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Original Article

The Impact of Debt-to-GDP Ratio on the GDP Growth Rate of the Philippines

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Abstract

Background: *Government borrowings could play an important role in maintaining economic stability; however, it is essential to keep the indebtedness manageable to ensure that debts continue contributing to economic growth. This concern is particularly relevant for the Philippine economy, which has faced recurring economic shocks, policy transitions, and fluctuating debt trajectories over the past decades.*

Methods: *This study analyzed the relationship between the debt-to-GDP ratio and GDP growth in the Philippines from 1986 to 2020, employing regression and correlation analyses to determine the optimal debt ratio. A quadratic regression model, demonstrating the highest adjusted R^2 and lowest MSE, revealed a U-shaped non-linear relationship. It suggests an optimal debt-to-GDP ratio of 57.64% when including extraordinary events and 60.23% excluding them.*

Results: *Spearman's correlation indicated a significant negative correlation between debt and growth at lower debt levels. In comparison, the relationship at higher debt levels was inconclusive, highlighting the influence of external shocks and domestic policies. The study identified periods characterized by varying debt and growth dynamics, illustrating the complex interplay of natural disasters, financial crises, fiscal policies, and global economic conditions.*

Conclusion: *Ultimately, the findings emphasize the context-dependent nature of the debt-growth nexus, advocating for nuanced policy responses tailored to the Philippines' specific economic environment. These insights inform more adaptive fiscal policymaking in the Philippine context and offer implications for other emerging economies dealing with similar debt sustainability challenges.*

Keywords

Gross Domestic Product, debt, debt trap, economic growth, data mining, polynomial regression, Philippines, economy

INTRODUCTION

Every economy seeks sustainable productivity and growth (Ordiz, 2017). One indicator used to measure productivity and growth is the Gross Domestic Product (GDP), which represents the final value of goods and services produced within a country during a specified period, normally a year (Kummu et al., 2018). To

contribute to the GDP and help stabilize the economy, the government adopts fiscal policy measures and monetary policy measures that regulate the money supply, credit, and interest rates (Chugunov et al., 2021). These fiscal policy measures include taxation, government spending, and borrowing. The government typically resorts to borrowings when taxes and other revenues are insufficient to finance government expenditures and service existing obligations (Al-qalawi & Al-Rabbaie, 2024). This aligns with Keynesianism, which advocates for active government intervention, especially during recession and depression (Aliño, 2013). Named after the economist John Maynard Keynes, Keynesianism assumes that government spending, which borrowings can finance, is a key factor in stimulating demand, employment, and growth (Seccareccia, 1995).

While government borrowings could play an important role in maintaining economic stability, the amount of indebtedness should be kept at a manageable level to help ensure that the debts continue to contribute to economic growth and do not put the country at risk of default (de Soyres et al., 2022). The debt level is measured and monitored through the "Debt-to-GDP Ratio," which is the percentage of the country's debt to the country's GDP. This ratio does not just show the degree of a country's indebtedness but reflects the country's ability to pay its debts. A high ratio could mean the country is not producing enough to pay its debts, while a low ratio could mean it produces too much output to make the payments (Kamiguchi & Tamai, 2023; Heimberger, 2021).

Research on the debt-growth link was conducted between 2010 and 2020 to assess the argument that high government debt-to-GDP ratios have negative or significant or both consequences on an economy's growth rate (Salmon & de Rugy, 2020). This supports the notion that a high amount of government debt hurts economic growth potential, with the impact becoming more pronounced as debt levels rise. The analyses also revealed that most debt-growth research found a threshold between 75 and 100 percent of GDP. More importantly, almost all studies demonstrate a negative association between high debt levels and economic development.

Empirical analysis based on data from 40 advanced and emerging economies over a four-decade period indicates that sustained accumulation of public debt is linked to lower levels of economic activity (Chudik et al., 2017). Additionally, the pattern or trajectory of debt over time may have a more pronounced effect on economic growth than the absolute level of debt measured by the debt-to-GDP ratio (Mensah et al., 2020).

The relationship between public debt and economic development remains inconclusive, with findings indicating it may be positive, negative, or non-linear depending on contextual factors (Presbitero, 2012; Rahman et al., 2019; Ueshina & Nakamura, 2019). Even when a positive relationship is identified, governments are encouraged to formulate fiscal policies carefully by regularly assessing appropriate debt levels (Mencinger et al., 2015). Mismanagement of public funds can hinder economic growth, while excessive borrowing risks lead to a debt trap, where new loans are taken solely to meet prior debt obligations (Karin & Klaeokla, 2024; Rahman et al., 2019).

An investigation of 17 OECD countries from 1970 to 2014 revealed that the impact of the public debt ratio on economic growth varies across countries, indicating that the relationship is highly context-dependent (Kummer-Noormamode, 2018; Teles & Mussolini, 2014). Thus, examining the relationship between the public debt ratio and a single country's economic growth reveals that governments must develop suitable fiscal policy guidelines.

Given that the influence of debt on economic growth is country-specific, this study looks into the impact of debt on the Philippine economy. Hence, this study attempts to determine the relationship between the debt-to-GDP ratio and the GDP growth rate of the Philippines from 1986 to 2020. The study further investigates how extraordinary economic events influence these relationships by conducting separate analyses that include and exclude such events.

METHODS

Research Design

This study adopted a quantitative, retrospective, and correlational research design to examine the nonlinear relationship between the debt-to-GDP ratio and GDP growth rate in the Philippines from 1986 to 2020. To identify the optimal debt-to-GDP ratio, defined as the level at which economic growth is minimized or maximized, this design enabled the detection of turning points and the characterization of structural trends over time. By utilizing historical macroeconomic data, the study aimed to generate evidence-based insights into how public debt levels relate to economic performance under normal and crisis conditions.

Data Source

The data for the study were sourced from the World Data Bank, explicitly focusing on the Philippines from 1986 to 2020. This data included annual figures for the debt-to-GDP ratio and GDP growth rate. The debt-to-GDP ratio represents a country's total public debt as a percentage of its gross domestic product. It serves as an indicator of a country's ability to pay back its debt. A high ratio may suggest economic risk. GDP growth rate measures the annual increase in a country's economic output. Together, these metrics help evaluate the sustainability of public debt and its effect on economic growth.

Data Analysis

A structured, three-triangulated data analysis approach was employed to investigate the nature and implications of the relationship between the debt-to-GDP ratio and GDP growth rate in the Philippines from 1986 to 2020. This approach consisted of regression modeling, nonparametric correlation analysis, and quadrant-based scenario classification to identify the threshold level of public debt associated with the lowest GDP growth and characterize the dynamics of this relationship under varying economic conditions.

Three functional forms were estimated to explore the potential nonlinear nature of the debt-growth relationship: linear, quadratic, and cubic regression models. The following general forms were specified:

Linear Regression Model:

$$Growth \quad Rate \quad = \quad a(Debt\_to\_GDPRatio) + b$$

Quadratic Regression Model:

$$Growth \quad Rate \quad = \quad a(Debt\_to\_GDPRatio)^2 + b\Big(Debt\_to\_GDP \quad Ratio\Big) + c$$

Cubic Regression Model:

$$Growth \quad Rate = a(Debt\_to\_GDPRatio)^3 + b(Debt\_to\_GDPRatio)^2 + c\Big(Debt\_to\_GDPRatio\Big) + d$$

where *a, b, c*, and *d* are the estimated regression coefficients for the model.

Model performance was assessed using adjusted R^2, mean squared error (MSE), and standard error of the estimate (SE). The quadratic model was selected as the best-fitting specification based on its superior performance across all three metrics. The Debt-to-GDP ratio associated with the lowest predicted GDP growth, referred to as the minimum growth point, was calculated using the vertex formula of the quadratic model:

$$Minimum \quad Growth \quad Point = -\frac{b}{2a}$$

Separate quadratic models were estimated using two datasets. The first included all years capturing general macroeconomic trends and the second excluded years with extraordinary economic events to isolate structural patterns from crisis-driven effects.

To further examine the association between public debt and economic growth, Spearman's rank-order correlation coefficients (ρ) were computed. This nonparametric measure was used due to violations of the normality assumption in the growth rate data. The analysis was stratified into two debt regimes: one for values below the estimated threshold and another for those above. This allowed for the examination of whether the strength and direction of the association varied depending on the level of public debt.

A quadrant analysis was conducted using the estimated threshold as the dividing line between low and high debt regimes to contextualize the regression and correlation findings. Each observation year from 1986

to 2020 was categorized into one of four quadrants based on its Debt to GDP ratio (low or high) and GDP growth rate (low or high): High Debt and High Growth (Q1), Low Debt and High Growth (Q2), Low Debt and Low Growth (Q3), and High Debt and Low Growth (Q4).

All statistical analyses and visualizations were conducted using Python 3.10. Data manipulation and correlation computations were performed with the NumPy, pandas, and scipy.stats libraries. Regression models were estimated using the scikit-learn library. Visualizations, including fitted regression curves and quadrant distributions, were created using Matplotlib.

RESULTS

Figure 1 presents the annual debt-to-GDP ratios and GDP growth rates in the Philippines from 1986 to 2020. The lowest recorded debt-to-GDP ratio was 39.61% in 2019, while the highest was 71.60% in 2004. Positive GDP growth was observed in most years, except for 1991 (-0.4%), 1998 (-0.5%), and 2020 (-9.5%).

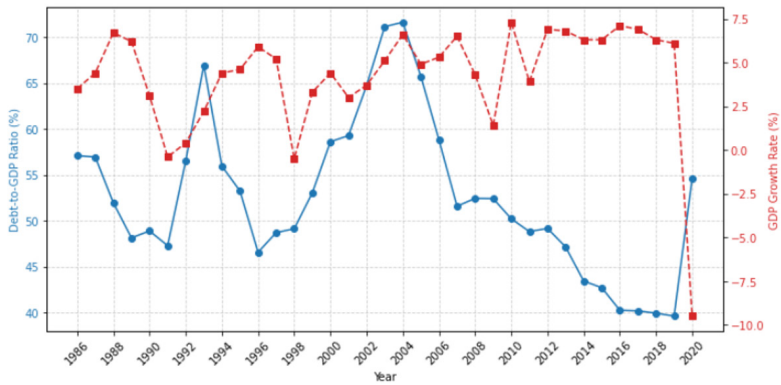

Figure 1. *Philippine Debt-to-GDP Ratio and GDP Growth Rate (1986-2020)*

Table 1 compares three regression models predicting GDP growth based on the debt-to-GDP ratio. Among the models, the quadratic regression yielded the best fit, with an adjusted R^2 of 0.108, mean squared error (MSE) of 9.07, and standard error (SE) of 3.01, outperforming the linear and cubic models. Table 2 provides the parameter estimates for this model. All coefficients were statistically significant at a 95% confidence level. Based on these estimates, the best-fitting quadratic regression model (including extraordinary events) is expressed as follows:

$$Growth \quad Rate = 0.0128331(Debt\_to\_Ratio)^2 - 1.47938\Big(Debt\_to\_Ratio\Big) + 45.6717$$

Table 1. *Comparison of Regression Models Predicting GDP Growth from Debt-to-GDP Ratio*

Model	Adjusted R^2	MSE	SE
Linear	0.9%	10.07	3.17
Quadratic	10.8%	9.07	3.01
Cubic	8.5%	9.30	3.05

Table 2. *Parameter Estimates of Quadratic Regression Model based on data including extraordinary events*

Parameter	Estimate	SE Estimate	95% CI
a	0.0128331	0.0059	(0.00072, 0.0249)
b	-1.47938	0.6541	(-2.81166, -0.1471)
c	45.6717	17.6930	(9.63235, 81.7111)

Using the vertex formula of a quadratic function, the estimated minimum growth point was 57.64% when all years, including those with extraordinary economic events, were considered. When such years were excluded, a separate quadratic regression produced a minimum growth point of 60.23%. Figure 2 presents the fitted regression curves for both scenarios, showing the U-shaped relationship between debt-to-GDP ratio and GDP growth.

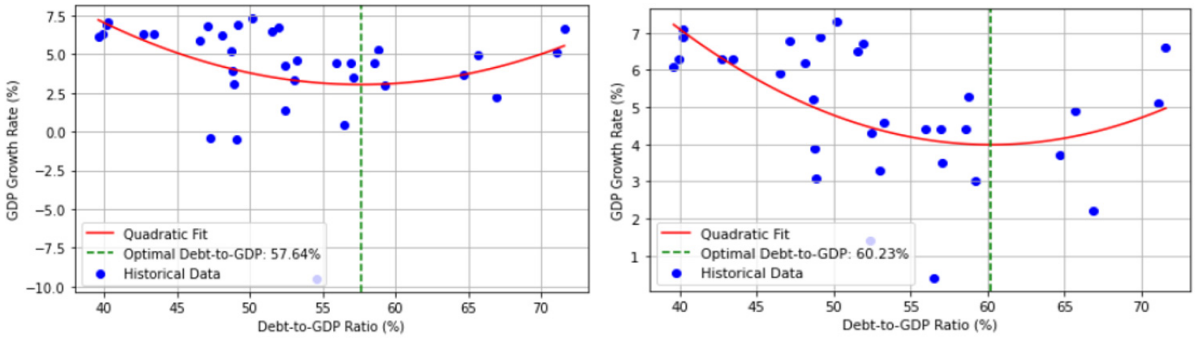

Figure 2. *Estimation of the Optimal Debt-to-GDP Ratio: (a) Including Extraordinary Events and (b) Excluding Extraordinary Events*

Spearman's rank-order correlation coefficients were computed to further investigate the nature of the relationship between public debt and economic performance due to a violation of the normality assumption. The analysis was stratified into two ranges based on the estimated minimum growth points obtained from the quadratic regression models: (1) debt levels below the threshold and (2) debt levels above the threshold. Tables 3 and 4 report the correlation results for the scenarios, including (57.64%) and excluding (60.23%) extraordinary economic events, respectively.

As shown in Table 3, the Spearman correlation between the Debt-to-GDP ratio and GDP growth for observations below this threshold was statistically significant and negative ($\rho = -0.491$, $p < .01$), indicating that as public debt increased within this range, economic growth tended to decline. Conversely, for debt levels exceeding 57.64%, the correlation turned positive ($\rho = 0.262$) but was not statistically significant ($p > .05$), suggesting a weak and inconclusive association.

Table 3. *Spearman's Correlation Between Debt-to-GDP Ratio and GDP Growth Rate (Including Extraordinary Events)*

Variable		Growth Rate (<57.64%)	Growth Rate (>57.64%)
Debt-to-GDP Ratio (<57.64%)	Spearman's rho	-0.491**	—
Debt-to-GDP Ratio (>57.64%)	Spearman's rho	—	0.262

*p < .05, **p < .01, ***p < .001

Table 4, which presents the analysis excluding extraordinary economic events, reveals a statistically significant negative correlation between the Debt-to-GDP ratio and GDP growth for debt levels below the 60.23% threshold ($\rho = -0.495$, $p < .01$). This indicates that under normal macroeconomic conditions, increases in debt at moderate levels are consistently associated with reduced economic growth. In contrast, for debt levels above 60.23%, the correlation coefficient increased substantially to $\rho = 0.700$; however, the result was not statistically significant ($p > .05$). These results suggest that the negative association between debt and growth is more consistent at lower debt levels, while the relationship at higher debt levels remains inconclusive.

The narrative above can be summarized in Table 5. The analysis shows that a rising Debt-to-GDP ratio has a statistically significant quadratic relationship with GDP growth in both scenarios. The statistical significance indicates that the observed patterns are unlikely due to random chance, confirming the model's strength across different economic contexts.

Table 4. *Spearman's Correlation Between Debt-to-GDP Ratio and GDP Growth Rate (Excluding Extraordinary Events)*

Variable		Growth Rate (<60.23%)	Growth Rate (>60.23%)
Debt-to-GDP Ratio (<60.23%)	Spearman's rho	-0.495**	—
Debt-to-GDP Ratio (>60.23%)	Spearman's rho	—	0.700

*p < .05, **p < .01, ***p < .001

Table 5. *Correlation Direction and Statistical Significance between Debt-to-GDP Ratio and GDP Growth Rate (Without and With Extraordinary Events)*

Correlation Direction	Without Extraordinary Events*	With Extraordinary Events^
Positive	Statistically insignificant	Statistically insignificant
Negative	Statistically significant	Statistically significant

Legend: *Optimal Debt-to-GDP ratio is 60.23% ; ^Optimal Debt-to-GDP ratio is 57.64%

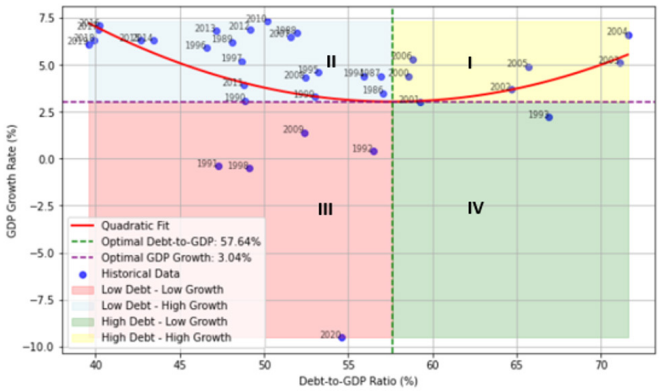

Figure 3. *Four Case Scenarios Illustrating the Relationship between Debt-to-GDP Ratio and GDP Growth Rate*

The optimal debt-to-GDP ratio in this model represents the debt-to-GDP ratio at which GDP growth is at its lowest before growth begins to rise again. The fact that the optimal debt-to-GDP ratio is lower when extraordinary events are present (57.63%) compared to periods without such events (60.23%) suggests that extraordinary conditions make the economy more sensitive to rising debts.

A quadrant classification was also conducted using the 57.64% threshold to explore further the interaction between the debt-to-GDP ratio and GDP growth across varying macroeconomic conditions to complement the correlation analysis. Figure 3 visualizes the Philippine economy from 1986 to 2020 across four quadrants based on high or low public debt and high or low GDP growth combinations. Quadrant I (High Debt–High Growth) consists of 6 years (2000, 2002–2006), representing only 17% of the 35-year observation period. This quadrant suggests that elevated debt levels coexisted with strong economic growth during a limited number of years, potentially due to effective fiscal management or favorable external conditions. Quadrant II (Low Debt–High Growth) accounts for most of the years, with 22 out of 35 years (63%) indicating that robust economic growth in the Philippines has historically been associated with relatively low debt burdens. This pattern reflects a generally prudent fiscal stance during periods of expansion and favorable macroeconomic environments. Quadrant III (Low Debt–Low Growth) includes 5 years (1991, 1992, 1998, 2009, 2020), or 14% of the total period. These years are largely characterized by internal disruptions and global crises, such as the 1991 Mount Pinatubo eruption, the 1998 Asian Financial Crisis, the 2009 Global Recession, and the 2020 COVID-19 pandemic. Despite low debt levels, these slow or negative growth episodes highlight the country's economic vulnerability to shocks. Quadrant IV (High Debt–Low Growth) is represented by only 2 years (1993 and 2001), comprising 6% of the total period. These years reflect instances where increasing debt levels were

not matched by proportionate economic expansion, suggesting possible inefficiencies in public spending or adverse global conditions. Overall, the distribution of years across quadrants shows that for most periods, the Philippines achieved high growth under conditions of low public debt, while years with high debt and low growth were relatively rare.

DISCUSSION

This study contributes to the ongoing discourse on the debt–growth nexus by empirically investigating the nonlinear relationship between the Debt to GDP ratio and economic growth in the Philippines from 1986 to 2020. Contrary to the widely cited inverted U hypothesis, which posits that debt initially promotes growth up to a certain threshold beyond which it becomes detrimental (Kumar & Woo, 2010; Mencinger et al., 2015; Ueshina & Nakamura, 2019), the results of this study reveal a U shaped pattern. The best-fitting quadratic regression model indicates that economic growth initially declines with rising debt levels but begins to recover beyond a certain debt threshold, consistent with the findings of Égert (2015), Presbitero (2012), and Chudik et al. (2017), who emphasizes that the relationship between public debt and growth is often context-specific and sensitive to economic structure, institutional quality, and fiscal governance.

The estimated turning points of 57.64% (including extraordinary events) and 60.23% (excluding extraordinary events) align with threshold ranges identified in other developing and middle-income economies (Égert, 2015). The significant negative Spearman correlation coefficients observed below these thresholds in both scenarios suggest that increases in public debt are associated with lower GDP growth rates when debt remains at moderate levels. This finding supports earlier empirical evidence indicating that moderate debt levels may lead to debt overhang, crowding out private investment, reducing fiscal space, or weakening market confidence (Rahman et al., 2019). However, when debt levels exceed these estimated thresholds, the observed correlation shifts to positive yet statistically insignificant. The non-significance suggests that factors other than the debt-to-GDP ratio might influence the relationship at high debt levels, such as countercyclical fiscal policies or external shocks (Jalles et al., 2024). Thus, while the negative association between debt and growth is consistently observed at lower debt levels, the relationship at higher debt levels remains inconclusive, highlighting the complexity and context-dependency of the debt-growth nexus. The result also aligns with the idea that the impact of public debt on economic growth can vary significantly across different economic environments, as shown by numerous studies (Cordella et al., 2010).

The estimated debt-to-GDP threshold is lower when extraordinary economic events are included in the analysis (57.64%) compared to when such periods are excluded (60.23%), suggesting that the economy becomes more sensitive to rising debt under heightened uncertainty. This discrepancy can be attributed to several interrelated factors. First, the fiscal effectiveness of public debt diminishes during crises, as disruptions to consumption, investment, and trade reduce the stimulative capacity of government spending (Bentour, 2021). Second, extraordinary events often heighten risk perceptions and economic uncertainty, reducing investor and consumer confidence. In such scenarios, increasing debt levels may signal fiscal stress rather than stability, undermining growth (Fischer & Storm, 2023). Third, the composition of debt during crisis periods typically shifts toward short-term relief measures, such as emergency aid or social protection, rather than productive public investment, limiting the long-term growth potential of debt-financed expenditures (Chudik et al. (2017). Finally, elevated debt burdens during these periods can crowd out private investment or impose additional constraints on fiscal space, particularly in emerging markets like the Philippines, exacerbating the economy's vulnerability even at relatively moderate levels of debt (Kamiguchi & Tamai, 2023). These dynamics collectively help explain why the estimated debt threshold associated with the lowest GDP growth is lower in the presence of extraordinary events.

The quadrant scenario analysis further contextualizes the statistical results. Most of the observation period (63%) falls within the low debt and high growth quadrant, illustrating that the Philippines has historically achieved stronger growth during periods of fiscal restraint and macroeconomic stability. These findings echo Rosellon and Medalla's (2017) and Bernales et al.'s (2024) conclusions, who argue that prudent debt management, political stability, and favorable external conditions such as high overseas remittances

and strong global demand have been central to sustained economic expansion. Conversely, only 6% of the years fall within the high debt and low growth quadrant, suggesting that although rare, these periods may reflect episodes of fiscal inefficiency, policy misalignment, or external shocks, as was the case during the 1993 energy crisis and the global slowdown following the 2001 terrorist attacks (Clarete et al., 2018; Selva, 2023). The presence of low growth even during periods of low debt, as seen in 1991, 1992, 1998, 2009, and 2020, underscores the complexity of the debt growth relationship. These years were marked by natural disasters, global financial contagions, or health crises, such as the Mount Pinatubo eruption, the Asian Financial Crisis, the Global Financial Crisis, and the COVID-19 pandemic (Clarete et al., 2018; de Lara-Tuprio et al., 2022; Habito, 2005). Such findings reinforce the argument that economic growth trajectories are highly vulnerable to domestic and external shocks and that debt levels alone may not fully account for growth variability (Bentour, 2021).

The results suggest that the relationship between public debt and economic growth in the Philippines is nonlinear and highly contingent on broader macroeconomic conditions, policy responses, and institutional resilience. These findings challenge the notion of a universal debt threshold and instead support a more nuanced perspective that considers country-specific factors, consistent with the critiques raised by Eberhardt and Presbitero (2015), Égert (2015), and Presbitero (2012). Therefore, while maintaining a sustainable debt level is essential, the quality of public spending, countercyclical fiscal strategies, and structural reforms may be equally critical in shaping long-term economic performance in emerging economies such as the Philippines.

CONCLUSION

This study highlights the complexity of the debt-growth relationship in the Philippine context, emphasizing that public debt does not independently determine economic performance. Effective debt management requires maintaining sustainable debt levels and ensuring that borrowed resources are allocated to productive and growth-enhancing sectors. Policymakers should adopt a dynamic and evidence-based fiscal framework integrating debt quality, institutional capacity, and macroeconomic resilience. Future research should incorporate multi-dimensional indicators and policy variables to inform debt sustainability strategies better tailored to national development priorities.

Author Contributions

E. Detoya: Conceptualization, Investigation, Writing-Original draft, Supervision, Formal analysis; **J. Dayap:** Formal analysis, Methodology, Visualization, Writing – review & editing; **J. Estorosos:** Formal analysis, Investigation, Writing – review & editing; **M. K. Mansueto:** Validation, Investigation, Writing – review & editing; **R. Salazar:** Methodology, Formal analysis, Writing – review & editing; **J. Susada:** Conceptualization, Formal analysis, Investigation, Writing-Original draft; **M. T. Vito:** Data curation, Investigation, Writing-Original draft; & **J. Magallon- Avenido**: Conceptualization, Investigation, Writing-Original draft, Supervision

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Ethical Approval

Not applicable.

Competing interest

The authors declare no conflicts of interest.

Data Availability

Data will be made available by the corresponding author on request.

Declaration of Artificial Intelligence Use

In this work, the authors utilized artificial intelligence (AI) tools and methodologies, specifically OpenAI's ChatGPT, to assist with paraphrasing, grammar refinement, and improving the clarity of written content. After using this tool, the authors carefully evaluated and revised the content as necessary and take full responsibility for the published content.

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