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Working Paper

Construction of an index tracker for debt sustainability assessment in the Philippines

ADB Working Paper, No. 1339

Provided in Cooperation with:

Asian Development Bank Institute (ADBI), Tokyo

Suggested Citation: Allado, Armin Paul D. et al. (2022) : Construction of an index tracker for debt sustainability assessment in the Philippines, ADB Working Paper, No. 1339, Asian Development Bank Institute (ADBI), Tokyo,
<https://doi.org/10.56506/LPBC3497>

This Version is available at:

<https://hdl.handle.net/10419/272882>

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CONSTRUCTION OF AN INDEX TRACKER FOR DEBT SUSTAINABILITY ASSESSMENT IN THE PHILIPPINES

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No. 1339
September 2022

Asian Development Bank Institute

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Suggested citation:

Allado, A. P. D., L. N. S. Lim, N. A. T. Tulauan, M. K. M. Abreu, P. L. M. Agabin, and J. C. D. Regio. 2022. Construction of an Index Tracker for Debt Sustainability Assessment in the Philippines. ADBI Working Paper 1339. Tokyo: Asian Development Bank Institute. Available: <https://doi.org/10.56506/LPBC3497>

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Abstract

With economies around the world facing more dire challenges as an immediate result of the COVID-19 pandemic, the need for national governments to borrow funds has grown. The abrupt increase in debt level highlights the importance of implementing suitable models to project emerging debt scenarios and assessing debt sustainability. Given that sustainable debt levels vary from country to country, this study applied the IMF's Debt Sustainability Analysis to assess the Philippines' debt burden over time to be used as an input in the construction of a debt index tracker that incorporates other relevant fiscal and economic indicators. The index tracker serves as an aggregate barometer on whether debt levels have breached the sustainable threshold level. Furthermore, the study will utilize the debt tracker to show the implicit debt ceiling and the available fiscal policy room that can respond to the next potential shock.

Keywords: debt sustainability, Debt Index tracker, sustainable debt threshold level, implicit debt ceiling, available fiscal space

JEL Classification: H63

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1. INTRODUCTION

The challenge brought about by the COVID-19 pandemic goes beyond a health crisis, as it has turned into a multifaceted problem that has not only put pressure on the health sector but also on the economic and financial sectors. The imposition of lockdowns and travel restrictions has taken its toll on different sovereigns, and has consequently led to a global economic downturn. Countries across the globe secured additional financing to implement their respective pandemic response measures to support private households and economic sectors heavily affected by the crisis. Due to the unprecedented spending necessitated by this crisis, various sovereigns are faced with issues such as the ballooning of public debt as well as the sustainability of public debt levels.

A myriad of factors has contributed to the fiscal developments that are observed around the world. Even prior to the pandemic, there have been record low nominal interest rates. With the onset of the pandemic, central banks have continued to implement further rate cuts to aid in terms of economic stimulus. By the end of 2019, a fifth of global bonds were being traded in negative territory (IMF 2020). Access to funds and rate cuts have steadily increased liquidity being circulated in economies, prompting global debt, both public and private, to rise, reaching \$226 trillion in 2020 (Gaspar et al. 2021). Slow growth and prior low inflation have also contributed to economic pressures. Since 2013, real growth rates of gross domestic product (GDP) per capita and public investment-to-GDP ratios have slowed down for emerging and middle-income countries (IMF 2020). Economic slowdown brought about by constrained supply chains and health risks have compounded this slow growth. Combinations of low interest rates, slow growth and the recession brought about by the pandemic have made public debt vulnerabilities even more accentuated.

In general, emerging and middle-income economies' average government debt is seen to maintain an upward trajectory, and the rise in public debt across the world may increase the risk of a fiscal crisis. This highlights the need for proper debt management policies and debt sustainability monitoring so as to mitigate the several risks associated with increasing debt. Downside risks that can put further pressure on growth and public finances include continued resurgence of infection rates, and volatility in commodity prices and in global financial markets. The outbreaks from the pandemic come in the form of waves; with every easing of restrictions come rising infection rates. Rising infection rates dampen consumer confidence in the economy, leading to delayed recovery across badly hit sectors of the economy. Risks associated with large swings in commodity prices can also exacerbate supply and demand shocks that economies may face with the rising and falling of infection rates. Since 2020, markets have experienced bouts of high volatility due to increasing concerns about the economic effects of the pandemic. During the initial lockdown and subsequent market selloff in 2020 following the coronavirus fallout, the Merrill Lynch Option Volatility Estimate (MOVE) Index, an indicator of US interest rate volatility, reached a high of 138.40 points in March 2020 from a low of 49.67 points in January 2020, prompting the FED to intervene amidst heightened market fears. Market pressures spur higher spreads for high-debt countries and exchange rate volatility. The Philippines, one of the fastest-growing emerging markets, mitigates this dilemma by keeping foreign debt to GDP sustained. As of the third quarter of 2021, the Philippines has maintained this metric at 27.3% (Bangko Sentral ng Pilipinas 2022). However, rising foreign debt, liquidity risk, and volatility in sovereign spreads could have sizable implications for the pace of economic recovery and management of public finances.

In the Philippines, the total outstanding national government debt as a percentage of GDP increased by 15 percentage points from 39.6% in 2019 to 54.5% by the end of 2020, which was attributed to the negative real economic growth rate resulting from disruptions in economic activity and the increased spending on COVID-19 emergency responses (Bureau of the Treasury [BTr], 2021). Under normal circumstances, such a large swing should render debt unsustainable, yet there are mitigating shifts in the quality of debt, indicating that it is still sustainable despite the increase in the debt ratio. For example, the share of foreign debt to the total outstanding debt (external debt-to-outstanding debt ratio) and the weighted average interest rate decreased from 2010 to 2020. Hence, the debt-to-GDP ratio alone may not be sufficient to describe the sustainability of debt, especially under the pandemic, and this calls for other alternative measures in assessing debt sustainability.

In light of these developments, this study implements the IMF's Debt Sustainability Framework (DSF) to project the emerging public debt scenario following the COVID-19 pandemic. Specifically, it proposes an alternative debt sustainability analysis framework that looks at various debt indicators, such as national government debt-to-GDP ratio, together with other relevant debt indicators that are used to measure the fiscal viability of the country.

The focus of this study is to aggregate various debt indicators into a composite index that takes into account possible changes in tolerance over time and can be used for cross-country comparison without losing heterogeneity. It develops a public debt assessment index tracker using critical fiscal and economic indicators to assess the sustainability of the national government's debt level. The debt index tracker combines an early warning signal for the eight fiscal and economic indicators with derived weights using the entropy method, which assigns greater weights to indicators with a higher degree of dispersion. An alternative approach is proposed in assigning weights, namely the analytic hierarchy process (AHP), which takes into account the subjective importance of the selected indicators. Finally, given the projections from the IMF's Debt Sustainability Framework as input, the public debt assessment index tracker will be used to assess the sustainability of emerging medium-term fiscal debt.

2. REVIEW OF RELATED LITERATURE

In theory, a public debt is regarded as sustainable when a country is solvent or has a credible ability to honor its current and future financial obligations without resorting to drastic or unfeasible measures. Moreover, debt sustainability requires the projected fiscal balance adjustment to be able to stabilize debt at an acceptable level with low liquidity risks, and to be able to maintain the country's growth potential (IMF 2013). Throughout history, the global economy has experienced severe financial and economic crises accompanied by episodes of rapid debt accumulation and large output losses, which were further amplified by domestic vulnerabilities to sudden extreme shocks. This underscores the need to understand the underlying factors and emerging risks a country faces in employing policies that preserve debt stability and prevent further sovereign debt crises.

At the core of the IMF's debt sustainability framework (IMF DSF) is projecting a country's debt threshold, typically in terms of public debt as a share of GDP, if it is at a dynamically stable trajectory going forward. A growing public debt has a turning point at which it starts to have a large negative impact on a country's growth. As such, significant empirical works have established prescribed debt thresholds to anchor as commitment tools that can help reinforce market confidence and diminish risk premia in

the government and private debt for the whole economy (Fall et al. 2015). Reinhart and Rogoff (2010) found that public debt over 90% of GDP had a detrimental growth impact across both advanced countries and emerging markets. Meanwhile, Fall et al. (2015) suggested different debt thresholds for three groups of countries: first, higher-income countries have a debt threshold range of 70% to 90% of GDP; second, euro area countries that do not have control over monetary policy have a lower debt threshold of 50% to 70%; and lastly, emerging economies who are at risk of capital flow reversals have an even lower debt threshold of 30% to 50% of GDP.

Over time, literature on debt sustainability has expanded its assessment to include various economic and financial indicators beyond the focus on debt dynamics. To supplement the risk analysis of the IMF's DSF in assessing a country's debt capacity, the IMF (2021b) has recently proposed a multivariate logit model for signaling debt vulnerabilities and the likelihood of future debt distress that includes debt burden and buffer indicators such as the change in public debt-to-GDP ratio, public debt-to-revenue ratio, foreign public debt as a share of GDP, and international reserves-to-GDP ratio. Aside from looking at the determinants of debt, a wide range of factors are considered, such as institutional quality and stress history, to characterize a country's structural background, and cyclical indicators such as the current account balance, real effective exchange rate and credit/GDP gap to reflect a country's external position, financial sector, and fiscal position. The model also takes into account global variables such as the change in the VIX proxies to measure global investor risk appetite in sovereigns that are being assessed.

Similarly to a study conducted by Koilo et al. (2020), the assessment of Ukraine's debt security index, which takes into account international experiences, was based on the systematization of indicators in four directions: (1) solvency, which includes external interest payments to exports, external debt service to budgeted revenue, and domestic debt service to budgeted revenue; (2) liquidity, measured by internal reserves to short-term debt, and short-term debt to total outstanding debt; (3) internal indebtedness, which considers ratios of domestic debt to GDP, outstanding public debt securities to GDP, and domestic debt to budgeted revenue; and (4) external indebtedness, which accounts for gross external debt to GDP, official international reserves to external debt, and multilateral debt to total external debt. Results showed that the debt security index, in the analyzed period from 2006 to 2016, decreased by 0.5 percentage points from 2014 to 2016 due to both solvency and domestic indebtedness indicators being at a more dangerous level.

To further the assessment of debt sustainability indicators, researchers have attempted to forecast the probability of the occurrence of debt crisis on the horizon given existing levels and thresholds of individual and integrated indicators. In a geographic-specific sample, Knedlik and von Schweinitz (2012) employed the signals approach presented by Kaminsky and Reinhart (1999) to transform individual indicators of macroeconomic imbalances and composite indicators into binary signal indicators that send an early warning signal of public debt crises in the euro zone. The study found that the government deficit as a share of GDP performs best in predicting a debt crisis, followed by the unemployment rate. Current account balance, domestic demand, non-FMI debt, household debt, private debt, foreign assets, and labor force participation were seen to be good indicators and all have utilities above 0.20. The authors' broad and equality-weighted composite indicator outperformed all other proposed composite indicators in previous studies.

Nursechafia and Muthohharoh (2015) analyzed the debt performance of Indonesia and produced an early warning system on the occurrence of a sovereign debt crisis by applying an empirical tree analysis or a binary recursive tree methodology developed by Manasse and Roubini (2009), which classifies observations from vulnerability indicators, sustainability indicators, and financial debt indicators into crisis or noncrisis-prone. Based on the model, Indonesia had a crisis probability of 2.3% in 2015, classified as noncrisis prone. However, the debt service ratio showed an upward trend, indicating a risk of higher debt burden. Meanwhile, on a local government level of assessing debt risk based on a machine learning algorithm, Chen (2021) constructed a local government risk assessment index that comprehensively weighted relevant indicators that measure the economic, fiscal income and expenditures, and debt situation of local governments in the People's Republic of China (PRC). The early warning forecast of the dynamic index was found to have an overall accuracy of 85.72%, demonstrating its advantage in monitoring, identifying, and warning local government of their systemic risks.

This study, then, focuses on assessing how the Philippines' path of debt sustainability prevailed in 2020 in spite of the unprecedented COVID-19 shock and impact on the economy, most especially on public finances and debt. Furthermore, this paper extends Chen's (2021) weight calculation of relevant fiscal and debt metrics, and builds a modified public debt assessment index tracker to be used as a policy instrument for further warning of risk to debt sustainability in the country.

3. DEBT SUSTAINABILITY ANALYSIS

This study intends to first evaluate the performance and trend of the country's debt stock over time through the IMF DSF and apply the IMF debt sustainability analysis (DSA) using 2021 baseline scenarios reflecting the 179th Development Budget Coordination Committee's (DBCC) macro-fiscal program as reported in Table A.1 of the Appendix. While the IMF already has a publicly available staff report on Philippine debt sustainability (2021a), we develop our own assessment using data only available to the BTr. In particular, we make an adjustment for the general government's accumulation of liquid assets using data for the actual accumulation and drawdown of cash balances for maturing obligations. A key difference emerging is that the IMF (2021a) expects the country's debt stock relative to the economy to expand by 24.1 points from 2020 to 2025 whereas our DSA identifies a 17.7-point increase over the same period. Another difference would be the attribution of factors leading to the cumulative rise in debt. While both our assessment and that of the IMF (2021a) foresee that the GG accumulation and withdrawal of assets can contribute sizably to the debt, we find that these debt-generating flows only impart 7.5 points to the debt stock, a difference of 5.2 points from the figure reported by the IMF (2021a). To reiterate, this difference emerges from disparities in the data that we used.¹ Hence, we do not foresee the Philippine debt-to-GDP ratio to become as bloated as in the IMF's assessment (2021a), as reported in Table A.3 of the Appendix.

Our DSA then identifies a substantial increase of 15 percentage points in the Philippines' gross public sector debt-to-GDP ratio from 2019 to 2020, as reported in Table A.2 of the Appendix. This comes from higher financing requirements accompanied by the contraction in economic activity brought about by the COVID-19

¹ In fact, this dissimilarity also appears in a Philippine Institute for Development Studies (PIDS) study by Debuque-Gonzales et al. (2022).

pandemic.² However, the Philippine economy is rebounding into positive territory (Philippine Statistics Authority [PSA] 2021),³ with stronger medium-term growth prospects of 6% to 7%. As such, the IMF DSA results show that the trajectory of the debt-to-GDP ratio is expected to peak and stabilize around the 60.0% level in 2022 to 2023 and decline thereafter, even as the government projects a large but diminishing fiscal deficit program, programmed to peak at 9.3% of GDP in 2021,⁴ followed by narrower deficits at 7.5% in 2022, 6.3% in 2023, and 5.3% in 2024. The IMF DSA identifies the primary deficit as a significant driver of additions in the current debt stock from 2021 thereafter, with the high growth rates tempering the deficit's effect on debt. Moreover, assuming no deviations of key macro-fiscal assumptions over the projected years, the IMF DSA engine estimates that the debt-stabilizing primary balance of the Philippines is at –2.2% of GDP or the equivalent of 4.6% of GDP in fiscal deficit.⁵

Therefore, this raises important questions on whether the deficit as a ratio of GDP exceeds the threshold needed to attain sustainable debt dynamics, which the upcoming sections of the paper will discuss. Furthermore, we generate a more forward-looking assessment by incorporating the outputs of our DSA, in particular the projected debt ratios, in the construction of the public debt index tracker. This exercise will help provide a clue on whether the higher debt-to-GDP ratios over the coming years will remain sustainable.

4. CONSTRUCTION OF PUBLIC DEBT INDEX TRACKER

This section discusses the construction and calculation of an annual public debt assessment index, and how an index tracker that provides the annual weighted threshold values to be compared with actual data is derived from it. To begin, the process of developing the index consists of three key steps, the first of which is to set the weights for each indicator. Two methods of assigning weights are performed, namely the entropy method and the analytic hierarchy process (AHP). The entropy method provides an objective method of assigning weights based on the degree of dispersion of each indicator as it assigns greater weight to more volatile indicators, while the AHP provides flexibility in weight assignment as it gives more weight to indicators that are deemed more important in achieving debt sustainability. The second step is to use the cumulative sum procedure to determine the threshold value for each indicator. The third step is to compare the index values computed using actual figures as well as threshold values calculated at varying levels of standard deviation.

In constructing the assessment index, the selected indicators must reflect the risk factors of public debt. The indicators evaluated are selected on the basis of relevance to public debt analysis and the availability of data in the context of the Philippines. A total of eight indicators are chosen for this study.

National Government Debt-to-GDP (*NG Debt/GDP*) refers to the ratio of total government debt to total GDP. The *NG Debt/GDP* ratio is one of the main benchmarks of a country's debt sustainability and has major implications for the overall economy. This indicator was chosen as it serves as a common and traditional benchmark in

² We report in Table A.2 of the Appendix that the negative real growth brought on by the pandemic contributed 4.1% of the change in gross public sector debt, whereas a sizable 7.5% contribution can be attributed to residual debt-creating flows.

³ The Philippine economy grew by an average of 5.1% year on year throughout the first three quarters of 2021 (PSA 2021).

⁴ However, the emerging 2021 deficit is at 8.2% of GDP, which is lower than the target by 13%.

⁵ Sum of primary deficit of 2.2% of GDP and interest payment average of 2.4% of GDP.

assessing a country's capacity to repay debt. Policymakers also have the option to make use of the central government or general government data depending on data availability.

The **Domestic-to-External Outstanding Debt Mix** (*Domestic/External Debt Mix*), on the other hand, is the ratio of the total outstanding domestic debt to the total outstanding external debt at the end of a year. Domestic debt is the portion of the national government debt that is owed to local lenders while external debt is the share of debt owed to foreign creditors. Moreover, the **Domestic-to-External Financing Mix** (*Domestic/External Financing Mix*) pertains to the borrowing ratio between domestic and external financing sources. Both the Domestic-to-External Outstanding Debt Mix and the Domestic-to-External Financing Mix serve as a proxy for assessing the foreign currency risk exposure of sovereign debt given that the Philippines is heavily biased towards domestic funding. These two indicators consider both stock and flow data wherein the Domestic-to-External Outstanding Debt Mix takes into account the structural aspect of existing debt while the Domestic-to-External Financing Mix covers the policy outlook aspect of emerging debt.

Furthermore, this study includes debt servicing indicators, namely the **IP-to-GDP** (*IP/GDP*) ratio, the **IP-to-Expenditures** (*IP/Expenditures*) ratio, and the **IP-to-Revenues** (*IP/Revenues*) ratio. The *IP/GDP* ratio allows policymakers to see the portion that debt servicing is taking up relative to the country's GDP. Moreover, the *IP/Expenditures* ratio refers to the share of the government's total spending that is being used to service the country's debt. As for *IP/Revenues*, this refers to how much of a country's revenues, which mostly come from taxes, is being spent on debt servicing. These indicators allow policymakers to assess whether fiscal resources are being funneled towards meaningful and productive spending instead of debt servicing. The Interest Payments (IP)-to-GDP, IP-to-Expenditures, and IP-to-Revenues ratios are used to assess the cost of borrowing and its impact on fiscal operations, including the ability to allocate resources for medium-term development. Hence, these indicators present a forward-looking component as interest payments spill over into future spending and affect available fiscal resources.

Another indicator used in this study is the **Nominal GDP Growth Rate**, which is the annual rate of change of a country's nominal GDP. Nominal GDP is the measure of a country's GDP at current market prices without adjusting for inflation or deflation. This indicator is used to track changes in a country's overall economic value. This indicator was also chosen as this represents the growth rate in the country's income level, which can be used as one of the measures to determine a country's capacity to repay debt.

Lastly, the **Deficit-to-GDP** (*Deficit/GDP*) ratio, which is the share of the deficit (revenues less expenditures) to the GDP, takes into account the fiscal position of the government. It is also the policy variable that indicates whether the country is doing fiscal consolidation or fiscal expansion. For historical years, we make use of *ex post* data, and for the forecasted period, we make use of *ex ante* or target data.

This study develops a public debt assessment index tracker, which considers the eight selected indicators that economic policymakers take into account in managing national government debt.

The first step in developing the index involves assigning weights per indicator. Assigning the correct weights is crucial given that weights correspond to the relative importance of an indicator. The greater the weight of an indicator, the greater its importance is in assessing debt sustainability. The assigned weights are needed inputs to derive the threshold index value, which then serves as an upper limit. Staying below this threshold index value signals that a country's debt level is still sustainable.

The study considers two methods of assigning weights to the selected indicators. The first method is the entropy method, which is an objective weighting procedure that is based on the dispersion of historical data, and it gives heavier weights to more volatile or uncertain indicators. The index construction starts by gathering historical data on the selected indicators for the years 1986 to 2020 to capture different economic cycles. The data are squared to eliminate the negative values, in line with Shannon's (1948) entropy calculation that uses the natural logarithmic function to model data dispersion. After this, the data are normalized by obtaining the contribution of each indicator per year. This can be done through the formula $r_{ij} = \frac{x_{ij}^2}{\sum_{i=1}^n x_{ij}^2}$, where the numerator is the squared value for each data point in time period i and indicator j , and the denominator is the sum of all squared values per indicator. With the normalized values, the entropy value can be calculated. This is done by following the entropy formula of $e_j = -h \sum_{i=1}^n r_{ij} \ln r_{ij}$, $\forall j$. Put simply, this formula computes on a per indicator basis the sum for all years of the product between the normalized indicator value (r_{ij}) and its equivalent natural logarithm value. Subsequently, the sum value is then multiplied by the negative value of h where $h = \frac{1}{\ln(m)}$ and m is equal to the total number of indicators. Finally, the weight assigned to each indicator is calculated by dividing the degree of diversification, $d_j = 1 - e_j$ per indicator, by the sum of all these values, or $w_j = \frac{1 - e_j}{\sum_{j=1}^n (1 - e_j)}$, $\forall j$.

Apart from the entropy method, the study also considers an alternative process in assigning weights through the analytic hierarchy process (AHP) method. In contrast to the entropy method, the AHP method is based on the subjective assessment of the policymaker of the relative importance of each selected indicator as a bellwether of debt sustainability. The adoption of the AHP and its subjective aspect serves as a demonstration in this study, indicating that future adjustments to the model can be done by different policymakers.

For the AHP method, a pairwise comparison is done for all indicators, and ratings are provided based on the relative importance of one indicator over another. Table 1 below provides the scale used to rate the pairs of indicators.

Table 1: Pairwise Comparison Rating under the Analytic Hierarchy Process

Rating	Interpretation
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance

Intermediate values (i.e., 2, 4, 6, and 8) are also possible ratings should they be deemed appropriate by the policymaker. To begin with the AHP method, the indicators are set in both the rows and columns of a matrix to allow the comparison of indicator pairs. To demonstrate, if the policymaker were to compare indicators A and B, and decided to rate indicator A as three times more important than B, this implies that the pair A-B (row-column) has a rating of 3, and the pair B-A (row-column) has a rating of $\frac{1}{3}$. Once ratings have been assigned for all pairs, the matrix values are standardized by obtaining the contribution of each rating to the sum of the ratings in the respective column. Thereafter the weights per indicator are derived by calculating the average of

the normalized ratings per row. After the weights have been assigned per indicator using the AHP method, the weighted actual and weighted threshold index values may then be computed.

The choice of whether to use the entropy method or the analytic hierarchy process will depend on the priority of the policymaker. If the policymaker opts to focus on the degree of uncertainty of indicators, it will be appropriate to use the entropy method. On the other hand, if the policymaker has a strong preference on the prioritization of indicators, then the analytic hierarchy process will be the more appropriate method to use. The rationale in the policymaker's choice of weighting method addresses possible discrepancies in the resulting weights to be applied per indicator. The weighting methods presented in the study provide options to the policymaker to aid in decision-making.

After deriving the weights per indicator, the index construction proceeds to the second step. The cumulative sum (CUSUM) method is used to obtain the upper control limit (UCL) or threshold values per indicator. The study only makes use of UCLs to maintain uniformity in the computation of threshold values. Given this, the signs of the following indicator values were reversed: *Domestic/External Debt Mix*, *Domestic/External Financing Mix*, *Nominal GDP Growth Rate*, and *Deficit/GDP*. Reversing the signs of the values for the *Domestic/External Debt Mix* and the *Domestic/External Financing Mix* was done due to the heavy bias of the Philippines towards domestic financing to attenuate the foreign currency risk exposure of its debt portfolio. The signs of the *Nominal GDP Growth Rate* values were reversed because higher values denote the expansion of the local economy. The signs of the *Deficit/GDP* ratio figures were also reversed as the country has been maintaining an expansionary fiscal policy by ramping up its expenditures in infrastructure and social services.

A CUSUM control chart is created for each indicator to detect the deviation of the actual change in indicator values from the mean. First, the mean (μ_j) and standard deviation (σ_j) were computed per indicator. The mean would be the average year-on-year change in indicator value from 1986 to 2020, and this is computed using the following formula $\mu_j = \frac{\sum_{i=1}^n (x_{ij} - x_{i-1,j})}{n}, \forall j$. Following this, standard deviation is computed as follows: $\sigma_j = \sqrt{\frac{\sum_{i=1}^n (x_{ij} - \mu_j)^2}{n}}, \forall j$. The UCL is computed as: $UCL_j = \mu_j + 2\sigma_j$. The UCL with 2 standard deviations from the mean is used as the base scenario, and this is adjusted across varying standard deviations.

For the CUSUM values, a reference value (K_j) was set at 0.5 sigma (i.e., $0.5\sigma_j$). This would serve as the allowable shift from the target value that one would like to detect. The upper and lower CUSUM values for each individual j value are then calculated as follows:

$$Upper\ CUSUM\ (Sh_i) = MAX[0, Sh_{i-1} + (x_{ij} - x_{i-1,j}) - \mu_j - K_j]$$

$$Lower\ CUSUM\ (Sl_i) = MIN[0, Sl_{i-1} + (x_{ij} - x_{i-1,j}) - \mu_j + K_j]$$

A chart is then constructed per indicator by plotting the UCL as well as the upper and lower CUSUM values for all years, after which the UCL is computed at the following levels of standard deviation for sensitivity analysis purposes: 1.00, 1.25, 1.50, 1.75, and 2.00.

For the third step, the indicators were assessed by comparing the index values that were computed using actual figures and threshold values. The actual value per indicator is computed as the difference between the current year value and the previous year value (i.e., $x_{ij} - x_{i-1,j}$). On the other hand, the threshold value per indicator is the *UCL* as previously calculated. Thereafter, the actual index value is determined by computing the weighted average of the actual indicator values; the weights per indicator were derived using the entropy method. Similarly, the threshold index value is calculated as the weighted average of the *UCL* per indicator. Once the index values are determined, the actual index value is compared to the threshold index values computed at different levels of standard deviation to examine whether the threshold index values were breached.

Finally, with the public debt assessment index, an index tracker can be derived by comparing the weighted threshold value with the weighted actual value. The difference between weighted threshold value and weighted actual value is defined as the *index gap*. A positive value for the index gap implies that the actual value has not breached the threshold limit, and therefore debt levels are still sustainable. A negative value for the index gap signals that the weighted average value has breached the threshold limit, and debt levels may be too high given the resulting indicators. Consequently, the *debt ceiling* can also be derived from the index gap by determining the *NG Debt/GDP* value that will render the weighted actual value to equate the weighted threshold. With the calculation of debt ceiling, the *fiscal policy flexibility* can be determined by obtaining the difference between the debt ceiling and the outstanding debt stock.

5. PUBLIC DEBT ASSESSMENT RESULTS

Table 2 presents the assigned weights for each of the selected indicators using the entropy method. *NG Debt/GDP* and *Domestic/External Debt Ratio* are given the highest weights as these indicators have the highest degree of dispersion. *Domestic/External Financing Ratio* is allocated the lowest weight as it proves to have the lowest degree of dispersion.

Table 2: Entropy Method Weight Assignments for All Selected Indicators for 2020

Indicators	NG Debt/ GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
Weights	13.20%	13.06%	10.34%	12.90%	12.88%	12.84%	12.95%	11.83%

The study also performs a sensitivity analysis of the assigned weights. The deviation of each indicator value from the mean (from 1986 to 2020) is obtained and added to the original indicator value. This results in transformed indicator values that are 2 standard deviations away from the mean. Table 3 shows the computed weights via the entropy method using the adjusted indicator values. Based on the derived weights, it can be observed that indicators with higher weights in Table 2 increased further, as can be seen with the following indicators: *NG Debt/GDP*, *Domestic/External Debt Mix*, *Nominal GDP Growth Rate*, *IP/GDP*, and *IP/Expenditures*. On the other hand, there is a decrease in the computed weights of the remaining indicators with lower assigned weights (*IP/Revenues*, *Deficit/GDP*, and *Domestic/External Financing Mix*).

Table 3: Sensitivity Analysis of Entropy Method Weight Computation for Selected Indicators for 2020

Indicators	NG Debt/ GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
Weights	13.65%	13.40%	9.04%	13.05%	13.07%	12.82%	13.25%	11.72%

Table 4 illustrates a sample input for weight calculation for each of the selected indicators under the AHP. A score of 1 to 9 is given for each pair of indicators in the row and column. A value greater than 1 means that the indicator in the row is more important than the indicator in the column. A value less than 1 means that the indicator in the column is more important than the indicator in the row. A value equal to 1 means that the indicators in the row and column are of equal importance.

Table 4: Analytic Hierarchy Process (AHP) Sample Input for Weight Assignment for All Selected Indicators for 2020

	NG Debt/ GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
NG Debt/GDP	1.00	3.00	2.00	1.00	2.00	2.00	1.00	1.00
Domestic/External Debt Mix	0.33	1.00	1.00	0.33	0.50	0.50	0.25	0.25
Domestic/External Financing Mix	0.50	1.00	1.00	0.50	0.50	0.50	0.33	0.33
IP/GDP	1.00	3.00	2.00	1.00	2.00	2.00	0.33	0.50
IP/Expenditures	0.50	2.00	2.00	0.50	1.00	1.00	0.33	0.33
IP/Revenues	0.50	2.00	2.00	0.50	1.00	1.00	0.33	0.33
Nominal GDP Growth Rate	1.00	4.00	3.00	3.00	3.00	3.00	1.00	1.00
Deficit/GDP	1.00	4.00	3.00	2.00	3.00	3.00	1.00	1.00

Table 5 presents the assigned weights under the AHP based on the sample inputs in Table 4. *Nominal GDP Growth Rate* is allocated the highest weight as it is given a greater importance in debt sustainability than other weights. *Domestic/External Debt Ratio* is allocated the lowest weight as it is given lower priority in debt sustainability relative to other indicators.

Table 5: Analytic Hierarchy Process Weight Assignment for All Selected Indicators for 2020

Indicators	NG Debt/ GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
Weights	16.20%	4.89%	5.93%	13.07%	8.30%	8.30%	22.36%	20.94%

Similarly, a sensitivity analysis is conducted on a per indicator basis using the AHP method by increasing the relative importance of one indicator vis-à-vis the other indicators. However, due to the subjective discretion of the pairwise comparison rating, no general trend can be observed from the resulting weights.

Table 6 presents a matrix containing the actual values and threshold values of selected indicators computed at different levels of standard deviation. The actual values are the change in indicator values (in percentage points) from 2019 to 2020. On the other hand, threshold values are the mean of the year-on-year change of the indicator value

adjusted at varying levels of standard deviation. Threshold values were adjusted by standard deviation levels ranging from 1 to 2.

Based on Table 6, the actual values for the *NG Debt/GDP* ratio, *Nominal GDP Growth Rate*, and *Deficit/GDP* ratio breached the threshold values by 1 to 2 standard deviations. For the remaining five indicators, no threshold values were breached by the actual values.

Table 6: Comparison of Actual Values versus Threshold Values of Selected Indicators for 2020

Indicators		NG Debt/GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
Actual		14.99	-0.19	-0.42	0.27	-0.50	1.82	14.94	4.26
Threshold	1	5.14	0.15	3.36	0.45	2.68	3.15	4.58	1.41
	1.25	6.44	0.19	4.19	0.56	3.42	4.03	5.62	1.74
	1.5	7.74	0.23	5.02	0.68	4.17	4.92	6.66	2.07
	1.75	9.04	0.28	5.85	0.80	4.91	5.80	7.70	2.40
	2	10.35	0.32	6.68	0.92	5.66	6.69	8.73	2.72

Public Debt Assessment Indices

The results in Figure 1 show a comparison of the index values using actual and threshold figures under the entropy method for 2020. On the other hand, Figure 2 shows a comparison of the index values under the AHP method. The index values are the weighted averages of the indicator values with weights that were computed using either the entropy method (Table 2) or the AHP (Table 5).

Figure 1: Results of Public Debt Assessment Index under the Entropy Method

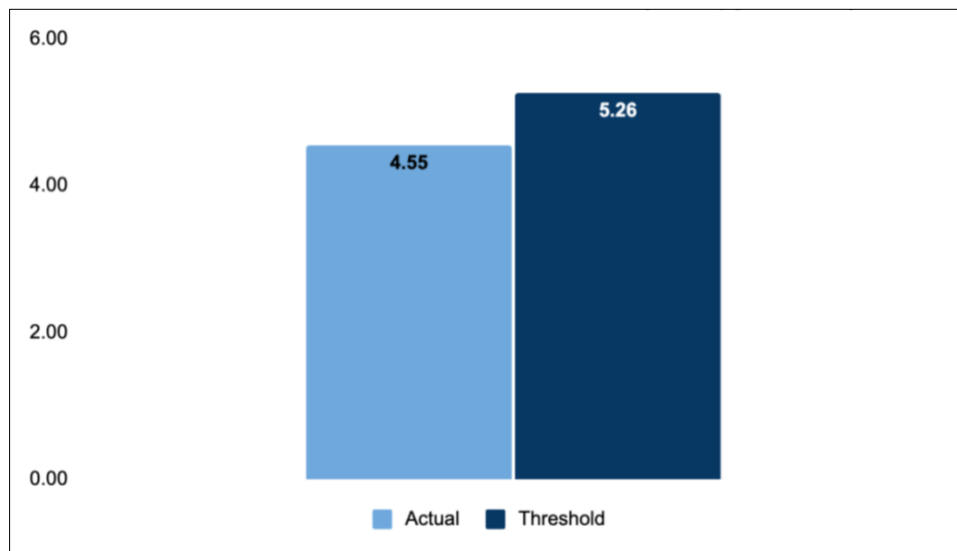
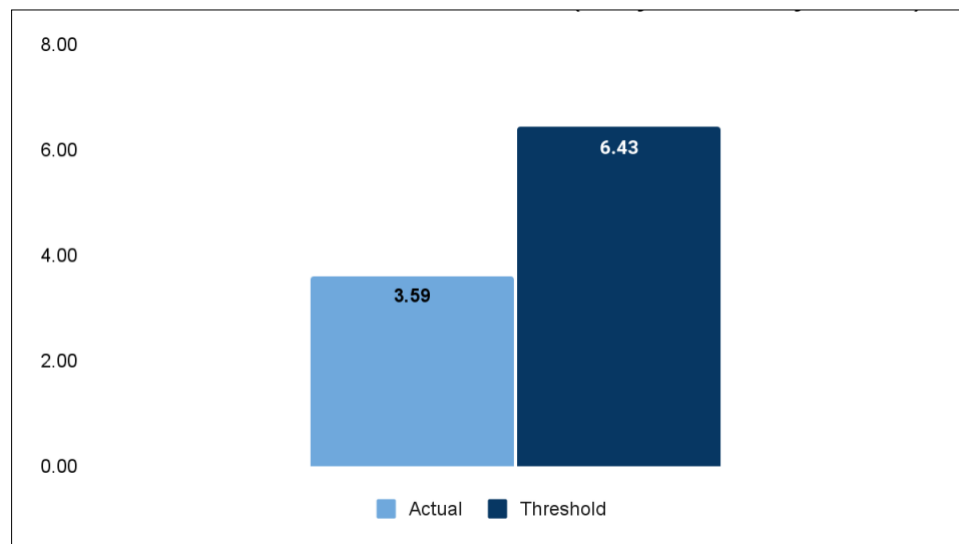


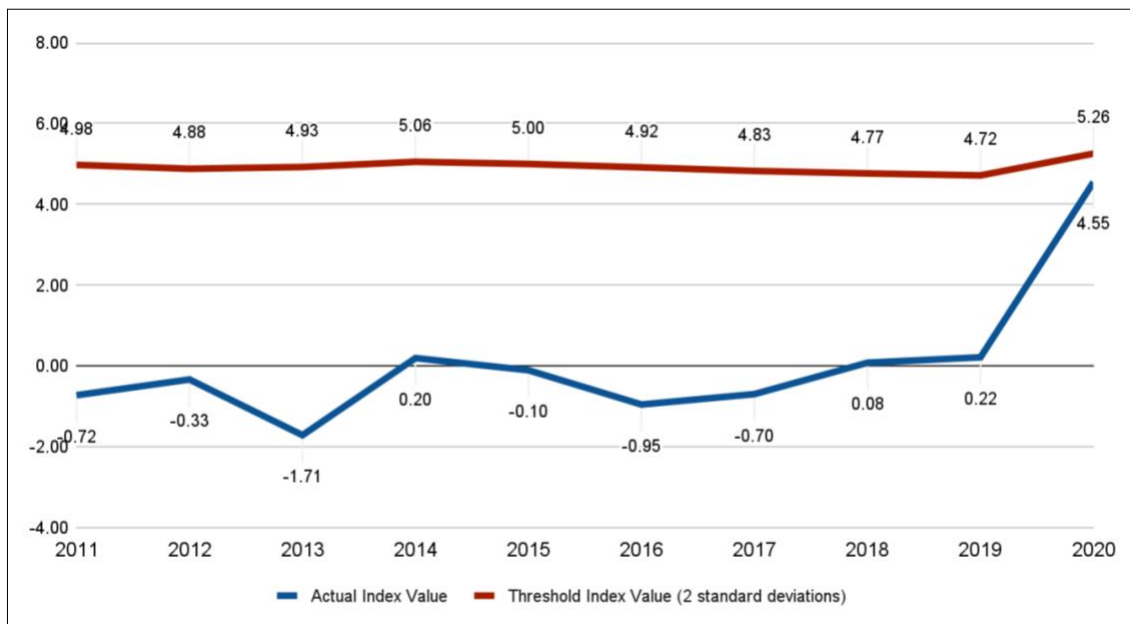
Figure 2: Results of Public Debt Assessment Index under the Analytic Hierarchy Process Method



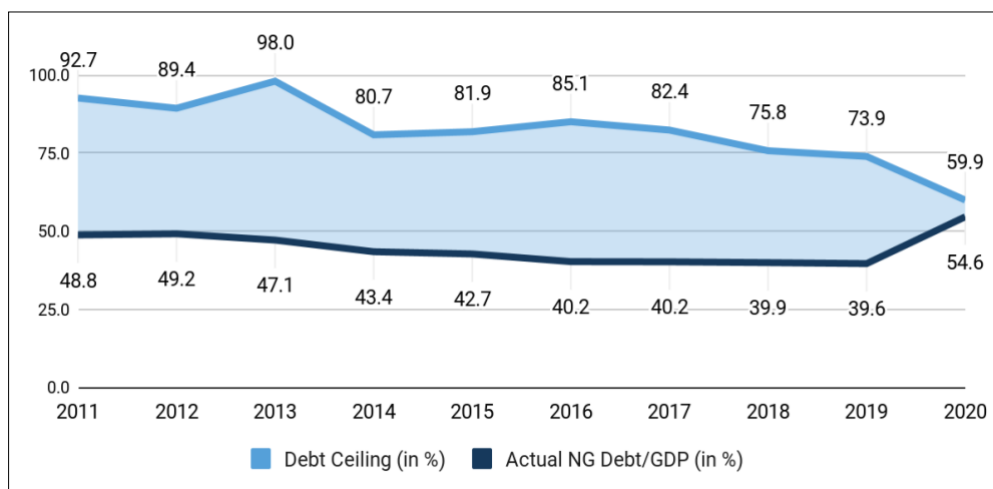
For the public debt assessment index, which considered the eight selected indicators, actual index values were below the threshold index values using the two methods of assigning weights. Under the entropy method, the actual index value was 4.55 whereas the threshold index value computed at 2 standard deviations was 5.26. As for the AHP method, the actual index value was 3.59 while the threshold index value was 6.43. Given the lower actual index values, the debt level in 2020 is deemed sustainable.

After developing the public debt assessment index for 2020, the study constructed a public debt index tracker from 2011 to 2020 as shown in Figure 3. For each year, actual index values and threshold index values (at 2 standard deviations) were computed. The weights used in arriving at the historical index values were calculated using the entropy method. Given that actual index values were below the threshold index values from 2011 to 2020, this shows that the debt levels of the Philippines have been sustainable.

Table 7 shows the annual debt index tracker using the entropy method for weight assignment and setting 2 standard deviations for cumulative sum threshold values. A comparison of the actual and threshold values shows that the Philippine debt level was on a sustainable path from 2011 to 2020, with the actual value remaining below the threshold value even in 2020. Furthermore, the table provides the *implied debt ceiling* (maximum *NG Debt/GDP*) and *fiscal policy flexibility*. The *implied debt ceiling* is the maximum *NG Debt/GDP* level that would make the actual index value exceed the threshold index value. On the other hand, the *fiscal policy flexibility* is the difference between the *implied debt ceiling* and the actual *NG Debt/GDP* ratio for a particular year; this would be the legroom available for policy movements should the *fiscal policy flexibility* value be greater than 0. Note that the *NG Debt/GDP* for 2020 of 54.60% is still below the ceiling of 59.97%. There is still some room for policy adjustments given the *fiscal policy flexibility* value of 5.37%.

Figure 3: Public Debt Index Tracker from 2011 to 2020**Table 7: Annual Debt Index Tracker, Implied Debt Ceiling, and Fiscal Policy Flexibility from 2011 to 2020**

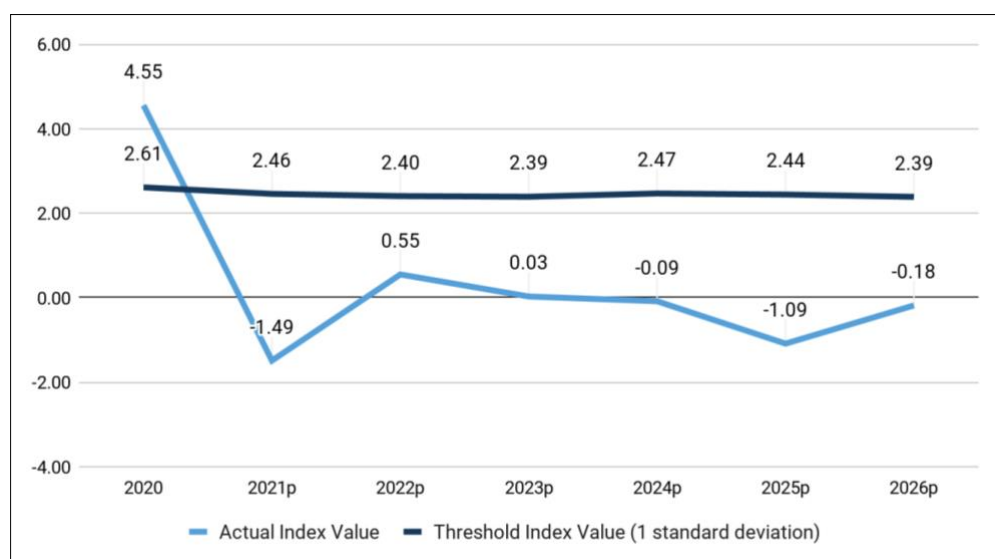
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Actual Index Value	-0.72	-0.33	-1.71	0.20	-0.10	-0.95	-0.70	0.08	0.22	4.55
Threshold Index Value (2 standard deviations)	4.98	4.88	4.93	5.06	5.00	4.92	4.83	4.77	4.72	5.26
Actual NG Debt/GDP (in %)	48.81	49.16	47.14	43.43	42.70	40.25	40.18	39.93	39.61	54.60
Debt Ceiling (in %)	92.65	89.37	98.04	80.86	81.85	85.05	82.38	75.77	73.94	59.97
Fiscal Policy Flexibility (in %)	43.84	40.21	50.9	37.43	39.15	44.8	42.2	35.84	34.33	5.37

Figure 4: Debt Ceiling and Fiscal Policy Flexibility from 2011 to 2020 (in %)

Furthermore, a public debt index tracker from 2020 to 2026 (Figure 5) was developed. Excluding the *NG Debt/GDP*, the rest of the indicator values from 2021 to 2024 are projections and assumptions made by the DBCC. Values from 2025 to 2026 are based on Bureau of the Treasury staff assumptions that indicator values will return to long-term average levels. *NG Debt/GDP* values from 2021 to 2026 are based on the IMF DSA results.

Since the country is still under the pandemic, a more conservative setting of threshold values was adopted using 1 standard deviation in the public debt index tracker from 2020 to 2026. For each year, actual index values and threshold index values were computed. The weights used in arriving at the historical index values were calculated using the entropy method. It can be seen that the actual index value in 2020 exceeded the threshold index value at 1 standard deviation; however, from 2021 to 2026, with the growth outlook of the Philippines, debt levels are projected to be sustainable given that actual index values are below the threshold.

Figure 5: Public Debt Index Tracker from 2020 to 2026



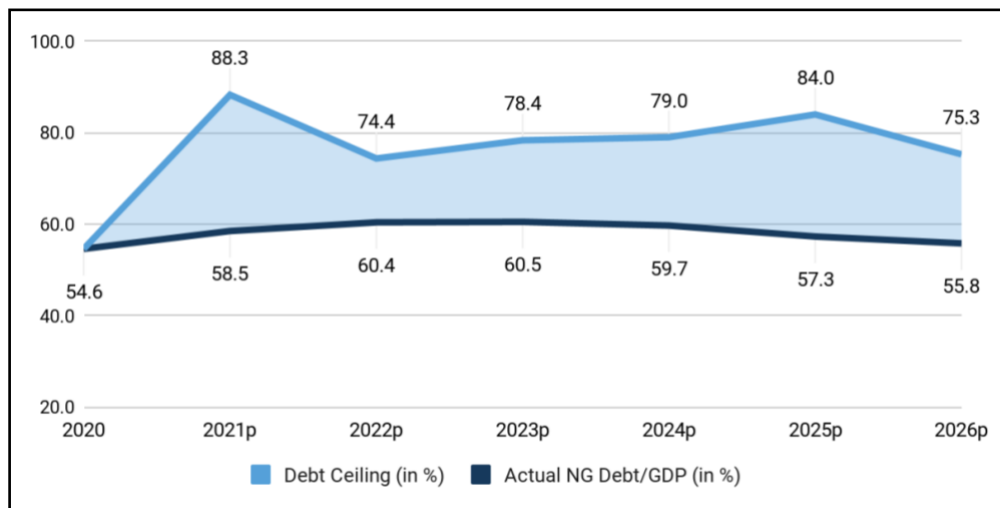
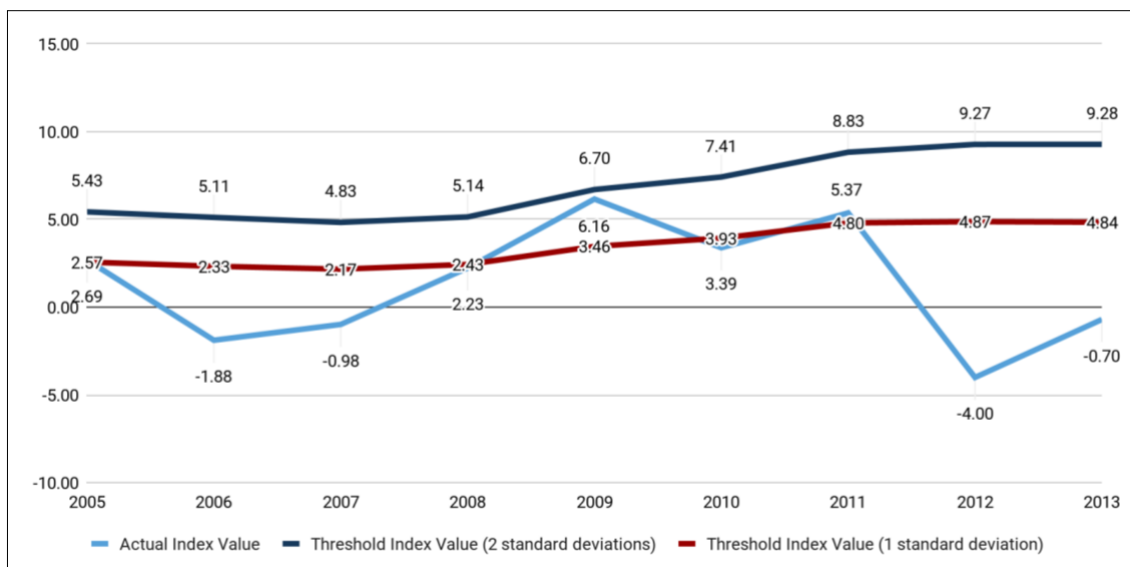
* p: projected.

Table 8 shows the annual debt index tracker from 2020 to 2026 using the entropy method for weight assignment and setting 1 standard deviation for cumulative sum threshold values. Comparison of the actual and threshold values shows the sustainability of the Philippines' debt levels given the downward trend of the actual index values and that they remain below the threshold index values from 2021 to 2026. Moreover, there is room for the country to absorb more debt given the optimistic outlook of the country's recovery and growth, which is evident in the increase in Nominal GDP Growth Rate (as seen in Table A.1 in the Appendix). The projected growth rate values led to higher index values and consequently resulted in higher *debt ceiling* values.

To further test the methodology, a public debt index tracker for Greece from 2005 until 2013 was constructed to validate whether the debt crisis that Greece faced in 2009 would be reflected in the results. Based on Figure 7, as can be seen in 2009, the actual index value breached the threshold index value adjusted by 1 standard deviation and almost exceeded the threshold index value adjusted by 2 standard deviations.

Table 8: Annual Debt Index Tracker, Implied Debt Ceiling, and Fiscal Policy Flexibility from 2020 to 2026

	2020	2021p	2022p	2023p	2024p	2025p	2026p
Actual Index Value	4.55	-1.49	0.55	0.03	-0.09	-1.09	-0.18
Threshold Index Value (1 standard deviation)	2.61	2.46	2.40	2.39	2.47	2.44	2.39
Actual NG Debt/GDP (in %)	54.60	58.50	60.40	60.50	59.70	57.30	55.80
Debt Ceiling (in %)	39.89	88.31	74.38	78.36	79.03	84.01	75.29
Fiscal Policy Flexibility (in %)	0.00	29.81	13.98	17.86	19.33	26.71	19.49

Figure 6: Debt Ceiling and Fiscal Policy Flexibility from 2020 to 2026 (in %)**Figure 7: Greece Public Debt Index Tracker (2005–2013)**

As an extension to this study, public debt index trackers from 2011 to 2019 are developed for Malaysia and Thailand to compare the Philippines' debt sustainability with its Southeast Asian peers (Figures 8, 9, 10). The selection of Southeast Asian countries, the indicators used, and the historical data coverage from 1996 to 2019 are based on the availability of data from the World Bank and the International Monetary Fund.

As can be observed, given the larger gap between the actual index values and threshold index values of the Philippines and Thailand, these results suggest larger fiscal policy flexibilities for these two countries. Based on the public debt index trackers of the three Southeast Asian countries, the respective debt levels are still sustainable given that actual index values remain below the threshold index values from 2011 to 2019.

Figure 8: Philippines Public Debt Index Tracker from 2011 to 2019

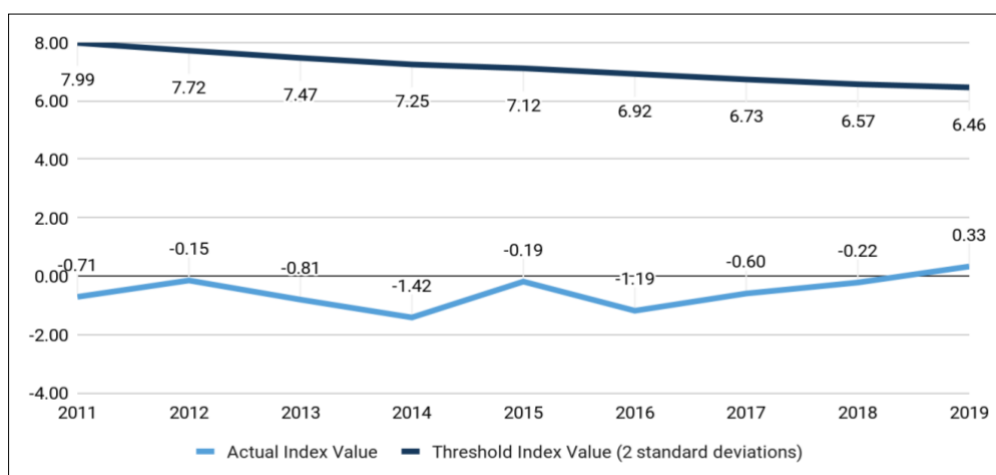


Figure 9: Malaysia Public Debt Index Tracker from 2011 to 2019

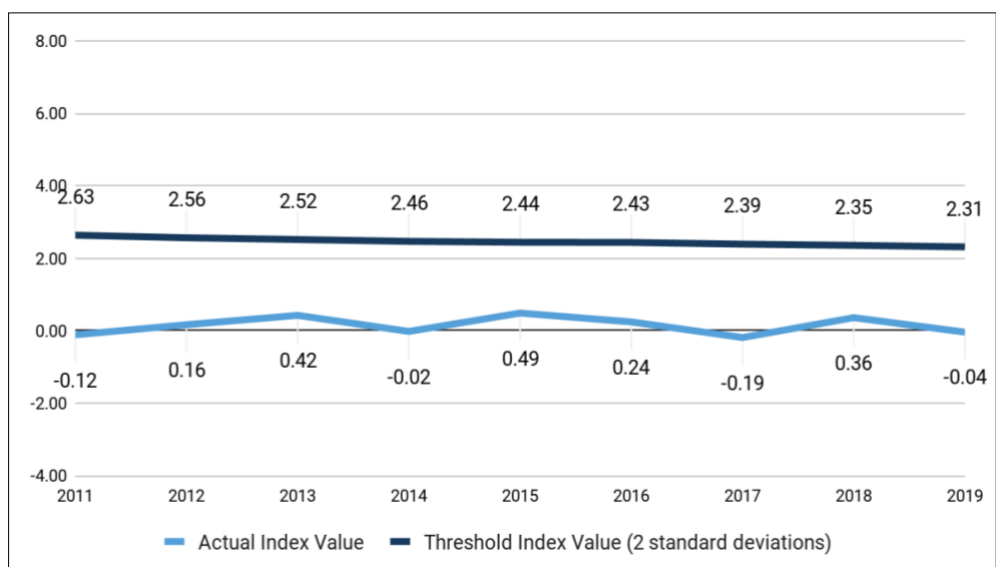
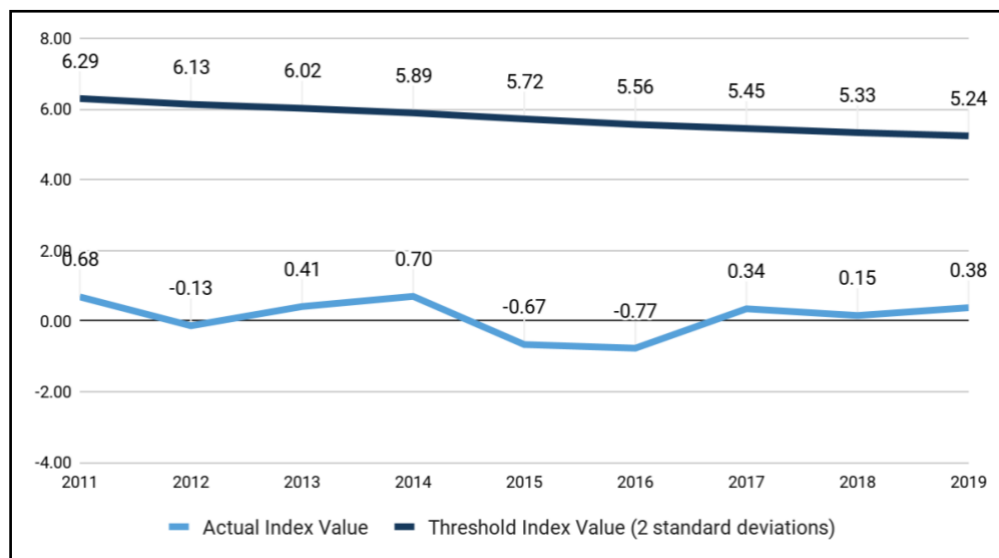


Figure 10: Thailand Public Debt Index Tracker from 2011 to 2019

6. CONCLUSION AND RECOMMENDATIONS

An evaluation of the Philippines' debt stock over time by applying the IMF's debt sustainability analysis (DSA) using the 2021 macro-fiscal assumptions as the baseline scenario shows how the country's gross public sector debt-to-GDP ratio could peak around the 60% level in 2022 to 2023, and may subsequently decline soon thereafter. In order to supplement the debt evaluation, the study adopts debt-to-GDP projections from the DSA as well as selecting debt risk indicators in the public debt index tracker.

The study presents the applicability of constructing a debt assessment tracker using both objective (entropy method) and subjective (analytic hierarchy process) methods of weight assignment and the cumulative sum method for determining threshold levels. When analyzing the results of the public debt index tracker, they point to the conclusion that the current debt level is still sustainable, leaving some fiscal space in case of further adverse shocks. Assessment of debt sustainability can be further refined by adjusting the scenarios using the flexibility offered by the analytic hierarchy process. This allows for different outcomes that policymakers can use to aid in decision-making.

As countries recover from the COVID-19 pandemic, the public debt assessment tracker puts together macroeconomic and debt indicators, not just *NG Debt-to-GDP* ratio alone, to evaluate debt sustainability. The *Nominal GDP Growth Rate* will serve as a measure of economic expansion and suggest the capacity of a country to outgrow its debt. Interest payment (IP) metrics will reflect future interest rate movements and policy decisions on short-term, medium-term, and long-term borrowings. Financing mix and borrowing mix ratios will show policy decisions concerning foreign currency borrowings, and the *Deficit/GDP* ratio points at the pace of fiscal consolidation and expansion. This study emphasizes the importance of how these indicators collectively serve as a barometer for assessing debt sustainability for post-pandemic public debt management.

Capital market development continues to be a key policy goal that the Philippines is working towards. This includes developing the bond market and improving liquidity conditions in the secondary market. In the context of this study, given that the entropy method and AHP can be adjusted when other indicators are considered, future studies can also explore other variables to incorporate demand-side factors such as traded volume in the domestic market, turnover of trades, and year-on-year change in the size of the bond market. Also, other studies may look at external factors that are important in debt sustainability and at the same time are uncorrelated or have a relatively low degree of correlation with existing indicators used in the study.

Furthermore, as debt sustainability operates not only in the supply-and-demand channel but also in the expectations channel, future research can consider extending this study from the point of view of forward-looking bond investors. For instance, future studies can look at how market expectations on interest rates and liquidity affect debt sustainability. From there, apart from focusing on levels of debt, additional points of interest may include the direction of expected change, how fast it is rising, and the distance of the Philippines' solvency level versus its peers.

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APPENDIX A: SUPPLEMENTARY TABLES AND FIGURES

Table A.1: Baseline Debt and Economic Indicators for the Philippine Debt Sustainability Analysis (DSA)¹

Variables	Actual					Projections ²				
	2010–2018	2019	2020	2021	2022	2023	2024	2025	2026	
Nominal national government debt (in % of GDP)	44.6	39.6	54.6	58.5	60.4	60.5	59.7	57.3	55.8	
Public gross financing needs (in % of GDP)	5.6	4.8	6.4	15.9	16.7	16.1	15.3	12.1	10.4	
Real GDP growth (in %)	6.4	6.1	–9.6	6.5	8.0	6.5	6.5	6.3	6.3	
Inflation (GDP deflator, in %)	2.4	0.8	1.6	3.9	3.0	3.0	3.0	3.1	3.1	
Nominal GDP growth (in %)	9.0	6.9	–8.1	10.7	11.2	9.7	9.7	9.6	9.6	
Effective interest rate ³ (in %)	5.6	4.8	4.7	4.3	4.3	4.2	4.5	4.8	4.9	

¹ On the back of these debt and economic indicators, sovereign spreads and sovereign credit ratings are also included in the DSA baseline scenario. As of 7 May 2021, the long-term spread over US bonds stood at 48 basis points (bps), while the five-year credit default swap (CDS) registered 47 bps. Local and foreign bond ratings were Baa2 for Moody's, BBB+ for Standard and Poor's, and BBB for Fitch Ratings.

² The figures reflect the projections of the 179th DBCC on 18 May 2021.

³ This is defined by the IMF (2021b) as the proportion of interest payments to the debt stock, excluding guarantees, at the end of the previous year.

Source: Development Budget Coordination Committee (2021).

Table A.2: Contributions to Changes in Public Debt Identified by the DSA

Variables	Actual					Projections ¹				
	2010–2018	2019	2020	2021	2022	2023	2024	2025	2026	Cumulative
Change in national government debt	–1.4	–0.3	15.0	3.9	1.9	0.1	–0.7	–2.4	–1.5	1.2
Identified debt-creating flows	–1.9	–0.1	7.5	3.9	1.1	0.1	–0.7	–2.4	–1.5	0.4
Primary deficit	–0.5	1.1	1.7	7.0	4.9	3.8	2.7	0.6	0.6	19.8
Primary revenues and grants	–12.9	–14.6	–17.5	–14.5	–14.9	–14.8	–15.1	–15.1	–15.1	–89.4
Primary expenditures	12.4	15.7	19.2	21.6	19.8	18.6	17.8	15.7	15.7	109.1
Automatic debt dynamics ²	–1.3	–1.3	4.7	–3.1	–3.7	–3.0	–2.9	–2.6	–2.5	–17.8
Interest rate/growth differential	–1.5	–0.8	5.5	–3.1	–3.7	–3.0	–2.9	–2.6	–2.5	–17.8
Real interest rate	1.3	1.5	1.4	0.1	0.5	0.6	0.7	0.8	0.8	3.5
Real GDP growth	–2.7	–2.3	4.1	–3.2	–4.2	–3.6	–3.6	–3.4	–3.3	–21.3
Exchange rate depreciation	0.2	–0.5	–0.8	–	–	–	–	–	–	–
Other debt-creating flows ³	–0.1	0.1	1.1	0.0	–0.2	–0.7	–0.6	–0.4	0.3	–1.6
Residual, including asset changes ⁴	0.5	–0.2	7.5	0.0	0.8	0.0	0.0	0.0	0.0	0.8
Debt-stabilizing primary balance ⁵							–2.2			

¹ The projections are based on the baseline macro-fiscal program of the 179th DBCC.

² The IMF (2021b) defines the debt dynamics with the following equation, $\{[r - \pi(1 + g) - g + \alpha e(1 + r)] / (1 + g + \pi + g\pi)\}d_{t-1}$, where d_{t-1} is the NG debt ratio during the previous period, r equals the nominal effective interest rate, π equals the growth of the GDP deflator, g is the real GDP growth rate, α is the share of debt denominated in foreign currencies, and e is the nominal depreciation of the peso against the US dollar.

³ This is the sum of the contributions of cash drawdown and accumulation and contingent liabilities to the change in gross public debt.

⁴ The IMF (2021b) includes asset changes and interest revenues, as well as exchange rate changes during the projection period.

⁵ The IMF (2021b) assumes that the variables do not evolve from their level at the last projection year.

Source: IMF (2021b) and authors' calculations.

Table A.3: Comparison of the IMF (2021a) DSA and the Authors' DSA

	Period						2020–2025
	2020 ¹	2021	2022	2023	2024	2025	
<i>National Government Debt-to-GDP Ratio (change in percentage points)</i>							
IMF	51.9 (14.9)	57.7 (5.9)	60.2 (2.4)	61.6 (1.4)	61.9 (0.3)	61.1 (−0.8)	61.1 (24.1)
Authors	54.6 (15.0)	58.5 (3.9)	60.4 (1.9)	60.5 (0.1)	59.7 (−0.7)	57.3 (−2.4)	57.3 (17.7)
Difference	2.7 (0.1)	0.8 (−2.0)	0.2 (−0.5)	−1.1 (−1.3)	−2.2 (−1.0)	−3.8 (−1.6)	−3.8 (−6.4)
<i>Primary Deficit Flows</i>							
IMF	3.9	5.1	3.5	2.8	1.5	0.6	17.5
Authors	1.7	7.0	4.9	3.8	2.7	0.6	20.8
Difference	−2.2	1.9	1.4	1.0	1.2	0.0	3.3
<i>Interest Rate-Growth Differential</i>							
IMF	5.1	−1.5	−2.6	−2.5	−2.3	−2.4	−6.1
Authors	5.5	−3.1	−3.7	−3.0	−2.9	−2.6	−9.8
Difference	0.4	−1.6	−1.1	−0.5	−0.6	−0.2	−3.7
<i>Accumulation and drawdown of balances and residual flows, including asset changes</i>							
IMF	5.8	2.2	1.5	1.1	1.1	1.0	12.7
Authors	8.6	0.0	0.6	−0.7	−0.6	−0.4	7.5
Difference	2.8	−2.2	−0.9	−1.8	−1.7	−1.4	−5.2

¹ For 2020, the authors use the already realized figures for the said period.

Table A.4: Summary Statistics of the Selected Debt Indicators

Statistic	NG Debt/ GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
<i>Full Sample (1986–2020)</i>								
Mean	52.642	1.445	2.758	3.623	21.714	25.105	10.030	−2.239
Standard Deviation	8.443	0.348	2.590	1.157	7.184	8.659	4.389	1.737
Skewness	0.508	0.493	3.432	0.096	−0.030	0.115	−1.789	−0.620
Kurtosis	2.786	1.960	17.621	1.795	1.995	1.822	9.535	4.051
Jarque-Bera Test Statistic [p-value]	1.573 [0.455]	2.993 [0.224]	380.474 [0.000]	2.172 [0.338]	1.478 [0.478]	2.099 [0.350]	80.958 [0.000]	3.856 [0.145]
<i>1986–1989</i>								
Mean	53.520	1.200	3.008	4.525	28.965	34.893	12.913	−2.768
Standard Deviation	4.315	0.108	0.895	0.954	6.386	5.565	4.757	1.196
Skewness	−0.363	−0.082	−0.425	−1.033	−1.029	−0.561	−0.589	−0.968
Kurtosis	1.470	1.276	1.581	2.232	2.246	2.071	1.802	2.185
Jarque-Bera Test Statistic [p-value]	0.478 [0.787]	0.500 [0.779]	0.456 [0.796]	0.809 [0.667]	0.800 [0.670]	0.354 [0.838]	0.471 [0.790]	0.735 [0.692]
<i>1990–1999</i>								
Mean	52.615	1.369	1.804	4.055	23.927	25.799	12.279	−1.054
Standard Deviation	6.127	0.264	1.590	1.071	5.940	7.569	2.935	1.458
Skewness	1.270	0.076	0.050	0.393	0.234	0.515	0.097	−0.233
Kurtosis	3.938	1.975	1.826	1.621	1.477	1.949	1.551	1.811
Jarque-Bera Test Statistic [p-value]	3.054 [0.217]	0.447 [0.800]	0.578 [0.749]	1.050 [0.592]	1.058 [0.589]	0.902 [0.637]	0.890 [0.641]	0.679 [0.712]

continued on next page

Table A.4 *continued*

Statistic	NG Debt/ GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
<i>2000–2009</i>								
Mean	60.621	1.191	2.235	4.234	25.105	30.203	9.649	–2.792
Standard Deviation	7.448	0.154	1.473	0.644	3.928	5.367	2.426	1.593
Skewness	0.232	0.225	1.860	–0.182	0.241	–0.132	–0.957	0.509
Kurtosis	1.743	2.006	5.489	1.567	1.710	1.597	3.581	1.836
Jarque-Bera Test Statistic [<i>p</i> -value]	0.748 [0.688]	0.496 [0.780]	8.348 [0.015]	0.911 [0.634]	0.791 [0.673]	0.850 [0.654]	1.668 [0.434]	0.996 [0.608]
<i>2010–2019</i>								
Mean	44.141	1.800	4.155	2.369	14.481	16.578	8.821	–2.118
Standard Deviation	4.274	0.239	4.106	0.460	3.606	4.314	1.789	0.982
Skewness	0.278	–1.143	2.348	0.266	–0.120	0.431	–0.109	0.187
Kurtosis	1.390	2.756	7.064	1.655	1.441	1.957	2.862	1.919
Jarque-Bera Test Statistic [<i>p</i> -value]	1.210 [0.546]	2.203 [0.332]	16.066 [0.000]	0.871 [0.647]	1.037 [0.595]	0.763 [0.683]	0.028 [0.986]	0.546 [0.761]

APPENDIX B: CONSTRUCTION OF AN ALTERNATIVE INDEX

As a point of exploration to the study, a second index was constructed to consider solely current debt stock and debt servicing levels, as measured by *NG Debt/GDP* and *IP/GDP*, respectively, together with the indicators uncorrelated to these. This is to assess the sustainability of the country's current debt level and debt servicing.

Table B.1 shows the correlation between the pairs of indicators. Note that historical data from 1986 to 2020 were gathered to capture different economic cycles. Cells highlighted in green pertain to pairs with positive correlation. Cells highlighted in red pertain to pairs with negative correlation. *NG Debt/GDP* is uncorrelated with *Nominal GDP Growth Rate* while *IP/GDP* is uncorrelated with *Deficit/GDP*. As such, the said index comprises the following indicators: *NG Debt/GDP*, *Nominal GDP Growth Rate*, *IP/GDP*, and *Deficit/GDP*.

Table B.1: Correlation Heatmap of Eight Selected Indicators (1986–2020)

Indicators	NG Debt/GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
NG Debt/GD	1.0000							
Domestic/External Debt Mix	−0.6078	1.0000						
Domestic/External Financing Mix	−0.2411	0.3036	1.0000					
IP/GDP	0.6385	−0.7681	−0.2227	1.0000				
IP/Expenditures	0.5946	−0.7420	−0.1597	0.9806	1.0000			
IP/Revenues	0.6719	−0.8110	−0.1816	0.9622	0.9573	1.0000		
Nominal GDP Growth Rate	−0.0162	−0.4264	−0.0776	0.5221	0.5912	0.4749	1.0000	
Deficit/GDP	−0.2672	0.1365	0.1029	0.0314	0.1438	−0.1243	0.5613	1.0000

Table B.2 shows the assigned weights for *NG Debt/GDP*, *IP/GDP*, *Nominal GDP Growth Rate*, and *Deficit/GDP* using the entropy method. *NG Debt/GDP* has nearly the same weight as *Nominal GDP Growth Rate* since the two indicators have approximately the same level of dispersion. *Deficit/GDP* was allocated the least weight given its lower degree of dispersion relative to the other indicators in this index.

Table B.2: Entropy Method Weight Assignments for Assessing Debt Level and Debt Servicing in 2020

Indicators	NG Debt/GDP	IP/GDP	Nominal GDP Growth Rate	Deficit/GDP
Weights	26.08%	25.41%	25.52%	22.99%

Table B.3 is a sample input for weight calculation for the indicators that are uncorrelated to the *NG Debt/GDP* and *IP/GDP* ratios using the AHP.

Table B.3: Analytic Hierarchy Process Sample Input for Weight Assignment for Assessing Debt Level and Debt Servicing in 2020

	NG Debt/GDP	IP/GDP	Nominal GDP Growth Rate	Deficit/GDP
NG Debt/GDP	1.00	1.00	1.00	1.00
IP/GDP	1.00	1.00	0.33	0.50
Nominal GDP Growth Rate	1.00	3.00	1.00	1.00
Deficit/GDP	1.00	2.00	1.00	1.00

Table B.4 shows the assigned weights under the AHP method based on the sample input in Table B.3. *Nominal GDP Growth Rate* has the highest weight as it was given a higher importance in debt sustainability relative to other weights. *IP/GDP* is allocated the lowest weight as it was given lower priority in debt sustainability compared to other indicators.

Table B.4: Analytic Hierarchy Process Weight Assignments for Assessing Debt Level and Debt Servicing in 2020

	NG Debt/GDP	IP/GDP	Nominal GDP Growth Rate	Deficit/GDP
Weights	24.46%	15.89%	31.61%	28.04%

Table B.5 presents a matrix containing the actual values and threshold values of the four indicators computed at different levels of standard deviation. The actual values for the *NG Debt/GDP* ratio, *Nominal GDP Growth Rate*, and *Deficit/GDP* ratio breached the threshold values from 1 to 2 standard deviations.

Table B.5: Comparison of Actual Values versus Threshold Values of Indicators for Assessing Debt Level and Debt Servicing in 2020

Indicators		NG Debt/GDP	IP/GDP	Nominal GDP Growth Rate	Deficit/GDP
Actual		14.99	0.27	14.94	4.26
	1	5.14	0.45	4.58	1.41
	1.25	6.44	0.56	5.62	1.74
Threshold	1.5	7.74	0.68	6.66	2.07
	1.75	9.04	0.80	7.70	2.40
	2	10.35	0.92	8.73	2.72

The results in Figure B.1 and Figure B.2 show a comparison of the actual and threshold index values making use of the entropy method and AHP, respectively. It can be seen that actual index values breached threshold index values when only four indicators were taken into account. However, it should be noted that the main index in the study consisting of eight indicators provides a relatively better picture in analyzing the debt scenario of the country since these are the indicators that are regularly monitored by policymakers in relation to debt sustainability.

Figure B.1: Results of Public Debt Assessment Index under the Entropy Method

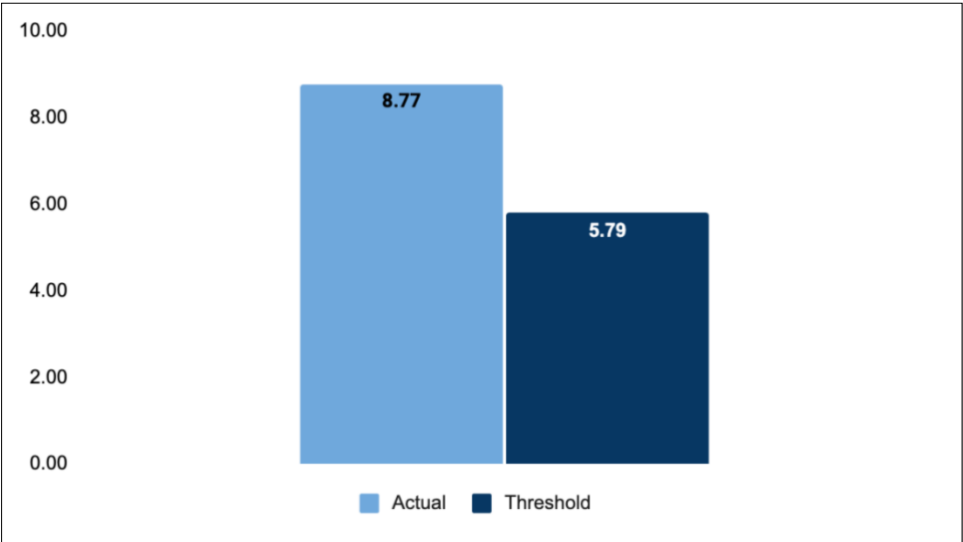
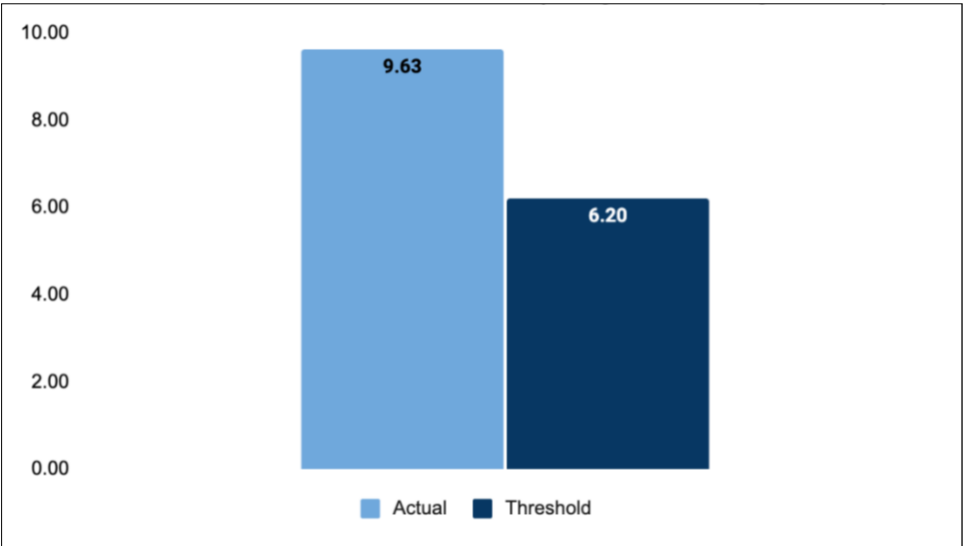


Figure B.2: Results of Public Debt Assessment Index under the Analytic Hierarchy Process



APPENDIX C: PUBLIC DEBT INDEX TRACKER

Appendix C contains charts that show the actual and threshold values per indicator from 2011 to 2020 that were used in the development of the public debt index tracker as shown in Figure 3.

Figure C.1: National Government Debt-to-GDP Tracker

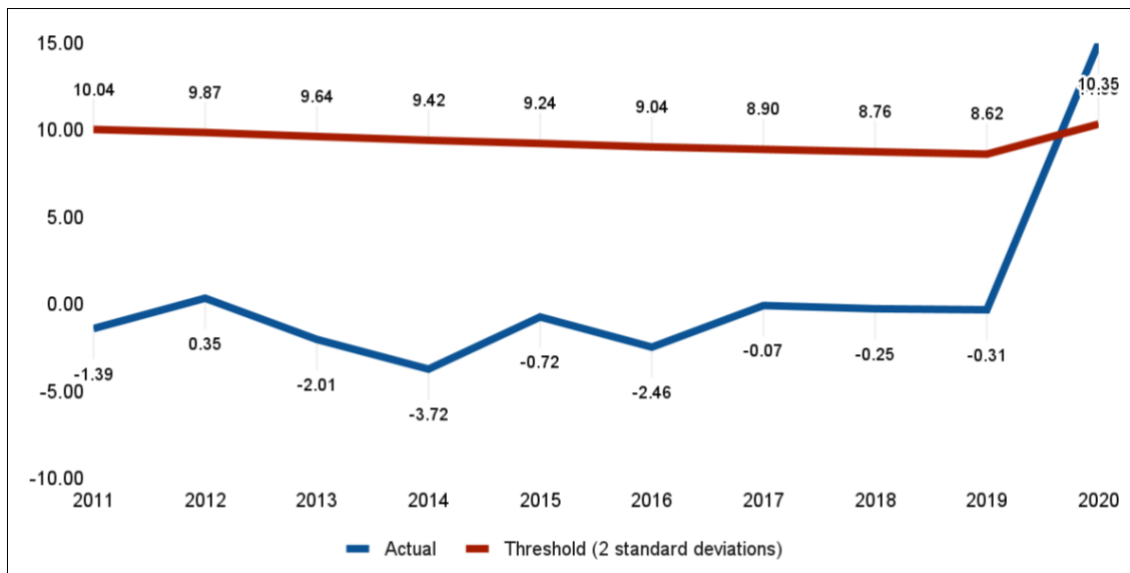


Figure C.2: Domestic-to-External Outstanding Debt Mix Tracker

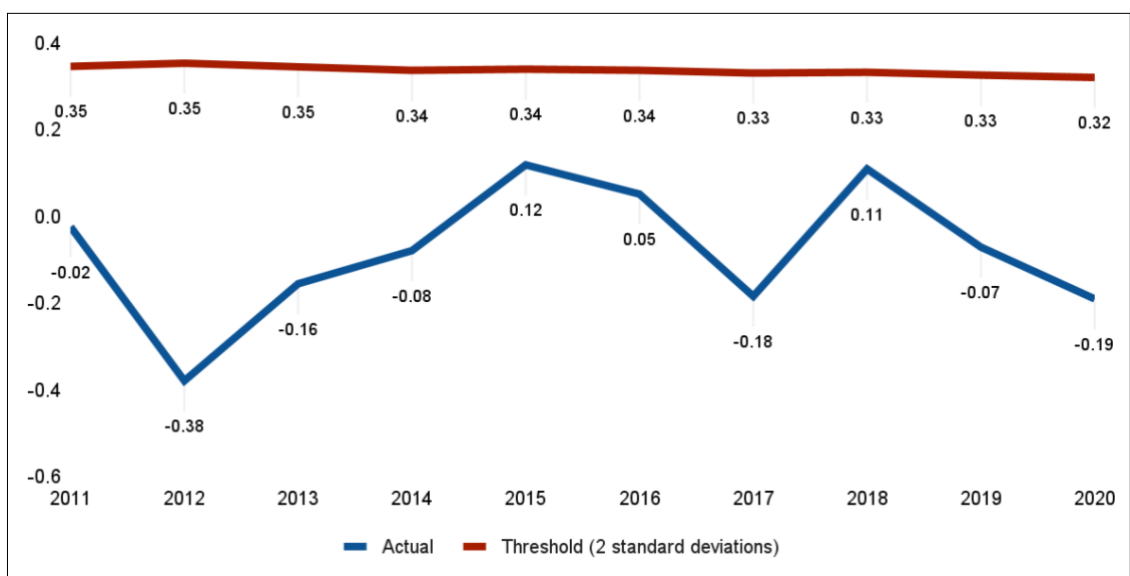


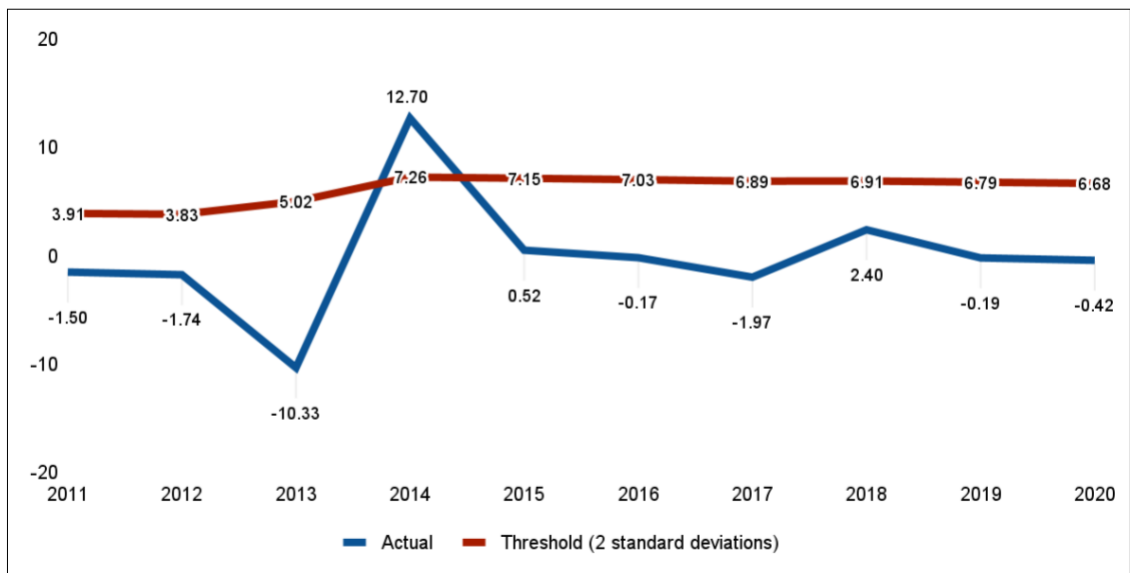
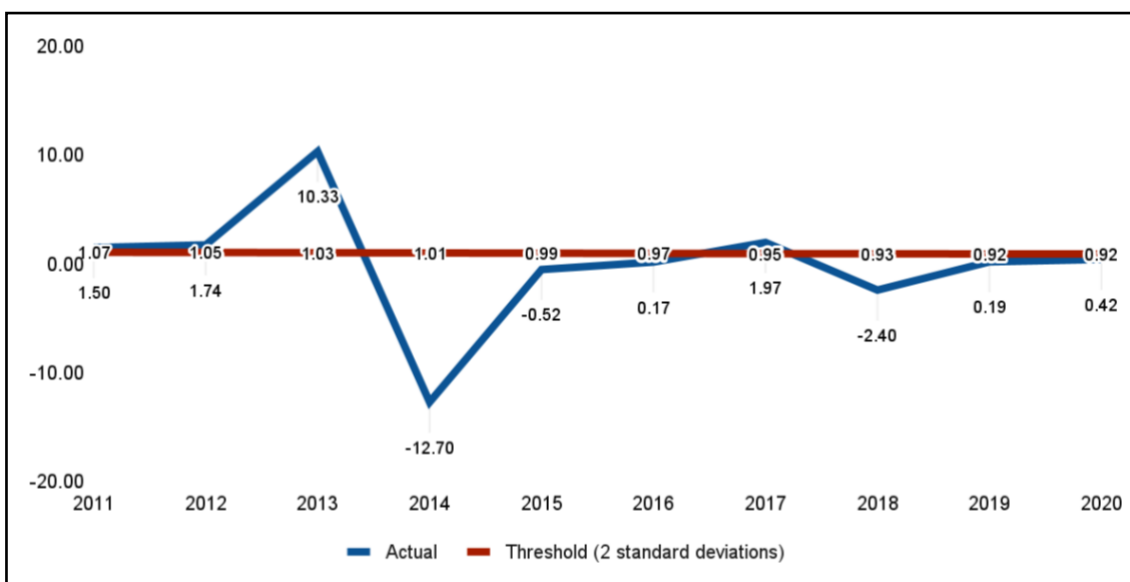
Figure C.3: Domestic-to-External Financing Mix Tracker**Figure C.4: Interest Payments-to-GDP Tracker**

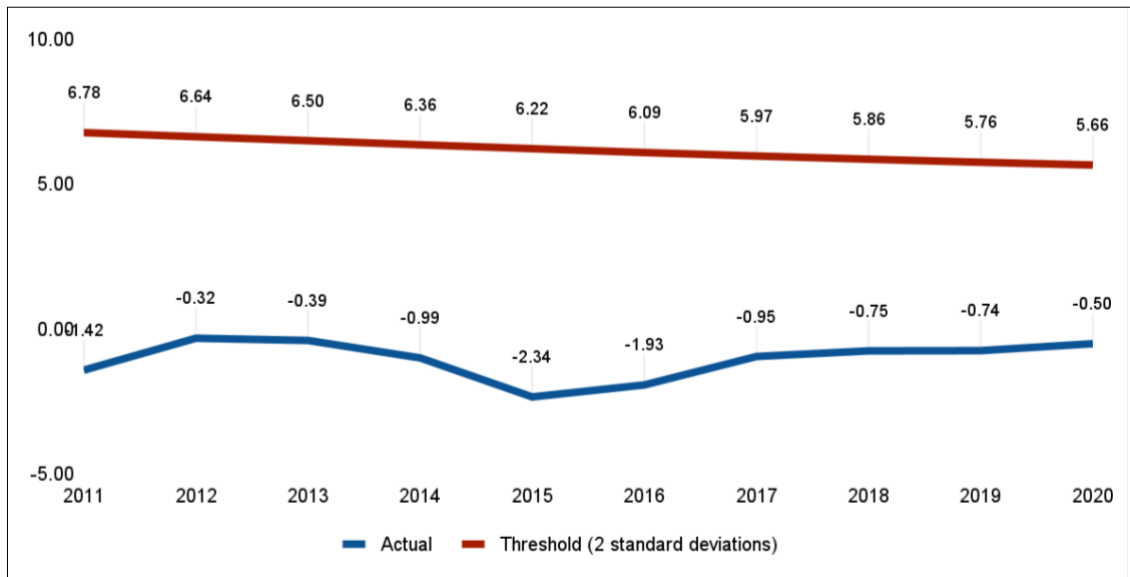
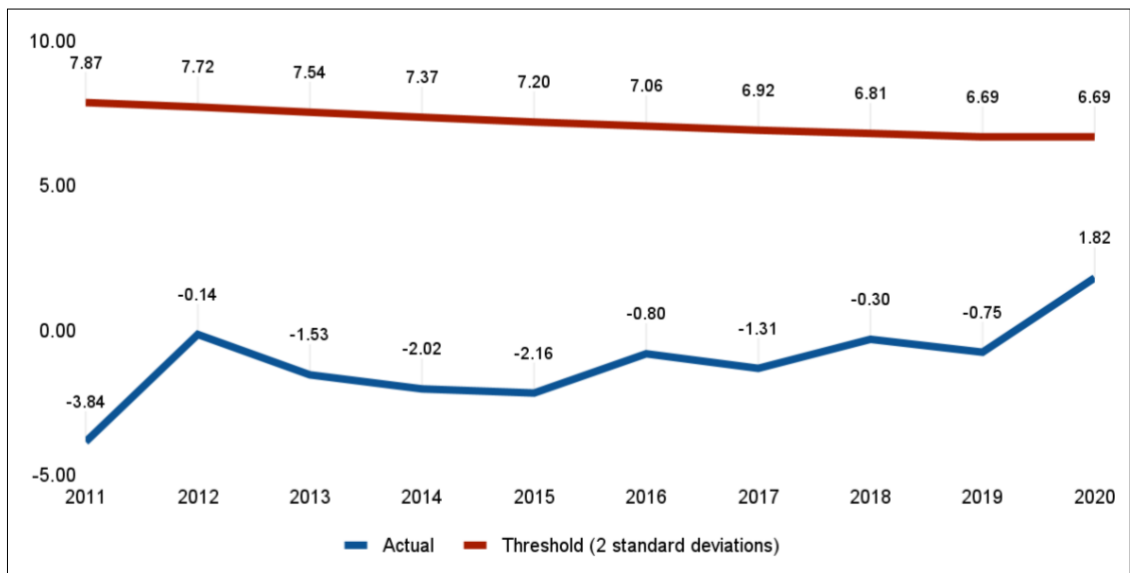
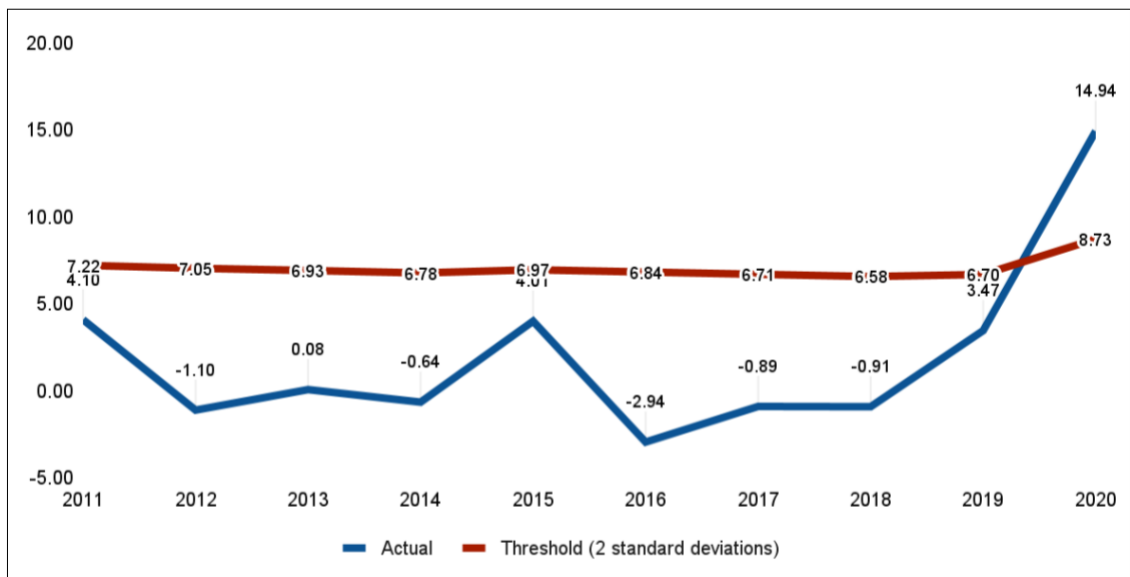
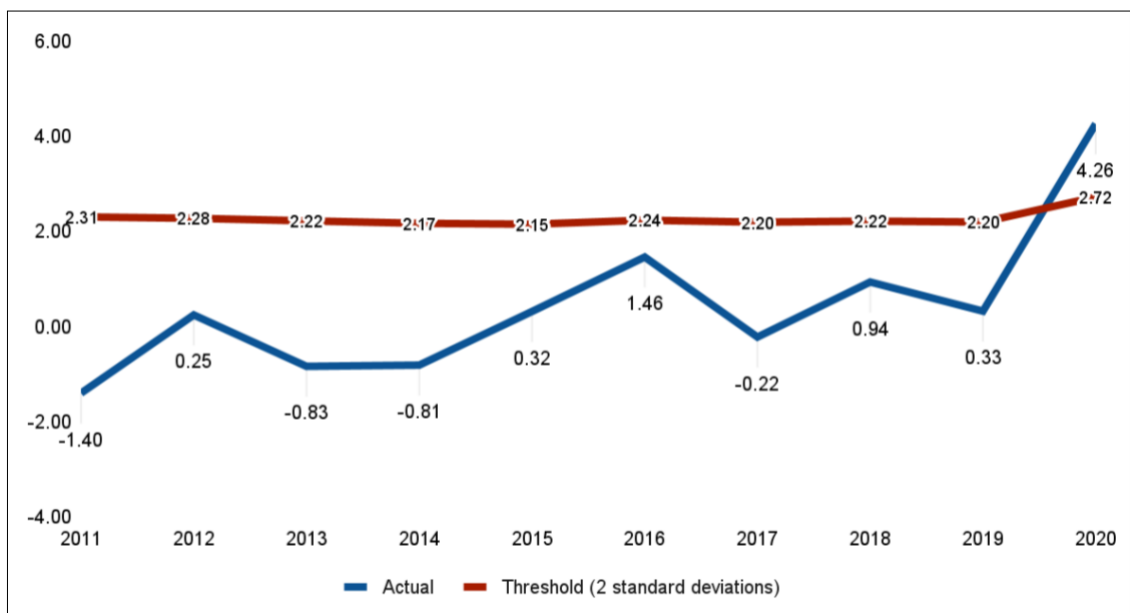
Figure C.5: Interest Payments-to-Expenditures Tracker**Figure C.6: Interest Payments-to-Revenues Tracker**

Figure C.7: Nominal GDP Growth Rate Tracker**Figure C.8: Deficit-to-GDP Tracker**

APPENDIX D: INDICATOR VALUES FROM 1986 TO 2026

Appendix D contains values of the eight indicators from 1986 to 2026. Actual indicator values are from 1986 to 2020. Excluding NG Debt/GDP, the rest of the indicator values from 2021 to 2024 are projections and assumptions made by the DBCC. Values from 2025 to 2026 are based on Bureau of the Treasury staff assumptions that indicator values will return to long-term average levels. NG Debt/GDP values from 2021 to 2026 are based on the IMF DSA results. *Domestic/External Debt Mix* and *Domestic/External Financing Mix* are expressed as ratios between the corresponding domestic and external values, whereas the remaining indicator values are expressed in percentage points.

Table D.1: Historical and Projected Values of Selected Indicators, 1986–2026

Year	NG Debt/GDP	Domestic/ External Debt Mix	Domestic/ External Financing Mix	IP/GDP	IP/ Expenditures	IP/ Revenues	Nominal GDP Growth Rate	Deficit/ GDP
1986	57.08	1.14	3.63	3.12	19.56	27.27	6.50	−4.51
1987	56.93	1.08	3.80	4.75	30.78	35.76	12.19	−2.15
1988	51.94	1.27	2.74	5.04	33.71	40.64	17.11	−2.55
1989	48.13	1.31	1.86	5.19	31.81	35.90	15.85	−1.86
1990	48.88	1.00	1.23	5.79	32.61	39.31	16.44	−3.03
1991	47.28	1.01	2.80	5.27	30.32	33.93	15.89	−1.85
1992	56.49	1.34	4.34	5.16	30.76	32.78	8.33	−1.04
1993	66.92	1.51	−0.44	4.55	27.10	29.37	9.14	−1.30
1994	55.94	1.60	0.38	4.09	24.74	23.54	14.87	0.84
1995	53.23	1.63	3.48	3.34	20.75	20.11	12.62	0.51
1996	46.56	1.80	2.85	3.08	18.93	18.64	14.00	0.25
1997	48.70	1.25	−0.11	2.81	16.58	16.52	11.77	0.06
1998	49.12	1.32	2.18	3.28	19.47	21.58	9.84	−1.64
1999	53.03	1.23	1.33	3.18	18.01	22.21	9.89	−3.34
2000	58.60	0.97	1.31	3.81	21.71	27.37	10.45	−3.63
2001	59.26	1.10	3.01	4.34	24.47	30.81	8.84	−3.65
2002	64.72	1.09	1.18	4.27	23.55	32.13	8.10	−4.84
2003	71.12	1.03	1.21	4.80	26.97	35.39	8.44	−4.24
2004	71.60	1.11	1.92	4.90	29.19	36.92	12.85	−3.51
2005	65.71	1.26	1.82	5.07	31.13	36.73	11.15	−2.48
2006	58.80	1.27	1.30	4.73	29.69	31.66	10.70	−0.99
2007	51.57	1.46	2.76	3.72	23.31	23.56	9.89	−0.17
2008	52.43	1.34	6.02	3.38	21.42	22.63	11.84	−0.85
2009	52.40	1.28	1.82	3.32	19.61	24.83	4.23	−3.56
2010	50.20	1.36	1.85	3.13	19.33	24.36	12.03	−3.35
2011	48.81	1.38	3.35	2.75	17.91	20.52	7.93	−1.95
2012	49.16	1.76	5.10	2.83	17.60	20.38	9.03	−2.20
2013	47.14	1.92	15.43	2.68	17.20	18.85	8.95	−1.36
2014	43.43	2.00	2.73	2.43	16.21	16.83	9.59	−0.55
2015	42.70	1.88	2.22	2.22	13.87	14.67	5.58	−0.87
2016	40.25	1.82	2.39	2.01	11.94	13.86	8.52	−2.34
2017	40.18	2.01	4.36	1.88	11.00	12.56	9.41	−2.12
2018	39.93	1.90	1.96	1.91	10.25	12.25	10.32	−3.06
2019	39.61	1.97	2.16	1.85	9.50	11.50	6.85	−3.38
2020	54.60	2.16	2.57	2.12	9.00	13.32	−8.08	−7.65
2021	58.50	2.33	4.26	2.31	9.68	15.92	10.70	−9.30
2022	60.40	2.33	3.55	2.61	11.62	17.50	11.20	−7.50
2023	60.50	2.33	3.35	2.50	11.84	16.89	9.70	−6.30
2024	59.70	2.33	3.35	2.57	12.64	17.08	9.70	−5.30
2025	57.30	2.33	3.17	2.31	9.68	15.92	9.60	−3.20
2026	55.80	2.33	3.04	2.31	9.68	15.92	9.60	−3.20