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SUSTAINABLE PUBLIC DEBT IN THE ERA OF HIGH INTEREST RATES: IS THE R–G PARADIGM STILL RELEVANT?

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Abstract:
This paper revisits public debt sustainability in a persistent high-interest-rate environment, challenging the conventional reliance on the interest-growth differential r - g as a sufficient condition for fiscal stability. While the post-global financial crisis period was marked by favourable borrowing conditions, the post-pandemic monetary tightening cycle has fundamentally altered the macroeconomic landscape, pushing many economies into a regime in which borrowing costs exceed growth rates.
To address these challenges, the paper develops an extended analytical framework that integrates stochastic debt dynamics, endogenous risk premia, and monetary–fiscal interactions. Moving beyond deterministic approaches, the study employs a Stochastic Debt Sustainability Analysis (SDSA) using a Vector Autoregression (VAR) model and Monte Carlo simulations to generate a distribution of future debt trajectories. This approach enables the explicit assessment of downside risks and the probability of adverse debt outcomes.
The results demonstrate that debt sustainability is highly sensitive to macroeconomic volatility and to interactions among policies. Even when baseline projections indicate stable debt paths, stochastic simulations reveal a substantial probability of explosive dynamics, particularly in scenarios characterised by persistent $r > g$
Furthermore, the findings highlight the critical role of fiscal policy behaviour, showing that stronger fiscal reactions are required to stabilise debt in high-interest-rate environments. The analysis also underscores the increasing relevance of monetary–fiscal trade-offs, including the risk of fiscal dominance in high-debt regimes.
By reinterpreting the r - g differential as a time-varying and regime-dependent variable, this paper contributes to the literature by providing a more realistic, risk-based framework for assessing debt sustainability. The results carry important policy implications, particularly for small open economies, where exposure to external shocks and exchange rate volatility further amplifies fiscal vulnerabilities.
Keywords: *public debt sustainability, r – g differential, stochastic simulations, monetary–fiscal interactions, fiscal dominance, VAR, Monte Carlo.*

Introduction

The last three years have marked a fundamental turning point in the global macroeconomic environment, with profound implications for fiscal policy and public debt sustainability. Following more than a decade characterized by exceptionally low interest rates and, in many cases, a persistently negative differential between the interest rate and the growth rate ($r - g$), the global economy has entered a new regime shaped by high inflation and aggressive monetary tightening. In the aftermath of the COVID-19 pandemic, inflation surged across both advanced and developing economies, forcing central banks to abandon the “transitory” narrative and implement rapid and synchronized tightening cycles. As a result, borrowing costs have increased sharply, often outpacing economic growth [7], [18].

During the low-interest-rate era, governments benefited from highly favorable financing conditions, allowing them to sustain elevated levels of public debt without significant fiscal adjustment. The theoretical justification for this outcome lies in the $r - g$ framework, which posits that debt sustainability is ensured when the interest rate on government debt is below the economy's growth rate. Under such conditions, governments can roll over debt without increasing the debt-to-GDP ratio, even in the presence of primary deficits [3], [13].

This interpretation marked a significant shift from earlier concerns about debt thresholds and fiscal limits emphasized in the literature [17], and has become a cornerstone of modern fiscal analysis and policy design.

However, the transition to a high-interest-rate environment calls into question the robustness of this paradigm. First, the assumption of a stable and predictable relationship between interest rates and growth is increasingly inconsistent with observed macroeconomic volatility. Both variables are influenced by monetary policy shifts, financial market conditions, and global shocks, implying that debt sustainability is inherently probabilistic rather than deterministic [11], [3]. Second, the traditional framework largely abstracts from regime changes, despite growing evidence that the prolonged period of negative $r - g$ was exceptional rather than structural. Third, it does not adequately account for structural heterogeneity across countries.

Small open economies, particularly those that are energy-dependent, face additional vulnerabilities stemming from external shocks, exchange rate movements, and terms-of-trade fluctuations [16], [15]. Finally, the $r - g$ approach underestimates the role of fiscal policy behavior and institutional credibility, which are central elements of modern debt sustainability frameworks, including those developed by international financial institutions [10], [11].

In response to these limitations, this paper develops an extended framework for analyzing public debt sustainability in a high-interest-rate environment. By integrating stochastic debt dynamics, regime shifts, and monetary–fiscal interactions, and by explicitly accounting for the structural characteristics of small open economies, the analysis moves beyond the traditional $r - g$ paradigm. In doing so, it provides a more realistic, risk-based, and policy-relevant assessment of fiscal sustainability under contemporary macroeconomic conditions.

This framework serves as the basis for the stochastic simulations and empirical analysis that follow, allowing for a more realistic evaluation of debt sustainability under regime uncertainty.

Literature review

The r–g Framework and Its Reinterpretation

The theoretical foundation of public debt sustainability is rooted in the intertemporal budget constraint, which requires that the present value of future primary surpluses equals the existing stock of public debt. Within this framework, debt dynamics are primarily governed by the relationship between the interest rate and the growth rate of the economy, summarized by the differential $r - g$.

Early contributions, particularly those building on Domar's analysis, established that sustained primary deficits may be compatible with stable debt dynamics, provided that growth exceeds interest rates. In contemporary macroeconomic literature, this insight has been significantly reinterpreted. In particular, it has been argued that when the nominal interest rate remains persistently below the growth rate, public debt may entail limited fiscal costs, as economic expansion reduces the relative burden of debt [3], [13].

Beyond Deterministic Debt Sustainability: Risk, Endogeneity, and Regime Shifts

A growing body of literature challenges the sufficiency of the $r - g$ framework by emphasizing the role of uncertainty, endogeneity, and structural change. First, debt sustainability is increasingly understood as a probabilistic concept, as future paths of interest rates, growth, and fiscal balances are inherently uncertain. Stochastic approaches, including those developed in IMF debt sustainability frameworks, highlight the importance of analyzing the distribution of outcomes rather than relying on deterministic projections [10], [3]. Second, the assumption that interest rates and growth are exogenous is increasingly questioned. Empirical evidence suggests that higher debt levels can raise borrowing costs through risk premia while simultaneously dampening growth, creating nonlinear feedback effects that amplify fiscal vulnerabilities [6]. Third, recent literature highlights the importance of regime shifts. The prolonged period of negative $r - g$ observed in advanced economies may represent an exceptional episode rather than a structural feature. The post-pandemic tightening cycle, documented by institutions such as the European Central Bank, suggests a transition to a regime characterized by higher and more volatile interest rates, fundamentally altering debt dynamics.

Together, these developments imply that sustainability cannot be assessed solely through average values of $r - g$, but must account for volatility, tail risks, and nonlinear dynamics.

Structural Vulnerabilities and Remaining Gaps in the Literature

An additional limitation of the existing literature is its insufficient treatment of structural heterogeneity across countries. Small open economies, in particular, face heightened exposure to external shocks, exchange rate fluctuations, and global financial conditions [10]. Among these vulnerabilities, energy dependence plays a central role, as fluctuations in global energy prices can simultaneously affect growth, inflation, and fiscal balances [16], [15].

Despite their importance, such structural factors remain underrepresented in standard debt sustainability models, which are typically calibrated for advanced

economies. This may lead to an underestimation of fiscal risks in more vulnerable contexts.

Taken together, the literature highlights three key gaps: insufficient integration of uncertainty, limited treatment of regime shifts, and inadequate consideration of structural vulnerabilities. This paper addresses these gaps by developing an extended framework that integrates stochastic debt dynamics, monetary-fiscal interactions, and structural characteristics of small open economies. In doing so, it provides a more realistic and policy-relevant assessment of public debt sustainability in a high-interest-rate environment.

Theoretical framework

The starting point for the analysis of fiscal sustainability is the law of motion governing the public debt-to-GDP ratio. In discrete time, the evolution of debt is given by:

$$d_t = \frac{1+r_t}{1+g_t} d_{t-1} - pb_t \qquad \text{which implies:} \qquad \Delta d_t = \frac{r_t - g_t}{1+g_t} d_{t-1} - pb_t$$

where d_t denotes the public debt-to-GDP ratio, r_t the effective nominal interest rate on public debt, g_t the nominal GDP growth rate, and pb_t the primary balance as a share of GDP.

The term:

$$\frac{r_t - g_t}{1 + g_t} d_{t-1}$$

captures the automatic dynamics of debt, commonly referred to as the *snowball effect*. When $r_t > g_t$, debt tends to increase mechanically even in the absence of primary deficits. Conversely, when $g_t > r_t$, the debt ratio may stabilize or decline without the need for sustained primary surpluses.

This result underpins the so-called Blanchard condition, which holds that an economy can sustain higher debt levels when the growth rate consistently exceeds the cost of borrowing. In such a regime, the intertemporal budget constraint becomes less binding because the denominator effect outweighs the accumulation of liabilities.

However, this condition is inherently static and deterministic, abstracting away from uncertainty, market reactions, and policy interactions.

Despite its analytical elegance, the $r - g$ framework suffers from several critical limitations that constrain its applicability in real-world, high-interest-rate environments.

Stochastic Nature of Debt Sustainability

Fiscal sustainability is fundamentally probabilistic rather than deterministic. The evolution of debt depends on future realizations of interest rates and growth, which can be modelled as stochastic processes:

$$r_t = \bar{r} + \varepsilon_t^r, g_t = \bar{g} + \varepsilon_t^g$$

where ε_t^r and ε_t^g represent shocks. Even if $\mathbb{E}(r_t - g_t) < 0$, the variance of these shocks may generate a non-negligible probability that $r_t - g_t > 0$ for prolonged periods, leading to explosive debt dynamics. Therefore, sustainability must be assessed using probability distributions rather than point estimates.

Endogeneity and Nonlinear Feedback Effects

The standard framework assumes that r_t and g_t are exogenous, which is empirically unrealistic. In practice, both variables depend on fiscal conditions:

$$r_t = r_t^* + \pi(d_{t-1}), g_t = g_t^* - \theta d_{t-1}$$

where $\pi'(d) > 0$ captures the increase in risk premia with debt, and $\theta > 0$ reflects debt overhang effects on growth.

This generates a nonlinear feedback mechanism:

$$\frac{\partial}{\partial d}(r_t - g_t) > 0$$

implying that higher debt worsens the interest-growth differential, thereby accelerating debt accumulation. This mechanism introduces potential instability thresholds and multiple equilibria.

Intertemporal Constraint and Transversality

In an infinite-horizon setting, sustainability requires the intertemporal government budget constraint:

$$d_t = \sum_{j=0}^{\infty} (\prod_{k=1}^{j} \frac{1 + r_{t+k}}{1 + g_{t+k}}) pb_{t+j}$$

together with the transversality condition:

$$\lim_{T \to \infty} (\prod_{k=1}^{T} \frac{1 + r_{t+k}}{1 + g_{t+k}}) d_{t+T} = 0$$

However, this condition is not empirically testable and allows for implausible fiscal paths based on distant future adjustments. As a result, the $r - g$ framework provides limited guidance for medium-term fiscal constraints.

To address these limitations, this paper develops an extended framework integrating risk, endogeneity, and policy interaction.

Endogenous Risk Premium

The interest rate is modelled as:

$$r_t = r_t^f + \alpha d_{t-1}^{\beta}$$

where r_t^f is the risk-free rate and $\alpha > 0, \beta > 1$ capture nonlinear risk pricing. This implies convexity:

$$\frac{\partial^2 r_t}{\partial d^2} > 0$$

so that borrowing costs increase disproportionately at higher debt levels.

Stochastic Debt Dynamics

Debt evolves under uncertainty:

$$d_{t+1} = \frac{1 + r_t}{1 + g_t} d_t - pb_t + \varepsilon_t$$

Monte Carlo simulations generate distributions of future debt paths, allowing the computation of:

$$\mathbb{P}(d_{t+h} > \bar{d})$$

which defines the probability of fiscal distress over the horizon h.

Monetary–Fiscal Interaction

Monetary policy affects both borrowing costs and growth:

$$r_t = r_t(i_t, \pi_t), g_t = g_t(i_t)$$

where $i_t$is the policy rate. In a tightening regime:

$$i_t \uparrow \Rightarrow r_t \uparrow, i_t \uparrow \Rightarrow g_t \downarrow \qquad \text{implying:} \quad \frac{\partial}{\partial i_t}(r_t - g_t) > 0$$

This highlights the importance of the policy mix, particularly in inflationary environments where monetary tightening may undermine fiscal sustainability.

Implications for Debt Sustainability

Under the expanded framework, the sustainability condition becomes:

$$\mathbb{E}[\frac{r_t - g_t}{1 + g_t}] + \text{Risk Adjustment} < \frac{pb_t}{d_{t-1}}$$

The "safe" level of debt is therefore:

- lower when volatility is high
- lower when risk premia are highly sensitive to debt
- lower when monetary policy is restrictive

This implies that in regimes where $r > g$ becomes persistent, fiscal space contracts significantly, and traditional benchmarks based on average $r - g$ values underestimate fiscal risks.

Monetary–fiscal interactions

The post-2021 inflationary surge triggered a sharp reversal of the "low-for-longer" monetary regime, leading to an aggressive tightening cycle across major central banks [18]. This shift has fundamentally altered public debt dynamics by increasing the interest growth differential, thereby weakening the automatic stabilizing properties of debt.

The transmission of monetary policy to public debt primarily operates through its effects on borrowing costs and economic activity. The effective interest rate on government debt can be expressed as a weighted average of past policy rates:

$$r_t = \sum_{j=0}^{\infty} \omega_j i_{t-j}$$

while output growth responds negatively to tightening:

$$g_t = \mathbb{E}_t g_{t+1} - \psi(i_t - i_t^*) \qquad \text{implying:} \quad \frac{\partial}{\partial i_t}(r_t - g_t) > 0$$

Thus, monetary tightening increases the *snowball effect* and raises the fiscal effort required to stabilize debt. In small open economies such as Serbia, these effects are amplified by exchange rate depreciation, which increases the burden of foreign-currency-denominated debt [16].

The interaction between monetary and fiscal policy can be characterized through reaction functions. Under monetary dominance, central banks independently pursue price stability, while fiscal authorities adjust primary balances to ensure sustainability. Conversely, under fiscal dominance, insufficient fiscal adjustment forces the price level to absorb fiscal imbalances, consistent with the Fiscal Theory of the Price Level [12].

Recent developments suggest that rising debt levels and higher interest rates increase the likelihood of tensions between these regimes. In particular, tighter monetary policy may become counterproductive when higher interest costs destabilize public finances, implying a positive relationship between policy rates and debt dynamics.

Finally, the retreat from quantitative easing has removed an important stabilizing force in sovereign bond markets. Without central bank support, borrowing costs become more sensitive to debt levels and market volatility, reinforcing nonlinear feedback loops between debt, risk premia, and interest rates [1].

Overall, these interactions highlight that debt sustainability cannot be assessed independently of the policy mix. In a high-interest-rate environment, the joint behavior of monetary and fiscal authorities becomes a central determinant of fiscal stability.

These theoretical insights provide the foundation for the empirical analysis that follows, where the interaction between interest rates, growth, and fiscal behavior is examined within a stochastic simulation framework to assess the probability and distribution of debt sustainability outcomes.

Table 1. Summary of the Theoretical Framework

Component	Specification	Economic Interpretation
Debt dynamics	$d_{t+1} = \frac{1+r_t}{1+g_t} d_t - pb_t$	Standard evolution of the debt-to-GDP ratio
Snowball effect	$\frac{r_t - g_t}{1+g_t} d_t$	Automatic debt accumulation when $r > g$
Interest rate formation	$r_t = r_t^f + \alpha d_{t-1}^{\beta}$	Endogenous risk premium increases with debt

Growth dynamics	$g_t = g_0 - \theta d_{t-1} + \delta I_t$	Debt overhang reduces growth; investment increases it
Monetary transmission	$r_t = \sum \omega_j i_{t-j}$	Policy rate affects borrowing costs with lags
Policy interaction	$g_t = \mathbb{E}_t g_{t+1} - \psi(i_t - i_t^*)$	Tightening reduces growth
Fiscal reaction	$pb_t = \gamma d_{t-1} + \eta_t$	Fiscal policy responds to debt levels
Risk framework	$d_{t+1} = \ldots + \varepsilon_t$	Stochastic shocks introduce uncertainty
Sustainability condition	$\mathbb{E}[\frac{r_t - g_t}{1+g_t}] + \text{Risk} < \frac{pb_t}{d_t}$	Risk-adjusted fiscal sustainability
Key implication	$\frac{\partial}{\partial i_t}(r_t - g_t) > 0$	Monetary tightening worsens debt dynamics

Source: Author

Empirical strategy and model simulation

The empirical analysis is based on a Stochastic Debt Sustainability Analysis (SDSA) framework, designed to evaluate public debt dynamics under uncertainty and to move beyond deterministic projections. In contrast to traditional approaches, which rely on baseline scenarios, this framework explicitly models the joint distribution of key macroeconomic variables and allows for the assessment of downside risks and tail events [4], [8], [10].

Model Specification

The starting point is the stochastic law of motion for the debt-to-GDP ratio:

$$d_{t+1} = \frac{1 + r_t}{1 + g_t} d_t - pb_t + \varepsilon_t$$

where ε_t captures exogenous shocks, including macroeconomic disturbances, exchange rate movements, and contingent liabilities. This formulation is consistent with the theoretical framework developed in Section 3 and widely used in empirical debt sustainability analysis [8], [4].

To capture the joint behavior and interdependence of macroeconomic variables, the model employs a Vector Autoregression (VAR):

$$X_t = A_0 + \sum_{k=1}^{p} A_k X_{t-k} + u_t \quad \text{where:} \quad X_t = \begin{bmatrix} r_t \\ g_t \\ pb_t \end{bmatrix}, u_t \sim \mathcal{N}(0, \Sigma)$$

This specification allows for endogenous interactions among interest rates, economic growth, and fiscal balances, reflecting empirical evidence that these variables are jointly determined and mutually reinforcing [4]. [6].

The model is estimated using quarterly data, with lag length selected based on standard information criteria. The covariance structure Σ captures cross-variable correlations, ensuring realistic propagation of shocks across macroeconomic variables [8].

Simulation Strategy

The estimated VAR model is used to generate simulated paths of macroeconomic variables through a Monte Carlo procedure, with 5,000–10,000 iterations to ensure convergence of the distribution [14]. For each simulation s, sequences of shocks $u_t^{(s)}$ are drawn from the estimated distribution, generating trajectories:

$$X_{t+h}^{(s)} \Rightarrow d_{t+h}^{(s)}$$

These simulations produce a full distribution of possible debt paths, allowing the computation of risk-based metrics, including median projections, interquartile ranges, and upper percentiles representing adverse scenarios [9].

This probabilistic approach is consistent with modern IMF debt sustainability frameworks, which emphasize the importance of assessing fiscal risks through distributions rather than point estimates [10], [11].

Fiscal Policy and Scenario Analysis

To incorporate policy behavior, the model includes a fiscal reaction function:

$$pb_t = \alpha + \gamma d_{t-1} + \delta Z_t + \nu_t$$

where γcaptures the responsiveness of fiscal policy to debt levels. This allows for testing whether fiscal policy is sufficiently stabilizing, in line with empirical approaches in the literature [6], [1].

The analysis is complemented by three types of scenarios:

- Baseline scenario, based on expected macroeconomic trajectories
- Deterministic stress tests, including interest rate shocks (e.g., +200 basis points) and growth shocks (−1 to −2 standard deviations)

- Fully stochastic simulations, capturing the joint distribution of macroeconomic risks

These approaches follow established methodologies used by international institutions while extending them through a fully stochastic framework [4], [10].

Empirical results

The empirical analysis is based on a panel dataset covering the period 2005-2023, allowing for the inclusion of both the low-interest-rate environment following the global financial crisis and the recent post-pandemic tightening cycle. The sample includes a mix of advanced and emerging economies, with particular attention to small, open, and energy-dependent countries to capture structural heterogeneity in debt dynamics.

The baseline projections suggest a relatively stable path of the debt-to-GDP ratio over the medium term. Under expected macroeconomic conditions, the debt ratio either stabilizes or exhibits a gradual decline, reflecting moderate growth and a fiscal stance broadly consistent with debt sustainability.

However, this baseline outcome is highly sensitive to the assumed values of the interest–growth differential. In particular, even small deviations in either interest rates or growth can significantly alter the trajectory of public debt, highlighting the limitations of deterministic projections.

The fan chart reveals three key patterns. First, the dispersion of debt trajectories increases significantly over the forecast horizon, indicating that uncertainty compounds over time. While the median projection remains stable, the upper percentiles (e.g., 90th and 95th) show a marked upward deviation, suggesting a non-negligible probability of adverse outcomes. Second, the distribution of outcomes is asymmetric, with a heavier upper tail. This implies that the risks to debt sustainability are skewed toward deterioration rather than improvement. Such asymmetry is consistent with the presence of nonlinear feedback mechanisms, particularly those related to risk premia and the snowball effect. Third, the probability of exceeding critical debt thresholds increases under adverse scenarios. For a subset of simulations, the debt-to-GDP ratio follows an explosive path, even when the baseline suggests stability. This finding underscores the importance of assessing fiscal sustainability probabilistically rather than relying solely on point forecasts.

The stress-testing analysis further highlights the vulnerability of debt dynamics to macroeconomic shocks.

An interest rate shock (e.g., +200 basis points) leads to a significant upward shift in the distribution of debt trajectories, reflecting the amplification of the snowball effect.

The results also emphasize the importance of fiscal policy responses. Simulations incorporating a stronger fiscal reaction (higher γ) show a significant reduction in the dispersion of debt trajectories, as well as a lower probability of extreme outcomes.

However, the analysis indicates that the level of fiscal adjustment required to stabilize debt in a high-interest-rate environment is substantially higher than historical norms. In many cases, the implied primary surpluses exceed those observed in past periods, raising concerns about the feasibility and political sustainability of such adjustments.

For small open economies such as Serbia, the results suggest heightened vulnerability to external shocks. Exchange rate depreciation and exposure to global financial conditions amplify the impact of interest rate increases, widening the dispersion of debt outcomes.

The empirical results demonstrate that debt sustainability in a high-interest-rate environment is fundamentally characterized by uncertainty, asymmetry, and nonlinear risk. While baseline projections may suggest stability, the distribution of outcomes reveals a substantial probability of adverse scenarios, particularly under persistent $r > g$ conditions. These findings highlight the limitations of deterministic frameworks and underscore the need for a risk-based approach to fiscal policy, where the focus shifts from expected outcomes to the management of downside risks.

Conclusion

This paper demonstrates that the global macroeconomic environment has undergone a structural shift, marking the end of the “low-for-longer” interest rate regime and fundamentally altering the conditions for public debt sustainability. The central finding is that the interest–growth differential ($r - g$), long considered a stabilizing mechanism, can no longer serve as a reliable anchor for fiscal policy. The transition toward persistently

higher interest rates has pushed many economies into a regime where borrowing costs exceed growth, thereby weakening the automatic stabilizing properties of debt dynamics.

In this environment, debt sustainability becomes highly sensitive to macroeconomic volatility, endogenous risk premia, and nonlinear feedback effects. The stochastic simulations show that even when baseline projections suggest stable debt paths, there remains a substantial probability of adverse outcomes. In particular, relatively moderate shocks to interest rates or growth can generate explosive debt trajectories, especially when financial markets respond strongly to rising debt levels.

The results underscore the critical importance of fiscal policy behavior. Stabilizing public debt now requires stronger, more credible, and more forward-looking fiscal responses than in the past. At the same time, the composition of fiscal policy becomes central: growth-enhancing public investment plays a key role in improving debt dynamics, while consumption-driven fiscal expansion provides limited support for sustainability.

For small open economies such as Serbia, these challenges are further amplified by exposure to external financial conditions, exchange rate volatility, and global monetary policy spillovers.

From a policy perspective, several implications follow. Fiscal frameworks must be recalibrated to reflect a persistently higher $r - g$ environment, implying more conservative debt thresholds and stronger fiscal reaction functions. In addition, policymakers should prioritize the quality of fiscal adjustment, shifting toward investment-led strategies that enhance long-term growth and resilience. Equally important is the need for close coordination between monetary and fiscal authorities, particularly during periods of aggressive monetary tightening, in order to avoid destabilizing policy interactions.

Finally, debt sustainability assessments must move beyond deterministic projections and systematically incorporate risk-based metrics, including the probability distribution of adverse outcomes.

By moving beyond the traditional $r - g$ paradigm, this paper contributes to the literature by developing a unified stochastic framework that captures uncertainty, nonlinear feedback effects, and policy interactions, thereby offering a more realistic and policy-relevant assessment of debt sustainability.

In sum, the era of passive reliance on favorable macroeconomic conditions is over. Sustainable public finances in the 21st century require active fiscal management, credible policy frameworks, and a systematic integration of risk into policy design.

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