What does Sovereign Borrowing Signal? Theory and Evidence from Advanced Economies*

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Abstract

We assess the relative importance of three common sources of government private information in asymmetric-information models of sovereign debt: time preference, default costs, and future economic fundamentals. We develop a parsimonious signaling model that nests all three information structures and show that only private information about future fundamentals can generate a state-dependent signaling effect of sovereign borrowing on default risk. Using quarterly data for 20 advanced economies (2000Q2–2020Q3), we document a new stylized fact supporting such a state-dependent signaling effect: debt growth improves sovereign ratings in good fiscal states (primarily due to increases in short-term bonds) and lowers them in poor fiscal states (mainly due to growth in long-term loans).

Keywords: sovereign borrowing, signaling, default risk

JEL classifications: F34, D82.

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1 Introduction

A longstanding literature on sovereign debt has established that governments possess private information relevant to default risk and sovereign premia. Three sources of private information are commonly considered: time preference (discount factors), default costs (commitment capacity to repay), and future economic fundamentals. Yet, there is little study assessing the relative importance of these sources.

In this paper, we develop a parsimonious two-period model of sovereign borrowing that nests the leading information structures in the literature. We uncover a novel qualitative difference in the implications of private information sources on sovereign borrowing and default risk. When the private information is about time preference or default costs, the relationship between borrowing and default risk is monotonic, irrespective of fiscal context. However, when the private information is about future economic fundamentals, the relationship between borrowing and default risk is *state-dependent*. Specifically, borrowing more when fiscal buffers are strong signals good news about future fundamentals and reduces default risk, whereas borrowing more in a weak fiscal state signals bad news and raises default risk.

We document new evidence consistent with the state-dependent relationship between sovereign borrowing and default risk proxied by sovereign credit ratings. Using a quarterly panel covering 20 advanced economies from 2000Q2 to 2020Q3, we find that when a government's recent fiscal performance is strong, debt growth raises the rating; when fiscal performance is weak, it lowers the rating. Moreover, this effect varies with debt composition – improving ratings in good fiscal states primarily through short-term bond growth, and lowering them in poor fiscal states mainly via long-term loan growth.

A potential concern is that the positive effect of debt growth on ratings could be driven by reverse causality: an improved rating may lower borrowing cost and encourage more borrowing. But the fact that we observe a sign reversal across fiscal states counters this interpretation. If reverse causality were the main driver, its effect would likely be similar – or even stronger – in poor fiscal states, but instead, we find a strong negative association between ratings and debt growth precisely when fiscal conditions are weak.

Taken together, our findings clarify when and how a government's private information about future fundamentals becomes a critical ingredient in models of sovereign risk and premia. One plausible channel for this informational advantage is that governments often possess superior knowledge about how debt-financed resources will be allocated and how much they are likely to contribute to future economic growth.

A telling example of sovereign borrowing as a signal of government optimism comes from March 2013, when Ireland reentered the markets with its first 10-year bond sale since the bailout (Reuters, 2013). The government unexpectedly increased the issue size to nearly double the market consensus, attracting bids far in excess of the amount offered. Conversely, evidence from Japan illustrates the other side of this informational channel: Melosi et al. (2025) document that announcements of larger-than-expected fiscal packages by the Prime Minister's office have been interpreted by the stock market as signals of government's deteriorating economic outlook.

We use sovereign credit ratings as our main proxy for default risk, as they reflect not only the government's ability but also its willingness to repay – making them particularly sensitive to private information and signaling effects.[1] Compared to market-based measures such as sovereign bond spreads or credit default swap (CDS) spreads, credit ratings provide a cleaner measure of default risk by abstracting from liquidity and risk-premium components. Moreover, sovereign credit ratings are also a central mechanism by which markets, investors, and institutions assess and respond to default risk. Upgrades and downgrades by agencies such as S&P have direct and significant effects on countries' borrowing costs, financial institutions' portfolio choices, and the pricing of assets such as credit default swap spreads – even after the Global Financial Crisis.[2] Understanding the informational content and determinants of sovereign credit ratings is therefore critical not only for governments and investors, but also for macro-financial stability.

1.1 Related Literature

The main contribution of this paper is to uncover a novel, *state-dependent* signaling effect of sovereign borrowing – a qualitative difference in model implications that al-

[1]Our paper uses sovereign ratings by S&P Global Ratings, whose methodology can be found at *How We Rate Sovereigns* 2019. Similar language is also used in the descriptions of Moody's and Fitch Ratings' sovereign ratings methodologies.

[2]See, for example, Binici et al., 2018, Nakai and Chebbi, 2023.

lows us to distinguish between competing sources of government private information. Specifically, only private information about future economic fundamentals can generate state-dependent relationship between borrowing and default risk, while hidden time preference and default costs cannot. Our empirical analysis provides new stylized facts supporting such a state-dependent effect: debt growth improves sovereign ratings in good fiscal states but lowers them in poor fiscal states.

The most closely related paper is Fourakis (2024), who develops a flexible model in which a wide range of government decisions influence its reputation for debt repayment, and provides novel evidence on the relative importance of these actions. While his framework centers government private information on time preference and default cost, our findings highlight the need to incorporate future economic fundamentals as an essential additional dimension of private information in sovereign debt models.

Canonical sovereign-default theory. The canonical sovereign default models (Eaton and Gersovitz, 1981; Aguiar and Gopinath, 2006; Arellano, 2008) predict a monotonic link between more sovereign borrowing and greater default risk. Our empirical results challenge this view: more sovereign borrowing can actually improve a country's rating when recent fiscal performance is strong, yet worsens it when performance is poor. This sign-reversing response points to a mechanism beyond the standard prediction, namely, the signaling effect of sovereign borrowing under private information.

Private information and signalling. Existing asymmetric-information models of sovereign debt overwhelmingly focus on default, or equivalently, repayment, as the informative and costly signal (Cole et al., 1995; Cole and Kehoe, 1998; Sandleris, 2008; D'Erasmo, 2011; Egorov and Fabinger, 2016; Phan, 2017a; Phan, 2017b; Amador and Phelan, 2021; Amador and Phelan, 2023). A small but growing strand expands the scope of signaling to include other government actions – such as maturity structure (Perez, 2017), fiscal austerity (Gibert, 2022), restructuring initiation (Fourakis, 2024), and inflation misreporting (Morelli and Moretti, 2023) – with empirical evidence that these actions, too, convey information about sovereign risk. Our contribution is to show, both theoretically and empirically, that debt growth can serve as a state-contingent signal: it is interpreted positively by markets when fiscal buffers are strong, and negatively when they are weak.

Empirical literature on the determinants of sovereign ratings. Our paper is also related to the empirical literature on the determinants of sovereign ratings. Moor et al. (2018), Fuchs and Gehring (2017), and Ozturk (2014) review the sovereign rating methodology and document the presence of subjective judgment in the ratings. We contribute by showing that such subjectivity may, in part, reflect credit rating agencies' learning about governments' private information relevant to future default risk. Our methodological innovation is to interact debt growth with a fiscal-performance indicator, uncovering a conditional signaling channel that standard specifications obscure.

The rest of the paper is organized as follows: Section 2 develops a theoretical framework that distinguishes among three sources of government private information and demonstrates the state-dependent signaling effect of sovereign borrowing. Section 3 presents the empirical results supporting this effect. Section 4 establishes the robustness of our empirical findings. Section 5 concludes.

2 Theoretical Framework

In this section, we develop a stylized two-period model of sovereign borrowing that nests three alternative forms of government private information. We first show that the two most common forms in the literature – hidden time preference and hidden default cost – both predict a *monotonic* relationship between borrowing and default risk. We then demonstrate that private information about future economic fundamentals can generate a *state-dependent* signaling effect of sovereign borrowing where more borrowing signals good news about future fundamentals and reduces default risk in good fiscal states, but signals bad news and raises default risk in poor fiscal states.

2.1 Model Setup

We begin with a canonical two-period model of sovereign borrowing, following Aguiar and Gopinath (2006). The government derives logarithmic utility from consumption in each period. In the first period, it receives endowment x and may issue debt $b \in \mathcal{B} = \{b_0, b_0 + h, b_0 + 2h, ..., b_{max}\}$ with $h > 0$ to smooth consumption over time. The price at which the government can issue debt, $q(b)$, is determined by competitive, risk-neutral creditors. Period-1 consumption is thus $x + q(b)b$.

In the second period, the government's resources consist of a base endowment y and a possible additional component φ. If the government repays its debt, its period-2 consumption is $y + \varphi - b$; if it defaults, it receives a fallback payoff κ, where $\kappa < y + \varphi$ as default punishment. Default occurs if and only if

$$y + \varphi - b < \kappa.$$

Here, κ can be interpreted as a minimum consumption threshold or fiscal floor, below which default is optimal. y is uniformly distributed on $[\underline{y}, \overline{y}]$, yielding the default probability: $D(\kappa + b - \varphi)$ that is increasing in b. This probability equals zero when $b < \underline{y} + \varphi - \kappa$ and one when $b > \overline{y} + \varphi - \kappa$. Default probability rises with the threshold κ and falls with the government's period-2 endowment φ.

2.1.1 Preference Shocks

Following Chatterjee et al. (2023), we assume that the government receives additively separable extreme value preference shocks, $\epsilon = \{\epsilon(b)\}_{b \in \mathcal{B}}$, to its period-1 utility. The set of preference shocks attaches to debt issuance choices b and each element $\epsilon(b)$ is drawn from a type I extreme value distribution with a scale parameter λ.

2.1.2 Private Information

We assume the government possesses private information about its preference shocks and its own default probability. Governments with lower default risk are referred to as the *safe* type (S), while those with higher default risk are labeled as the *risky* type (R). Differences in default risk can arise from two sources: (1) heterogeneity in the default threshold κ, or (2) variation in the expected period-2 endowment φ.

2.1.3 Government's Problem

In period 1, a government of type $i \in \{S, R\}$ chooses borrowing b, taking the debt pricing function $q(b)$ as given, to maximize the sum of its period-1 and expected period-2 utilities. Denote $u_i(b)$ as the government's utilities without the preference shocks when it chooses b.

$$u_i(b) = \ln(x + q(b)b) + D(\kappa_i + b - \varphi_i)\ln(\kappa_i) + \left[1 - D(\kappa_i + b - \varphi_i)\right]\mathbb{E}\left[\ln(y + \varphi_i - b) \,\middle|\, y + \varphi_i - b > \kappa_i\right] \tag{1}$$

For each type i, the optimal debt level b_i is:

$$b_i = \arg\max_{b \in \mathcal{B}} u_i(b) + \epsilon(b) \tag{2}$$

and the implied choice probability is:

$$\Pr(b|i) = \frac{\exp(u_i(b)/\lambda)}{Z_i}, \qquad Z_i := \sum_{b' \in \mathcal{B}} \exp(u_i(b')/\lambda). \tag{3}$$

given that ϵ are drawn from type I extreme value distribution.

2.1.4 Creditors' Problem

Creditors do not observe the government's type i or preference shocks ϵ but observe its borrowing decision b. Let π denote their prior beliefs that the government is of the safe type, creditors update beliefs about the government's type using Bayes' rule:

$$\rho(b) := \Pr(i = S|b) = \frac{\pi \Pr(b|i = S)}{\pi \Pr(b|i = S) + (1 - \pi)\Pr(b|i = R)}, \tag{4}$$

where $\Pr(b|i)$ is the choice probability of type i defined in (3).

Being risk-neutral and competitive, creditors price debt such that the expected return equals the risk-free rate:

$$q(b) = \frac{1 - \rho(b)D_S - (1 - \rho(b))D_R}{1 + r}, \tag{5}$$

where D_S and D_R denote the default probabilities of the safe and risky types, respectively, and r is the risk-free rate.

2.1.5 Equilibrium

An equilibrium consists of type-specific choice probabilities $\Pr(b|i)$ and a pricing function $q(b)$ such that: (i) each government type maximizes its objective given $q(b)$, and (ii) creditors form beliefs consistent with Bayes' rule and price debt accordingly.

2.2 Signaling

Our interest lies in how creditors' posterior belief $\rho(b)$ responds to borrowing decisions. Since the safe type has a lower default probability, an increase in $\rho(b)$ following more borrowing indicates *positive signaling* – creditors interpret debt growth as a sign of better creditworthiness. Conversely, if $\rho(b)$ declines with b, more borrowing signals worse creditworthiness, resulting in *negative signaling.*

Define the likelihood ratio:

$$L(b) := \frac{\Pr(b|i=S)}{\Pr(b|i=R)} = \frac{Z_R}{Z_S} \exp\Big[u_S(b) - u_R(b)\Big] = \text{const} \times \exp\big[\Delta(b)\big], \tag{6}$$

where $\Delta(b) := u_S(b) - u_R(b)$. The sign of the posterior belief's response to sovereign borrowing is determined by how the likelihood ratio changes with b:

$$\forall b \in \mathcal{B}, \rho(b+h) \geq \rho(b) \text{ iff } L(b+h) > L(b) \text{ i.e. } \Delta(b+h) - \Delta(b) \geq 0 \tag{7}$$

Assuming the debt grid $\mathcal{B} = \{b_0, b_0 + h, b_0 + 2h, ..., b_{max}\}$ is sufficiently fine (a mesh size $h > 0$ is small enough) that

$$\Delta(b+h) - \Delta(b) \approx h\Delta'(b) \tag{8}$$

where $\Delta'(b) = u'_S(b) - u'_R(b)$ is the first derivative of the smooth extension of $\Delta(b)$ over $[b_0, b_{max}]$. For each type $i \in \{S, R\}$, the marginal utility of (1) decomposes as $u'_i(b) = MB(b) - MC(b, \kappa_i, \varphi_i)$ with $MB(b)$ being the marginal benefit of borrowing and $MC(b, \kappa_i, \varphi_i)$ the marginal cost:

$$MB(b) = \frac{1}{x + q(b)b} \frac{\partial [q(b)b]}{\partial b} \tag{9}$$

$$\begin{aligned} MC(b, \kappa_i, \varphi_i) = {} & [1 - D(\kappa_i + b - \varphi_i)] E \left[\frac{1}{y + \varphi_i - b} \,\middle|\, y > \kappa_i + b - \varphi_i \right] \\ & + D'(\kappa_i + b - \varphi_i) \left(E \left[\ln(y + \varphi_i - b) \,|\, y > \kappa_i + b - \varphi_i \right] - \ln(\kappa_i) \right) \end{aligned} \tag{10}$$

Because the marginal benefit of borrowing is type-invariant, the sign of $\Delta'(b)$ is governed entirely by the difference in marginal borrowing costs: $\Delta'(b) \geq 0$ iff $MC(b, \kappa_R, \varphi_R) \geq MC(b, \kappa_S, \varphi_S)$. We therefore have the following result:

Proposition 1. *Creditors' posterior belief $\rho(b)$ is increasing in b (positive signaling) if and only if the risky type's marginal cost of borrowing is higher than the safe type's, i.e. $MC(b, \kappa_R, \varphi_R) \geq MC(b, \kappa_S, \varphi_S)$ for all $b \in \mathcal{B}$.*

2.3 Monotonic Signaling Effect under Hidden κ

We now examine the scenario in which the government's default threshold κ is private information, and show that it *always* produces a monotonic relationship between government borrowing and perceived default risk by creditors. Two common approaches to modeling private information in the sovereign debt literature – heterogeneity in time preference and in default costs – can both be interpreted as private information about the default threshold in our framework. A more patient government (e.g. D'Erasmo (2011)) or one facing higher costs of default (e.g. Morelli and Moretti (2023)) will choose to default less readily, corresponding to a lower threshold κ, and vice versa.

Specifically, suppose that the government's default threshold is $\kappa \in \{\kappa_R, \kappa_S\}$ with $\kappa_R > \kappa_S$ and this value is known only to the government. For this exercise, assume there is no private variation in future fundamentals (i.e. φ is identical for both types), so that any signaling comes solely from differences in default thresholds. More borrowing in this case always signals that the government is more likely to be the risky type, implying a single-signed debt–belief relationship.

Proposition 2 (Single-signed debt–belief relationship under hidden κ)**.** *Suppose the two government types share the same φ and $\kappa_R > \kappa_S$, the risky type's marginal cost of* *borrowing is lower than the safe type's, i.e.* $MC(b, \kappa_R, \varphi) < MC(b, \kappa_S, \varphi)$ *for all* $b \in \mathcal{B}$*. Therefore, creditors' posterior belief* $\rho(b)$ *always* decreases *in* b *(negative signaling).*

Proof. See the Appendix. □

Intuition. The marginal cost of borrowing has two components: (1) conditional on repayment, additional borrowing reduces period-2 resources and thus increases the utility cost of repayment; and (2) higher borrowing raises the probability of default, in which case the government incurs the utility loss associated with the default punishment. When the only difference between government types lies in the default threshold κ, the risky type – with a higher κ – repays only in more favorable endowment realizations than the safe type, and thus faces a lower average utility cost of repayment. Moreover, because a higher κ implies a smaller utility loss from default, the second component of marginal cost is also lower for the risky type.

2.4 State-dependent Signaling Effect under Hidden φ

We next turn to an information structure where the sovereign's private information concerns its *future economic fundamentals*, $\varphi \in \{\varphi_S, \varphi_R\}$ with $\varphi_S > \varphi_R$. To isolate its signaling effect, we assume that κ is identical for both types and is observable to both the government and creditors. In this setting, a government's borrowing can have *opposite* implications for default risk depending on the value of κ.

Proposition 3 (State-dependent signaling under hidden φ)**.** *Suppose the two government types share the same* κ *and* $\varphi_S > \varphi_R$*, there exists a threshold* $\hat{\kappa} \in (\underline{y} + \varphi_R - b,\ \underline{y} + \varphi_S - b]$ *such that* $MC(b, \kappa, \varphi_R) > MC(b, \kappa, \varphi_S)$ *if and only if* $\kappa < \hat{\kappa}$*. Therefore,*

- *When* κ *is* low*, the risky type's marginal cost of borrowing is higher than the safe type's so that creditors' posterior belief* $\rho(b)$ increases *in* b *(positive signaling).*
- *When* κ *is* high*, the risky type's marginal cost of borrowing is lower than the safe type's so that creditors' posterior belief* $\rho(b)$ decreases *in* b *(negative signaling).*

Proof. See the Appendix. □

Intuition: The key distinction when private information lies in the government's future endowment φ, rather than the default threshold κ, is that the private information *enters the marginal utility cost of repayment* – which is lower for the safe type – and creates space for the state-dependent effect.

Recall that the marginal cost of borrowing (10) consists of two components. The first is the product of the repayment probability and expected marginal utility cost of repayment. The second is the product of the utility penalty and the marginal increase in the probability of default.

When κ is sufficiently low ($\kappa < \underline{y} + \varphi_i - b$ for $i = S, R$), both types repay with certainty. In this case, the marginal cost of borrowing is dominated by the expected marginal utility cost of repayment. Since the safe type has a higher endowment φ, it retains more resources after repayment and thus incurs a lower marginal utility cost.

When κ is sufficiently high ($\kappa \geq \underline{y} + \varphi_i - b$ for $i = S, R$), the probability of default becomes non-negligible for both types. Now, both components matter for comparing marginal costs across types. The first component becomes larger for the safe type: although it still has a lower marginal utility cost of repayment, its higher repayment probability dominates the comparison. The second component is also higher for the safe type, as it faces a larger utility penalty upon default.

As κ moves from the sufficiently low to sufficiently high values, the comparison between the two types' marginal costs of borrowing flips from the safe type having a lower marginal cost to the risky type having a lower marginal cost. This is the key mechanism that generates the state-dependent effect.

2.5 Interpreting the Model Results

Although highly stylized, our model clearly distinguishes between sources of private information in terms of their implications for the relationship between sovereign borrowing and perceived default risk by creditors.

In the model, the probability that a government repays its debt depends on b, κ and φ, where b is the debt level, and κ and φ can represent either public or private information. If both κ and φ are public information, as in canonical sovereign debt models, higher debt always reduces the probability of debt repayment, thus increasing default risk. When either κ or φ is private information, their economic interpretation becomes richer: κ may capture unobservable factors such as the government's political constraints (time preference) or willingness to honor obligations (default costs), while φ reflects the government's private knowledge about how much its debt-financed resources will contribute to future economic growth (future fundamentals).

When κ is private information and φ is public, Proposition 2 shows that, regardless of the level of φ (good or bad public information), the risky type always has a lower marginal cost of borrowing than the safe type. This implies that creditors' posterior belief $\rho(b)$ of the government being the safe type is always decreasing in b; in other words, borrowing sends a negative signal.

In contrast, when φ is private information and κ is public, Proposition 3 demonstrates that the level of κ is critical for the monotonicity of creditors' posterior belief $\rho(b)$ in b. Specifically, if κ is low (indicating good public information about repayment probability), the risky type's marginal cost of borrowing exceeds that of the safe type, so $\rho(b)$ increases with b (positive signaling). Conversely, if κ is high (indicating bad public information about repayment probability), the risky type's marginal cost of borrowing is lower, so $\rho(b)$ declines with b (negative signaling).

3 State-dependent Signaling Effect in Data

This section demonstrates that the state-dependent signaling effect of sovereign borrowing is not merely a theoretical possibility, but is supported by the empirical evidence.

3.1 Sample and Data Sources

Our empirical analysis uses a quarterly panel of 20 advanced economies from 2000Q2 to 2020Q3,[3] including Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Hungary, Ireland, Israel, Italy, Luxembourg, Netherlands, New Zealand, Portugal, Spain, Sweden, the United Kingdom, and the United States.[4]

[3]Our sample period is determined by sovereign debt data availability, with the endpoint chosen to exclude the Covid-19 pandemic. Additional details are provided in the Appendix.

[4]Japan and South Korea are excluded due to missing quarterly data on general government fiscal performance and consolidated debt, respectively. Germany, Norway, Singapore, and Switzerland are dropped for lacking variation in rating data. Greece is excluded due to data inaccuracies exposed by the 2010 debt crisis and subsequent events.

Our main outcome variable is the *issuer credit rating (ICR) on a sovereign* assigned by S&P GLOBAL RATINGS. Government debt statistics, operating balances, long-term bond yields, current account balances, and fiscal reserves come from the BIS, the OECD, the IMF's IFS, the ECB's GFS, and the World Bank's QPSD databases. Macroeconomic controls (nominal and real GDP, CPI inflation) are drawn from national accounts compiled by CEIC.

3.2 Key Variables and Fiscal-State Classification

Sovereign rating. According to S&P's methodology, the issuer credit rating (ICR) reflects "a sovereign's ability and willingness to service financial obligations to nonofficial (commercial) creditors" (*How We Rate Sovereigns* 2019). The ICR is assigned as a letter-grade rating, ranging from class D (default) to class AAA (prime), and is typically accompanied by a rating outlook – categorized as negative, stable, or positive. As stated by S&P, the outlook reflects its assessment of the likely direction of a sovereign rating over the intermediate term (typically six months to two years)(*Guide to Credit Rating Essentials* 2024).

Because the outlook can change more frequently than the rating category, we interpret it as capturing incremental information about a country's creditworthiness that does not yet warrant a category adjustment. To facilitate regression analysis, we convert S&P's letter grades to a 21-point numeric scale (AAA = 20, AA^+ = 19, ..., D = 0) and then map the outlook category {negative, stable, positive} to numerical values {-0.5, 0, 0.5}.[5] We then define a continuous rating measure as the sum of the numeric rating and the mapped outlook value:

$$\text{ICR}_{it} = \text{RatingScore}_{it} + \text{OutlookAdj}_{it},$$

where $\text{RatingScore}_{it} \in [0, 20]$ is the numeric conversion of the S&P letter grade, and $\text{OutlookAdj}_{it} \in \{-0.5, 0, 0.5\}$ reflects the rating outlook. Because S&P updates its ratings on an irregular schedule, we use the rating and outlook as of *the end of quarter*

[5]There are two main econometric approaches in the literature on the determinants of sovereign ratings: one, beginning with Cantor and Packer (1996), converts ratings to a numerical scale for linear regression; the other, dating to Hu et al., 2002, treats ratings as discrete choices and employs ordered probit/logit models. We follow the first strand to maximize clarity, since panel extensions of ordered probit are not straightforward. Notably, Mora (2006) and Afonso et al. (2011) show that both approaches yield similar empirical findings.

t as our proxy for a country's sovereign creditworthiness in that quarter.

Debt growth. Let B_{it} denote the consolidated general-government debt of country i in quarter t. We measure debt growth as the change in the debt-to-GDP ratio from the previous quarter, expressed in percentage points:

$$\Delta \text{Debt}_{it} = 100 \times \left(\frac{B_{it}}{\text{GDP}_{it}} - \frac{B_{i,t-1}}{\text{GDP}_{i,t-1}} \right). \tag{11}$$

Debt composition. Let $D_{it}^{(j)}$ denote the outstanding amount of debt component j in country i in quarter t, where j indexes short-term bonds, long-term bonds, short-term loans, or long-term loans.[6] We define the share change of debt component j as its quarterly change scaled by total debt in the previous quarter:

$$\delta_{it}^{(j)} = 100 \times \frac{D_{it}^{(j)} - D_{i,t-1}^{(j)}}{B_{i,t-1}}. \tag{12}$$

Fiscal performance. We measure a government's recent fiscal stance using its *net operating balance (NOB)*, defined as general government revenue minus total expenditure (including interest payments), expressed as a percentage of GDP. Unlike the primary balance, NOB captures debt servicing costs and thus more fully reflects the government's fiscal position. Because it excludes net acquisitions of nonfinancial and financial assets, NOB does not necessarily equal the negative of debt growth. For example, a government may run a positive operating balance yet increase debt by accumulating assets, or post a negative balance while reducing debt through asset sales.

Let NOB_{it} denote NOB-to-GDP ratio for country i in quarter t. We classify fiscal states as:

$$\begin{aligned}
\text{Good}_{it} &= \mathbf{1}\left\{\text{NOB}_{it-1} > \overline{\text{NOB}}_i + \lambda^G \sigma_i\right\}, \\
\text{Poor}_{it} &= \mathbf{1}\left\{\text{NOB}_{it-1} < \overline{\text{NOB}}_i - \lambda^P \sigma_i\right\}, \\
\text{Normal}_{it} &= \mathbf{1}\left\{\overline{\text{NOB}}_i - \lambda^P \sigma_i \leq \text{NOB}_{it-1} \leq \overline{\text{NOB}}_i + \lambda^G \sigma_i\right\}.
\end{aligned} \tag{13}$$

Fiscal states are based on lagged NOB to ensure they are predetermined with respect to the dependent variables in our regressions. $\overline{\text{NOB}}_i$ and σ_i denote the country-specific

[6] Short-term bonds or loans are defined as those with a residual maturity of one year or less.

mean and standard deviation of NOB over the sample period. The threshold multipliers $\lambda^G = 1$ and $\lambda^P = 0.8$ are set to yield roughly equal shares (about 14.5%) of observations classified as good and poor fiscal states.

3.3 State-Dependent Effect of Consolidated Debt Growth

To examine how sovereign debt growth affects ratings across different fiscal states, we estimate the following baseline regression specification:

$$\text{ICR}_{it} = \rho \text{ICR}_{i,t-1} + \sum_{s \in \{\text{Good,Normal,Poor}\}} \beta_s \times s_{it} \times \Delta\text{Debt}_{it} + \gamma' \mathbf{X}_{it} + \alpha_i + \lambda_t + \varepsilon_{it},$$

where ICR_{it} is the sovereign rating of country i in quarter t, ΔDebt_{it} is the change in debt-to-GDP ratio from the previous quarter defined in (11), and s_{it} is the fiscal state of country i in quarter t defined in (13). $\mathbf{X}_{it}$ is a set of control variables. α_i and λ_t are country and time fixed effects. Standard errors are clustered at the country level.

The two most important controls in our specification are the lagged sovereign rating and the contemporaneous long-term government bond yield (10-year maturity). Including the lagged rating absorbs all information S&P possessed about the country's creditworthiness prior to the current quarter. The period-t long-term yield serves two critical roles. First, it helps address potential reverse causality: higher ratings can lower borrowing costs and encourage additional borrowing within the same period. By controlling for the prevailing long-term yield,[7] we better isolate the effect of debt growth on ratings.

Second, and equally important, the long-term yield acts as a catch-all proxy for time-varying omitted factors related to default risk. Many unobserved determinants can affect both sovereign ratings and borrowing decisions, potentially leading to spurious correlation if uncontrolled. Because sovereign bond yields are widely used in the literature as proxies for default risk,[8] including them as controls helps absorb these confounding influences and mitigate omitted variable bias.

Our remaining controls follow S&P's published methodology, which emphasizes several key determinants of sovereign creditworthiness: fiscal performance, external

[7]We use long-term yield rather than short-term yield, since the latter is often a monetary policy instrument. As a robustness check, we also use a weighted average of long- and short-term yields.

[8]Baek et al. (2005); Eichler and Maltritz (2013); Gilchrist et al. (2021).

liquidity, economic growth, and monetary policy effectiveness. We capture these factors using the contemporaneous net operating balance, current account balance, fiscal reserves, real GDP growth, inflation, and an EU dummy. To account for different baseline risk levels across fiscal states, we also include fiscal-state indicator variables.

Table 1 reports the estimates of the baseline regression.

Unconditional effect of debt growth. Column (1) estimates the unconditional effect of debt growth on sovereign ratings at -0.010 ($p < 0.05$): a one-percentage-point increase in the debt-to-GDP ratio results in a *0.010-notch downgrade* in the sovereign rating. This aligns with the conventional wisdom that debt growth in general reduces a country's creditworthiness.

State-dependent effects of debt growth. Column (2) reveals that the impact of debt growth effect on sovereign ratings is highly state-dependent. In *good fiscal states* ($\text{Good}_{it} = 1$), a one-percentage-point increase in the debt-to-GDP ratio leads to a *0.013-notch rating upgrade* ($\hat{\beta}_{\text{Good}} = 0.013$, $p < 0.10$). By contrast, in *poor fiscal states* ($\text{Poor}_{it} = 1$), the same debt increase results in a *0.025-notch downgrade* ($\hat{\beta}_{\text{Poor}} = -0.025$, $p < 0.10$).

This sign reversal in the effect of debt growth is noteworthy because it *rules out reverse causality as the main driver*: if the positive debt-rating relation is merely driven by better (worse) ratings encouraging (reducing) borrowing, the effect would not flip across fiscal state – and might even be stronger in poor states. Yet, we find a sizable negative effect of debt growth precisely when fiscal conditions are weak.

In *normal states*, the coefficient is also negative and significant ($\hat{\beta}_{\text{Normal}} = -0.006$, $p < 0.05$), but its economic magnitude is much smaller – about half that in good states and a quarter of that in poor states – indicating that the negative perception of debt accumulation is *substantially muted* when fiscal conditions are neither strong nor weak.

Control variables. The control variables exhibit patterns consistent with economic intuition and rating agency practices. The lagged rating coefficient of 0.951 ($p < 0.01$) indicates strong persistence in sovereign credit assessments. The long-term government bond yield enters negatively and significantly (-0.082, $p < 0.01$), aligning with its role as a market-based default risk measure. The net operating balance shows a modest positive effect (0.006, $p < 0.10$), confirming that stronger fiscal positions support higher ratings. The remaining controls all lack statistical significance at conventional levels. This pattern suggests that while these variables inform rating decisions as per S&P's methodology, their incremental impact is limited once we account for lagged ratings and contemporaneous market signals.

These results establish our first stylized fact: *the effect of sovereign debt growth on ratings depends critically on fiscal conditions – debt increases lead to rating upgrades when fiscal performance is strong but downgrades when it is weak.*

3.4 Debt Composition

We next investigate whether this state-dependent effect on sovereign ratings extends beyond the sovereign debt level to the structure of government liabilities – such as increasing reliance on short-term loans or long-term bonds.

To this end, we estimate the following specification separately for each debt component $j \in$ {short-term bonds, long-term bonds, short-term loans, long-term loans}:

$$\text{ICR}_{it} = \rho \text{ICR}_{i,t-1} + \beta \Delta \text{Debt}_{it} + \sum_{s \in \{\text{Good,Normal,Poor}\}} \theta_s^{(j)} \times s_{it} \times \delta_{it}^{(j)} + \gamma' \mathbf{X}_{it} + \alpha_i + \lambda_t + \varepsilon_{it},$$

where ICR_{it} is the sovereign rating, $\delta_{it}^{(j)}$ is the change in the composition share of component j defined in (12), and s_{it} is the fiscal state defined in (13). We use the same set of control variables as in the baseline regression, but include the debt growth term ΔDebt_{it} to account for the direct effect of total debt growth on the sovereign rating.

Table 2 reports the regression results, with Columns 1–4 corresponding to short-term loans, short-term bonds, long-term loans, and long-term bonds, respectively.

Instrument-specific effects. The results highlight two channels through which the composition of borrowing matters: short-term bonds in good fiscal states and long-term loans in poor fiscal states. When fiscal conditions are strong, an increase in the share of short-term bonds is associated with an improvement in the sovereign rating ($\hat{\theta}_{\text{Good}}^{\text{st\_bond}} = 0.013$, $p < 0.05$). This suggests that S&P views such issuance as a signal of confidence rather than desperation for funds.[9] In contrast, when fiscal conditions are

[9] This finding aligns with the incentive benefits of short-term bonds, which provide stronger repayment incentives (Arellano and Ramanarayanan, 2012; Dovis, 2019)

poor, greater reliance on long-term loans leads to a decline in ratings ($\hat{\theta}^{\text{lt\_loan}}_{\text{Poor}} = -0.04$, $p < 0.10$), consistent with market perceptions of constrained financing options in weak fiscal conditions (Corsetti et al., 2006).

Interaction terms for other debt components are statistically insignificant, suggesting that the fiscal-state-dependent effects of debt composition are concentrated in these two instruments. Importantly, the negative and significant coefficient on overall debt growth remains robust across specifications, indicating that total borrowing continues to influence ratings even after accounting for compositional shifts.

Control variables. Control variables show similar patterns to those in the baseline regression. Ratings remain highly persistent, and higher long-term bond yields and weaker operating balances are associated with lower ratings. Other controls remain insignificant, reinforcing the primacy of fiscal and market-based indicators.

These results thus extend our baseline finding by showing that *the effect of sovereign borrowing on ratings is both fiscal-state dependent and instrument-specific.* Even conditional on total borrowing, S&P's rating response varies systematically with the maturity and type of debt issued and the prevailing fiscal context. In particular, *the only significant positive response* occurs when governments in *strong* fiscal positions increase their use of *marketable short-term bonds*, while *the only significant negative response* arises when governments in *weak* fiscal positions rely more heavily on *long-term loans.*

3.5 Connecting the Model and the Empirical Results

Our model analysis demonstrates that only government's private information about future fundamentals – rather than time preference or default costs – can generate a state-dependent signaling effect of sovereign borrowing. When public information about repayment probability is favorable, increased borrowing leads creditors to update their beliefs in favor of the government being a safe type, thereby lowering perceived default risk. In contrast, under unfavorable public information, higher borrowing raises the likelihood that the government is risky, resulting in increased default risk.

Empirically, we find that the effect of debt growth on sovereign ratings depends critically on both fiscal state and debt composition, each of which provides public information about a government's repayment probability. Fiscal state is classified as *good* if it falls into the top 15% of the country's observed fiscal performance over time, measured by its government net operating balance (NOB) as a share of GDP. Conversely, it is classified as *poor* if in the bottom 15%. Debt instruments are classified by residual maturity and liquidity: short-term bonds (maturity under one year) are easily traded, while long-term loans (maturity over one year) are less liquid. Accordingly, markets view repayment of short-term bonds as more likely than long-term loans.

Therefore, being in a good fiscal state and borrowing via short-term bonds are favorable public information about repayment probability. In these cases, more borrowing, measured by an increased debt-to-GDP ratio or a larger share of short-term bonds, improves sovereign ratings. By contrast, being in a poor fiscal state and borrowing via long-term loans are unfavorable public information, so more borrowing in these contexts lowers sovereign ratings.

4 Robustness Checks

Section 3 demonstrates that the effects of sovereign debt growth – both in aggregate and by composition – are highly state-dependent: higher debt growth improves sovereign ratings in good fiscal states but lowers them in poor states. These effects are instrument-specific, with positive impacts driven mainly by short-term bonds and negative effects by long-term loans.

Concerns about reverse causality and omitted variable bias are addressed: the observed sign reversal across fiscal states rules out reverse causality as the main driver, while controlling for sovereign borrowing cost helps mitigate omitted variable concerns.

This section further confirms the robustness of these empirical patterns to additional controls for omitted variables beyond borrowing cost and to alternative borrowing cost measures. We also show that similar state-dependent effects emerge when sovereign bond spreads are used as the outcome variable.

4.1 Changes in Government

We consider the possibility that a change in government might simultaneously lead to an improvement in a country's credit rating and a shift toward greater tolerance of sovereign debt.[10]

To control for this, we construct an indicator variable for leadership transitions. Specifically, when a country's president or prime minister is replaced, the variable takes a value of 1 if the new leader is from a different political party, and 0.5 if the replacement is from the same party. The indicator is set to 0 in quarters with no change in leadership. In our sample, there are 61 instances coded as 1 and 30 as 0.5.

Table 3 presents the results from the baseline regression (column 1) and the specifications for each debt component (columns 2–5), after adding the leadership transition indicator in the control variables. The estimated coefficients and significance levels closely mirror those reported in Tables 1 and 2, confirming the robustness of our main findings. The coefficient on the government change indicator is positive across all regressions, but it is not statistically significant in any specification.

4.2 GDP Growth Rate Forecast

If a country is expected to experience higher future growth, its sovereign rating is likely to improve, and the government may borrow more even if borrowing costs remain unchanged. As shown in the theory section, this mechanism can rationalize the observed state-dependent effect of debt growth on sovereign ratings when the government possesses private information about future economic fundamentals, which rating agencies infer from observed borrowing behavior. However, there may also be public information about a country's growth prospects that simultaneously drives both higher sovereign ratings and increased government borrowing, without implying a causal effect from borrowing to ratings.

To address this possibility, we proxy public information using quarterly GDP forecasts from the OECD Economic Outlook database (via CEIC). Specifically, we use the "GDP growth forecast by volume," which reports annualized quarter-over-quarter real GDP growth. For each country and quarter, we take the average forecasted growth rate for the next eight quarters as our measure of publicly available expectations about future growth. Table 4 reports results from the baseline regression (column 1) and from specifications for each debt component (columns 2–5), after including the GDP forecast as an additional control.

[10] We thank a referee for highlighting this potential confound.

The estimated coefficients and their significance levels are similar to those in Tables 1 and 2. The positive coefficient on consolidated debt growth in good fiscal states (column 1) is slightly reduced in magnitude compared to the baseline. The positive effect of short-term bonds (column 3) and the negative effect of long-term loans (column 4) remain robust and statistically significant. The coefficient on the GDP forecast itself is positive but insignificant across all regressions.

4.3 Alternative Control for Borrowing Cost

In Table 5, we use the weighted average bond yield as an alternative control for a country's borrowing cost, replacing the government long-term bond yield. The weighted average bond yield is calculated as the average of the long-term (10 years) and short-term (1 year or less) bond yields, weighted by their shares in total bond stock.[11] The results remain similar to those in Tables 1 and 2.

4.4 Alternative Proxy for Sovereign Risk

We have shown the state-dependent effects of sovereign debt growth on default risk, using sovereign ratings as the proxy for default risk. In this subsection, we investigate whether sovereign bond spreads – another widely used proxy for default risk – exhibit similar state-dependent effects.

To do so, we replace the dependent variable in our baseline regression and the debt composition regressions with the one-quarter-ahead sovereign bond spread, defined as the difference between a country's long-term sovereign bond yield and that of the US (in percentage points).[12] We use the one-quarter-ahead bond spread to avoid contemporaneous feedback between sovereign borrowing and bond spreads, since both variables are measured at a quarterly frequency. The regression specification retains the same set of control variables, except that we replace the last-quarter sovereign rating with the current and previous quarter's sovereign bond spreads, and exclude the current-quarter sovereign bond yield from the controls.

We report the results in Table 6. The findings for sovereign bond spreads broadly

[11] We use the government bond yield with a maturity of one year or less from CEIC when available; otherwise, the 3-month interbank rate is used.

[12] As a result, the US is excluded from the sample in this analysis.

mirror the state-dependent effects observed for sovereign ratings. When fiscal conditions are strong, higher consolidated debt growth (column 1) is associated with a reduction in the next-quarter bond spread, suggesting lower perceived default risk. In contrast, under poor fiscal conditions, higher debt growth increases the spread, indicating greater perceived risk. However, these coefficients are not statistically significant. This is not unexpected, as sovereign spreads often reflect liquidity and term-premium components unrelated to default risk, highlighting the advantage of sovereign ratings as a cleaner measure of creditworthiness.

Examining debt composition, short-term bond growth (column 3) lowers the next-quarter bond spread, i.e., perceived default risk (significant in poor fiscal states), while long-term loan growth (column 4) raises it (significant in normal and poor fiscal states). Overall, these findings reinforce the conclusion that the effects of sovereign borrowing on perceived default risk are both state-dependent and instrument-specific.

5 Conclusion

In this paper, we establish that a state-dependent signaling effect of sovereign borrowing on perceived default risk arises both theoretically and empirically. We show that this effect serves as a powerful discriminator among different modeling choices for government private information: only private information about future fundamentals can generate the observed state-dependent signaling, whereas hidden time preference or default costs cannot.

Taken together, these findings imply that future asymmetric-information models of sovereign borrowing, default risk, and risk premia should consider private information about future fundamentals as an important modeling element. Focusing solely on hidden patience or default costs is insufficient to capture how markets interpret sovereign borrowing decisions and the informational content of credit ratings.

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Table 1: Effect of Consolidated Debt Growth on Sovereign Ratings

	(1) Unconditional Effect	(2) Conditional Effects
Last-quarter S&P Rating	0.951***	0.951***
	(0.009)	(0.009)
Consolidated Debt-to-GDP Change:		
ΔDebt	-0.010**	
	(0.003)	
Good Fiscal State × ΔDebt		0.013*
		(0.007)
Normal Fiscal State × ΔDebt		-0.006**
		(0.003)
Poor Fiscal State × ΔDebt		-0.025*
		(0.013)
Control Variables:		
Long-term Gov Bond Yield	-0.085***	-0.082***
	(0.015)	(0.014)
NOB (% of GDP)	0.007*	0.006*
	(0.004)	(0.003)
Current Account Balance (% of GDP)	0.001	0.001
	(0.003)	(0.003)
Fiscal Reserves (% of GDP)	0.000	-0.000
	(0.001)	(0.001)
Real GDP Growth (yoy, %)	0.002	0.002
	(0.003)	(0.003)
Inflation (qoq, %)	0.004	0.005
	(0.021)	(0.021)
EU Dummy	-0.013	-0.015
	(0.062)	(0.066)
Good Fiscal State	0.048	0.040
	(0.038)	(0.032)
Normal Fiscal State	0.060	0.036
	(0.037)	(0.030)
Constant	0.937***	0.968***
	(0.161)	(0.161)
Time Fixed Effects	Yes	Yes
Country Fixed Effects	Yes	Yes
Observations	1,597	1,597
R^2	0.994	0.994

Robust standard errors clustered at country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents regression results examining how sovereign debt changes affect S&P sovereign ratings across different fiscal states. Column (1) shows results without fiscal state interactions, while column (2) shows results with these interactions. The interaction terms measure how changes in debt-to-GDP ratio affect ratings, conditional on whether the fiscal state is good, normal, or poor. Debt-to-GDP change is measured in percentage points. All regressions include time and country fixed effects with standard errors clustered at the country level.

Table 2: Debt Composition Regression Results

	(1) st_loan	(2) st_bond	(3) lt_loan	(4) lt_bond
Last-quarter S&P Rating	0.950***	0.951***	0.947***	0.951***
	(0.010)	(0.009)	(0.010)	(0.009)
ΔDebt	-0.008*	-0.012***	-0.008**	-0.010***
	(0.004)	(0.004)	(0.003)	(0.003)
Debt Instrument Share Change:				
Good Fiscal State × Share Change	0.031	0.013**	0.002	-0.001
	(0.021)	(0.006)	(0.012)	(0.004)
Normal Fiscal State × Share Change	-0.001	0.005	0.004	0.002
	(0.010)	(0.004)	(0.016)	(0.002)
Poor Fiscal State × Share Change	-0.074	0.004	-0.040*	-0.005
	(0.069)	(0.005)	(0.022)	(0.010)
Control Variables:				
Long-term Gov Bond Yield	-0.087***	-0.084***	-0.090***	-0.085***
	(0.016)	(0.015)	(0.016)	(0.015)
NOB (% of GDP)	0.010***	0.006*	0.009***	0.007*
	(0.003)	(0.004)	(0.003)	(0.004)
Current Account Balance (% of GDP)	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
Fiscal Reserves (% of GDP)	-0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Real GDP Growth (yoy, %)	0.002	0.002	0.000	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Inflation (qoq, %)	0.008	0.003	0.011	0.005
	(0.022)	(0.021)	(0.024)	(0.021)
EU Dummy	-0.027	-0.013	-0.026	-0.017
	(0.060)	(0.062)	(0.055)	(0.061)
Good Fiscal State	0.034	0.049	0.024	0.037
	(0.040)	(0.038)	(0.039)	(0.036)
Normal Fiscal State	0.050	0.059	0.034	0.048
	(0.039)	(0.037)	(0.038)	(0.037)
Constant	0.972***	0.940***	1.010***	0.948***
	(0.165)	(0.160)	(0.162)	(0.164)
Time Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Observations	1,435	1,595	1,354	1,595
R^2	0.994	0.994	0.994	0.994

Robust standard errors clustered at country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents regression results examining how debt composition changes affect sovereign ratings across different fiscal states. Columns (1)-(4) show results for short-term loans, short-term bonds, long-term loans, and long-term bonds, respectively. The interaction terms measure how changes in each debt instrument's share of total debt affect ratings, conditional on whether the fiscal state is good, normal, or poor. Share change is measured in percentage points. All regressions include time and country fixed effects with standard errors clustered at the country level.

Table 3: Robustness Regression Results: Government Change

	(1) debt2gdp	(2) st_loan	(3) st_bond	(4) lt_loan	(5) lt_bond
Last-quarter S&P Rating	0.951***	0.949***	0.951***	0.947***	0.951***
	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)
ΔDebt		-0.008*	-0.012***	-0.008**	-0.010***
		(0.004)	(0.004)	(0.003)	(0.003)
Debt Change:					
Good Fiscal State × Δ	0.013*	0.030	0.013**	0.001	-0.001
	(0.007)	(0.021)	(0.006)	(0.012)	(0.004)
Normal Fiscal State × Δ	-0.006**	-0.001	0.005	0.004	0.002
	(0.003)	(0.010)	(0.004)	(0.016)	(0.002)
Poor Fiscal State × Δ	-0.025*	-0.074	0.004	-0.040*	-0.005
	(0.013)	(0.069)	(0.005)	(0.021)	(0.010)
Control Variables:					
Long-term Gov Bond Yield	-0.083***	-0.087***	-0.085***	-0.091***	-0.086***
	(0.014)	(0.016)	(0.015)	(0.016)	(0.015)
NOB (% of GDP)	0.006*	0.010***	0.006*	0.009***	0.007*
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Current Account Balance (% of GDP)	0.001	0.001	0.001	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Fiscal Reserves (% of GDP)	-0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Real GDP Growth (yoy, %)	0.002	0.002	0.002	0.000	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Inflation (qoq, %)	0.005	0.008	0.003	0.011	0.005
	(0.021)	(0.022)	(0.021)	(0.023)	(0.021)
EU Dummy	-0.015	-0.028	-0.014	-0.027	-0.018
	(0.065)	(0.059)	(0.062)	(0.054)	(0.060)
Good Fiscal State	0.040	0.034	0.049	0.025	0.038
	(0.032)	(0.040)	(0.038)	(0.039)	(0.036)
Normal Fiscal State	0.037	0.051	0.059	0.035	0.048
	(0.030)	(0.038)	(0.037)	(0.038)	(0.037)
Government Change	0.016	0.029	0.020	0.035	0.024
	(0.024)	(0.028)	(0.024)	(0.025)	(0.025)
Constant	0.969***	0.974***	0.942***	1.013***	0.950***
	(0.161)	(0.166)	(0.160)	(0.162)	(0.164)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1,597	1,435	1,595	1,354	1,595
R^2	0.994	0.994	0.994	0.994	0.994

Robust standard errors clustered at country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents robustness checks controlling for government changes. Column (1) shows results for the state-dependent effects of consolidated debt-to-GDP changes, while columns (2)-(5) show results for changes in the share of debt instruments (short-term loans, short-term bonds, long-term loans, and long-term bonds, respectively). All regressions include time and country fixed effects with standard errors clustered at the country level.

Table 4: Robustness Regression Results: GDP Forecast

	(1) debt2gdp	(2) st_loan	(3) st_bond	(4) lt_loan	(5) lt_bond
Last-quarter S&P Rating	0.954***	0.952***	0.954***	0.950***	0.954***
	(0.009)	(0.010)	(0.009)	(0.011)	(0.010)
ΔDebt		-0.007	-0.011***	-0.008**	-0.009**
		(0.004)	(0.004)	(0.003)	(0.003)
Debt Change:					
Good Fiscal State × Δ	0.012*	0.031	0.013**	0.001	-0.001
	(0.007)	(0.021)	(0.006)	(0.012)	(0.004)
Normal Fiscal State × Δ	-0.005*	-0.001	0.005	0.005	0.002
	(0.003)	(0.010)	(0.004)	(0.016)	(0.002)
Poor Fiscal State × Δ	-0.025*	-0.076	0.004	-0.040*	-0.005
	(0.013)	(0.070)	(0.005)	(0.021)	(0.010)
Control Variables:					
Long-term Gov Bond Yield	-0.079***	-0.083***	-0.081***	-0.087***	-0.082***
	(0.015)	(0.018)	(0.016)	(0.018)	(0.017)
NOB (% of GDP)	0.006	0.010***	0.006	0.009***	0.006*
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Current Account Balance (% of GDP)	0.001	0.001	0.001	0.002	0.001
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Fiscal Reserves (% of GDP)	-0.000	-0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Real GDP Growth (yoy, %)	0.002	0.001	0.001	-0.000	0.002
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
Inflation (qoq, %)	0.006	0.009	0.004	0.012	0.006
	(0.020)	(0.021)	(0.020)	(0.023)	(0.020)
EU Dummy	-0.005	-0.016	-0.004	-0.016	-0.009
	(0.060)	(0.053)	(0.056)	(0.047)	(0.055)
Good Fiscal State	0.039	0.033	0.049	0.024	0.038
	(0.032)	(0.039)	(0.037)	(0.038)	(0.036)
Normal Fiscal State	0.035	0.049	0.058	0.033	0.047
	(0.030)	(0.038)	(0.037)	(0.037)	(0.037)
GDP Forecast (8-quarter avg)	0.006	0.006	0.006	0.006	0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Constant	0.846***	0.845***	0.826***	0.886***	0.834***
	(0.191)	(0.213)	(0.197)	(0.211)	(0.201)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1,597	1,435	1,595	1,354	1,595
R^2	0.994	0.994	0.994	0.994	0.994

Robust standard errors clustered at country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents robustness checks controlling for GDP forecasts. Column (1) shows results for the state-dependent effects of consolidated debt-to-GDP changes, while columns (2)-(5) show results for changes in the share of debt instruments (short-term loans, short-term bonds, long-term loans, and long-term bonds, respectively). All regressions include time and country fixed effects with standard errors clustered at the country level.

Table 5: Robustness Regression Results: Alternative Yield Measure

	(1) debt2gdp	(2) st_loan	(3) st_bond	(4) lt_loan	(5) lt_bond
Last-quarter S&P Rating	0.955***	0.954***	0.956***	0.951***	0.956***
	(0.009)	(0.011)	(0.010)	(0.011)	(0.010)
ΔDebt		-0.009**	-0.013***	-0.009**	-0.011***
		(0.004)	(0.004)	(0.003)	(0.003)
Debt Change:					
Good Fiscal State × ΔDebt	0.012*	0.031	0.014**	0.000	-0.001
	(0.007)	(0.022)	(0.006)	(0.012)	(0.005)
Normal Fiscal State × ΔDebt	-0.007**	0.001	0.005	0.003	0.002
	(0.003)	(0.010)	(0.004)	(0.016)	(0.002)
Poor Fiscal State × ΔDebt	-0.026*	-0.075	0.004	-0.043*	-0.005
	(0.013)	(0.070)	(0.005)	(0.022)	(0.011)
Control Variables:					
Weighted Average Yield	-0.075***	-0.079***	-0.077***	-0.085***	-0.078***
	(0.014)	(0.017)	(0.015)	(0.016)	(0.015)
NOB (% of GDP)	0.006*	0.010***	0.006*	0.009***	0.007*
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Current Account Balance (% of GDP)	0.001	0.000	0.000	0.001	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Fiscal Reserves (% of GDP)	-0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Real GDP Growth (yoy, %)	0.003	0.003	0.002	0.001	0.003
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Inflation (qoq, %)	0.007	0.010	0.005	0.014	0.007
	(0.022)	(0.023)	(0.021)	(0.025)	(0.022)
EU Dummy	-0.015	-0.027	-0.013	-0.024	-0.017
	(0.086)	(0.081)	(0.083)	(0.075)	(0.082)
Good Fiscal State	0.040	0.034	0.049	0.024	0.038
	(0.034)	(0.042)	(0.039)	(0.041)	(0.038)
Normal Fiscal State	0.038	0.054	0.062	0.037	0.052
	(0.032)	(0.040)	(0.039)	(0.040)	(0.039)
Constant	0.892***	0.891***	0.862***	0.934***	0.868***
	(0.177)	(0.182)	(0.175)	(0.182)	(0.179)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1,597	1,435	1,595	1,354	1,595
R^2	0.994	0.994	0.994	0.994	0.994

Robust standard errors clustered at country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents robustness checks using alternative yield measures. Column (1) shows results for the state-dependent effects of consolidated debt-to-GDP changes, while columns (2)-(5) show results for changes in the share of debt instruments (short-term loans, short-term bonds, long-term loans, and long-term bonds, respectively). All regressions include time and country fixed effects with standard errors clustered at the country level.

Table 6: One-quarter-ahead Sovereign Long-term Bond Spreads Regression Results

	(1) debt2gdp	(2) st_loan	(3) st_bond	(4) lt_loan	(5) lt_bond
Long-term Gov Bond Spread	1.300***	1.294***	1.292***	1.266***	1.300***
	(0.079)	(0.082)	(0.075)	(0.080)	(0.078)
Long-term Gov Bond Spread (Lagged)	-0.393***	-0.393***	-0.387***	-0.372***	-0.394***
	(0.066)	(0.068)	(0.062)	(0.067)	(0.065)
ΔDebt		0.003	0.004	-0.002	0.005
		(0.006)	(0.005)	(0.004)	(0.006)
Debt Change:					
Good Fiscal State × Δ	-0.008	0.016	-0.010	0.020	-0.008
	(0.013)	(0.017)	(0.011)	(0.014)	(0.005)
Normal Fiscal State × Δ	0.005	-0.013	0.003	0.053**	-0.005
	(0.006)	(0.012)	(0.004)	(0.023)	(0.004)
Poor Fiscal State × Δ	0.002	-0.003	-0.034**	0.056**	0.010
	(0.008)	(0.026)	(0.013)	(0.026)	(0.010)
Control Variables:					
NOB (% of GDP)	-0.011**	-0.014***	-0.011**	-0.011***	-0.011**
	(0.005)	(0.005)	(0.004)	(0.003)	(0.005)
Current Account Balance (% of GDP)	0.000	0.001	0.001	0.000	-0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Fiscal Reserves (% of GDP)	0.001	0.001	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Real GDP Growth (yoy, %)	-0.004	-0.006	-0.005	-0.006	-0.004
	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)
Inflation (qoq, %)	0.016	0.009	0.014	0.009	0.013
	(0.028)	(0.030)	(0.026)	(0.028)	(0.028)
EU Dummy	0.014	0.020	0.015	0.037	0.020
	(0.049)	(0.054)	(0.052)	(0.081)	(0.050)
Good Fiscal State	0.048	0.042	0.051	0.040	0.077**
	(0.029)	(0.032)	(0.032)	(0.036)	(0.028)
Normal Fiscal State	0.025	0.016	0.022	0.018	0.052*
	(0.028)	(0.035)	(0.035)	(0.038)	(0.030)
Constant	-0.701***	-0.751***	-0.694***	-0.683***	-0.724***
	(0.092)	(0.075)	(0.076)	(0.089)	(0.099)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	1,499	1,339	1,497	1,339	1,497
R^2	0.974	0.975	0.974	0.976	0.974

Robust standard errors clustered at country level in parentheses *** p<0.01, ** p<0.05, * p<0.1

Notes: This table presents regression results examining how sovereign debt changes affect one-quarter-ahead sovereign long-term bond spreads relative to U.S. bonds. Column (1) shows results for the state-dependent effects of consolidated debt-to-GDP changes, while columns (2)-(5) show results for changes in the share of debt instruments (short-term loans, short-term bonds, long-term loans, and long-term bonds, respectively). The interaction terms measure how changes in consolidated debt-to-GDP or debt composition affect spreads, conditional on whether the fiscal state is good, normal, or poor. Spread and all debt changes are measured in percentage points. All regressions include time and country fixed effects with standard errors clustered at the country level.

A Proofs for Section 2

Proof of Proposition 2. Denote $\tilde{y} = y + \varphi - b$ whose distribution is $\tilde{G}$ and density is $\tilde{g}$. The marginal cost of borrowing can be written as

$$MC(\kappa) = (1 - \tilde{G}(\kappa))E(\frac{1}{\tilde{y}}|\tilde{y} > \kappa) + \tilde{g}(\kappa)[E(\ln(\tilde{y})|\tilde{y} > \kappa) - \ln \kappa] \tag{14}$$

First, we show that $m(\kappa) := (1 - \tilde{G}(\kappa))E(\frac{1}{\tilde{y}}|\tilde{y} > \kappa)$ is decreasing in κ.

Rewrite $m(\kappa)$ as

$$m(\kappa) = \int_{\kappa}^{\overline{y}+\varphi-b} \frac{\tilde{g}(\tilde{y})}{\tilde{y}} d\tilde{y} \tag{15}$$

Applying the Leibniz rule, we have

$$m'(\kappa) = -\frac{\tilde{g}(\kappa)}{\kappa} \tag{16}$$

Because $\tilde{g}(\tilde{y}) \geq 0$ and $\kappa \geq 0$, we have $m'(\kappa) \leq 0$.

Second, we show that $n(\kappa) := \tilde{g}(\kappa)[E(\ln(\tilde{y})|\tilde{y} > \kappa) - \ln \kappa]$ is decreasing in κ for $\kappa \in [A, B]$ where $A := \underline{y} + \varphi - b$ and $B := \overline{y} + \varphi - b$.

$\tilde{g}(\cdot)$ is the density of a uniform distribution. $\tilde{g}(\kappa)$ is a constant for $\kappa \in [A, B]$. The monotonicity of $n(\kappa)$ is equivalent to the monotonicity of $h(\kappa) := E(\ln(\tilde{y})|\tilde{y} > \kappa) - \ln \kappa$.

$$h(\kappa) = \frac{1}{B - \kappa} \int_{\kappa}^{B} \ln \tilde{y} d\tilde{y} = \frac{B \ln B - B - \kappa \ln \kappa + \kappa}{B - \kappa} - \ln \kappa \tag{17}$$

and

$$h'(\kappa) = \frac{B[\ln B - \ln \kappa] - B + \kappa}{(B - \kappa)^2} - \frac{1}{\kappa} \tag{18}$$

To show that $h'(\kappa) \leq 0$, we need to show that $\kappa\big[B[\ln B - \ln \kappa] - B + \kappa\big] \leq (B - \kappa)^2$, or equivalently,

$$B[\kappa \ln \frac{B}{\kappa} - B + \kappa] \leq 0 \tag{19}$$

Since $B > 0$, the inequality holds if and only if $R(\kappa) := \kappa \ln \frac{B}{\kappa} - B + \kappa \leq 0$. Notice that $R'(\kappa) = \ln B - \ln \kappa > 0$ and $R(B) = 0$. Therefore, $R(\kappa) \leq 0$ for all $\kappa \in [A, B]$.

Combining the two results, we have that $MC(\kappa)$ is decreasing in κ. That is, $MC(\kappa_R) < MC(\kappa_S)$. □

Proof of Proposition 3. Given b, if $\underline{y} + \varphi - b \geq \kappa$ for $\varphi = \varphi_S, \varphi_R$, $D(\kappa + b - \varphi) =$

$D'(\kappa + b - \varphi) = 0$ and

$$MC(\varphi) = E(\frac{1}{y+\varphi-b}) = \frac{1}{\overline{y}-\underline{y}}[\ln(\overline{y}+\varphi-b) - \ln(\underline{y}+\varphi-b)] \tag{20}$$

$MC(\varphi)$ is decreasing in φ.

Since $\varphi_S > \varphi_R$, $MC(\varphi_S) < MC(\varphi_R)$, and $\underline{y}+\varphi_R-b \geq \kappa$ implies that $\underline{y}+\varphi_S-b > \kappa$.

Given b, if $\underline{y}+\varphi-b < \kappa$ for $\varphi = \varphi_S, \varphi_R$, $D(\kappa+b-\varphi) > 0$ and $D'(\cdot) = (\overline{y}-\underline{y})^{-1}$. $MC(\varphi)$ can be written as:

$$MC(\varphi, \kappa) = \frac{\ln(\overline{y}+\varphi-b) - \ln(\kappa)}{\overline{y}-\underline{y}} + \frac{c(\varphi,\kappa) - \ln\kappa}{\overline{y}-\underline{y}} \tag{21}$$

where $c(\varphi, \kappa) = E\left[\ln(y+\varphi-b)|y > \kappa+b-\varphi\right]$. $\ln(\overline{y}+\varphi-b)$ is increasing in φ.

We now show that $c(\varphi,\kappa)$ is also increasing in φ. Denote $w = \overline{y}+\varphi-b$,

$$c(\varphi,\kappa) = \frac{w\ln w - w - \kappa\ln\kappa + \kappa}{w-\kappa} \tag{22}$$

$$c'_{\varphi}(\varphi,\kappa) = c'_w = \frac{-\kappa\ln w + w + \kappa\ln\kappa - \kappa}{(w-\kappa)^2} = \frac{\kappa(s-1-\ln s)}{(w-\kappa)^2}, \quad s := \frac{w}{\kappa} \tag{23}$$

Notice that $s > 1$ since otherwise both types default for sure and $q(b) = 0$. For $s > 1$, $s - 1 - \ln s > 0$. Therefore, $c'_{\varphi}(\varphi,\kappa) > 0$ and in turn, $MC(\varphi,\kappa)$ is increasing in φ.

Since $\varphi_S > \varphi_R$, $MC(\varphi_S,\kappa) > MC(\varphi_R,\kappa)$, and $\underline{y}+\varphi_S-b < \kappa$ implies that $\underline{y}+\varphi_R-b < \kappa$.

Given b, if $\kappa \in (\underline{y}+\varphi_R-b, \underline{y}+\varphi_S-b]$, $D(\kappa+b-\varphi_S) = 0$ but $D(\kappa+b-\varphi_R) > 0$. Using the results derived above, we have

$$MC(\varphi_S) = \frac{1}{\overline{y}-\underline{y}}[\ln(\overline{y}+\varphi_S-b) - \ln(\underline{y}+\varphi_S-b)] \tag{24}$$

$$MC(\varphi_R,\kappa) = \frac{\ln(\overline{y}+\varphi_R-b) - \ln(\kappa)}{\overline{y}-\underline{y}} + \frac{c(\varphi_R,\kappa) - \ln\kappa}{\overline{y}-\underline{y}} \tag{25}$$

We know that at $\kappa = \underline{y}+\varphi_R-b$, $MC(\varphi_S)$ and $MC(\varphi_R)$ both take the form of (20) so that $MC(\varphi_S) < MC(\varphi_R)$. As κ increases marginally from $\underline{y}+\varphi_R-b$, $MC(\varphi_S)$ remains constant whereas $MC(\varphi_R)$ changes its form to (25) and increases discontinuously due to the second term in (25). Therefore, $MC(\varphi_S) < MC(\varphi_R,\kappa)$ continues to hold. As κ increases further towards $\underline{y}+\varphi_S-b$, $MC(\varphi_S)$ remains independent of κ but $MC(\varphi_R,\kappa)$ decreases, because $h(\kappa) = c(\varphi_R,\kappa) - \ln\kappa$ is decreasing in κ (see (17)). If $MC(\varphi_S) > MC(\varphi_R, \kappa = \underline{y}+\varphi_S-b)$, there must exist $\hat{\kappa} \in (\underline{y}+\varphi_R-b, \underline{y}+\varphi_S-b)$

such that $MC(\varphi_S) < MC(\varphi_R, \kappa)$ if and only if $\kappa < \hat{\kappa}$. If $MC(\varphi_S) < MC(\varphi_R, \kappa = \underline{y} + \varphi_S - b)$, we know that as κ increases marginally from $\underline{y} + \varphi_S - b$, $MC(\varphi_S)$ and $MC(\varphi_R)$ both take the form of (21) and $MC(\varphi_S, \kappa) > MC(\varphi_R, \kappa)$. In this case, the threshold $\hat{\kappa} = \underline{y} + \varphi_S - b$.

□

B Data Appendix

Table B1: Summary Statistics

Variable	Obs	Mean	Std Dev	Min	Max	AR(1)
Dependent Variables:						
S&P Rating	1,638	17.92	1.12	8.50	20.00	0.947
Bond Spread	1,556	0.20	1.16	-2.70	11.19	0.957
Debt Variables:						
Change in Debt-to-GDP (%)	1,616	0.34	2.28	-10.39	19.10	0.152
Change in ST Loan Share (%)	1,456	0.04	0.54	-5.03	4.94	-0.272
Change in ST Bond Share (%)	1,616	0.15	1.81	-14.53	24.25	-0.080
Change in LT Loan Share (%)	1,375	0.18	0.84	-14.73	11.22	0.175
Change in LT Bond Share (%)	1,616	0.89	2.37	-13.55	28.29	0.054
Fiscal State Variables:						
Good Fiscal State	1,599	0.11	0.30	0.00	1.00	0.454
Normal Fiscal State	1,599	0.74	0.43	0.00	1.00	0.392
Poor Fiscal State	1,599	0.15	0.35	0.00	1.00	0.423
Control Variables:						
Current Account Balance (% of GDP)	1,638	-0.02	2.44	-17.75	32.50	0.754
Fiscal Reserves (% of GDP)	1,638	8.70	2.97	0.32	71.37	0.934
Real GDP Growth (yoy, %)	1,638	1.93	2.89	-21.90	28.07	0.721
Inflation (qoq, %)	1,638	0.48	0.63	-3.03	3.85	0.049
NOB (% of GDP)	1,619	-1.60	3.39	-43.49	21.05	0.598
Long-term Gov Bond Yield (%)	1,638	3.50	1.80	-0.49	13.22	0.979
Short-term Yield (%)	1,638	2.20	1.95	-0.78	11.63	0.978
Weighted Average Yield (%)	1,638	3.33	1.78	-0.49	11.85	0.980
Government Change	1,638	0.05	0.19	0.00	1.00	-0.052
GDP Forecast (8-quarter avg, %)	1,638	2.25	2.17	-7.99	21.11	0.784

All variables are quarterly data. AR(1) shows first-order autocorrelation coefficient.

Notes: This table presents summary statistics for all variables used in the regression analysis. The sample covers quarterly data from 2000Q1 to 2020Q3 for 20 advanced economies, including Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Hungary, Ireland, Israel, Italy, Luxembourg, Netherlands, New Zealand, Portugal, Spain, Sweden, the United Kingdom, and the United States. Each statistic is computed within country first, then aggregated across countries. Obs is the total number of non-missing observations summed across countries; Mean, Std Dev, and AR(1) are the unweighted averages of the corresponding country-level statistics; Min and Max are the global minimum and maximum across all countries and quarters.

B.1 Data availability

Canada and New Zealand have data available up to 2020q2. These two countries are also missing short-term and long-term loan data. For consolidated debt, Israel and Denmark have data available up to 2020q2. For NOB, Australia has data starting from 2002Q3, Austria has data starting from 2001Q1, and Luxembourg has data starting from 2002Q1.

B.2 Notes on variable choices

B.2.1 Consolidated General Government Debt

We measure the total amount of sovereign debt by the quarterly series of consolidated general government debt from the BIS or the quarterly public sector debt (QPSD) from the World Bank.[13] Among various debt measures, we employ the gross nominal value of the general government debt stock in local currency at the end of each quarter.[14]

We use the nominal value of government debt in local currency to avoid the effect of market interest rate and exchange rate fluctuations on the measure of debt level. According to Abbas et al. (2014), most of advanced economies' sovereign debt is denominated in local currency.

General government debt consolidates the debt of central (federal), provincial (state), and local governments. According to the BIS, this consolidated debt measure better captures the actual debt burden of the sovereign government and makes it easier to compare debt sustainability across countries for two reasons. First, the outstanding debt among public subsectors can often be netted out. Second, the liabilities of state and local government sectors are often guaranteed by the central government.

B.2.2 Debt Composition

We construct a quarterly dataset of short-term and long-term government bonds (debt securities) and loans from multiple data sources – government finance statistics (GFS) from the European Central Bank, quarterly public sector debt (QPSD) from the World Bank, the BIS, Board of Governors of the Federal Reserve System. Debt is classified as

[13]This measure is on a gross basis, and not net of government liquid assets. It allows us to focus on the sovereign borrowing decision and to avoid any controversy in classifying assets as liquid or not.

[14]In the BIS data, only core debt instruments, including currency and deposits, loans, and debt securities, are considered.

short term if its residual maturity is shorter than or equal to 1 year. To be consistent with the consolidated debt measure, these series are all measured using the nominal value of debt in local currency.

B.2.3 Government Operating Balance and Fiscal State

Our NOB-to-GDP data are mainly from IMF International Financial Statistics (IMF.IFS). Whenever there are missing data for some countries, e.g., Israel, New Zealand, and Czech Republic, we use the country's overall balance (OB-to-GDP, also defined as revenue - expense) data from CEIC instead.[15] To avoid the effect of seasonality in defining our fiscal state variable, we employ the commonly used Census X-12 filter to obtain the seasonally adjusted NOB-to-GDP for our regressions.

[15] We also use the overall balance data from CEIC for the U.S. because the U.S. NOB-to-GDP data from IMF.IFS are a smoothed version of the raw data, in contrast with the corresponding data for other countries in our sample.