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titleAn Empirical Analysis of the Relationship Between Government Debt and Interest Rate Fluctuations in Developed Economies
authorDaniel Rivera, Daniel Young, David Nelson
date
maketitle

beginabstract This paper presents a novel empirical investigation into the complex relationship between government debt levels and interest rate fluctuations in developed economies, employing an innovative methodological framework that combines traditional econometric approaches with machine learning techniques. Unlike previous studies that primarily focus on linear relationships and conventional macroeconomic variables, our research introduces a multi-dimensional analytical approach that incorporates behavioral economics, market sentiment analysis, and network effects between sovereign debt markets. We develop a unique dataset spanning 25 developed economies over a 30-year period, enriched with unconventional indicators including political stability metrics, institutional quality indices, and real-time market sentiment data derived from natural language processing of financial news. Our methodology employs a hybrid approach combining vector autoregression models with random forest algorithms to capture both linear dependencies and complex non-linear interactions. The findings reveal several counterintuitive relationships, including threshold effects in debt-interest rate dynamics and significant variations across different monetary policy regimes. Particularly noteworthy is our discovery of asymmetric responses in interest rates to debt accumulation during periods of economic expansion versus contraction, challenging conventional wisdom about fiscal-monetary policy interactions. The research contributes to both theoretical understanding and practical policy formulation by providing a more nuanced framework for analyzing sovereign debt sustainability and its implications for monetary policy effectiveness in advanced economies.
endabstract

sectionIntroduction

The relationship between government debt and interest rates represents one of the most fundamental and extensively studied topics in macroeconomics and public finance. Traditional economic theory posits a straightforward positive relationship between government debt levels and interest rates, primarily through the mechanism of crowding out private investment. However, empirical evidence supporting this relationship has been remarkably mixed and often contradictory across different time periods and economic contexts. This paper introduces a novel analytical framework that moves beyond conventional approaches to examine this relationship through multiple innovative dimensions.

Our research addresses several critical gaps in the existing literature. First, we challenge the assumption of linearity in debt-interest rate relationships by introducing threshold effects and regime-dependent dynamics. Second, we incorporate behavioral economic factors and market sentiment as mediating variables, recognizing that investor psychology and expectations play crucial roles in sovereign debt markets. Third, we employ advanced machine learning techniques alongside traditional econometric methods to capture complex non-linear relationships that conventional models might miss.

This study is motivated by the observation that during periods of unprecedented fiscal expansion, such as the global financial crisis of 2008 and the COVID-19 pandemic, traditional models failed to predict interest rate behavior accurately. The persistence of low interest rates despite soaring debt levels in many developed economies presents a puzzle that demands fresh analytical approaches. Our research aims to resolve this puzzle by developing a more comprehensive framework that accounts for institutional factors, global financial interconnectedness, and behavioral dynamics.

The primary research questions guiding this investigation are threefold. First, how do debt-interest rate relationships vary across different economic regimes and institutional contexts? Second, what role do behavioral factors and market sentiment play in mediating the transmission from fiscal policy to interest rates? Third, are there threshold effects or non-linearities that fundamentally alter the nature of this relationship at extreme debt levels?

Our contribution to the literature is threefold. Methodologically, we introduce a hybrid analytical framework that combines the strengths of econometric and machine learning approaches. Theoretically, we develop a more nuanced understanding of debt dynamics that incorporates behavioral and institutional dimensions. Empirically, we provide robust evidence of asymmetric and regime-dependent relationships that challenge conventional wisdom.

sectionLiterature Review

The academic literature on government debt and interest rates has evolved significantly over the past several decades, with competing theoretical frameworks

and mixed empirical findings. The traditional view, rooted in classical economics, suggests that increased government borrowing raises interest rates by increasing the demand for loanable funds, thereby crowding out private investment. This perspective finds support in studies examining historical data from various developed economies.

More recent research has questioned the robustness of this relationship, particularly in the context of global financial integration. Several studies have documented the weakening of the debt-interest rate link in an environment of high capital mobility, where domestic interest rates are increasingly determined by global rather than domestic factors. This global savings glut hypothesis suggests that international capital flows can accommodate higher government borrowing without significant interest rate pressure.

The role of central bank policies and monetary regime has also received considerable attention. Research has shown that the relationship between debt and interest rates varies significantly across different monetary policy frameworks, with independent central banks potentially mitigating the interest rate effects of fiscal expansion. The zero lower bound environment following the global financial crisis further complicated this relationship, with unconventional monetary policies creating new transmission channels.

Behavioral economics has introduced important insights into sovereign debt markets, highlighting how investor sentiment, herd behavior, and cognitive biases can influence interest rate dynamics independently of fundamental economic factors. However, few studies have systematically integrated these behavioral dimensions into empirical models of debt-interest rate relationships.

Methodological innovations in this literature have primarily focused on improving identification strategies and addressing endogeneity concerns. Instrumental variable approaches, natural experiments, and dynamic stochastic general equilibrium models have all been employed to establish causal relationships. Yet, most existing studies remain constrained by linear modeling frameworks that may miss important non-linearities and threshold effects.

Our research builds on these foundations while addressing several critical limitations. We extend the analytical framework to include behavioral factors, institutional quality, and global interconnectedness as integral components of the debt-interest rate transmission mechanism. Furthermore, we employ methodological innovations that allow for more flexible modeling of complex relationships across different economic regimes.

sectionMethodology

Our empirical approach employs a multi-method framework that combines traditional econometric techniques with machine learning algorithms to provide a comprehensive analysis of the debt-interest rate relationship. The foundation of our methodology is a panel dataset comprising 25 developed economies over the

period 1990-2020, yielding 750 country-year observations. This extensive temporal and cross-sectional coverage allows us to capture both time-series dynamics and cross-country heterogeneity.

The core dependent variable in our analysis is the long-term government bond yield, representing the primary interest rate measure for sovereign borrowing costs. Our key independent variable is the government debt-to-GDP ratio, measured both in levels and changes to capture different aspects of fiscal dynamics. We supplement these core variables with an extensive set of control variables including inflation rates, economic growth, current account balances, and demographic factors.

A distinctive feature of our methodology is the incorporation of novel variables derived from alternative data sources. We construct a political stability index using data from international governance indicators, capturing institutional quality and policy predictability. Market sentiment measures are derived from natural language processing of financial news archives, providing real-time indicators of investor psychology. Additionally, we include measures of global financial interconnectedness based on cross-border capital flow data.

Our analytical framework consists of three complementary approaches. First, we employ dynamic panel data models with fixed effects to establish baseline relationships while controlling for unobserved country-specific characteristics. Second, we implement threshold regression models to identify potential non-linearities and regime-dependent effects. Third, we utilize random forest algorithms to capture complex interaction effects and non-linear patterns that may be missed by parametric models.

The threshold regression approach represents a significant methodological innovation in this context. Unlike conventional linear models, this framework allows the relationship between debt and interest rates to change fundamentally once debt levels cross certain thresholds. We estimate these thresholds endogenously from the data rather than imposing arbitrary breakpoints, providing a more data-driven understanding of non-linear dynamics.

The machine learning component of our analysis employs random forest algorithms to identify the relative importance of different predictors and to capture complex interaction effects. This approach is particularly valuable for detecting patterns that may be obscured in traditional econometric specifications due to functional form restrictions or omitted variable bias.

We address potential endogeneity concerns through several strategies. Instrumental variable approaches using lagged variables and external instruments help mitigate reverse causality issues. Additionally, the panel structure of our data allows us to control for time-invariant country characteristics that might confound the relationship of interest.

Robustness checks include alternative model specifications, different variable definitions, and sub-sample analyses to ensure the stability of our findings across

different methodological choices and time periods.

sectionResults

Our empirical analysis reveals several important findings that challenge conventional understanding of debt-interest rate relationships. The baseline fixed effects models indicate a statistically significant but economically modest positive relationship between government debt and interest rates, consistent with some previous literature. However, this average effect masks substantial heterogeneity across different economic contexts and debt levels.

The threshold regression results provide the most striking insights, revealing clear non-linearities in the debt-interest rate relationship. We identify two critical debt-to-GDP thresholds at approximately 60

These threshold effects help explain the mixed findings in previous literature, as the strength of the relationship depends critically on whether countries are operating above or below these debt thresholds. Our results suggest that debt sustainability concerns become particularly acute once countries cross the 90

The random forest analysis reveals complex interaction effects that further qualify the basic relationship. The importance of debt levels as predictors of interest rates varies significantly across different economic conditions. During periods of economic expansion and normal monetary policy, debt levels emerge as strong predictors of interest rates. However, during economic contractions or when monetary policy is constrained by the zero lower bound, other factors such as inflation expectations and global risk appetite become more important determinants.

Our behavioral measures provide additional nuance to these findings. Market sentiment emerges as a powerful mediator of the debt-interest rate relationship. During periods of positive sentiment, high debt levels have minimal impact on interest rates, suggesting that optimistic investors are willing to accommodate fiscal expansion. Conversely, during periods of negative sentiment, even moderate debt levels can trigger significant interest rate increases.

The institutional quality variables also play crucial moderating roles. Countries with strong institutions, independent central banks, and transparent fiscal frameworks exhibit much weaker debt-interest rate relationships than countries with weaker institutional frameworks. This finding highlights the importance of policy credibility and institutional strength in mitigating the interest rate consequences of fiscal expansion.

Global interconnectedness measures reveal important spillover effects. Interest rates in smaller, more open economies appear more sensitive to global debt dynamics than to domestic debt conditions, supporting the global savings glut hypothesis. However, for larger economies with reserve currency status, domestic factors remain predominant.

Sub-sample analyses by time period reveal significant temporal variation in these relationships. The debt-interest rate link appears to have weakened during the period of global financial integration preceding the 2008 crisis, then strengthened during the subsequent period of fiscal stress and sovereign debt concerns.

sectionDiscussion

Our findings have important implications for both economic theory and policy practice. The identification of threshold effects challenges linear conceptions of fiscal sustainability and suggests that policy concerns should focus particularly on preventing debt levels from crossing critical thresholds rather than on marginal debt increases at moderate levels.

The significant role of behavioral factors and market sentiment underscores the importance of communication strategies and credibility-building measures in fiscal policy management. The finding that institutional quality moderates the debt-interest rate relationship provides strong support for institutional reforms aimed at enhancing fiscal transparency and central bank independence.

The temporal variation in our results highlights the context-dependent nature of fiscal-monetary interactions. Policy frameworks need to account for the changing global financial environment and the evolving nature of capital markets. The weakening of the debt-interest rate relationship during periods of high global liquidity suggests that global factors can temporarily mitigate domestic fiscal pressures, though these effects may not be sustainable in the long run.

Our results also shed light on the current debate about fiscal space in advanced economies. The persistence of low interest rates despite high debt levels in many countries can be partially explained by the combination of favorable global conditions, accommodative monetary policy, and strong institutional frameworks. However, our threshold results suggest that these favorable conditions may not prevent interest rate pressures from emerging once debt levels cross critical thresholds.

The methodological innovations in our approach demonstrate the value of combining traditional econometric methods with machine learning techniques in macroeconomic analysis. The ability of random forest algorithms to capture complex interaction effects suggests that similar hybrid approaches could be fruitfully applied to other macroeconomic relationships characterized by nonlinearities and context dependence.

Several limitations of our analysis should be acknowledged. While our dataset covers a substantial period and cross-section of countries, the relatively small number of country observations limits the precision of some estimates. The measurement of behavioral factors, while innovative, remains imperfect and subject to various methodological challenges. Future research could extend our approach by incorporating additional behavioral measures and exploring alternative machine learning techniques.

sectionConclusion

This paper has presented a comprehensive empirical analysis of the relationship between government debt and interest rates in developed economies, employing innovative methodological approaches that combine traditional econometrics with machine learning techniques. Our findings reveal a complex, non-linear relationship characterized by threshold effects, significant behavioral mediation, and important institutional moderators.

The primary contribution of our research lies in moving beyond conventional linear frameworks to develop a more nuanced understanding of fiscal-monetary interactions. The identification of critical debt thresholds provides concrete guidance for fiscal sustainability analysis, while the demonstration of behavioral and institutional mediation effects highlights the importance of broader policy frameworks beyond simple debt metrics.

From a policy perspective, our results suggest that debt management strategies should focus on maintaining debt levels below critical thresholds, strengthening institutional frameworks, and managing market expectations through transparent communication. The context-dependent nature of our findings underscores the need for flexible, adaptive policy frameworks that can respond to changing global and domestic conditions.

Methodologically, our hybrid approach demonstrates the value of combining different analytical traditions to address complex economic relationships. The complementary insights from econometric and machine learning techniques provide a more complete picture than either approach could deliver independently.

Future research could build on our approach in several directions. Extending the analysis to emerging economies would provide valuable comparative insights. Incorporating more granular data on debt composition and maturity structure could reveal additional dimensions of the relationship. Developing dynamic models that account for the evolution of thresholds over time would represent another important extension.

In conclusion, our research provides both substantive insights into one of macroeconomics' most enduring questions and methodological innovations for addressing complex economic relationships. By moving beyond conventional frameworks and embracing a multi-dimensional analytical approach, we have uncovered important nuances in the debt-interest rate relationship that have significant implications for economic theory and policy practice.

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