of growth variables and the debt indices, all variables are in natural logarithms and all variables are $I(0)$ and $I(1)$ as required for the ARDL model. Δ is the difference operator, γ and δ are the short-run coefficients for the lagged dependent variable and independent variables respectively, φ is the parameter for the error correction term (ECT) which captures the speed of adjustment towards long-run equilibrium and ε_t is the error term. Data for other common variables in the empirical literature such as the number of years schooling, gross capital

TABLE 6 | Economic growth regression estimates with specific debt variables.

Specification 1: Debt indicator—CDI (excl. oil price)		Short-run coefficients		Diagnostics	
Long-run coefficients					
$RGDPG_{t-1}$	−0.6404*** (0.1266)	Δd_t	−1.0053*** (0.3544)	Bounds F -statistic	5.6989***
d_{t-1}	−2.2049*** (0.6786)	Δd_{t-1}	0.7036* (0.3882)	Jarque-Bera test	2.5041
INF_{t-1}	−0.3273 (0.2047)	ΔU_t	10.0129* (5.0307)	BPG test	0.7675
CAP_{t-1}	0.7738 (1.1087)	ΔFD_t	−9.2028 (5.5649)	BG LM test	2.1489
U_{t-1}	2.0800** (0.9717)	ΔFD_{t-1}	7.5457* (4.4093)		
FD_{t-1}	−2.1960 (3.8432)	ECT_{t-1}	−0.6904*** (0.1014)		
α_0	5.7028 (14.7697)				

TABLE 6 | (Continued)

Specification 2: Debt indicator—CDI (incl. oil price)				
Long-run coefficients		Short-run coefficients		Diagnostics
$RGDPG_{t-1}$	−0.8098*** (0.1618)	Δd_t	−0.9630** (0.3069)	Bounds F -statistic
d_{t-1}	−2.0844*** (0.7158)	Δd_{t-1}	0.6782* (0.4011)	Jarque-Bera test
INF_{t-1}	−0.3586* (0.2082)	ΔU_t	−12.3973** (6.0222)	BPG test
CAP_{t-1}	1.2957 (1.2420)	ΔU_{t-1}	−7.0735 (5.4478)	BG LM test
U_{t-1}	1.6051 (1.5689)	ΔFD_t	−10.6600* (5.7681)	
FD_{t-1}	−0.4657 (4.8959)	ΔFD_{t-1}	6.3282 (4.9841)	
OP_{t-1}	−1.0415 (1.5151)	ECT_{t-1}	−0.8098*** (0.1182)	
α_0	4.1075 (15.1323)			
Specification 3: Debt indicator—Debt-to-GDP (excl. oil price)				
Long-run coefficients		Short-run coefficients		Diagnostics
$RGDPG_{t-1}$	−0.5341*** (0.1549)	$\Delta RGDPG_{t-1}$	−0.2297 (0.1453)	Bounds F -statistic
d_{t-1}	−0.7989 (1.5932)	ΔU_t	−12.3296** (5.2656)	Jarque-Bera test
INF_{t-1}	−0.6334** (0.2613)	ΔU_{t-1}	−8.0338 (5.4375)	BPG test
CAP_{t-1}	0.4975 (1.1835)	ΔFD_t	−17.3969*** (5.9519)	BG LM test
U_{t-1}	3.4270*** (1.2584)	ΔFD_{t-1}	6.2706 (4.5901)	
FD_{t-1}	−7.8495** (3.8737)	ECT_{t-1}	−0.5341*** (0.0920)	
α_0	26.9970* (15.1378)			
Specification 4: Debt indicator – Debt-to-GDP (incl. oil price)				
Long-run coefficients		Short-run coefficients		Diagnostics
$RGDPG_{t-1}$	−0.7139*** (0.1667)	$\Delta RGDPG_{t-1}$	−0.1800 (0.1388)	Bounds F -statistic
d_{t-1}	−2.3099 (1.5991)	ΔU_t	−13.2287** (5.3925)	Jarque-Bera test
INF_{t-1}	−0.7819*** (0.2450)	ΔU_{t-1}	−12.7668** (5.5807)	BPG test
CAP_{t-1}	1.4398 (1.0906)	ΔFD_t	−13.2972** (6.1868)	BG LM test
U_{t-1}	2.5679* (1.4269)	ΔOP_t	1.9519 (2.3183)	

(Continues)

TABLE 6 | (Continued)

Specification 4: Debt indicator – Debt-to-GDP (incl. oil price)			
Long-run coefficients		Short-run coefficients	Diagnostics
FD_{t-1}	–1.2347 (4.3335)	ECT_{t-1}	–0.7139*** (0.1065)
OP_{t-1}	–1.9271* (1.0643)		
α_0	17.6913 (14.2836)		
Specification 5: Debt indicator – DVI (excl. oil price)			
Long-run coefficients		Short-run coefficients	Diagnostics
$RGDPG_{t-1}$	–0.6286*** (0.1630)	$\Delta RGDPG_{t-1}$	–0.2404 (0.1459)
d_{t-1}	–0.8195** (0.3630)	ΔCAP_t	1.0314 (1.9818)
INF_{t-1}	–0.6185** (0.2570)	ΔCAP_{t-1}	3.0959 (1.9050)
CAP_{t-1}	–4.4068** (2.1145)	ΔFD_t	–15.7557** (6.1650)
U_{t-1}	–8.8823** (4.3705)	ECT_{t-1}	–0.6286*** (0.0969)
FD_{t-1}	1.9475 (5.5461)		
α_0	44.5236*** (16.0695)		
$Trend$	–0.6626*** (0.2386)		
			Bounds F -statistic 5.1270***
			Jarque-Bera test 1.5599
			BPG test 0.9762
			BG LM test 0.6340
Specification 6: Debt indicator – DVI (incl. oil price)			
Long-run coefficients		Short-run coefficients	Diagnostics
$RGDPG_{t-1}$	–0.6484*** (0.1641)	$\Delta RGDPG_{t-1}$	–0.2424 (0.1459)
d_{t-1}	–0.8269** (0.3631)	ΔCAP_t	0.0294 (2.2187)
INF_{t-1}	–0.7162** (0.2757)	ΔCAP_{t-1}	3.3461* (1.9211)
CAP_{t-1}	–5.3363** (2.3081)	ΔFD_t	–13.4592** (6.5751)
U_{t-1}	–9.2157** (4.3826)	ECT_{t-1}	–0.6484*** (0.0972)
FD_{t-1}	2.2074 (5.5515)		
OP_{t-1}	2.1952 (2.1866)		
α_0	42.8443*** (16.1545)		
$Trend$	–0.8078*** (0.2790)		
			Bounds F -statistic 4.6131***
			Jarque-Bera test 1.4732
			BPG test 0.7974
			BG LM test 0.5191

Note: The sample for specifications one to four is 1971 to 2021 and for specifications five and six is 1975 to 2021. The optimal lags and trend specification are determined by the Akaike Information Criterion (AIC). The Bounds F -statistic tests for the presence of cointegration with the null hypothesis of no cointegration, the Jarque-Bera (JB) statistic tests for residual distribution with the null hypothesis of normally distributed residuals, the Breusch-Pagan-Godfrey (BPG) statistic tests the residuals for heteroscedasticity with the null hypothesis of homoscedastic residuals, and the Breusch-Godfrey (BG) statistic tests the residuals for serial correlation with the null hypothesis of no serial correlation. Robust standard errors are in parentheses, * denotes statistical significance at the 10% significance level, ** denotes statistical significance at the 5% significance level, and *** denotes statistical significance at the 1% significance level.

formation, and national savings are not available for T&T. We use annual data between 1971 and 2021 and based on similar time series analysis for developing and developed economies (see, e.g., Afonso and Jalles 2016; Appiah-Otoo and Song 2022; Ramzan and Ahmad 2014), we expect the sample size to yield precise results.

We display the results from our estimation in Table 6 and we begin with the baseline specification (specification one) which assesses the debt-growth nexus using the CDI as the debt indicator. We find a negative and statistically significant relationship between the CDI and economic growth in the long run. This is consistent with the findings of Afonso and Jalles (2013) and Afonso and

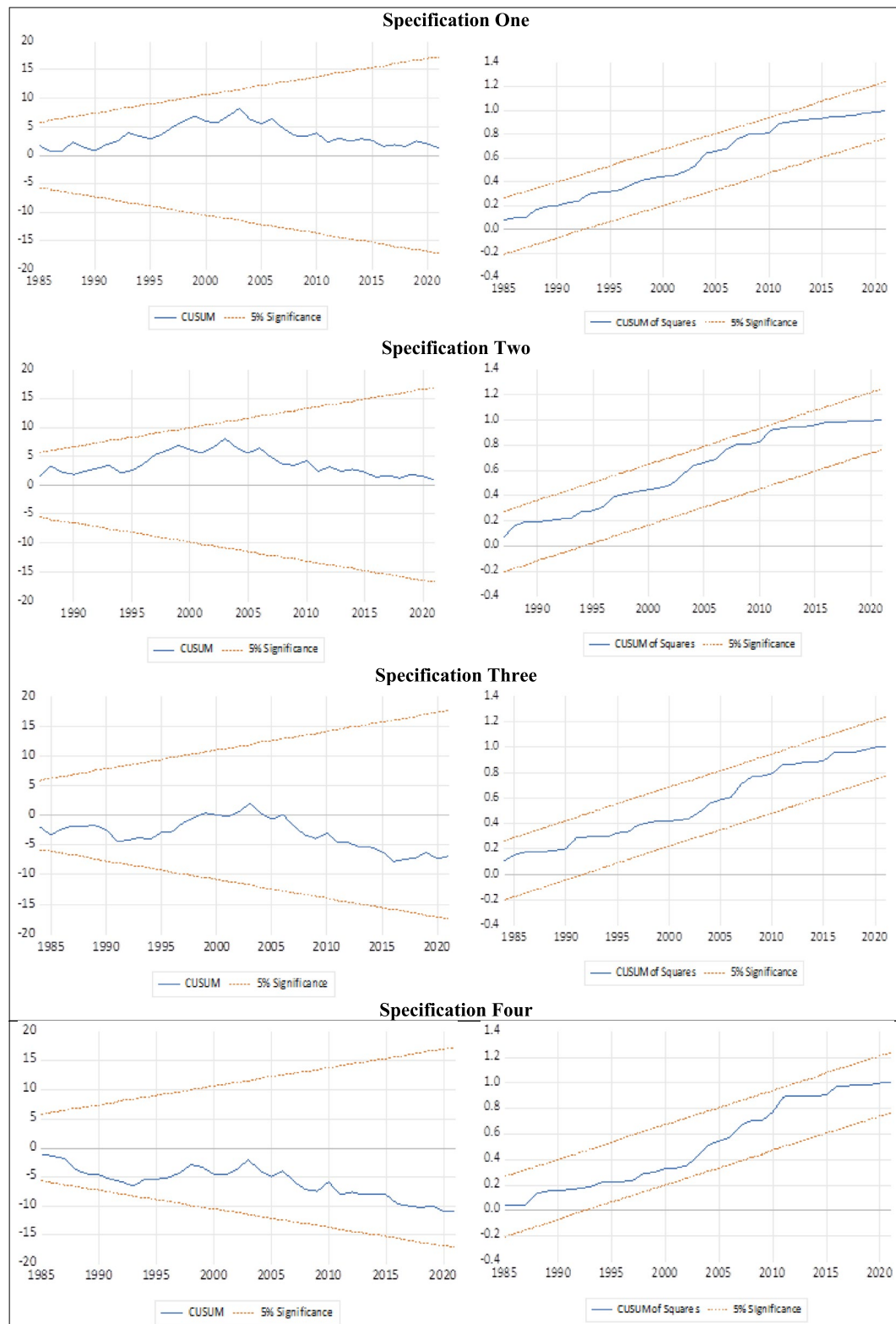


FIGURE 4 | CUSUM and CUSUM of squares plots. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/ode.7000313)]

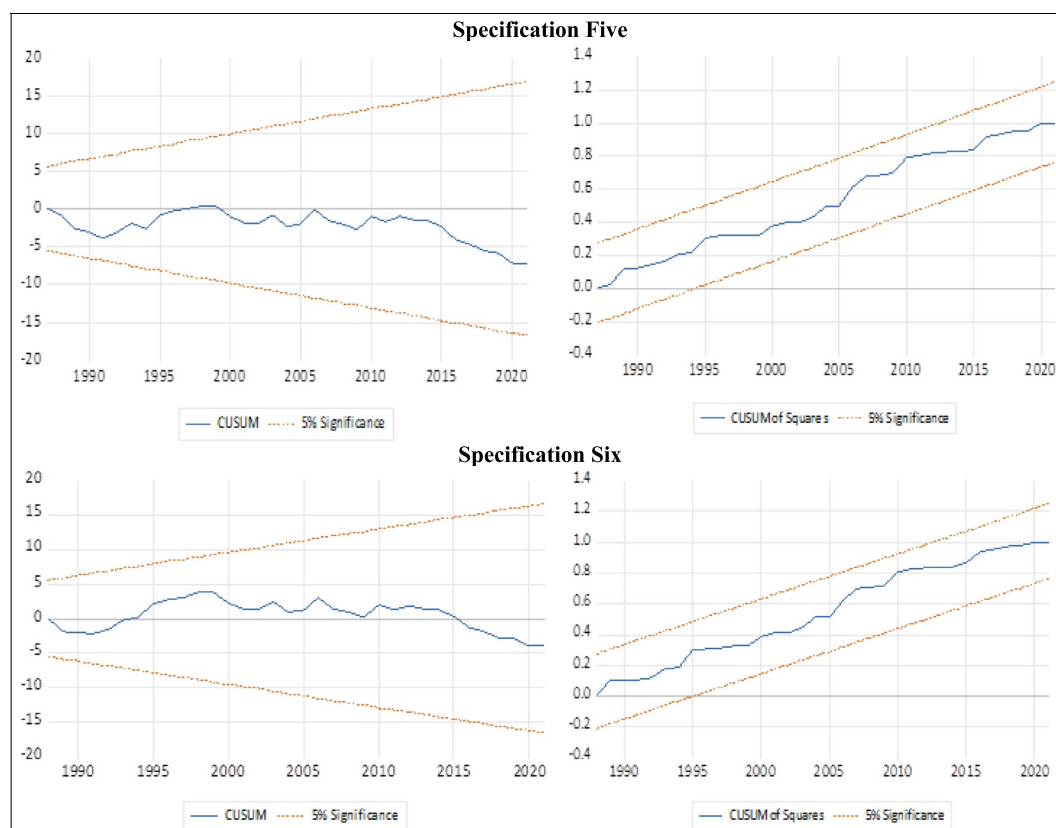


FIGURE 4 | (Continued)

Alves (2015) across a panel of 155 countries and 15 OECD countries respectively, where the authors find the presence of a negative relationship between debt levels over 90% and economic growth. Law et al. (2021) have similar findings across a panel of 71 developing countries but the debt threshold is much lower and similar to debt levels in T&T. Our findings are realistic since a large proportion of government debt acquisition is allocated to recurrent expenditure instead of productive activities and sectors. As such, an increase in indebtedness leads to a fall in economic growth in the long run. The CDI is also statistically significant in the short run. These results are robust when we include oil price as a regressor (specification two) given the energy-dependent nature of T&T. However, oil price is statistically insignificant.

We proceed to replace the CDI with the debt-to-GDP ratio to further highlight the robustness and use of our index. We find that in specification three, debt-to-GDP is statistically insignificant, and the results remain consistent when we include oil price in specification four. Like other energy-dependent nations, the complicated relationship between oil price and growth reappears, capturing a negative and statistically significant relationship between oil price and economic growth. This is plausible in T&T since this country is regarded as a welfare state and prosperity from the energy sector translates into increased spending on subsidies and transfer payments, with a significantly lesser proportion of the prosperity allocated to capital expenditure and other growth-related activities. The resource curse, which characterizes the paradoxical inability of natural resource-rich countries to grow in line with their resource-poor counterparts (see, *inter alia*, Sachs and Warner 2001), is not an infrequent finding in the empirical literature, as booming oil prices can negatively impact

growth. Manzano and Rigobon (2001) argue that debt overhang is a plausible channel of the resource curse, as resource-rich developing countries that use high commodity prices as collateral for debt tend to experience debt crises when such international prices collapse. As future increases in commodity prices are likely used to service debt and related fiscal expenses rather than contribute to economic growth, it becomes plausible to establish a negative link between booming oil prices and growth.

As mentioned previously, the DVI can be particularly useful for resource-dependent or undiversified economies that are susceptible to large and frequent shocks. To the best of our knowledge, there are no studies investigating the relationship between debt volatility and economic growth because debt-to-GDP may not exhibit significant volatility. However, for small states and developing economies, multiple debt indicators that measure debt from a more robust perspective can exhibit greater volatility, especially given the smallness and openness of these economies and susceptibility to adverse shocks such as commodity price shocks or natural disaster shocks. For example, T&T's exposure to the international energy markets results in sizable and frequent volatility in GDP, export earnings and government revenue. Similarly, Caribbean economies are highly vulnerable to natural disaster shocks such as flooding and hurricanes which lead to overall economic volatility that lasts from the short to medium-term. Studies often focus on oil price volatility (see, e.g., Wang et al. 2022) and in a similar vein, we propose that for an oil-dependent economy, debt volatility is also important. As such, we continue to demonstrate the use of our companion index, the DVI, as the measure of debt in specification five. We find that the results remain robust to the CDI with a negative

and statistically significant relationship between the DVI and economic growth. That is, as the volatility of indebtedness increases, it adversely affects growth in the long-run due to instability in the governments repayment variables and overall higher fiscal risks from uncertainty in government's fiscal maneuverability. The results remain robust when we include oil price in specification six.

As it relates to the other control variables, inflation has a negative and statistically significant relationship in the long run, and this can be due to the distortionary effects of inflation leading to greater uncertainty and stifled economic growth. Our findings are consistent with other studies on developing and developed economies such as Azam and Khan (2022) and Ayyoub and Wörz (2021). Capital expenditure is statistically insignificant in most instances, and this is consistent with capital expenditure routinely receiving less than 10% of the budgetary allocation in T&T. Unemployment is negative and statistically significant in the short run in most instances, which signals that Okun's Law holds, and these short-run trade-offs are similar to the findings of Schubert and Turnovsky (2018). Financial development, which is captured by credit from the banking system, has a similar negative and statistically significant relationship with economic growth in the short run, and this can be due to credit misallocation and the crowding out effect, as the government of T&T is a large borrower from the domestic banking system, which can crowd out private sector investment. These results are also in line with Narayan and Narayan (2013) in the analysis of 65 developing nations.

The Bounds test supports the presence of cointegration across all specifications, and the ECT is negative and statistically significant but with varying magnitudes. The CUSUM and CUSUM squares plot indicate that the parameters are stable over time (see Figure 4) and all model diagnostics are satisfied.

5 | Conclusion

We acknowledge the merits of debt-to-GDP as the most commonly used indicator of government debt. However, there are several limitations that can be addressed with a more comprehensive approach. As such, we propose and develop a novel composite debt index (CDI) and its companion debt volatility index (DVI) to better assess the fiscal health of the country.

Using the OECD (2008) methodology and principal component analysis (PCA), we construct the CDI and DVI using six globally recognized indicators of government indebtedness, along with one country-specific measure. We posit that these indices are superior to debt-to-GDP since they combine various indicators of government debt, including interest payments, as well as different repayment capacities such as exports and government revenue, which can better help policymakers understand the true state of government debt. We show that the indices can serve as early warning indicators since they conform to domestic and global macroeconomic events. The indices are also easy to understand and communicate a country's debt profile instead of debt-to-GDP alone or being overwhelmed by multiple indicators.

The CDI and DVI also offer practical tools for fiscal planning and debt management in developing countries and align with

the IMF–World Bank multipronged approach to addressing debt vulnerabilities. One of the key pillars of this approach, as outlined by the IMF (2020), is the enhancement of debt analysis tools, often through complex models such as dynamic general equilibrium frameworks. However, implementing such models can be difficult in low-capacity settings due to outdated or incomplete debt data. In contrast, the CDI and DVI are designed to bridge this gap. These indices are adaptable to environments with limited data availability and institutional capacity, making them feasible for constrained debt management offices. Notably, the DVI introduces a forward-looking volatility dimension that is absent from traditional debt sustainability frameworks. This is particularly valuable for countries exposed to commodity price shocks or external volatility, as the DVI can serve as an early warning indicator and inform timely adjustments in fiscal and borrowing strategies.

Additionally, just as existing debt sustainability frameworks are used to generate forecasts, simulate debt trajectories, and assess debt reduction pathways through stochastic simulations, the CDI and DVI can be similarly incorporated to strengthen scenario planning and fiscal risk analysis. Further to their utility for operational debt management, the CDI and DVI also align with the IMF–World Bank's call for tools that support integrated macro-fiscal-debt analysis (IMF 2020). These indices allow for empirical assessment of how changes in debt dynamics affect macroeconomic performance, particularly economic growth, and thus provide value beyond diagnostics by informing fiscal strategy design. For instance, the CDI and DVI can be used in empirical research such as the debt-growth nexus or debt sustainability assessment within the Bohn (1998) fiscal reaction function to assess sustainability by examining fiscal policy response to changes in the CDI and DVI.

We construct the CDI and DVI for Trinidad and Tobago (T&T), but its applicability extends to any developing economy and small state, as the variables are likely to be readily available. The reliability of our index is supported by the simultaneity of pronounced movements in the CDI and DVI with remarkable historical events that impact T&T, the source of which originates from global energy market shocks. The reliability and use of our index are further reinforced through its application in assessing the debt-growth nexus for T&T. We find that all specifications using our indices produce robust and significant results when compared to alternative specifications using the debt-to-GDP ratio. Simply put, our CDI and DVI provide clear results to a topic that frequently finds insignificant or inclusive results and noise. With these indices, users can analyse and examine the true level of government debt, the progress made towards moving debt to sustainable levels, its relationship with key macroeconomic performance indicators such as growth, and the expected volatility that may arise should adverse shocks occur.

Although the CDI and DVI are constructed using a standard set of debt indicators that are commonly available for developing countries, data limitations remain a potential challenge. In cases where certain indicators are unavailable, the indices can be adapted to use a subset of the available variables without compromising the overall methodology. Similarly, countries with access to more detailed or context-specific data may expand the indices to include additional indicators that better reflect their

unique debt dynamics, such as debt-to-tourism receipts for tourism-dependent economies or external debt-to-remittances in countries with large diaspora inflows. To maintain consistency and transparency, data from multiple reputable sources can be validated or combined, and any adjustments or substitutions should be clearly documented. This approach ensures that the construction process remains consistent, transparent, and replicable while accommodating country-specific data realities.

In this contribution, we do not explicitly explore debt sustainability. However, an interesting area for further research is to incorporate the CDI and DVI within a fiscal reaction function and investigate the relationship between fiscal policy and government debt. Additional studies could investigate the applicability of the indices across a wider range of developing countries, particularly those with different economic characteristics such as tourism-based economies or post-conflict states, in order to evaluate the consistency and adaptability of the framework. Furthermore, the integration of the CDI and DVI into the aforementioned macro-fiscal forecasting tools or debt sustainability frameworks, could enhance the ability of policymakers to anticipate and respond to emerging debt vulnerabilities. We also recognize that, just as alternative indicators of GDP may be ineffective within the current preference system (Felice 2016), our alternative to the debt-to-GDP ratio may encounter similar resistance. However, as developing economies and small states strive to get out a recurring cycle of indebtedness (see, e.g., Abotebuno Akolgo 2023), robust indices such as the CDI and DVI can serve as useful tools for research, policy-making, and overcoming the noise of erroneous, insignificant, and inconclusive results.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

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

Endnotes

¹ See details in Appendix 2.

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Appendix 1

Comparative Summary of Debt Index Approaches

Dimension	CDI and DVI (this study)	Blanchard and Das (2017)	Doemeland et al. (2022)
Main objective	Develop a composite debt index (CDI) and a debt volatility index (DVI) to provide a holistic view of sovereign debt in developing countries.	Develop an index of external debt sustainability by modeling uncertainty in exchange rates and net exports.	Develop a multi-angle debt vulnerability framework (with four sub-indices) to predict sovereign default risk.
Debt indicators	Debt-to-GDP, debt-to-revenue, interest-to-revenue, external debt to exports/reserves/energy exports.	Net debt, net exports, exchange rate, return differentials.	Debt stock, debt service, maturity structure, debt composition, current account, credit ratings, CDS spreads.
Analytical tools	Principal Component Analysis (PCA) to create indices.	Vector autoregression and stochastic simulations for exchange rate scenarios.	PCA, dynamic factor models, and machine learning.
Novelty	Inclusion of country-specific indicators (such energy exports for Trinidad and Tobago), and a DVI to capture debt volatility.	Use of exchange rate distributions to model sustainability thresholds.	Use of machine learning to estimate default risk from combined sub-indices.
Case countries	Trinidad and Tobago (developing, resource-rich, monocrop).	Chile (emerging market) and the U.S. (developed).	Market access countries.
Policy orientation	Meant for developing economies with data constraints, aiming to improve policy diagnostics and assess debt-growth relationship and debt sustainability.	Focused on external sustainability and balance of payments crises.	Designed for early warning and policy response, targeting multilaterals and country authorities.
General findings	Standard metrics like debt-to-GDP may understate debt risks. The indices reveal that fiscal stress may not be captured by single indicators as the CDI and DVI show a significant negative relationship with growth while traditional metrics like the debt-to-GDP ratio show no such link.	Sustainability of external debt is highly sensitive to exchange rate uncertainty. A stable debt ratio is possible under various rate paths and sustainability depends more on net exports and capital account behavior than on current account or GDP alone.	Simple rules such as debt-to-GDP thresholds often miss key risks. A multi-angle approach improves predictive power for defaults as machine learning models using four indices outperform traditional models in predicting sovereign defaults in market access countries.

Appendix 2

Steps in Constructing an Index

Step 1. The Theoretical Framework

The first step we take in constructing the CDI is creating the theoretical framework to identify and define the concept being measured as well as the selection criteria for the underlying indicators. The CDI aims to provide a comprehensive measure of government indebtedness that captures both liquidity and solvency while addressing the limitations of the debt-to-GDP ratio.

Step 2. Variable/Indicator Selection

The next important step is the selection of variables or indicators. Garbage in results in garbage out, and high-quality indicators are key to the creation of a robust composite index. The quantitative or hard input indicators we select include gross debt-to-GDP, gross debt-to-revenue, gross debt-to-exports, external debt-to-energy exports, external debt-to-exports, and external debt to gross international reserves. These indicators were largely selected based on potential data availability for developing economies and small states. It features multiple measures of repayment capacity as well as explicitly identifies debt denominated in foreign currency relative to the stock of foreign reserves. As such, it improves on some of the limitations identified earlier on the use of the gross debt-to-GDP ratio only. These indicators are also analytically sound and globally recognized as key indicators for capturing government indebtedness. They are widely accessible through domestic agencies such as Central Banks and Ministries of Finance as well as external data sources such as the IMF and the World Bank. In the absence of these variables, a subset can be used or similar variables that capture debt and country-specific ability to service debt.

Step 3. Dealing with Missing Data

The third step deals with issues relating to missing data that can either be random or non-random. However, given the choice of indicators selected, we do not expect missing data to be an issue since it may either be captured and recorded by domestic institutions or estimated by an international financial institution. However, missing data can distort composite indices and as such, the issue of missing data must be addressed if it exists. At the

end of this step, the dataset must be complete with no missing values, or any issues of missing values addressed. Any adjustments must be detailed and documented for transparency and replicability. As the quality of debt recording data improves, the composite index should improve in parallel.

Step 4. Normalization

After all data issues are identified and addressed, the next step involves converting the data into a common, comparable form to avoid mixed measurement problems relating to units, scales, and ranges. Normalization also helps eliminate extreme values or outliers from the indicators (Freudenberg 2003; Jacobs et al. 2004). Of the normalization methods available, standardization and min-max are the two most appropriate methods based on the debt indicators used for constructing the CDI, but PCA uses the standardization approach.

Step 5. Weighting

The next critical step in the construction of the CDI is the weighting of the indicators for the index. The most commonly used weighting method for a composite index is equal weighting. This is largely due to its simplicity and high degree of objectivity. It is also useful for indices where alternative weighting schemes cannot be justified. However, equal weighting can be viewed as an oversimplification of the index by treating all indicators as equal when some indicators may be more important than others (Paruolo et al. 2013).

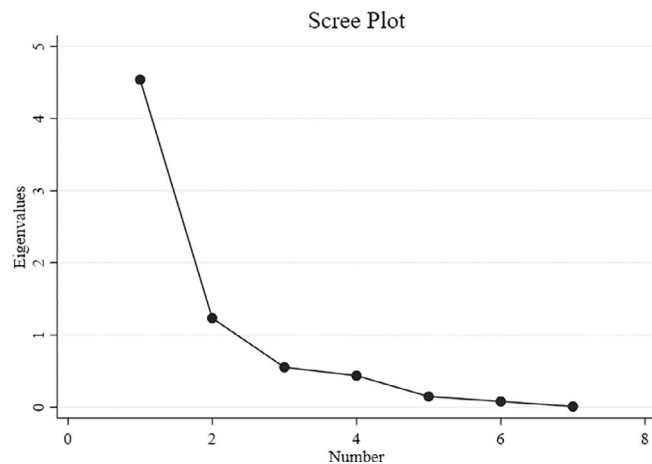
Given the nature of the index and the use of economic data, Principal Component Analysis (PCA) would be the most appropriate choice for weighting the CDI if there is high correlation between the selected indicators. PCA is a statistical approach to reduce data dimensions by capturing the highest variance in the least dimensions. PCA creates a system of equation where the first equation will capture the most variance and each subsequent equation within the system will capture the variance not captured by the previous equation. PCA is quite popular and prevalent in the applied literature on index construction given its convenience (using statistical software), transparency and relative objectivity (Greco et al. 2019). However, PCA cannot be used if the indicators have low correlation. In some instances, the PCA can produce negative weights and when this occurs, PCA should not be used.

Step 6. Aggregation

The final step in the construction of the CDI is the aggregation of the weighted indicators. The linear method of aggregation is the most used, where the composite is simply the sum product of the weights and indicators using an additive utility function. Following the CDB (2012), the linear approach will be utilized given the number of variables and the nature of the variables as it relates to macroeconomic computations, and PCA and its derived components are computed using a linear aggregation approach to produce the overall index.

Appendix 3

Scree Plot—Composite Debt Index



Appendix 4

ARCH LM Test

Lags/df	DTR	DTX	DTG	ITR	EDEE	EDE	EDRES
1	0.168	13.502*	7.086*	0.911	4.005*	3.090	5.852*
2	0.427	13.878*	6.813*	0.790	3.955	2.983	7.663*
3	0.501	13.595*	6.720	0.970	3.995	4.471	7.530
4	2.650	16.968*	10.023*	2.017	4.006	4.481	7.571
5	2.754	17.014*	13.294*	2.133	8.631	7.436	7.712

Note: * denotes the presence of ARCH effects at 5% significance level, where df refers to degrees of freedom.

Appendix 5

Variables and Descriptions for the Debt-Growth Nexus Model

Variable	Description	Source
Real GDP growth	The percentage change in GDP at constant prices.	Central Bank of T&T.
Financial development	The ratio of private sector credit as a per cent of nominal GDP.	Central Bank of T&T and author's calculation.
Inflation	The year-on-year per cent change in the Index of Retail Prices for all items with a base year of 2015.	Central Bank of T&T.
Oil price	The price of crude oil (measured in US\$ per barrel) as priced by West Texas Intermediate (WTI).	Central Bank of T&T and Statista.
Unemployment	The number of unemployed persons as a percent of the labor force.	Central Bank of T&T.
Capital expenditure	Annual capital expenditure as a percent of nominal GDP.	Central Bank of T&T and author's calculation.