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Assessing Vietnam's Public Debt Risk: An Application of the Manasse–Roubini Binary Tree Framework

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Abstract

This study examines the risk of a public debt crisis in Vietnam by applying a binary decision tree framework to identify key determinants and critical threshold conditions that may increase fiscal vulnerability. In the aftermath of the COVID-19 pandemic and amid heightened global economic uncertainty, assessing debt sustainability requires more than evaluating absolute debt levels; it also necessitates consideration of macroeconomic conditions that could trigger heightened risk. Using data for the period 2019-2023, the analysis focuses on the public debt-to-GDP ratio along with selected macroeconomic indicators. A binary decision tree model is developed to classify risk states and detect significant splitting thresholds within the dataset. The findings indicate that although Vietnam's public debt-to-GDP ratio has declined and remains below the statutory ceiling of 60 percent of GDP, fiscal risk exposure continues to be influenced by economic growth dynamics and related fiscal factors. The model helps identify specific conditions under which the probability of elevated risk increases substantially. The study contributes empirical evidence on the application of non-linear classification techniques in public debt risk assessment and offers policy-relevant insights for the development of early warning mechanisms aimed at strengthening long-term fiscal sustainability.

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1. Introduction

Amid growing global uncertainty triggered by the COVID-19 pandemic, international interest rate fluctuations, and downside risks to economic growth, public debt has re-emerged as a central concern for many developing economies. In the case of Vietnam, public debt is not merely an indicator of fiscal burden but also a critical factor affecting macroeconomic stability, sovereign creditworthiness, and the government's long-term fiscal policy space.

The period from 2019 to 2023 witnessed notable shifts in Vietnam's public debt dynamics. After a slight increase in 2020 due to the pandemic shock, the public debt-to-GDP ratio declined significantly in subsequent years, supported by economic recovery and fiscal policy adjustments. Although the ratio remained below the statutory ceiling of 60 percent of GDP set by the National Assembly, this does not necessarily imply the absence of fiscal risk. The likelihood of a public debt crisis depends not only on the absolute level of the debt-to-GDP ratio but also on broader macroeconomic conditions, including economic growth performance, debt structure, borrowing costs, and exposure to external shocks.

Previous studies on public debt in Vietnam have primarily focused on fiscal sustainability analysis, the relationship between public debt and economic growth, or trend assessments using conventional econometric techniques such as linear regression, VAR, and ARDL models. While these approaches provide valuable insights into causal relationships and long-term dynamics, limited attention has been given to risk classification frameworks aimed at identifying early warning signals of potential crisis states. In particular, non-linear methods capable of detecting threshold effects and regime shifts remain underexplored in the

Vietnamese context.

To address this research gap, this study investigates the risk of a public debt crisis in Vietnam by employing a binary decision tree model—a classification technique that enables the identification of critical splitting thresholds and the conditions associated with elevated risk states. This approach not only enhances understanding of the macroeconomic determinants of debt vulnerability but also contributes to the development of an analytical framework that may support early warning mechanisms for fiscal policy management.

2. Theoretical Framework and Literature Review

2.1. Theoretical Foundations

A public debt crisis generally refers to a situation in which a sovereign government is either unable or unwilling to meet its debt obligations in full and on time, potentially resulting in default or debt restructuring, often with the involvement of international financial institutions. The debt overhang theory developed by Krugman (1988)^[9] argues that excessively high debt burdens reduce incentives for private investment because anticipated future repayment obligations discourage capital accumulation, thereby constraining economic growth. Similarly, Reinhart and Rogoff (2010)^[14], drawing on extensive historical data, suggest that economic performance tends to weaken markedly when public debt exceeds approximately 90 percent of GDP.

International experience indicates that sovereign debt crises usually arise from the convergence of several adverse factors, including: (i) large debt stocks combined with fragile debt structures, particularly high shares of short-term or external debt; (ii) slow economic growth that erodes fiscal revenues; (iii) unfavorable shifts in global interest rates and financial conditions; and (iv) declining investor confidence (Cline, 1981; Lane, 2012)^[4, 10]. The Latin American debt crises of the 1980s and the European sovereign debt crisis during 2009–2012 exemplify how fiscal imbalances, market volatility, and reliance on external borrowing can interact and trigger systemic debt distress.

From a theoretical standpoint, public borrowing involves a trade-off between leveraging debt to finance development and the risk of surpassing sustainable thresholds. As highlighted by Eichengreen, Hausmann, and Panizza (2003)^[6], emerging economies are particularly vulnerable due to their dependence on foreign-currency-denominated debt, which exposes them to exchange rate and liquidity risks. Consequently, public debt management should not focus solely on the debt-to-GDP ratio, but must also consider maturity profiles, currency composition, access to capital markets, and resilience to external macroeconomic shocks (IMF, 2013).

2.2. Analytical Models of Public Debt Crisis Risk

In macroeconomic and fiscal policy research, assessing sovereign debt vulnerability has long been a central concern

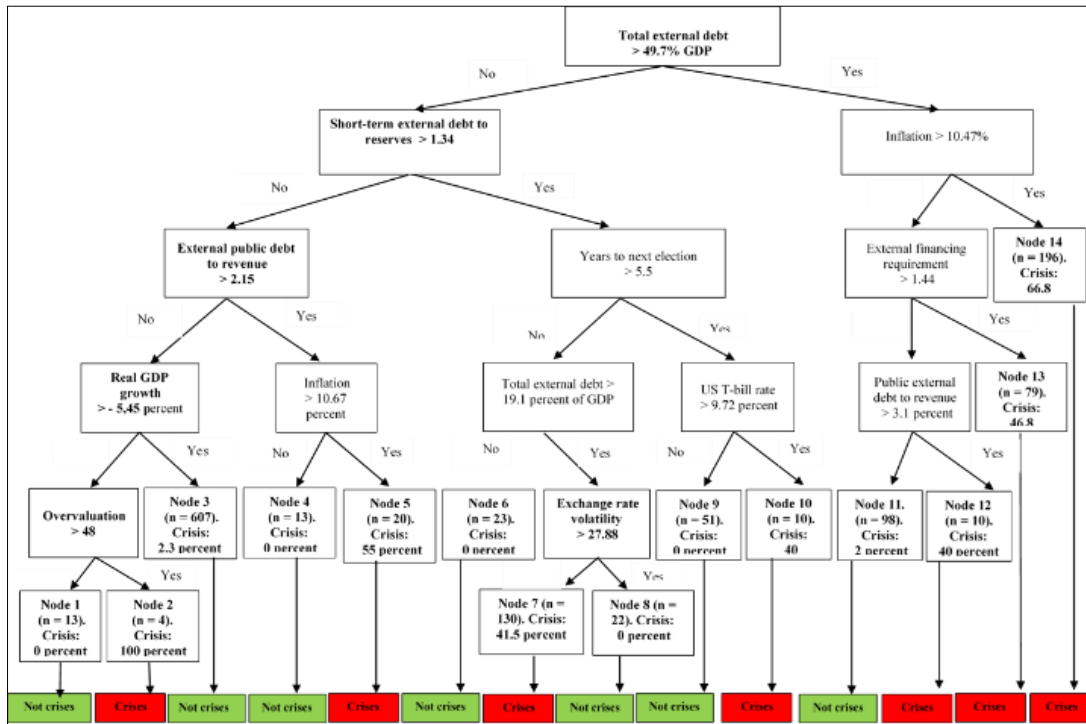
for both academics and international organizations. One of the most widely used frameworks is Debt Sustainability Analysis (DSA), institutionalized by the IMF (2011) and further refined in collaboration with the World Bank (World Bank & IMF, 2018). DSA evaluates debt risk using quantitative indicators such as the public debt-to-GDP ratio, debt service-to-revenue ratios, and fiscal balance projections under alternative macroeconomic scenarios. Despite its policy relevance, DSA has been criticized for being largely descriptive and for its limited ability to fully capture uncertainty and contagion risks, especially during episodes of financial turmoil (Kraay & Nehru, 2006).

To enhance predictive capacity, various Early Warning System (EWS) models have been developed to detect signals of impending sovereign debt crises. Manasse, Roubini, and Schimmelpfennig (2003) apply regression-based methods to estimate default probabilities in developing countries, while Reinhart and Rogoff (2010)^[14] adopt a non-linear threshold approach to examine the link between high debt levels and slower economic growth, which may increase crisis vulnerability. Although these models provide more refined risk quantification than traditional DSA, they often rely on linear assumptions, face challenges related to data complexity, and can be sensitive to model specification and variable selection (Eichengreen, Hausmann & Panizza, 2003; Panizza, Sturzenegger & Zettelmeyer, 2009)^[6].

2.3. The Binary Decision Tree Model of Manasse and Roubini

In addition to the approaches discussed above, the binary decision tree model proposed by Manasse and Roubini (2005) represents a significant methodological advancement in sovereign risk analysis. By combining multiple macroeconomic indicators—such as the public debt-to-GDP ratio, foreign exchange reserves, short-term external liabilities, and fiscal deficits—within a tree-structured framework, the model enables the classification of countries according to their likelihood of experiencing debt distress. Its intuitive design and empirical applicability have led to its widespread reference in subsequent studies on sovereign debt crises (Ardagna, Caselli & Lane, 2007; Baldacci, Gupta & Mati, 2011)^[10].

Compared with traditional DSA and regression-based EWS approaches, the decision tree framework offers greater flexibility in capturing non-linear relationships and threshold effects. At its core, the model relies on a hierarchical tree structure that assigns countries to either a “safe zone” or a “vulnerable zone” based on data-driven splitting rules derived from historical patterns (Figure 1). This characteristic enhances its relevance for policy analysis, particularly in emerging market economies such as Vietnam, where macroeconomic conditions may exhibit structural shifts and regime changes.



Source: Manasse và Roubini (2005) [11]

Fig 1: Binary Tree Model

The classification mechanism of the model is structured around a recursive branching process. The analysis begins with a root variable-external debt-to-GDP-which captures the relative burden of debt in relation to the size of the economy. From this starting point, subsequent branches are generated based on additional conditioning variables. When a country’s indicator exceeds a specified threshold, the model directs the observation toward a different branch associated with a higher level of risk.

This iterative procedure continues until terminal nodes are reached. At each terminal node, the model assigns a quantified probability of crisis occurrence, which may range from 0 percent to progressively higher levels such as 2 percent, 2.3 percent, 40 percent, 41.5 percent, 55 percent, and in extreme cases, 100 percent. Through this framework, the decision tree does not merely provide a numerical risk estimate but also offers a transparent and intuitive representation of the pathways that may lead an economy toward debt distress.

Unlike conventional regression models that typically yield average marginal effects, the binary decision tree reveals heterogeneous risk trajectories, demonstrating that each economy’s vulnerability depends on its specific debt structure and macroeconomic environment.

2.4. Literature Review

The measurement and prediction of sovereign debt crises have long been central topics in macroeconomic research. Early theoretical contributions focused on explaining the underlying mechanisms of debt crises. Krugman (1988) [9] argued that crises may arise when economic growth falls short of borrowing costs, while Eaton and Gersovitz (1981) [5] developed a model of sovereign default risk emphasizing market discipline and repayment capacity. These foundational studies laid the groundwork for subsequent quantitative tools designed to assess crisis vulnerability. Beginning in the late 1990s, significant efforts were made to

construct empirical models for forecasting financial and sovereign debt crises. Kaminsky, Lizondo, and Reinhart (1998) [14] introduced the “early warning signal” approach, which monitors macroeconomic indicators-such as fiscal deficits, foreign exchange reserves, exchange rates, and interest rates—to detect potential crisis episodes. Although relatively straightforward to implement, this method has been criticized for its relatively high false alarm rates. To address these limitations, Berg and Pattillo (1999) applied regression-based techniques to estimate crisis probabilities using multiple macroeconomic variables, allowing for a more quantitative assessment of risk. Nevertheless, such models have been challenged for their limited interpretability and lack of flexibility across different economic contexts.

A notable methodological contribution was made by Manasse and Roubini (2005) [11], who introduced a binary decision tree framework to classify and predict sovereign debt crises. Following their seminal work, several studies extended or applied this approach. Ciarlone and Trebesch (2006) [3] tested the model on emerging market data and found that the decision tree framework produced more reliable predictions than linear alternatives. Baldacci *et al.* (2011) combined decision trees with regression analysis to evaluate debt sustainability in low-income countries, demonstrating the model’s adaptability. More recently, Trebesch and Zabel (2017) [15] employed similar classification techniques to analyze historical sovereign defaults, reinforcing the relevance of non-linear approaches in sovereign risk assessment. Collectively, these studies highlight the broad applicability of decision tree models and support their relevance for the Vietnamese context.

In Vietnam, however, the application of advanced quantitative models to forecast sovereign debt crises remains limited. Existing studies largely focus on debt sustainability indicators (Nguyen & Tran, 2021; World Bank, 2020; IMF, 2021) or empirical analyses conducted in earlier economic periods (Nguyen Thi Lan, 2018) [13]. This gap underscores the

need to apply the Manasse and Roubini decision tree framework to assess public debt crisis risk in Vietnam during the 2019–2023 period.

2.5. Theoretical Framework Applied in the Study

The analytical framework employed in this study is directly derived from the binary decision tree model developed by Manasse and Roubini (2005). The model suggests that sovereign debt crises tend to occur when several adverse conditions coincide, including: (i) a public debt-to-GDP ratio exceeding critical thresholds; (ii) a high ratio of short-term external debt to foreign exchange reserves; (iii) weak economic growth or elevated inflation; and (iv) persistent fiscal deficits.

Each node in the decision tree represents a threshold value of these macroeconomic variables, leading to alternative branches that correspond to safe or high-risk scenarios. This approach allows for the identification of multiple potential pathways to crisis, rather than assuming a single linear relationship as in traditional regression models. By capturing non-linear interactions and threshold effects, the framework provides a more nuanced understanding of sovereign debt vulnerability.

3. Data and Research Methodology

3.1. Data

This study employs time-series data for Vietnam covering the period 2019–2023. The dataset is compiled from official domestic sources, including the Ministry of Finance and the General Statistics Office, as well as international databases such as the World Bank and the International Monetary Fund. Drawing on multiple sources enhances data reliability, transparency, and cross-country comparability.

The selected time frame captures significant recent macroeconomic and fiscal developments. Specifically, it reflects: (i) the dual impact of the COVID-19 pandemic during 2020–2021, which contributed to rising fiscal deficits and public debt; (ii) the subsequent economic recovery amid

heightened global uncertainty in 2022–2023; and (iii) improvements in fiscal balances and the accumulation of foreign exchange reserves, which may help mitigate sovereign debt risk. This period therefore provides a relevant context for assessing short-term debt vulnerability and fiscal resilience.

3.2. Research Methodology

The study adopts a binary decision tree approach based on the framework developed by Manasse and Roubini to assess sovereign debt risk in emerging economies. This method classifies economies into “safe” or “vulnerable” zones according to a set of macroeconomic indicators. The classification mechanism follows a hierarchical tree structure in which threshold values are used to determine whether an economy is exposed to elevated debt distress risk.

Using secondary data on Vietnam’s public debt and key macroeconomic variables for the period 2019–2023, the study conducts descriptive analysis and compares observed indicators with the threshold conditions identified in the Manasse and Roubini framework. Through this comparative assessment, the research evaluates Vietnam’s public debt risk profile by examining whether actual macroeconomic conditions meet or exceed the critical thresholds associated with heightened crisis probability.

4. Research Findings and Discussion

4.1. The Current State of Public Debt in Vietnam

In studies of fiscal sustainability and sovereign debt vulnerability, the public debt-to-GDP ratio is widely regarded as a core indicator of the relative debt burden of an economy. This ratio provides a measure of fiscal safety by comparing total outstanding debt with the economy’s income-generating capacity. Accordingly, analyzing the evolution of Vietnam’s public debt-to-GDP ratio over the 2019–2023 period is essential for identifying emerging risk trends and establishing a foundation for the classification analysis presented in subsequent sections (Table 1).

Table 1: Public Debt-to-GDP Ratio in Vietnam, 2019–2023 Unit: Percent (%)

No	Indicator	2019	2020	2021	2022	2023
1.	Public Debt/GDP	55.0	55.9	42.7	37.3	36.4
2.	Government Debt/GDP	48.0	49.9	38.7	34.0	33.5
3.	Government-Guaranteed Debt/GDP	6.7	5.8	3.8	3.1	2.8
4.	Local Government Debt/GDP	0.7	0.7	0.6	0.6	0.6

Source: Ministry of Finance of Vietnam, Public Debt Disclosure Reports, 2019–2023.

In 2019, public debt accounted for 55.0% of GDP, rising slightly to 55.9% in 2020, when the outbreak of the Covid-19 pandemic led to a slowdown in economic growth while fiscal expenditure expanded significantly. From 2021 onward, however, the public debt-to-GDP ratio declined steadily, falling to 42.7% in 2021 and further to 36.4% by 2023. This downward trend reflects the recovery of economic activity, with GDP growth outpacing the accumulation of public debt, and also suggests improvements in the Government’s borrowing and debt management practices.

In terms of debt composition, the ratio of central government debt to GDP decreased markedly from 48.0% in 2019 to 33.5% in 2023, indicating a consolidation of fiscal discipline and tighter control over direct sovereign borrowing. Government-guaranteed debt also declined substantially, from 6.7% of GDP in 2019 to 2.8% in 2023, implying a deliberate effort to limit contingent liabilities arising from

state-owned enterprises and externally financed investment projects. Local government debt remained stable at a very low level (approximately 0.6–0.7% of GDP), reflecting strict fiscal discipline at the subnational level as well as institutional constraints on local borrowing autonomy.

After a modest increase in 2020 due to pandemic-related shocks, the public debt-to-GDP ratio fell considerably during the 2021–2023 period. This development constitutes a positive signal for national financial security, allowing Vietnam to maintain its public debt well below the 60% of GDP ceiling approved by the National Assembly. Nevertheless, the observed decline in the debt ratio is attributable to two concurrent factors: (i) the recovery of economic growth, which expanded the GDP base, and (ii) a relatively prudent approach to new borrowing. Among these, the growth effect appears to be the dominant driver. Consequently, should economic growth decelerate, upward

pressure on public debt could re-emerge. Going forward, effective debt management should therefore not only focus on restraining new borrowing but also prioritize enhancing

the efficiency of debt utilization in order to safeguard long-term fiscal sustainability.

4.2. Assessment of Public Debt Crisis Risk in Vietnam Using the Binary Tree Model

Table 2: Indicators for Assessing Public Debt Crisis Risk under the Binary Tree Framework Unit: Percent (%)

No	Indicator	2019	2020	2021	2022	2023
1.	External debt/GDP	14.33	14.12	12.68	10.13	9.31
2.	External debt/Reserves	61.1	56.0	46.4	50.1	40.2
3.	External debt/Total revenue	71.1	75.2	67.6	53.6	54.8
4.	GDP growth	7.02	2.91	2.56	8.54	5.07

Source: Compiled by the author based on data from the Vietnam Statistical Yearbooks (2019–2023) and the World Bank database.

Applying the Manasse and Roubini (2005) ^[11] binary tree framework to the 2019–2023 period reveals a relatively favorable risk profile for Vietnam’s public debt dynamics. At the first decision node, the model considers the external debt-to-GDP ratio, with a threshold of 49.7%. Throughout the period under review, Vietnam’s external debt remained substantially below this cutoff: 14.33% in 2019, 14.12% in 2020, 12.68% in 2021, 10.13% in 2022, and 9.31% in 2023. Consequently, in each year the model follows the left branch, corresponding to a low external debt burden relative to economic size. The second node evaluates the ratio of short-term external debt to foreign exchange reserves, with a threshold value of 1.34. Vietnam’s corresponding ratio—proxied by external debt relative to reserves—remained well below this benchmark during the entire period: 61.1% (2019), 56.0% (2020), 46.4% (2021), 50.1% (2022), and 40.2% (2023). These values imply a comfortable reserve buffer against short-term external liabilities, directing the model consistently toward the left branch. The next decision node assesses the ratio of external public debt to total government revenue, with a threshold of 2.15. Vietnam’s ratio remained significantly below this level: 71.1% (2019), 75.2% (2020), 67.6% (2021), 53.6% (2022), and 54.8% (2023). Accordingly, the model continues along the left branch for all observed years. The subsequent node considers GDP growth, with a crisis-trigger threshold of –5.45%. Vietnam’s growth performance remained well above this critical level: 7.02% (2019), 2.91% (2020), 2.56% (2021), 8.54% (2022), and 5.07% (2023). Although growth slowed during the pandemic years, it remained positive and rebounded strongly in 2022. Given that all observations exceed the model’s critical threshold, the decision path ultimately leads to Node 3—the “safe zone”—where the estimated probability of a debt crisis is approximately 2.3%.

4.3. Several key implications emerge from this analysis

First, the core indicators embedded in the model suggest that Vietnam’s debt structure remains broadly sound. External debt relative to GDP, short-term external debt relative to reserves, and external public debt relative to government revenue all remain comfortably below the respective warning thresholds. This indicates a manageable debt burden and solid short-term repayment capacity, reducing the likelihood of a near-term debt crisis. These findings are consistent with Ciarlone and Trebesch (2006) ^[3], who argue that prudent debt composition significantly mitigates crisis risks in emerging markets. Similarly, Baldacci, Gupta, and Mati (2011) emphasize the importance of fiscal space and sustainable debt structures in maintaining macroeconomic stability under adverse shocks.

Second, economic growth plays a pivotal role in sustaining debt safety. Despite the temporary slowdown during 2020–2021, Vietnam maintained positive growth and achieved a strong rebound in 2022. Robust growth dynamics help contain the debt-to-GDP ratio and reduce the probability of entering a crisis region. This aligns with Reinhart and Rogoff (2010) ^[14], who highlight the role of sustained growth in alleviating debt burdens, and with Trebesch and Zabel (2017) ^[15], who demonstrate that stable growth trajectories significantly lower sovereign default risk.

Third, the consistent placement of Vietnam in Node 3—the safe region with an estimated crisis probability of only 2.3%—underscores the effectiveness of recent debt management policies and reinforces the assessment of fiscal sustainability during the study period. The results are broadly consistent with international theoretical and empirical frameworks, which suggest that economies maintaining moderate debt levels and stable growth foundations are substantially less prone to debt crises (Baldacci *et al.*, 2011; Trebesch & Zabel, 2017) ^[15].

5. Conclusion and Policy Implications

The findings indicate that, during 2019–2023, Vietnam’s public debt remained within the safe range defined by the Manasse-Roubini (2005) ^[11] framework. This outcome strengthens investor confidence, supports sovereign credit ratings, and provides fiscal space for the Government to implement socio-economic support measures without significantly elevating fiscal risk. Nonetheless, stability does not eliminate potential vulnerabilities. Contingent liabilities stemming from government guarantees, state-owned enterprises, and subnational borrowing could still exert pressure on public finances in the future. To enhance long-term debt sustainability, several policy recommendations are proposed. First, the implementation of a comprehensive public debt strategy toward 2030 should prioritize extending debt maturities,

deepening the domestic government bond market, and gradually reducing reliance on foreign-currency-denominated debt. Second, strengthening foreign exchange reserves and utilizing appropriate hedging instruments would improve resilience to external shocks. Third, broadening the sustainable revenue base through tax reform can reduce dependence on volatile revenue sources. Fourth, improving public investment efficiency and closely monitoring contingent liabilities—particularly government guarantees and SOE debt—are essential to mitigate fiscal risks. Finally, enhancing fiscal transparency and conducting periodic stress testing would strengthen early-warning capacity and reinforce confidence in international capital markets.

In sum, although Vietnam's debt crisis risk remained low during the study period, maintaining fiscal prudence and advancing structural reforms remain crucial. A forward-looking and adaptive fiscal strategy will be key to consolidating debt safety, preserving macroeconomic stability, and sustaining long-term growth in an increasingly uncertain global environment.

Despite providing useful insights into Vietnam's public debt risk profile, this study is subject to several limitations. First, the analysis relies on a relatively short time horizon (2019–2023), which constrains the ability to capture long-term cyclical dynamics and structural regime shifts. Second, the study applies the threshold structure of the Manasse–Roubini framework without re-estimating the decision tree using country-specific or panel data, which may limit the model's predictive precision in the Vietnamese context. Future research could expand the dataset over a longer period, integrate cross-country comparisons, or employ alternative non-linear techniques to enhance robustness and predictive performance.

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