Fiscal Capacity and Sovereign Debt Crises in the G7

Frank Schmid

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Abstract. This paper develops a model of sovereign debt crises in the Group of Seven and applies it to the United States and the other six economies alike, under one sunspot common to all of them. Sovereign debt is priced as a fixed point: the yield carries a sovereign spread that compensates for a default hazard, and the hazard depends on the distance between the debt ratio that the yield itself produces and a fiscal limit, the present value of the largest primary surplus the government can sustain. Over a range of debt, the crisis zone, the pricing equation has three solutions, two of them stable, and a sunspot selects between the two stable ones; beyond the zone, only the crisis solution exists. The fiscal capacity is taken from each economy's historical record rather than assumed. On those capacities, France and the United Kingdom are on the crisis equilibrium in their baselines in every year in which the crisis root is their only root, the baseline being the path on the trends of record on which the market does not coordinate; the United States and Japan are inside their zones from the first year of the horizon, and Germany, Italy, and Canada lie below theirs. A crisis in the United States, once begun, persists through the horizon under both monetary-fiscal regimes considered, the cost falling on output and the debt ratio in one and on the price level in the other. A crisis abroad does not require one in the United States: on most of the simulated paths with a crisis abroad and none in the United States, the crisis years lie in the United Kingdom and France alone, the two economies whose crisis years rest on their own baselines and on the growth draw common to the eight economies as well as on the common sunspot. The paper solves for what would remove the crisis equilibrium—an announced fiscal capacity, an unconditional ceiling on the sovereign spread, an increment to trend growth, or a delivered primary balance—and sets the required consolidation against the historical record. It measures how the range of debt over which two stable solutions exist varies with the dispersion of the fiscal limit and how the crisis years vary with the loss given default. The results are shares of simulated paths under stated assumptions, not forecasts.

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Abbreviations and Acronyms

AI	artificial intelligence
BIS	Bank for International Settlements
CBO	Congressional Budget Office
ECB	European Central Bank
ESA	European System of Accounts
FEDS	Finance and Economics Discussion Series (Federal Reserve Board)
G7	Group of Seven
GDP	gross domestic product
IMF	International Monetary Fund
INSEE	Institut national de la statistique et des études économiques
ISTAT	Istituto Nazionale di Statistica
JEL	*Journal of Economic Literature* (classification codes)
JST	Jordà–Schularick–Taylor (macrohistory database)
NBER	National Bureau of Economic Research
OECD	Organisation for Economic Co-operation and Development
PEPP	pandemic emergency purchase programme (Eurosystem)
PSPP	public sector purchase programme (Eurosystem)
SE	standard error
SNA	System of National Accounts
TFP	total factor productivity
WEO	World Economic Outlook (IMF database)

Greek letters (the stressed syllable in italics)

α	alpha (*al*-fuh): weight on lagged inflation in expected inflation
β	beta (*bay*-tuh): response coefficients of output and of foreign yields
$\bar{\delta}$	delta-bar (*del*-tuh): conditionality tolerance of the central-bank backstop
Δ	capital delta (*del*-tuh): change from the year before
ε	epsilon (*ep*-sih-lon): output-gap innovation
ζ	zeta (*zay*-tuh): elasticity of the convenience yield to debt at the initial ratio
η	eta (*ay*-tuh): equity-value response to the output gap
θ	theta (*thay*-tuh): term-premium response to debt
ι	iota (eye-*oh*-tuh): inflation risk premium coefficient
κ	kappa (*kap*-uh): Phillips-curve slope
λ	lambda (*lam*-duh): loss given default
Λ	capital lambda (*lam*-duh): the logistic function
π	pi (*pie*): inflation
ρ	rho (*row*): persistence of the output gap
ϱ	varrho (*row*): the real interest-growth differential at a neutral policy rate, as discount rate
σ	sigma (*sig*-muh): dispersion of the fiscal limit
τ	tau (*tow*): trade spillover coefficient
ϕ	phi (*fie*): Taylor-rule and corporate-spread coefficients
ω_i	omega (oh-*may*-guh): share of the market-held stock that pays the short rate

Executive Summary

This paper develops a model of sovereign debt crises in the Group of Seven (G7)—Germany, France, Italy, the United Kingdom, Canada, and Japan alongside the United States—and applies it to the United States and the others alike, under one sunspot common to all of them. Its main findings are these. On the historical fiscal capacities, the United States, France, and Japan are inside their crisis zones (the range of debt over which the market can price the debt at either a benign or a crisis yield) in 2027, the first year of the horizon; the United Kingdom is beyond its own, the crisis yield being the only one its pricing equation carries; and Germany, Italy, and Canada lie below theirs. The baselines of France and the United Kingdom are themselves on the crisis equilibrium, the United Kingdom's in every year and France's from 2032. Once a U.S. crisis begins, it does not end within the 10-year horizon under either of the two policy regimes the paper models: where the primary balance must close the gap between the debt and what the fiscal capacity can back, debt held by the public reaches 195.1 percent of gross domestic product (GDP) in 2036; where the price level closes it, inflation rises to 9.9 percent by 2036. Across 10,000 simulated paths the United States spends at least one year on the crisis equilibrium on 54 percent of them. Removing the U.S. crisis equilibrium takes an announced fiscal capacity of 2.75 percent of GDP from 2027, against a historical capacity of 1.91, the largest 10-year average primary surplus the United States has sustained; an unconditional ceiling on the spread removes the crisis equilibrium only where the baseline keeps a benign one, as it does for the United States, and removes none for the United Kingdom and France, whose baselines carry years in which the crisis yield is the only one the market can set.

In the stochastic simulation a crisis abroad does not require one in the United States: of the paths with no U.S. crisis year, 70 percent carry one elsewhere, 54 percent one outside the United Kingdom, and 11 percent one outside the United Kingdom and France, the two economies whose crisis years rest on their own baselines and on the growth draw common to the eight economies as well as on the common sunspot. China is carried in the computation and reported in an addendum, its sovereign spread being administered rather than set by a marginal investor. The model prices sovereign debt as a fixed point: the yield equals the risk-free rate plus expected inflation, an inflation risk premium, and the sovereign spread that compensates for the default hazard implied by the debt ratio that the yield itself produces. The fiscal limit is the present value of the largest primary surplus the government can sustain, discounted at the real interest-growth differential at a neutral policy rate, so it is unbounded while the real financing rate at that policy rate does not exceed trend real growth and finite once it does. Where debt lies above a boundary the pricing equation itself sets, the equation has three solutions, two of them stable, and the market can coordinate on the higher of the two stable ones; where debt and the financing rate rise further, the low solution ceases to exist, and the high one is the only equilibrium of the year. An economy is in crisis in a year it spends on the crisis equilibrium by either route: coordination, where the market selects the high solution while the low one exists, or sole survival, where the high solution is the only one. A closed-form corner condition places the boundary in proportion to the fiscal capacity and decreasing in the product of the default hazard and the loss given default; the operative boundary, the one the simulated paths obey and against which the paper reads whether an economy lies inside or outside its zone, lies above it by 45 percentage points of GDP for the United States, 19 for the United Kingdom, 60 for Canada, and 59 for Japan. For Germany, France, and Italy, whose spreads the Eurosystem's ceiling caps, it lies 17, 8, and 11 percentage points of GDP below the corner evaluated at the ceiling.

The fiscal capacity is taken from history rather than assumed. The historical capacity is the largest 10-year average primary surplus each economy has sustained, which is 1.91 percent of GDP

for the United States on the federal basis (1993 through 2002), 2.18 for Germany, 1.06 for France, 3.27 for Italy, 1.43 for the United Kingdom, 3.52 for Canada, and 1.31 for Japan; for China, whose record shows no 10-year average above zero, it is scaled from revenue. Debt is read net of the government's financial assets: debt held by the public for the United States, which includes the Federal Reserve's holdings, at 100.6 percent of GDP; 134.3 for Japan against a gross figure of 204.4; 10.3 for Canada against 110.7; and, for China, the International Monetary Fund (IMF) staff's augmented measure of 135.3, which adds local government financing vehicles. On those capacities the United Kingdom lies beyond its crisis zone, its pricing equation carrying the crisis equilibrium as the only one in every year of the baseline; the United States, France, and Japan lie 3, 42, and 9 percentage points of GDP above their operative boundaries at their 2026 debt, each inside its zone in 2027; Germany, Italy, and Canada lie 129, 39, and 155 percentage points of GDP below theirs; and China's boundary is the one its administered spread does not price, its debt rising on its augmented primary deficit with or without a U.S. crisis.

The share of the stock the central banks hold is financed at the policy rate. Japan's boundary rests on this: the Bank of Japan holds 43.1 percent of the stock, and it has had no standing ceiling since yield curve control ended in March 2024. As a backstop, the Eurosystem's Transmission Protection Instrument is carried as a stylized experiment calibrated to its charter and record rather than as an implementation of it: a ceiling on the sovereign spread, enforced by purchases without ex ante limit while a fiscal conditionality holds. What the charter establishes is the absence of an ex ante quantity limit and the conditionality; it establishes no numerical spread the instrument defends, and the level used here is an assumption. The same holds for the Bank of Japan variant, whose withdrawn instrument was a ceiling on the level of the 10-year yield rather than on the sovereign spread, and which is carried here as a spread ceiling because that is the object the model prices. A ceiling bounds the marginal financing rate and so raises the limit at which the hazard is assessed. The Eurosystem's is available in a year while two conditions held in the year before: the primary balance, net of the automatic stabilizers, stood no more than a tolerance below its projected path, and the debt did not exceed the fiscal limit. On the deterministic paths of regime M it binds for France in 2027, for Italy in 2031 and 2032, and for Germany in 2034 and 2035, and it is withdrawn the year after each economy is first priced on a crisis root, the debt having exceeded the limit; Italy is on the crisis equilibrium in 2032 through 2036 with the ceiling and in 2028 through 2036 without it, and France and Germany are on it in the same years either way. Across the stochastic paths it lowers the share of paths carrying a year on that equilibrium from 46 percent to 40 for Italy, 81 to 77 for France, and 29 to 24 for Germany. A Bank of Japan ceiling of 1.0 percentage points, carried as a variant, would lower Japan's share from 44 percent to 27. Carried across the stochastic paths, the announced run-off of the central banks' portfolios raises the share of paths carrying coordination by 1.1 through 7.1 percentage points for Japan, Italy, and Germany and the share carrying the crisis state by 5.2 through 17.2 percentage points for Japan, France, Italy, Germany, and the United Kingdom, and leaves the U.S. shares within a percentage point of the central calibration's.

Two policy regimes are modeled, the active-money (regime M) and active-fiscal (regime F) regimes of Leeper developed in Section 2.6: the gap between the debt and the limit is left to the primary balance in the first and to the price level in the second. In the central scenario the two regimes differ in the outcome of the crisis. Under regime M the crisis runs 10 of the horizon's 10 years, because a capacity of 1.91 percent of GDP places the fiscal limit below the debt at any crisis financing rate. The Federal Reserve cuts to the zero bound, reaching it in 2030, and the spread rises through the crisis years to 4.1 percentage points in 2036. In that year debt held by the public stands at 195.1 percent of GDP, the output gap at −9.2 percent, and inflation, fallen from the

target, at −0.8 percent. Under regime F the price level carries the adjustment, inflation rising to 9.9 percent by 2036 as each year's excess of debt over the limit is spread over the maturity of the debt, and the debt ratio ends at 121.2 percent, 1.1 percentage points of GDP above its own baseline, having run below it in 2027 through 2035. The crisis persists in both regimes: under regime F the spread stands at 3.85 percentage points in 2036, and the limit falls from 81.0 percent of GDP to 45.0, so the excess widens from 19.6 percentage points of GDP to 72.7 while the debt ratio tracks its baseline within 4.1 percentage points of GDP.

The shares that follow are shares of simulated paths under the ranges the assumption tables state, not forecasts and not probabilities estimated from a record: the ranges are chosen for admissibility rather than fitted, the two policy regimes are drawn with equal probability, which no record supports, and a reader holding different ranges obtains different shares. Across 10,000 stochastic paths that draw the capacity around its estimate, the other quantities the assumption tables mark as varied, and annual shocks, the United States spends at least one year on the crisis equilibrium by 2036 on 54 percent of paths, the market coordinating on 21 and the benign equilibrium disappearing on the rest, and a U.S. credit event occurs on 27 percent. The share with a crisis year runs from 43.6 through 60.5 percent as the coordination probability, which no record identifies, is pinned at the ends of the range it is drawn on. Conditional on a crisis, the median peak 10-year yield is 12.1 percent, and the median debt ratio in 2036 is 141.7 percent of GDP. A sensitivity that adds the Penn Wharton Budget Model's projected contribution of generative artificial intelligence (AI) to productivity growth to every trend path, with the fiscal capacity responding to growth at the Eichengreen and Panizza estimate, moves the share of paths carrying a U.S. crisis to 52 percent and the conditional median debt ratio to 138.5. The transmission to the other G7 economies is a statement about shares of simulated paths at the estimated neutral rates: in the central scenarios France, the United Kingdom, and Japan are on the crisis equilibrium beside the United States in every year under both regimes, Germany and Italy in 2035 and 2036 and in 2032 through 2036 under regime M alone, and Canada in no year, while across the paths at least one year on it occurs on 44 percent for Japan, 24 for Germany, 40 for Italy, 77 for France, and 10 for Canada, against 80 for the United Kingdom; among the paths that carry any such year the median count runs from 2 years for Canada through 10 for the United Kingdom. Trend growth, drawn as widely as the record of five-year projection errors, is the largest single contributor to the variance of whether a crisis occurs, of the peak yield, and of the debt ratio in 2036; the fiscal capacity is the second contributor to the occurrence and the bound on the default hazard the second to the peak yield, the sunspot selecting between equilibria where two exist rather than creating the years in which only one does.

The estimates on the Jordà–Schularick–Taylor macrohistory database are reported beside the model and are parameters of nothing in it. The U.S. primary balance shows no response to lagged debt over 1871 through 2020 under the construction available there, against the response that Bohn reported on his own data; the interest-growth differential has been negative in 62 percent of years since 1950 with a one-year autocorrelation of 0.48; and the annual pass-through of U.S. long-rate changes to the other six economies lies between 0.40 and 0.83. Those are full-sample moments; the pass-through the model carries is estimated on the OECD series over 1996 through 2024, under inflation targeting, and runs from 0.26 through 0.85.

No trend growth path of the central calibration makes the limit unbounded: at the maximal crisis yield of the corner condition the real marginal financing rate is 5.44 percent against a U.S. terminal real trend of 1.77. Solving for the capacity that removes the crisis equilibrium, rather than reading a requirement off the recorded paths, gives 2.75 percent of GDP announced in 2027 under regime M and 2.67 under regime F, against a historical capacity of 1.91. A primary surplus delivered from 2027, rather than announced, removes the U.S. crisis equilibrium at 1.64 percent of GDP

under regime M and 0.46 under regime F, both below the historical capacity, the delivered balance acting through the debt alone. The onset is 2027, and the requirement rises with the delay after it, to 5.06 percent of GDP from 2033 under regime M and 3.40 under regime F. Across the drawn parameter sets, a set that requires no capacity entering at its drawn capacity, the requirement's median is 2.93 percent of GDP under regime M, and the central figure lies below it; for the United Kingdom, on the crisis equilibrium in its baseline, the requirement is 6.63 percent of GDP under regime M and 4.28 under regime F, against a historical capacity of 1.43, the largest consolidation required of any economy in the model at the central calibration. The same question solved for three instruments—the announced capacity, an unconditional ceiling on the sovereign spread, and a permanent increment to trend growth—gives a map: a ceiling of 1.32 percentage points announced in 2027 removes the U.S. crisis equilibrium under regime M and is reached in the final years of the horizon, the purchases carrying a spread the hazard prices above it while no crisis root exists; of the 23 ceilings of the map that clear, 5 are not reached on the path they clear; no ceiling removes the crisis equilibrium of the United Kingdom and France; the growth increment that removes the crisis equilibrium is 0.61 percentage points for the United States and between 1.08 and 4.97 for the United Kingdom and France; every announced instrument must be in force through 2036, the final year solved, and beyond it, since the limit it lifts is a perpetuity; and under a ceiling of 1.0 percentage points or lower, the U.S. historical capacity suffices.

1 Introduction

The Congressional Budget Office (CBO) projects federal debt held by the public at 100.6 percent of GDP for fiscal year 2026 and, under current law, at 120.2 percent for 2036; net outlays for interest rise from 3.3 to 4.6 percent of GDP over the same period.[1] The projection names among the consequences of that path "the risk of a fiscal crisis," a situation in which investors lose confidence in the value of the government's debt and interest rates rise abruptly.[2] The IMF projects U.S. general government gross debt at 125.8 percent of GDP in 2026 and identifies the erosion of the Treasury's safety premium as a structural shift amplifying vulnerability to repricing.[3]

A sovereign crisis in the issuer of the world's reserve asset differs from the emerging-market and euro-area episodes the literature has studied in three respects the model must carry. First, Treasury debt yields less than comparable securities because of the liquidity and safety services it provides; a crisis removes that convenience yield in addition to adding a sovereign spread.[4] Second, U.S. monetary policy is a driver of the global financial cycle, which Rey finds is not aligned with countries' own macroeconomic conditions, so a rise in the U.S. risk-free rate reaches foreign financial conditions independently of foreign fiscal positions.[5] Third, the debt is denominated in the issuer's own currency, so the course of a crisis depends on which policy authority accommodates the other.[6]

The paper carries those three features into one calibrated model of the G7. Its fiscal limit takes Bi's form, the present value of the largest primary surpluses the government can deliver with a distribution over it, and two steps are this paper's: the limit is discounted at a financing rate that carries the spread being priced, and it is evaluated at the fiscal capacity measured on the economy's own record. The range of debt over which its pricing equation has a benign and a crisis solution is called the crisis zone, a term taken from Cole and Kehoe for another object, and on the crisis solution the yield moves within the year while the effective rate and the debt move gradually with the share of the stock that reprices each year, as the debt does in the slow-moving crisis of Lorenzoni and Werning. The model prices each economy's debt on that zone;[7] it treats the two regimes of Leeper as the two courses a crisis can take; and it solves for what would end the crisis rather than reading a requirement off the crisis paths. The model is an annual system of the seven G7 economies, with China carried alongside and reported in the addendum. Its parameters are of three kinds: values taken from published projections and estimates, among them the CBO's and

[1] Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036* (Washington, DC: Congressional Budget Office, February 2026), Chapter 1, accessed 21 August 2026.

[2] Congressional Budget Office, *Budget and Economic Outlook*, Chapter 1. The quoted phrase is the source's.

[3] International Monetary Fund, *World Economic Outlook Database*, April 2026, accessed 3 October 2026, for the debt ratio; International Monetary Fund, *Fiscal Monitor: Fiscal Policy under Pressure: High Debt, Rising Risks* (Washington, DC: International Monetary Fund, April 2026), Chapter 1, accessed 21 August 2026, for the safety premium.

[4] Arvind Krishnamurthy and Annette Vissing-Jorgensen, "The Aggregate Demand for Treasury Debt," *Journal of Political Economy* 120, no. 2 (2012): 233–267.

[5] Hélène Rey, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence," NBER Working Paper 21162 (Cambridge, MA: National Bureau of Economic Research, 2015).

[6] Thomas J. Sargent and Neil Wallace, "Some Unpleasant Monetarist Arithmetic," *Federal Reserve Bank of Minneapolis Quarterly Review* 5, no. 3 (1981): 1–17; Eric M. Leeper, "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies," *Journal of Monetary Economics* 27, no. 1 (1991): 129–147; Christopher A. Sims, "A Simple Model for Study of the Determination of the Price Level and the Interaction of Monetary and Fiscal Policy," *Economic Theory* 4, no. 3 (1994): 381–399.

[7] Harold L. Cole and Timothy J. Kehoe, "Self-Fulfilling Debt Crises," *Review of Economic Studies* 67, no. 1 (2000): 91–116; Guido Lorenzoni and Iván Werning, "Slow Moving Debt Crises," *American Economic Review* 109, no. 9 (2019): 3229–3263; Huixin Bi, "Sovereign Default Risk Premia, Fiscal Limits, and Fiscal Policy," *European Economic Review* 56, no. 3 (2012): 389–410.

the IMF's projections and the published estimates of the neutral rates; estimates made here on other records, among them the pass-through of U.S. long rates on the OECD series and the fiscal capacities on each economy's official fiscal record; and 30 structural assumptions, each listed in the appendix with its basis and with its treatment in the stochastic simulation. The estimates on the Jordà–Schularick–Taylor macrohistory database are reported beside the model and are parameters of nothing in it. Section 2 sets out the framework: the debt dynamics, the interest-growth differential and the two strands of literature that bear on it, the fiscal limit as a present value, the pricing fixed point, the crisis zone and the corner condition of its boundary, the two policy regimes, the transmission, the central-bank backstops, and the calibration with its empirical estimates and its baseline check. Section 3 reports the results. On the fiscal capacities of record, the United Kingdom is beyond its crisis zone with no benign equilibrium in any baseline year, the United States, France, and Japan are inside theirs in 2027, and Germany, Italy, and Canada lie below theirs. Under the active-money regime (regime M) a crisis so placed does not end within the horizon; under the active-fiscal regime (regime F) the price level carries the adjustment, holding the debt ratio near its baseline through an inflation that rises as the excess of debt over a falling limit widens. The crisis ends in neither regime. Across the stochastic paths at least one year on the crisis equilibrium occurs on 54 percent by 2036. A crisis abroad does not require one in the United States: of the paths with no U.S. crisis year, 70 percent carry one elsewhere, 54 percent one outside the United Kingdom, and 11 percent one outside the United Kingdom and France, whose crisis years rest on their own baselines and on the growth draw common to the eight economies as well as on the common sunspot. Section 3.7 adds an AI-adoption productivity path as a sensitivity, and Section 3.8 carries the central banks' announced run-off paths, which lower every affected economy's crisis-zone boundary and raise the debt carried through the crisis, leaving the U.S. shares within a percentage point of the central calibration's. Section 4 states what would end a crisis in the model's terms. Solving for the capacity that removes the crisis equilibrium gives 2.75 percent of GDP announced in 2027 under regime M and 2.67 under regime F, against a historical capacity of 1.91. Solving the same question for three instruments shows that an unconditional ceiling on the spread removes the crisis equilibrium only where the baseline keeps a benign one, that a ceiling which removes it can still be reached, that the growth increment that removes it is at most 0.64 percentage points for the United States, Japan, Italy, and Germany where it is announced in 2027 and between 1.08 and 4.97 percentage points for the United Kingdom and France, and that every announced instrument must be in force through 2036, the final year solved, and beyond it, since the limit it lifts is a perpetuity; for the United Kingdom and France and, once the U.S. crisis has begun, for the United States, a surplus delivered rather than announced is smaller the later the exit year sought. Section 4.2 places the requirement against the record of large primary surpluses, and Section 4.3 against the fiscal history of the two economies that supplied the world's safe asset before the United States. Section 5 states what the model does not carry, and Section 6 concludes.

2 The Macroeconomic Framework

This section builds the model: the debt dynamics (Section 2.1), the interest-growth differential (Section 2.2), the fiscal limit (Section 2.3), the price of the debt (Section 2.4), the multiplicity and the crisis zone (Section 2.5), the two policy regimes (Section 2.6), output, inflation, and the transmission (Section 2.7), the central-bank backstops (Section 2.8), and the calibration (Section 2.9). Eight economies are indexed by i: the United States (US), Germany (DE), France (FR), Italy (IT), the United Kingdom (UK), Canada (CA), Japan (JP), and China (CN). Germany, France, and Italy

share the euro. Time is annual; $t = 0$ is 2026, and the horizon is 2036. Rates, spreads, and inflation are in percent; debt and balances in percent of GDP; the output gap in percent of potential GDP.

2.1 Debt Dynamics

The debt ratio evolves with the effective nominal interest rate on the stock, $i^{e}_{i,t}$ (the letter i with a superscript denotes an interest rate, and the subscript i the economy), nominal growth $n_{i,t}$, and the primary balance $pb_{i,t}$ (a surplus is positive):

$$d_{i,t} = d_{i,t-1}\,\frac{1 + i^{e}_{i,t}/100}{1 + n_{i,t}/100} - pb_{i,t}, \qquad i^{e}_{i,t} = i^{e}_{i,t-1} + \frac{1}{m_i}\left(i^{\text{new}}_{i,t} - i^{e}_{i,t-1}\right), \tag{1}$$

where m_i is the average maturity; the recursion reprices a share $1/m_i$ of the stock at the marginal rate each year whatever the change in the stock, so net new issuance is not priced at the marginal rate. The marginal financing rate is the consolidated government's: $i^{\text{new}}_{i,t} = (1 - h_i)\left[\omega_i\,(i^{s}_{i,t} + s_{i,t}) + (1 - \omega_i)\,y_{i,t}\right] + h_i\,i^{s}_{i,t}$, the weighted average of the short rate plus the sovereign spread and the 10-year yield on the share $1 - h_i$ of the stock the market holds, ω_i being the share of that stock that pays the short rate, and the policy rate on the share h_i the central bank holds, whose coupons return to the treasury as remittances while its reserves are remunerated at the policy rate. Both shares are read for each economy from the records of its debt office and its central bank (Section 2.9, Table 4) and are held fixed over the horizon: the central bank's share is 14.1 percent for the United States, 28.6 for Germany, 19.2 for France, 18.1 for Italy, 17.6 for the United Kingdom, 11.9 for Canada, 43.1 for Japan, and nil for China. The primary balance follows a fiscal rule around a projected path $pb^{\text{proj}}_{i,t}$, with a response b to debt above the debt $d^{\text{hf}}_{i,t-1}$ of the hazard-free path that Section 2.7 defines, an automatic-stabilizer response a to the output gap y^{gap}, a response c to the sovereign spread, and a ceiling $pb^{\max}_{i}$ at the largest surplus the government can sustain:

$$pb_{i,t} = \min\left\{pb^{\max}_{i},\; pb^{\text{proj}}_{i,t} + b\,(d_{i,t-1} - d^{\text{hf}}_{i,t-1}) + a\,y^{\text{gap}}_{i,t} + c\,s_{i,t-1}\right\}. \tag{2}$$

The projected path is, for the United States, the CBO's projected primary balance by fiscal year, read as its projected primary deficit before any adjustment for shifts in the timing of payments, in dollars over fiscal-year GDP and with the sign reversed, and, for each of the other seven economies, its 2026 balance held in every year of the horizon; Section 2.9 sets that choice against the record of the IMF's projections. The response to debt is zero in every scenario of the central configuration, a stated assumption that the same section sets against the evidence, so the balance departs from its projected path through the automatic stabilizers, at $a = 0.4$ percentage point of GDP per percentage point of the output gap, and through the response to the spread, at $c = 0.25$ percentage point of GDP per percentage point of spread, and in no scenario of the central calibration does it reach the ceiling.

The initial effective rate is the cost of the debt: consolidated general government interest paid in 2026 over the consolidated gross general government debt that interest accrued on, the stock outstanding at the end of 2025. Germany enters at 1.92 percent, France at 2.15, Italy at 2.96, the United Kingdom at 3.39, Canada at 3.11, and Japan at 0.85. The United States enters at 3.44 percent and China at 3.5, from sources of their own; the U.S. figure, 3.4435 percent to four decimals (Table 1), is the CBO's net interest, which is interest outlays less interest income, over debt held by the public at the end of fiscal year 2025, so its numerator is net of a receipt the other six carry gross. Equation (1) applies the cost to the net stock, which is the identity for net debt on the condition

that the netted assets earn what the debt costs: net debt is gross debt less assets, so it grows at the debt's rate only where the assets' return equals it, more slowly where they earn more and faster where they earn less. The condition is not imposed but measured. On the 2026 vintage the assets the netting removes are 70 percent of GDP in Japan and 100 in Canada against 15 or less in the other four, and the interest they earn is 1.94 percent in Japan against a debt cost of 0.85 and 1.74 percent in Canada against 3.11. Japan's assets therefore earn more than the condition requires, and its modeled path lies above the path the accounts imply, which errs toward stress. Canada's assets, on the interest they earn, do not, so its modeled path lies below and errs the other way. These are the two economies whose netted assets are large enough for the direction to matter. One qualification applies to both: the assets' return is not a variable of the model, so in a year when a crisis raises the debt's cost without raising that return, the modeled path understates the rise in net debt.

2.2 The Interest-Growth Differential and the Stationarity of the Debt Ratio

Equation (1) is the compound-interest form of a relation the literature states through the interest-growth differential:

$$d_{i,t} - d_{i,t-1} = \frac{i^{e}_{i,t} - n_{i,t}}{100 + n_{i,t}}\, d_{i,t-1} - pb_{i,t}, \tag{3}$$

so that the debt-stabilizing balance is $pb^{*}_{i,t} = (i^{e}_{i,t} - n_{i,t})\, d_{i,t-1}/(100 + n_{i,t})$. Bohn's condition for sustainability is that the primary balance respond positively to debt; b of equation (2) is a coefficient of that kind, read against the debt of the hazard-free path, and the ratio is stationary only where it exceeds $(i^{e} - n)/(100 + n)$; the central configuration sets it to zero (Section 2.9), a value that meets the stationarity condition only where the differential is negative.[8] Where the differential is negative, the ratio is stationary at any constant primary deficit, the debt limit in the sense of Barrett is unbounded, and the welfare cost of rolling debt over is small, the case Blanchard made in 2019.[9] A negative differential is an average over states and not a guarantee, since Mauro and Zhou find that differentials before defaults were no higher than at other times and that marginal borrowing costs rose only shortly before default.[10]

Two strands of the literature bear on how a positive differential, once it obtains, is reversed. The economic-history strand assembles the record of large debt reductions. Abbas and co-authors identify 129 large debt movements in 19 advanced economies between 1880 and 2007 and find the primary balance to be the main contributor to reductions except after the Second World War, when the differential accounted for the reduction. Eichengreen and co-authors decompose the reductions of Britain over 1822 through 1913, the United States over 1867 through 1913, and France over 1896 through 1913 and find that primary surpluses sustained against a positive differential account for them, over nine decades in Britain, five decades in the United States, and under two decades in France, where consolidation was delayed for two decades after the Franco-Prussian War. By contrast, the U.S. reduction of 1947 through 1956 rested on a negative differential produced by

[8] Henning Bohn, "The Behavior of U.S. Public Debt and Deficits," *Quarterly Journal of Economics* 113, no. 3 (1998): 949–963.

[9] Philip Barrett, "Interest-Growth Differentials and Debt Limits in Advanced Economies," IMF Working Paper 18/82 (Washington, DC: International Monetary Fund, 2018); Olivier Blanchard, "Public Debt and Low Interest Rates," *American Economic Review* 109, no. 4 (2019): 1197–1229; Neil R. Mehrotra and Dmitriy Sergeyev, "Debt Sustainability in a Low Interest Rate World," *Journal of Monetary Economics* 124, supplement (2021): S1–S18.

[10] Paolo Mauro and Jing Zhou, "$r - g < 0$: Can We Sleep More Soundly?" *IMF Economic Review* 69, no. 1 (2021): 197–229.

growth, inflation, and capped nominal rates, with primary surpluses contributing about 40 percent of a decline of 66 percentage points of GDP.[11] Hall and Sargent attribute the U.S. reduction of 1945 through 1974 in similar shares to primary surpluses and to real growth and in a smaller share to the negative real return that holders received, and Reinhart and Sbrancia document the regulatory apparatus that held those returns down from 1945 through 1980.[12] On the primary-balance route, Eichengreen and Panizza count three non-overlapping 10-year episodes at an average primary surplus of at least 5 percent of GDP among 113 such episodes in high-income and middle-income economies, and Pina, Hitschfeld, and Miyahara, examining 34 debt-reduction episodes of at least 10 percentage points of GDP and five years in a sample of 33 member countries of the Organisation for Economic Co-operation and Development (OECD) between 1976 and 2019, find that favorable cyclical conditions, through growth and through the primary balance, were the main driver over the length of the episodes.[13] The model's ceiling $pb_i^{\max}$ on the primary surplus is the quantity this record measures, and Section 2.3 makes it the object that backs the debt.

The finance strand concerns what determines the interest rate in the differential. The rate that matters for the government's intertemporal budget is the discount rate on its future surpluses, which are risky, and not the risk-free rate; Jiang, Lustig, Van Nieuwerburgh, and Xiaolan show that at a discount rate appropriate to the riskiness of U.S. surpluses the market value of Treasury debt exceeds the present value of the surpluses the data support, and that the convenience yield holders pay for the safety and liquidity of Treasuries does not close the gap.[14] Brunnermeier, Merkel, and Sannikov and Reis give that gap a theoretical form in which the debt can be rolled over at a rate below growth only because it serves as a store of value, and Cochrane's treatment of the fiscal theory places the price level as the variable that adjusts when surpluses fall short of the debt's value.[15] Berk and van Binsbergen add that the debt-to-GDP ratio compares a stock to a flow and is informative only where the two are cointegrated, which is the stationarity of the ratio that the condition on b of equation (2) governs, and that the flow-to-flow ratio of interest to GDP and the stock-to-stock ratio of debt to equity sit below their historical averages while the debt ratio sits at a peacetime high.[16]

[11] S. M. Ali Abbas, Nazim Belhocine, Asmaa El-Ganainy, and Mark Horton, "Historical Patterns and Dynamics of Public Debt—Evidence from a New Database," *IMF Economic Review* 59, no. 4 (2011): 717–742; Barry Eichengreen, Asmaa El-Ganainy, Rui Esteves, and Kris James Mitchener, "Public Debt Through the Ages," IMF Working Paper 19/6 (Washington, DC: International Monetary Fund, 2019); Barry Eichengreen, Asmaa El-Ganainy, Rui Esteves, and Kris James Mitchener, *In Defense of Public Debt* (New York: Oxford University Press, 2021); Barry Eichengreen and Rui Esteves, "Up and Away? Inflation and Debt Consolidation in Historical Perspective," *Oxford Open Economics* 1 (2022): odac008.

[12] George J. Hall and Thomas J. Sargent, "Interest Rate Risk and Other Determinants of Post-WWII US Government Debt/GDP Dynamics," *American Economic Journal: Macroeconomics* 3, no. 3 (2011): 192–214; Carmen M. Reinhart and M. Belen Sbrancia, "The Liquidation of Government Debt," *Economic Policy* 30, no. 82 (2015): 291–333.

[13] Barry Eichengreen and Ugo Panizza, "A Surplus of Ambition: Can Europe Rely on Large Primary Surpluses to Solve Its Debt Problem?" *Economic Policy* 31, no. 85 (2016): 5–49; Álvaro Pina, Mauricio Hitschfeld, and Takashi Miyahara, "Drivers of Public Debt Reductions: Lessons from Past Episodes in OECD Countries," OECD Economics Department Working Paper 1841 (Paris: OECD, 2025).

[14] Zhengyang Jiang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan, "The U.S. Public Debt Valuation Puzzle," NBER Working Paper 26583 (Cambridge, MA: National Bureau of Economic Research, 2019); Zhengyang Jiang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan, "Manufacturing Risk-Free Government Debt," NBER Working Paper 27786 (Cambridge, MA: National Bureau of Economic Research, 2020).

[15] Markus K. Brunnermeier, Sebastian Merkel, and Yuliy Sannikov, "The Fiscal Theory of Price Level with a Bubble," NBER Working Paper 27116 (Cambridge, MA: National Bureau of Economic Research, 2020); Ricardo Reis, "The Constraint on Public Debt When $r < g$ but $g < m$," BIS Working Paper 939 (Basel: Bank for International Settlements, 2021); John H. Cochrane, *The Fiscal Theory of the Price Level*, manuscript version of 2021 posted on the author's website, accessed 5 October 2026.

[16] Jonathan B. Berk and Jules H. van Binsbergen, "Why Care About Debt-to-GDP?" NBER Working Paper 34629 (Cambridge, MA: National Bureau of Economic Research, 2026).

The model carries the convenience yield as a function of debt and of the safety of the debt, and Sections 2.4 and 2.5 derive the reversal of the differential from the loss of the convenience yield.

2.3 The Fiscal Limit as a Present Value

The fiscal limit is the level of debt beyond which the government cannot service its obligations: in Bi's construction, the present value of the largest primary surplus the government can deliver, a quantity over which the market holds a distribution. What that construction needs is the largest surplus a government could sustain; what this paper supplies for it is the largest 10-year average surplus each government has sustained on its long record, or, for China, whose record shows no 10-year average above zero, a value scaled from revenue, which is a calibration moment from the realized record and not a structural ceiling. The two differ, and the direction depends on the comparator. Against the largest surplus the government could run, the measure is a lower bound read as though it were the capacity itself: realized policy reflects the demands placed on it, so a government that has never needed a large surplus has not shown it could not run one. Against an average the government can repeat, it is an upper reading, the largest of a record's 10-year averages being an extreme statistic (Section 2.9). Every boundary, zone, and crisis year below is conditional on that reading, and an economy whose record contains no episode of fiscal stress will be placed nearer its boundary than a structural estimate would place it.[17] The ceiling $pb_i^{\max}$ is a real quantity, a share of GDP, so the limit is the present value of the maximum real surplus at the real interest-growth differential,

$$d^*_{i,t} = \frac{pb_i^{\max}}{\varrho_{i,t}}, \qquad \varrho_{i,t} = \frac{r^{\lim}_{i,t} - \bar{g}_i}{100 + \bar{g}_i}, \tag{4}$$

with $d^* = \infty$ where $\varrho \leq 0$. A perpetuity discounts at one long-run differential, so both of its sides are long-run objects. The differential is small, and its components are uncertain by more than it: the published bands on neutral rates are wider than half a percentage point, and a neutral rate half a percentage point higher lowers a corner boundary by 1 through 7 percentage points of GDP, one half a percentage point lower raising it by 1 through 9. A limit discounted at a difference smaller than the error on either of its parts does not measure a level. What the construction identifies is the existence of a crisis root: with the neutral real rate half a percentage point lower or higher in every economy, the United States, France, Italy, Japan, and the United Kingdom carry years on the crisis equilibrium under regime M in either case. The level of the limit changes with the shift, and so do four readings that rest on it, as the one-at-a-time test of Section 5 reports: the year in which the U.S. crisis begins, 2028 in place of 2027 at the lower rate; the number of U.S. crisis years; Germany's crisis years, which the lower rate removes; and U.S. debt in 2036. On the growth side, $\bar{g}_i$ is the terminal real trend of Table A.4. On the rate side, $r^{\lim}_{i,t} = (1 - h_i)\left[\omega_i\,(r^*_i + s_{i,t}) + (1 - \omega_i)\,(y_{i,t} - \pi^e_{i,t})\right] + h_i\,r^*_i$ is the real marginal financing rate of equation (1) with the policy rate at its neutral level: the economy's neutral real rate r^*_i, which is fixed over the horizon and is not drawn in the stochastic simulation, plus the sovereign spread on the short leg, the real 10-year yield on the long leg, and r^*_i on the central bank's share, which is the remuneration on the reserves that finance those holdings once the central bank and the treasury are consolidated. Two of the three legs are therefore policy-rate objects rather than market borrowing rates, which is what r^*_i estimates. The two legs of the stock

[17] Bi, "Sovereign Default Risk Premia," for the limit as a present value of maximal surpluses and the distribution over it; Atish R. Ghosh, Jun I. Kim, Enrique G. Mendoza, Jonathan D. Ostry, and Mahvash S. Qureshi, "Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies," *Economic Journal* 123, no. 566 (2013): F4–F30, for a limit built from a response of the primary balance estimated on the realized record. The argument that a realized maximum is a lower bound on the largest surplus a government could run is this paper's and is neither's.

the market holds carry the sovereign spread of the same period, the short leg directly and the long leg through the yield, so the limit moves with the spread the pricing equation is solving for. That step is this paper's. In Bi's construction the maximal surpluses are discounted at the household's stochastic discount factor, and the limit does not depend on the equilibrium; the limit of Ghosh and co-authors, which for a primary balance held at its maximum is that maximum over the differential, is evaluated at the risk-free rate, and the interest rate reaches the probability of default through the debt of the next period. Where $\varrho_{i,t}$ is positive, $d_{i,t} > d^*_{i,t}$ is the inequality $\varrho_{i,t}\, d_{i,t} > p b_i^{\max}$: the debt exceeds the limit exactly where the growth-adjusted interest bill on the whole stock, at the marginal rate the candidate spread implies, exceeds the capacity. That comparison is the feedback from the interest rate to the burden of the debt in Calvo and in Ghosh and co-authors, whose debt is of one period, so that the whole stock pays the candidate rate; here it is applied as a threshold to a stock of which the fraction $1/m_i$ reprices in a year, which is an assumption of the construction and a result of none of those sources.[18] Section 2.5 reports what follows from the step: the second solution of the pricing equation exists because the limit carries the spread. Inflation enters the limit directly through one term alone, the inflation risk premium that the real 10-year yield carries on the long leg, which is zero while expected inflation is at or below its target.[19] The debt identity of equation (1) is a year-by-year object and reads the year's nominal financing rate, growth, and inflation, so inflation erodes the nominal debt through the identity, which is the channel the price-level adjustment of Section 2.6 runs through; the corner condition of Section 2.5 evaluates the same real object. The limit therefore covers both signs of the differential: while the government borrows in real terms below its trend growth rate at a neutral policy rate, no level of debt exceeds the present value of its capacity, and the debt carries no credit risk, which is the Barrett and Blanchard case; once that real financing rate exceeds trend growth, the limit is finite and falls as the differential widens. The default hazard over the coming year is the probability that the realized limit lies below the debt, with a logistic distribution of dispersion σ around d^* and an upper bound $p^{\max}$ that is the probability of default conditional on the limit being exceeded, the bound on the default hazard, which enters the spread as a default probability enters the bond price of Cole and Kehoe, where it

[18] Bi, "Sovereign Default Risk Premia"; Ghosh, Kim, Mendoza, Ostry, and Qureshi, "Fiscal Fatigue, Fiscal Space and Debt Sustainability"; Guillermo A. Calvo, "Servicing the Public Debt: The Role of Expectations," *American Economic Review* 78, no. 4 (1988): 647–661.

[19] The neutral rate is taken per economy. The United States, Canada, and the euro area carry the one-sided Holston–Laubach–Williams estimates for 2026:Q2, the euro-area estimate assigned to Germany, France, and Italy; Japan carries the midpoint of the Bank of Japan's estimated range; China carries the estimate of Sun and Rees, "a bit above 2 per cent" as of the end of 2019, in a band of 1.5 through 3; and the United Kingdom carries the estimate of the longer-run real neutral rate for the second half of 2026 by Ferreira, Lott, and Richards of the Federal Reserve Board's staff, which is the authors' own and not an official view, the Holston–Laubach–Williams estimates carrying no series for the United Kingdom. A common euro-area value is what a monetary union implies, there being one policy rate and so one neutral policy rate, and González-Astudillo and Vilán estimate the members' neutral rates separately and find differences across country groups, Germany and France belonging to the core and Italy to the periphery, with limited within-group variation among the core and broadly similar trajectories among the periphery. Kathryn Holston, Thomas Laubach, and John C. Williams, "Measuring the Natural Rate of Interest after COVID-19," Federal Reserve Bank of New York Staff Report 1063 (2023), estimates updated through 2026:Q2; Bank of Japan, "Developments in the Natural Rate of Interest and the Assessment of the Degree of Monetary Accommodation," Bank of Japan Review 2026-E-4 (Tokyo: Bank of Japan, March 2026); Thiago Ferreira, Mitch Lott, and Keith Richards, "Real-Time Global Longer-Run Neutral Rates," FEDS Notes (Washington, DC: Board of Governors of the Federal Reserve System, 9 April 2025), data file accessed 5 October 2026; Guofeng Sun and Daniel M. Rees, "The Natural Interest Rate in China," BIS Working Paper 949 (Basel: Bank for International Settlements, 2021), 11; Manuel González-Astudillo and Diego Vilán, "One Policy Rate, Many Stances: Evidence from the European Monetary Union," Finance and Economics Discussion Series 2025-087 (Washington, DC: Board of Governors of the Federal Reserve System, 2025).

is the probability that the sunspot arrives, a separate parameter here (q of Section 2.5):[20]

$$p_{i,t+1} = p^{\max}\,\Lambda\!\left(\frac{d_{i,t} - d^{*}_{i,t}}{\sigma}\right), \qquad \Lambda(x) = \frac{1}{1+e^{-x}}. \tag{5}$$

The bound $p^{\max}$ is this paper's. A logistic probability of reaching a fiscal limit appears in Davig, Leeper, and Walker, where it is a function of the lagged tax rate and the limit is a date from which the tax rate stays at its maximum; their model has no default and no sovereign spread.[21]

2.4 The Price of Sovereign Debt

This subsection prices the debt: the yield combines the risk-free rate, compensation for inflation, and a spread for the risk of default, and the spread in turn depends on the debt the yield produces. The 10-year yield is

$$y_{i,t} = rf_{i,t} + \pi^{e}_{i,t} + \iota \max\{0, \pi^{e}_{i,t} - \pi^{*}_{i}\} + s_{i,t}, \qquad s_{i,t} = 100\,\frac{\lambda\, p_{i,t+1}}{1 - \lambda\, p_{i,t+1}}, \tag{6}$$

the sum of the real risk-free long rate, expected inflation $\pi^{e}_{i,t} = (1-\alpha)\pi^{*}_{i} + \alpha\,\pi_{i,t-1}$, an inflation risk premium with coefficient ι, and the sovereign spread $s_{i,t}$ (in the legends of the figures, the credit spread) that compensates a risk-neutral holder for the expected loss at loss given default λ, which is exact for a spread that multiplies the gross risk-free return and a first-order approximation as added to the yield here. For the United States the risk-free rate is

$$rf_{\mathrm{US},t} = r^{*}_{\mathrm{US}} + tp_{\mathrm{US},t} - cv_{\mathrm{US},t}, \qquad cv_{\mathrm{US},t} = \max\!\left\{0,\; cv_0\left[1 - \zeta \ln\!\left(\frac{d_{\mathrm{US},t}}{d_{\mathrm{US},0}}\right)\right]\right\}\left(1 - \frac{p_{\mathrm{US},t+1}}{p^{\max}}\right), \tag{7}$$

where r^{*}_{i} is the neutral real rate of economy i. The *long-rate residual* rises with debt at the rate θ per percentage point of GDP from its initial level, $tp_{i,t} = tp_{i,0} + \theta\,(d_{i,t-1} - d_{i,0})$, where $tp_{i,0} = y_{i,0} - r^{*}_{i} - \pi^{*}_{i} + cv_{i,0}$ is the residual that reproduces the observed initial 10-year yield, within the range that Laubach and that Engen and Hubbard estimate,[22] and the convenience yield declines with debt along a demand curve in the direction Krishnamurthy and Vissing-Jorgensen estimate and vanishes as the debt loses its safety, the hazard rising toward $p^{\max}$. The semi-elasticity carried, $cv_0\,\zeta$, is 0.125 percentage points per unit of log debt to GDP, or 0.12 basis points per percentage point of debt to GDP at the initial ratio. It is an assumption and is not placed on the scale of the estimates of Jiang, Richmond, and Zhang, who estimate the response of the convenience yield, in percentage points, to the log of a maturity bucket's Treasury supply relative to GDP over 1998:Q1 through 2023:Q4 at -0.376 through -0.545 by ordinary least squares and -0.161 through -1.316 by instrumental variables across the short, medium, and long buckets, larger in magnitude at long maturities: the value used here applies to total debt held by the public rather than to a maturity bucket's supply.[23] The level cv_0 is set at 0.25 percentage points, against an average 10-year premium of about 24 basis points of nominal Treasuries over synthetic nominal Treasuries constructed

[20] Cole and Kehoe, "Self-Fulfilling Debt Crises."

[21] Troy Davig, Eric M. Leeper, and Todd B. Walker, "Inflation and the Fiscal Limit," NBER Working Paper 16495 (Cambridge, MA: National Bureau of Economic Research, 2010), 10.

[22] Thomas Laubach, "New Evidence on the Interest Rate Effects of Budget Deficits and Debt," *Journal of the European Economic Association* 7, no. 4 (2009): 858–885; Eric M. Engen and R. Glenn Hubbard, "Federal Government Debt and Interest Rates," *NBER Macroeconomics Annual* 19 (2004): 83–138.

[23] Zhengyang Jiang, Robert J. Richmond, and Tony Zhang, "Convenience Lost," NBER Working Paper 33940 (Cambridge, MA: National Bureau of Economic Research, 2025).

from inflation-protected securities and a long-bond range of 10 through 40 basis points; measures taken from swap spreads lie below it and are carried at the floor of the drawn range.[24] The level is not identified separately from the initial long-rate residual $tp_{\mathrm{US},0}$, which reproduces the observed initial 10-year yield and therefore rises one for one with cv_0: the level governs the erosion of the convenience yield as debt rises along the demand curve and the amount the hazard removes, not the initial yield, and the draw over cv_0 in the stochastic simulation is a draw over what a crisis takes away. For the other economies $rf_{i,t} = r_i^* + tp_{i,t} + \beta_i \left(rf_{\mathrm{US},t} - rf_{\mathrm{US},t}^{\mathrm{hf}}\right)$, the final term being the pass-through of the U.S. risk-free rate relative to its hazard-free path, the path with the default hazard set to zero that Section 2.7 defines. For France and Italy, whose neutral rate is the euro area's, the residual $tp_{i,0}$ also carries each one's 2026 spread over the German 10-year yield, so that for them it is a term premium and a spread together, and the limit capitalizes both (Section 5, third limitation). The response θ, 0.03 percentage points per percentage point of GDP, is applied linearly at every debt ratio the paths reach, up to 300.4 percent of GDP for the United States at the 95th percentile of its 2036 debt among the paths with a U.S. crisis, and at those ratios the linear response is an extrapolation of the estimates it rests on.

Equations (1) through (7) form a fixed point in $y_{i,t}$ each period. A candidate yield determines the marginal financing rate, the effective rate, and, through the real long rate, the output gap and nominal growth; these determine the debt ratio and the limit; the limit determines the hazard; and the hazard determines the spread and the convenience yield that return a yield. The period is solved in the sovereign spread rather than in the yield: the spread residual, the spread the hazard implies less the spread posited, is evaluated on a grid of 48 evenly spaced points over $[0, s^{\max}]$, both ends included. A residual at or below 10^{-12} at the left endpoint is the no-credit-risk root at a spread of zero, and each downward sign change between neighboring points is refined by bisection to a root. Two roots that fall inside one cell of the grid, or inside the two cells around one point, leave the residual with one sign at the points around them, and a search of sign changes alone does not see them. The solver therefore also searches the two cells around each point at which the residual on the grid has a local minimum and is positive, for the residual's minimum, by golden-section search with parabolic interpolation to within 10^{-6} percentage point of spread, and where that minimum lies below -10^{-12} it bisects the stable root between the lower end of the cells and the minimum; around each point at which the residual has a local maximum and is not positive it searches for the maximum, and where that maximum lies above 10^{-12} it bisects the stable root between the maximum and the upper end of the cells. A local minimum whose cells reach the root at a spread of zero is not searched, a crossing there being that root. The unstable root of each pair so found is not reported, as the unstable root between two sign changes is not, and where no extremum crosses the tolerance the roots are those of the sign changes alone. The search does not resolve two pairs of roots inside the two cells around one point, nor a pair whose extremum crosses zero by no more than 10^{-12}, which is a tangency within the precision of the evaluation. A coordinating economy takes the largest root when two or more exist; every other economy, and a coordinating one when a single root exists, takes the smallest. Where the search finds no root the period has no equilibrium on the interval, and it is treated as having none rather than being assigned the grid point of smallest residual, which is not a root: the grid point is accepted only where its residual lies within 10^{-6}, a tangency rather than a missing root. Across the deterministic scenarios and the stochastic paths on which the residual is recorded, the largest residual at any equilibrium is 10^{-12}. The spread is the variable the multiplicity runs through: it prices the hazard, the hazard is what the limit determines, and it lies on the bounded interval $[0, s^{\max}]$; a candidate

[24] Viral V. Acharya and Toomas Laarits, "Tariff War Shock and the Convenience Yield of US Treasuries—A Hedging Perspective," NBER Working Paper 34640 (Cambridge, MA: National Bureau of Economic Research, 2026).

spread fixes the hazard, the yield that clears equation (6) at that spread follows, and the state that yield produces returns a spread. The yield at a given spread is itself an inner fixed point, solved to convergence: the convenience yield of equation (7) and the hazard the state returns read the year's end-of-period debt, which the candidate yield produces through the identity, while the long-rate residual reads the debt entering the year; the hazard factor of the convenience yield reads the hazard the candidate spread carries, so the pricing side does not re-enter the hazard. With that return map written as $S_{i,t}(s)$, the period's equilibria are the roots of $S_{i,t}(s) - s$. Solving in the spread places every equilibrium of the period on one bounded interval, where the yield parameterization reaches the same equilibria through an inner iteration in which the marginal financing rate and the limit move together.

2.5 Multiplicity, the Crisis Zone, and the Sunspot

The spread of equation (6) is a one-period object: it compensates the investor for a one-year hazard at a given loss given default, and it is applied to the financing rate rather than derived from the survival distribution of a 10-year bond, which would require the expected path of the hazard, the recovery convention, the maturity structure, and a risk premium. It is a reduced form, and its role is to close the fixed point and generate the multiplicity the paper is about; the level of the crisis yield it produces is set by $p^{\max}$ and λ, which the sensitivity of Section 3.6 reports and which a reader of the scenarios can vary. Writing the pricing map in the yield as G, the yield that equation (6) returns at the state a candidate yield y produces, G depends on y through the debt and the limit, and it is bounded, since the spread is bounded by $s^{\max} = 100\lambda p^{\max}/(1 - \lambda p^{\max})$, which is 4.2 percentage points under the central calibration. Where the differential is negative at the risk-free rate, the low root is the yield without credit risk; where the debt is high enough that at the yield with the full spread the limit falls below the debt, a second root can exist, at which the spread approaches $s^{\max}$ and the hazard $p^{\max}$. The set of debt levels at which both roots exist is called the crisis zone here. The term is Cole and Kehoe's, and their zone is another object: the range of debt over which a government repays if its maturing debt is rolled over and defaults if it is not, with the probability of the sunspot priced in the bond; what the construction shares with theirs is the term, a sunspot that selects, and the three positions distinguished below.[25] Two solutions in the interest rate are Calvo's, in whose model the rate contracted on the debt raises the burden of servicing it.[26] Here the second solution has another source. A candidate spread reaches the hazard by two routes, through the debt it produces and through the limit it lowers, and the multiplicity comes through the second. For the United States in 2027, the first year of the crisis under regime M, the period map has three solutions, at spreads of 0.00, 2.28, and 3.14 percentage points, the middle one unstable; with the limit discounted without the candidate spread it has one, at a spread of 0.00; and with the limit held at the value it takes on the crisis root while the spread varies, the slope of the map at that root is 0.022 against 0.608, so that the route through the debt carries 3.7 percent of the slope and the route through the limit the remainder (Table 13). The measurement is of one economy, one regime, and one year, and holding the limit is a device for reading the map and not a model. With long-maturity debt the stock reprices at the rate $1/m$ a year, so the effective rate and the debt move gradually on the high root, as the debt does in the slow-moving crisis of Lorenzoni and Werning, in whose model the price of the bond moves at once and the premium reaches the debt on the refinanced fraction.[27] Here the yield reaches the high root within the year in which the market coordinates on it. The map

[25] Cole and Kehoe, "Self-Fulfilling Debt Crises."
[26] Calvo, "Servicing the Public Debt."
[27] Lorenzoni and Werning, "Slow Moving Debt Crises."

carries no third equilibrium: across the 800,000 periods of the stochastic simulation the residual crosses zero from above at most twice, and it does so twice in 119,248 of them. Between the two roots it crosses zero once from below, at a yield the model never selects; that crossing is unstable, in that the return map crosses the diagonal from below there, so an economy could sit on it only if the market coordinated on it exactly, and the solver takes crossings from above alone as equilibria.

Three positions are distinguished throughout. A root of the year's pricing equation is a crisis root where the hazard it carries exceeds half of its bound $p^{\max}$, and a benign root otherwise, by the reading set out at the end of this subsection. An economy lies *below* its crisis zone in a year whose equation carries no crisis root; *inside* the zone where a crisis root stands beside a benign one, so a crisis is available and the market's coordination selects between them; and *beyond* the zone where no benign root exists, the crisis equilibrium being the only one. The zone proper is the multiplicity region, so an economy beyond it is past the zone rather than inside it, and the distinction matters for reading a result: a crisis inside the zone is self-fulfilling and a crisis beyond it is not. The paper calls the first a crisis of coordination and the second a crisis of sole survival, the crisis equilibrium then being the only one. Evaluating the limit at the maximal crisis yield gives a corner condition for the zone in closed form. With the maximal real crisis yield $y_i^{\text{high}} = r_i^* + tp_{i,0} + s^{\max}$ and the corresponding real marginal financing rate $r_i^{\text{high}} = (1 - h_i)\left[\omega_i\,(r_i^* + s^{\max}) + (1 - \omega_i)\,y_i^{\text{high}}\right] + h_i\,r_i^*$,

$$d_i^{\text{zone}} = \frac{pb_i^{\max}\,(100 + \bar{g}_i)}{r_i^{\text{high}} - \bar{g}_i}, \tag{8}$$

so that this corner boundary is proportional to the fiscal capacity and decreasing in the product $\lambda p^{\max}$ through $s^{\max}$. The convenience yield's response to debt and to the hazard does not enter, because the convenience yield is lost on the high root; the long-rate residual enters through $tp_{i,0}$, and with it the level of the convenience yield, since $tp_{i,0}$ carries $cv_{i,0}$, which is nonzero for the United States alone. Under the central calibration the corner condition of equation (8) is 53 percent of GDP for the United States, 73 for Germany, 30 for France, 82 for Italy, 34 for the United Kingdom, 105 for Canada, and 67 for Japan, whose central bank holds the largest share of the stock (Section 2.8), with China taken up in the addendum; it moves to 83 for the United States at a fiscal capacity of 3 percent of GDP and to 138 at 5 percent. The boundary the paths obey is a different object. The hazard of equation (5) is a logistic in the excess of debt over the limit, the dispersion of the fiscal limit being 30 percentage points of GDP, so the crisis equilibrium is a fixed point of a smooth map and exists only where the excess of debt over the corner is enough for the hazard it implies to price the spread that lowers the limit. The operative boundary is the smallest initial debt at which the period map, read against the hazard-free path (Section 2.7) at the same initial debt, carries a crisis equilibrium in the first year of the horizon, found by bisection to within 0.1 percentage point of GDP under the central calibration, the long-rate residual and the convenience yield evaluated at each trial initial debt as in Figure 2, and Section 3.1 reads every economy's position by it. For the economies without a ceiling it lies 19 through 60 percentage points of GDP above the corner; for the three euro-area economies, whose ceiling caps the spread, it lies 8 through 17 percentage points of GDP below the corner evaluated at the ceiling: a root held at the ceiling is a crisis root where the debt at the end of the year exceeds the limit at the capped rate, the hazard reads that debt after the year's deficit, and the corner condition differs from the operative boundary there as elsewhere. Figure 2, in Section 3.1, shows both.

The dispersion of the fiscal limit has a counterpart in the analysis of Blanchard, Martínez-Bruera, and Huertas, who characterize how wide the range of multiple equilibria is.[28] In their model the debt is of one period, investors are risk-neutral, a default imposes a haircut, and the primary balance is exogenous and uncertain. The range of debt over which an equilibrium at a low rate and one at a high rate coexist narrows as the uncertainty about the balance widens, and disappears where it is wide enough, the rate then being a continuous function of the debt: wider uncertainty lowers the effect of the perceived probability of default on the actual one, and that effect is what sustains two equilibria. A rule that raises the balance with the debt, by more than the safe rate and by less than the rate under certain default, raises the debt at which the second equilibrium appears without removing it, and a cap on the fiscal effort restores a finite range. Each of those objects has a counterpart here. The cap on the fiscal effort is the capacity $pb_i^{\max}$, which bounds the rule of equation (2) and which the limit capitalizes. The feedback coefficient is the response b of that rule, which is zero in the central configuration, so the model stands in their case of a balance that does not respond to the debt. The haircut is the loss given default λ, and their pricing condition is the exact form of which the spread of equation (6) is the first-order approximation. The uncertainty is σ: the logistic of equation (5) is a distribution of the limit about its central value, and a wider one lowers the largest response of the hazard to the debt, which is $p^{\max}/(4\sigma)$ per percentage point of GDP. The two constructions differ in the route by which a belief validates itself. In theirs the rate the market requires raises the next period's debt on a stock that is refinanced whole. Here the stock reprices at the rate $1/m$ a year, and of the slope of the U.S. map at the crisis root of 2027 the route through the debt carries 3.7 percent and the route through the limit, which the candidate spread lowers, the remainder. Their result is therefore a property this model does not inherit by construction, and Section 3.6 measures it: the range of initial debt over which the first year's pricing equation has two stable solutions, at dispersions from a quarter of the central value through eight times it.

Coordination is triggered by a sunspot, and selection is persistent. A year's map has one stable root or two, and each is read by the hazard it carries. A root is a crisis root where that hazard exceeds half of $p^{\max}$, which is the debt at the end of the year standing above the central value of the limit at the financing rate of that root, and a benign root otherwise. The rule is one rule for a root that stands alone and for a root that stands beside another, so the reading does not rest on the number of roots: a year with a single root may be one in which the crisis root is the only equilibrium rather than one in which it has gone, and a year with two roots carries a crisis root only where the upper of them prices a debt above the limit. An economy on the crisis equilibrium in a year, whether the market coordinated on it or no benign root existed, stays on it for as long as a crisis root exists, and only a sunspot moves an economy from a benign root to a crisis root while both exist. A sunspot moves a coordinating economy to the highest root of the year. Where that root is not a crisis root, the year is priced on it and is not a crisis year, and the selection is not carried into the year after; where it stands at a central bank's ceiling, the economy pays the ceiling and the purchases absorb the spread the hazard prices above it. In the deterministic scenarios the sunspot is common and arrives in every year from 2027: each economy, the United States and every other alike, moves to its crisis root in the first year in which that root exists for it, so a coordination abroad does not wait for an onset in the United States; an economy whose crisis root has ceased to exist is not coordinated again: in the year in which it ceases the sunspot still moves the economy to the highest root, which is then not a crisis root, and from the year after the economy takes the smallest root. In the stochastic simulation the sunspot arrives with an annual probability q and is common

[28] Olivier J. Blanchard, Pedro Martínez-Bruera, and Gonzalo Huertas, "Debt Sustainability and the Range of Multiple Equilibria," NBER Working Paper 35850 (Cambridge, MA: National Bureau of Economic Research, 2026).

to the eight economies, coordinating each that is inside its zone in the year it arrives; an economy that has left the crisis equilibrium can be coordinated again by a later sunspot, each arrival being a separate event, and the default itself is drawn in each year t with the hazard $p_{i,t+1}$ of equation (5) that the year's pricing carries.

2.6 Monetary-Fiscal Regimes

A government's intertemporal budget constraint has to be satisfied by some authority, and Leeper's classification is the statement of which one.[29] An authority is active when it sets its instrument without regard to the debt and passive when it adjusts to whatever the other leaves. With active money and passive fiscal policy the central bank raises the nominal rate more than one for one with inflation, so the price level is pinned, and the primary balance must then move with the debt for the constraint to hold; this is the configuration Bohn's condition tests, and it is the configuration under which a fiscal limit binds, because the balance that must move is bounded by the capacity of Section 2.9. With passive money and active fiscal policy the causation runs the other way: the primary balance is whatever fiscal policy chooses, the central bank accommodates, and the price level moves to make the real value of the outstanding nominal debt equal the present value of the surpluses the fiscal authority will deliver. Only these two configurations deliver a determinate stable equilibrium; active money with active fiscal policy admits no bounded equilibrium, the government budget constraint being violated, and passive money with passive fiscal policy leaves the price level undetermined. The paper names its two regimes for these configurations, regime M for the first and regime F for the second, and defines each by what its rules do. Under regime M the central bank's rule is active and the primary balance follows equation (2): its projected path, the automatic stabilizers, and a response to the sovereign spread, bounded by the capacity. With the response to debt at zero that rule is not passive in Leeper's sense, since the balance does not move with the debt, and the paper does not call it so; the shortfall of the limit below the debt is priced as default risk. Under regime F the central bank's rule is passive, the responses of the balance to debt and to the spread are zero, the automatic stabilizers remaining, and the price level adjusts.

The distinction is what gives the crisis of this model two courses rather than one. The pricing equation and the crisis zone of Section 2.5 are built on the debt identity and the limit and hold under either regime: they determine when a second equilibrium exists and when the market can coordinate on it. They do not determine what acts on the resulting gap between the debt and the limit; the regime does. Under regime M inflation follows its target and the output gap, the price-level term of equation (9) below being absent, and the gap is left to the primary balance, which the rule moves with the spread and the capacity bounds, so the crisis persists as long as the gap does. Under regime F it is left to the price level, over the maturity of the debt, through the reduced form of equation (9) below. The two regimes therefore do not change whether a crisis occurs in the United States, which the zone determines, and in the central scenario its onset is the same year, 2027, under both; abroad the U.S. regime can decide it, Germany and Italy reaching the crisis equilibrium under regime M and in no year under regime F (Section 3.3). For the United States they determine what a crisis is once it occurs, and the contrast the results report—a debt ratio of 195.1 percent of GDP against 121.2, and inflation of at most 2.0 percent against 9.9 percent in 2036, still rising—is that difference and not a difference of severity.

Which regime prevails is not modeled. The stochastic simulation draws the two with equal probability, which no record supports; the per-regime results are reported separately as well as

[29] Leeper, "Equilibria under 'Active' and 'Passive' Monetary and Fiscal Policies."

pooled, so a reader who holds a different view of the likelihood can read the regime medians of Table 19, in Section 3.5, directly.

The short rate follows a Taylor rule with a lag and a floor at zero, $i^{s}_{i,t} = \max\{0,\ r^{*}_{i} + \pi^{*}_{i} + \phi_{\pi}(\pi_{i,t-1} - \pi^{*}_{i}) + \phi_{y}\, y^{\text{gap}}_{i,t-1}\}$, the floor binding in the U.S. central scenario from 2030. Germany, France, and Italy share one policy rate, since one central bank sets it for the area: for those three the rule reads the area's inflation and output gap, each the members' values weighted by their shares of the area's nominal GDP in 2026, and the area's target, in place of their own. The lagged arguments leave the rate predetermined within the year. The policy rate enters the model at one place, the marginal financing rate of equation (1), as the short funding cost of the debt: the rate paid, with the sovereign spread, on the short leg of the market-held stock, and the rate paid on the share the central bank holds. It enters neither the output gap, which reads the real long yield, nor inflation, so the two regimes differ on the monetary side only in that cost, and the zero floor acts on that cost alone. Under regime M $\phi_{\pi} > 1$, and the fiscal rule of equation (2) carries its response c to the spread, its response b to debt being zero in the central configuration. Under regime F $\phi_{\pi} < 1$, and the response c is also zero, in every year of the horizon, the regime being a standing configuration of policy rather than a response to the crisis, and the price level adjusts so that the real value of the debt moves toward the backing the fiscal capacity provides. The regime is a property of one government's budget constraint with its own central bank, and the one at issue here is that of the United States: under regime F the passive coefficient and the zero fiscal responses apply to the United States alone, and the other central banks keep an active rule, since nothing in the U.S. configuration makes them abandon it. The price-level term of equation (9) is likewise U.S.-only. With long-maturity debt the adjustment can be spread over time. That proposition is taken from Cochrane: the longer the maturity of the debt, the more of a shortfall in the present value of surpluses can be met by future rather than immediate inflation.[30] The rule that carries it here is the paper's: inflation each year erodes, through the debt identity, a fraction $1/m$ of the excess of debt over the limit of equation (4), a real object that inflation reaches directly only through the premium on its long leg. Equation (9) states that rule as a reduced form,

$$\pi_{\text{US},t} = \pi^{*}_{\text{US}} + \kappa\, y^{\text{gap}}_{\text{US},t} + \frac{100}{m_{\text{US}}}\ \max\left\{0,\ \frac{d_{\text{US},t-1} - d^{*}_{\text{US},t}}{d_{\text{US},t-1}}\right\}, \tag{9}$$

with the final term absent under regime M and zero under regime F in any year in which the limit is unbounded; under regime F the term acts at every candidate spread of the year's map, since the limit the candidate implies is what it reads, and the regime-F run is read against the same baseline as the regime-M run. The backing the term reads is the capacity, capitalized in the limit of equation (4), and not the surpluses the rule delivers on the path. The term is a linearization: a price level that brought the real value of the debt down to the limit would rise in proportion to $(d - d^{*})/d^{*}$, and the term spreads the smaller ratio $(d - d^{*})/d$ over the maturity, the two agreeing to first order in the excess and the term falling below the required rise as the excess grows. Expected inflation places a weight of 0.5 on the previous year's inflation and the rest on the target (Table A.11), so it lags realized inflation: under regime F it lies below realized inflation in every year from 2027 through 2036, and under regime M, where inflation falls, above it. Two objects act on the same debt in this regime, and their coexistence is an assumption of the construction rather than a result of it: the price level adjusts toward the fiscal backing, and the hazard of equation (5) continues to price a default on the debt so adjusted. A price-level adjustment that validated the debt in full would leave no default to price. What the model carries is a partial one—the adjustment works on the fraction $1/m$ of the stock that reprices each year, so the excess is eroded slowly and a residual credit risk

[30] Cochrane, *Fiscal Theory of the Price Level*, 251 (section 8.4).

remains on what is not yet eroded—and the paper does not derive that partial adjustment from a state-contingent budget constraint. Where the adjustment validates the debt in full, regime F's default probabilities are an upper bound. How much the price level can do depends on whether nominal rates follow it, since the erosion works on the fraction of the debt not yet repriced: the average maturity and the share of the market-held stock that pays the short rate govern it. Eichengreen and Esteves find that inflation contributed to debt consolidation chiefly where nominal rates failed to keep up, under financial repression and long maturities, and that consolidations were less frequent in periods of high inflation, where rates caught up quickly.[31] The model carries no instrument of financial repression, so the configuration in which the inflation route worked historically lies outside its scope. The limit of equation (4) is thus one object with two readings: under regime M the shortfall of the limit below the debt is default risk; under regime F it is the price-level adjustment that the valuation equation requires. The regime describes U.S. policy; the other seven economies keep the rules of regime M throughout. The model does not determine which regime obtains; the deterministic scenarios report both, and the stochastic simulation draws the regime with a stated probability.

2.7 Output, Inflation, Asset Prices, and Transmission

The output gap responds to the real long rate relative to its hazard-free path, defined at the end of this subsection, to the investment-grade corporate spread cs, and, for the foreign economies, to the U.S. gap through trade:

$$y^{\text{gap}}_{i,t} = \rho\, y^{\text{gap}}_{i,t-1} - \beta_r \left(rL_{i,t} - rL^{\text{hf}}_{i,t}\right) - \beta_s \left(cs_{i,t-1} - cs_0\right) - \beta_f\, \Delta\tilde{pb}_{i,t-1} + \tau_i\, y^{\text{gap}}_{\text{US},t} + \varepsilon_{i,t}, \qquad (10)$$

with $rL_{i,t} = y_{i,t} - \pi^{e}_{i,t}$, $\tau_{\text{US}} = 0$, and $cs_{i,t} = cs_0 + \phi_s s_{i,t} + \phi^{cs}_{y} \max\{0, -y^{\text{gap}}_{i,t-1}\}$. The fourth term is the fiscal impulse: $\tilde{pb}_{i,t} = (pb_{i,t} - a\, y^{\text{gap}}_{i,t}) - (pb^{\text{hf}}_{i,t} - a\, y^{\text{gap,hf}}_{i,t})$ is the structural primary balance, net of the automatic stabilizers, relative to the hazard-free path, and $\Delta\tilde{pb}_{i,t-1} = \tilde{pb}_{i,t-1} - \tilde{pb}_{i,t-2}$ its change in the year before, with $\tilde{pb}$ zero in 2026 and before, so that a consolidation the fiscal rule delivers beyond what the hazard-free path carries costs output with a one-year lag and the cost decays at the gap's persistence; the balance on the hazard-free path itself carries no impulse. The reference is the regime-M hazard-free path for both regimes. On that path the spread is zero and the response to debt is zero, so its rule is the projected balance and the automatic stabilizers, which is also the rule of regime F: the U.S. structural balance under regime F equals the reference's in every year of the central scenario, and the term is zero there. Under regime M the response to the spread raises the structural balance above the reference's, by 1.0 percentage point of GDP in 2036, the largest excess of the central scenario, and the term carries the output cost of that consolidation. The coefficient β_f is set so that the model's own response in the second year of a permanent consolidation of 1 percent of GDP, begun in the first year of the horizon under regime M with the hazard off, equals the effect Guajardo, Leigh, and Pescatori estimate for a shock raising the cyclically adjusted primary balance by 1 percent of GDP, identified by their narrative record of deficit-driven measures across 17 OECD economies from 1978 through 2009: real GDP 0.82 percent lower in the second year, with a standard error (SE) of 0.333 percentage points.[32] The model carries no exchange rate, so the support to output from net exports that the source attributes to depreciation is absorbed by the

[31] Eichengreen and Esteves, "Up and Away?"

[32] Jaime Guajardo, Daniel Leigh, and Andrea Pescatori, "Expansionary Austerity? International Evidence," *Journal of the European Economic Association* 12, no. 4 (2014): 949–968, Table 3, single-equation two-stage least squares. The chapter of the *World Economic Outlook* from which the paper grew reports that the policy rate falls by about 20 basis

coefficient rather than reproduced by a channel, and the policy rate, which reaches only the short funding cost (Section 2.6), carries no part of the output response, so the policy-rate response that the estimate contains is absorbed by the coefficient as well. The calibrated coefficient is 0.836779, and the stochastic simulation draws it uniformly between the coefficients calibrated to the estimate one standard error below and above the point, 0.504054 through 1.169505 (Table A.10).

Realized growth is the year's trend plus the change in the gap, $g_{i,t} = \bar{g}_{i,t} + \left(y^{\text{gap}}_{i,t} - y^{\text{gap}}_{i,t-1}\right)$, and nominal growth compounds it with the year's inflation, $1 + n_{i,t}/100 = (1 + g_{i,t}/100)(1 + \pi_{i,t}/100)$. Trend growth $\bar{g}_{i,t}$ is a path rather than a constant, tabulated by economy and year in Table A.4: the IMF's projection for the seven economies other than the United States and the CBO's for the United States, each as published. No level correction is applied to them. The five-year projection errors of Table A.5 average -0.48 percentage points a year across the eight economies, an overprediction, but they are measured on seven baseline windows that open in 2008 through 2014, and the sign of such an error follows the cycle the window spans: over the CBO's 45 baselines of 1976 through 2020 the mean error of its five-year projections is -0.28, which is -0.66 over the 26 baseline periods that contain a recession and 0.25 over the 19 that do not. The errors therefore set the standard deviation of the growth draw and not its center: for each economy it is the root mean square of its errors about zero, 1.18 for the United States against 1.21 over the CBO's full record. The debt identity of equation (1) reads the path year by year, while the fiscal limit of equation (4) is a perpetuity and reads the terminal value. The construction carries no separate scarring term: the persistent output cost of a crisis arises in the model from the crisis itself, whose financing rate holds the gap open for as long as the interest-growth differential keeps the limit finite, which is the debt overhang that, in Arslanalp and Eichengreen's words, acts "as a tax on growth."[33] The historical record shows losses of this character: on the crises of the Jordà–Schularick–Taylor chronology, the median deviation of log real GDP per head from its pre-crisis trend is -10.3 percent at its peak in the fourth year and -8.1 a decade on, about 0.79 of the peak still present. The record is 37 of the 88 crises of the chronology: 35 are excluded because the 10 years before the crisis or the 10 after it overlap a world war, 6 because another crisis falls in the 10 years before, and 10 because either span runs off the panel. That chronology counts banking crises, and it is not a target the response coefficients were set to: Table 15, in Section 3.2, places the loss of the central scenario against it year by year from the onset. On paths where a crisis ends, output here returns toward trend, which understates the scarring the banking record shows.

Inflation outside the regime-F term follows $\pi_{i,t} = \pi^{*}_{i} + \kappa\, y^{\text{gap}}_{i,t}$ at home and abroad. The log equity index is a dividend-discount value, $\ln E_{i,t} = \left[-D_E\,(rL_{i,t} - rL^{\text{hf}}_{i,t}) + \eta\, y^{\text{gap}}_{i,t}\right]/100$, with D_E the duration of equity. Three channels carry the crisis abroad: the pass-through β_i of the U.S. risk-free rate, the trade term τ_i, and the common sunspot, which coordinates each economy that is inside its own zone. The pass-through coefficient β_i is estimated by regressing changes in foreign long yields on changes in the U.S. long yield, so it measures the comovement of the two and not the causal transmission of a U.S. risk premium: a regression of that form absorbs the common global inflation, monetary, growth, and risk-premium shocks along with any U.S. effect. It is used here as a comovement elasticity, and the model applies it to the constructed U.S. risk-free component, which is a narrower object than the regressor. The neutral rates carry no common innovation in

points per 1 percent of GDP of consolidation and that the output cost about doubles at the zero interest rate floor: International Monetary Fund, *World Economic Outlook: Recovery, Risk, and Rebalancing* (Washington, DC: International Monetary Fund, October 2010), Chapter 3.

[33] Serkan Arslanalp and Barry Eichengreen, "Living with High Public Debt" (paper presented at the Jackson Hole Economic Policy Symposium, Federal Reserve Bank of Kansas City, August 2023), 21.

the stochastic simulation, so the coefficient is the one channel through which the risk-free rates of the eight economies move together. The model carries no exchange rate: each economy's real exchange rate against the dollar is taken to stay on its hazard-free path, so no currency movement enters foreign output or inflation. A block of uncovered and purchasing-power parity would read the rise in a crisis economy's yield as a return that appreciates its currency, while most of that rise is the sovereign spread, priced here as the expected default loss, which raises no expected return; and the channel by which a sovereign crisis moves its own currency, a risk premium, has a size the record does not identify and, for the dollar in a crisis of the issuer of the safe asset, a sign the record does not settle. Structural exchange-rate models did not outperform a random walk out of sample at horizons of 1 through 12 months in the study of Meese and Rogoff.[34] The sixth limitation of Section 5 states the direction of the omission. The sovereign-bank loop and the holdings of Treasuries by foreign institutions are not carried separately and are subsumed in β_i and τ_i.[35]

Every quantity the model reads relative to a reference path—the real long rate in equation (10) and in the equity index, the structural primary balance of the fiscal impulse, and the U.S. risk-free rate in the pass-through—is read against the hazard-free path of the same parameters: the run of the same draw with the sovereign default hazard set to zero under the regime-M policy configuration, so that its spread is zero, its convenience yield carries no hazard factor, and its inflation no regime-F term; for a stochastic path it is the run under the same drawn parameters and the same innovations. That path always exists and is one path, since no root selection enters it, and it coincides with the low-root path wherever the limit is unbounded; where the limit is finite and stands above the debt, as it does in the U.S. baseline from 2029, the low root carries a spread of at most 0.0001 percentage point in any year of the five baselines without a crisis year. The hazard-free path is its own reference, so those terms are zero on it; every other run, the baseline included, is read against it, so a baseline that carries a spread, as those of France and the United Kingdom do, carries the output gap that spread implies, and a regime-M crisis path coincides with the baseline until the sunspot first arrives. The reference is defined this way because it has to exist for every economy in every year: a run holding the low root where it exists has none for the United Kingdom in any year and none for France from 2032, and a path read against a reference that is itself in crisis could hold a benign root that exists only relative to it.

2.8 Central-Bank Backstops: Mandates and Record

A central bank that stands ready to buy its sovereign's debt without limit changes the pricing equation, because the sovereign spread on which the limit of equation (4) depends is then bounded by the price at which the central bank buys. Whether a central bank may do so is a matter of its charter, and whether it would is a matter of record.

The European Central Bank (ECB) charter prohibits the purchase of member states' debt directly from the issuer but not in the secondary market, and its Governing Council has built two instruments on that distinction. Outright Monetary Transactions, announced in September 2012 after the President's statement of that July that the ECB would do whatever it took within its mandate to preserve the euro, provide for unlimited secondary-market purchases of a member state's

[34] Richard A. Meese and Kenneth Rogoff, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?" *Journal of International Economics* 14, no. 1–2 (1983): 3–24.

[35] Markus K. Brunnermeier, Luis Garicano, Philip R. Lane, Marco Pagano, Ricardo Reis, Tano Santos, David Thesmar, Stijn Van Nieuwerburgh, and Dimitri Vayanos, "The Sovereign-Bank Diabolic Loop and ESBies," *American Economic Review* 106, no. 5 (2016): 508–512; Viral V. Acharya, Itamar Drechsler, and Philipp Schnabl, "A Pyrrhic Victory? Bank Bailouts and Sovereign Credit Risk," *Journal of Finance* 69, no. 6 (2014): 2689–2739.

bonds of one through three years' maturity, conditional on the state being under a European Stability Mechanism program; the Court of Justice of the European Union upheld the instrument in 2015, and it has never been activated, the announcement alone having reduced the spreads it was designed to contain.[36] The Transmission Protection Instrument, approved on 21 July 2022, provides for secondary-market purchases of public sector securities of 1 through 10 years' maturity in jurisdictions whose financing conditions deteriorate in a way not warranted by their fundamentals; the Governing Council stated that purchases are not restricted ex ante, that the Eurosystem accepts the same treatment as private creditors, and that purchases would be terminated either upon a durable improvement in transmission or on an assessment that persistent tensions are due to country fundamentals. Eligibility is a cumulative list of four criteria: compliance with the European Union's fiscal framework, meaning not being subject to an excessive deficit procedure or being assessed as having failed to act on a Council recommendation; absence of severe macroeconomic imbalances; fiscal sustainability, assessed with the debt sustainability analyses of the Commission, the European Stability Mechanism, the IMF, and the ECB's own; and compliance with the commitments of the recovery and resilience plans and the Commission's fiscal recommendations.[37] The instrument has not been activated. The Federal Constitutional Court of Germany's judgment of 5 May 2020 on the earlier public sector purchase programme (PSPP), which found the Court of Justice's proportionality review wanting, is the record that the instrument's legal limit is contested within the euro area, not only between the Eurosystem and the market.[38]

The Bank of Japan's charter sets price stability as the purpose of its currency and monetary control and permits it to subscribe for or underwrite government bonds only within the limit the Diet decides under the proviso of Article 5 of the Fiscal Act, which otherwise prohibits the central bank's underwriting of government debt; secondary-market purchases are not restricted.[39] Under that charter the Bank held the 10-year government bond yield within a band around zero from September 2016 through March 2024 by fixed-rate purchase operations of unlimited amount, raised the band's ceiling in steps from 2022, and came to hold about half of the outstanding stock; the policy held the yield where the Bank set it, and the record of the 2022 episode is that a ceiling defended by unlimited purchases holds even when the market expects it to be raised.[40] The Federal Reserve's record is the peg of 1942 through 1951, under which it held the Treasury bill rate at 0.375 percent until 1947 and the Treasury bond yield at a ceiling of 2.5 percent until the Treasury–Federal Reserve Accord of March 1951 ended the obligation; the Federal Reserve Act permits open-market purchases of Treasury securities without limit but not purchases from the Treasury directly.[41]

[36] Court of Justice of the European Union, Judgment in Case C-62/14, *Gauweiler and Others v Deutscher Bundestag*, 16 June 2015. On the effect of the announcement, Arvind Krishnamurthy, Stefan Nagel, and Annette Vissing-Jorgensen, "ECB Policies Involving Government Bond Purchases: Impact and Channels," *Review of Finance* 22, no. 1 (2018): 1–44, and Carlo Altavilla, Domenico Giannone, and Michele Lenza, "The Financial and Macroeconomic Effects of the OMT Announcements," *International Journal of Central Banking* 12, no. 3 (2016): 29–57.

[37] European Central Bank, "The Transmission Protection Instrument," press release, 21 July 2022, accessed 22 August 2026.

[38] Bundesverfassungsgericht, Judgment of the Second Senate of 5 May 2020, 2 BvR 859/15; Court of Justice of the European Union, Judgment in Case C-493/17, *Weiss and Others*, 11 December 2018.

[39] Bank of Japan Act (Act No. 89 of 1997), Articles 2, 33, and 34; Fiscal Act (Act No. 34 of 1947), Article 5; English translations at the Japanese Law Translation Database, accessed 22 August 2026.

[40] Bank of Japan, *Review of Monetary Policy from a Broad Perspective* (Tokyo: Bank of Japan, December 2024), accessed 22 August 2026; Matthew Higgins and Thomas Klitgaard, "Japan's Experience with Yield Curve Control," *Liberty Street Economics*, Federal Reserve Bank of New York, 22 June 2020.

[41] Robert L. Hetzel and Ralph F. Leach, "The Treasury-Fed Accord: A New Narrative Account," *Federal Reserve Bank of Richmond Economic Quarterly* 87, no. 1 (2001): 33–55.

A central bank that already holds a large share of the stock is carried as a holder as well as a ceiling: the share h_i of equation (1) is financed at the policy rate rather than at the market yield, which is the consolidated government's cost of debt the central bank has bought, and the limit of equation (4) is evaluated at that consolidated real marginal rate at the neutral policy rate. For Japan, where the share is 43.1 percent, the largest of the eight economies, the holdings raise the corner boundary to 67 percent of GDP and the operative boundary to the 125.7 of Section 3.1, by the difference between the policy rate and the crisis yield on that share of the stock; the central calibration holds the share fixed, which is a statement about the balance sheet's size relative to the stock rather than about its transactions: a constant share of a growing nominal stock is maintained by reinvesting maturing holdings and adding to them as the stock grows, and the calibration carries that reinvestment implicitly. Section 3.8 carries the announced run-off paths as the variant in which it stops, the share then falling as the stock grows past a balance sheet that does not. Neither path is a forecast of the operations themselves. The model carries the Eurosystem's backstop as a ceiling on the sovereign spread that the central bank enforces by purchases, available in a year while two conditions held in the year before, which stand in for the eligibility criteria of the instrument and for the clause that ends its purchases: the primary balance net of the automatic stabilizers stood no more than a stated tolerance below its projected path, and the debt did not exceed the fiscal limit of that year, evaluated at the rate at which the debt was financed:

$$s_{i,t} = \min\left\{ 100\,\frac{\lambda\, p_{i,t+1}}{1-\lambda\, p_{i,t+1}},\ \bar{s}_i \right\}, \qquad \bar{s}_{\mathrm{DE,FR,IT}} = 1.5, \\ \text{while } pb_{i,t-1} - a\, y^{\mathrm{gap}}_{i,t-1} \geq pb^{\mathrm{proj}}_{i,t-1} - \bar{\delta} \ \text{ and } \ d_{i,t-1} \leq d^{*}_{i,t-1}, \tag{11}$$

and unbounded otherwise. The first condition reads what the government decides and not what the cycle does to its balance, so a recession does not by itself end the ceiling; it stands in for the instrument's criteria of compliance with the fiscal framework and with the fiscal recommendations. The second stands in for its criterion of a sustainable trajectory of the debt and for the clause under which purchases end on an assessment that tensions are due to country fundamentals: a debt above the limit at the capped rate is a debt the ceiling does not make sustainable. It adds no parameter, and it is the condition under which the hazard of the year does not exceed half of its bound, so the year in which a backstopped economy is first priced on a crisis root is the final year of its ceiling. Both conditions read the year before, an assessment being made on outturns. The second condition is the model's form of the question on which Blanchard, Martínez-Bruera, and Huertas close: whether a rise in a sovereign's rate is a move to the equilibrium at the high rate, which a central bank is charged to prevent, or a rise that the fundamentals warrant, which it is not. They conclude that assessing which of the two a given rise is, and thus whether to intervene, is likely to be difficult.[42] The model does not carry that difficulty. The central bank here reads the limit without error, so a ceiling conditioned in this way holds exactly where the debt is backed at the capped rate and ends exactly where it is not; what a central bank that reads the limit with error would do lies outside the model. The United States, the United Kingdom, Canada, and Japan carry none: for the United States, policy is the regime of Section 2.6; the United Kingdom and Canada have no standing instrument; and the Bank of Japan withdrew yield curve control in March 2024, its standing commitment since being to purchase against a rapid rise in yields rather than to defend a level, so that a ceiling for it is an assumption without an announcement; a ceiling of 1.0 percentage points on its spread, an assumption set at the figure of the withdrawn yield ceiling, is carried as a variant in Section 3.3. China's spread is administered rather than backstopped. Its holder base is state-directed banks under capital controls: foreign institutions held 3.8 trillion yuan of Chinese bonds

[42] Blanchard, Martínez-Bruera, and Huertas, "Debt Sustainability," 29.

in all, 3.7 trillion of it in the interbank market and 2.0 trillion in treasury bonds against 39.4 trillion outstanding, which leaves at most a small fraction of the 53.7 trillion yuan of local government bonds,[43] the multiplicity of Section 2.5 requires an investor who prices the hazard and can refuse to roll over, and the state directs the holders rather than purchasing subject to a conditionality. The model therefore carries a ceiling of zero on China's spread that holds without conditionality and is not a purchase program, so the no-backstop variant of Section 3.5 leaves it in place; the reading in which China is priced as a market issuer is carried in the addendum. The Eurosystem ceiling of 1.5 percentage points is an assumption, set at the level at which spreads were contained in the 2012 and 2022 episodes; the variant's Japanese ceiling is set below it because the Bank's practice was a ceiling on the level of the yield. Because the ceiling bounds the marginal financing rate, it raises the limit at which the hazard is assessed, so that a low enough ceiling removes the high root: the corner boundary of equation (8) with $\bar{s}$ in place of $s^{\max}$ is 179 percent of GDP for Italy against 82 without the ceiling, and the operative boundary 167.8 against 129.4; Italy's net debt of 129.0 lies above the corner without the ceiling, below both boundaries with it, and 0.4 percentage point of GDP below the operative boundary without it; for Japan the variant's ceiling would raise the corner boundary to 819 percent of GDP against 67 without it, 684 percentage points of GDP above its net debt. A backstop that removes the high root and whose ceiling the remaining spread does not reach is never called upon, which is the record of the 2012 announcement; a backstop whose ceiling the spread reaches buys bonds while the debt stays within the limit at the capped rate and for one year more, the second condition of equation (11) ending it the year after the debt exceeds that limit. Which of the two a given ceiling is depends on the fiscal capacity of Section 2.9, since the boundary is proportional to it.

2.9 Calibration, Estimates, and the Baseline

This subsection sets out the calibration: the initial conditions and the net-debt measure; the estimates from the macrohistory database; the response of the primary balance to debt, the composition of the debt, and the projected path of the primary balance, none of which is fitted; the interest-growth differential and the pass-through; the fiscal capacity; the inflation targets; and the baseline, set beside the published projections. Table 1 lists the initial conditions. The debt measure the model reads is net debt, general government gross debt less the government's holdings of financial assets in the form of debt instruments, because the fiscal limit of Section 2.3 compares the present value of surpluses with the obligations those surpluses must service, and assets that earn a return service part of the gross stock. The distinction is largest for Canada and Japan, at 100.4 and 70.0 percentage points of GDP against 25.2 for the next largest, the United States. For the United States the net measure is federal debt held by the public, the measure of the CBO projections, which includes the Federal Reserve's holdings and stands at 100.6 percent of GDP in 2026 against a gross general government figure of 125.8 for the same year; the Federal Reserve's 14.1 percent share of the stock is counted as held, since its remittances to the Treasury are not a contractual offset. For Japan the net measure is 134.3 percent of GDP against a gross figure of 204.4, the difference being the social security reserves and other financial assets of the general government. For Canada the net measure is 10.3 against 110.7, the Fund's net debt for Canada being its net financial liabilities, which net holdings of equity and investment fund shares as well as debt instruments, so Canada is read as a low-debt economy. Germany, France, Italy, and the United Kingdom are read on IMF net

[43] People's Bank of China, *Financial Market Report (October 2025)* (Beijing: People's Bank of China, 2025); the local-government bound follows from the report's composition of overseas holdings.

debt for 2026; China on the IMF staff's augmented general government debt for 2026, 135.3 percent of GDP, which adds the debt of local government financing vehicles and government-guided funds to the official perimeter and is the basis of the staff's own sustainability assessment, with the augmented primary deficit of 10.0 percent of GDP and the effective interest rate of 3.5 from the same source; net debt is not published for China, and the narrower World Economic Outlook (WEO) figure of 106.9 for 2026 is shown for reference.[44]

Table 1: Initial conditions of the seven G7 economies and of China, all for 2026. Net debt, gross debt, and the primary deficit are in percent of GDP; the effective interest rate, the 10-year yield, and real growth are in percent; maturity is the number of years over which the debt stock reprices. The model reads the net debt column. For the United States that is federal debt held by the public at the end of fiscal year 2026, with the primary deficit for the same year (Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036*, February 2026, baseline data files, accessed 3 October 2026), and the gross column is general government gross debt; for Germany, France, Italy, the United Kingdom, Canada, and Japan net and gross debt and the primary balance are general government values (International Monetary Fund, World Economic Outlook database, April 2026, accessed 3 October 2026), as is the U.S. gross figure; for China the model reads the IMF staff's augmented general government debt and primary deficit, which add local government financing vehicles and government-guided funds to the official perimeter (International Monetary Fund, *People's Republic of China: 2025 Article IV Consultation*, Country Report 26/44, February 2026, Table 1 and Appendix V), and the gross column is the World Economic Outlook figure on the narrower perimeter. The effective rate is interest paid in 2026 over the debt outstanding at the end of 2025 and the 10-year yield is the 2026 projection, with the sources Table A.2 lists; real growth is the first year of the trend path of Table A.4, and maturity is an assumption (Table A.3). The effective rate carries four decimals here and the text prints it at two, except China's, which is carried at one decimal in both.

Economy	Net debt	Gross debt	Primary deficit	Effective rate	10-year yield	Real growth	Maturity
United States	100.6	125.8	2.6	3.4435	4.1	2.364	6
Germany	49.4	64.6	2.8	1.9190	3.0	0.791	7
France	110.2	118.4	2.7	2.1541	3.7	0.858	8
Italy	129.0	138.4	−0.8	2.9560	3.8	0.521	7
United Kingdom	95.5	103.6	1.2	3.3936	4.5	0.797	14
Canada	10.3	110.7	2.4	3.1118	3.4	1.500	7
Japan	134.3	204.4	1.7	0.8508	2.6	0.719	9
China	135.3	106.9	10.0	3.5	1.8	4.413	7

Four quantities are estimated on the Jordà–Schularick–Taylor (JST) macrohistory database, release 6, which covers 18 economies from 1870 through 2020 and carries public debt, government revenue and expenditure, nominal GDP, and long-term interest rates.[45] The release supersedes the third, and the two are compared over the observations both cover: of 7,091 observations of the seven series the constructions read across the seven economies, 5,774 reproduce and 1,317 differ, 18.6 percent, with no observation added or dropped inside the common window. U.S. revenue and expenditure reproduce in every year, as do Canadian long rates and U.K. consumer prices, while French consumer prices differ in all but one year and French long rates in 85; the U.S. debt ratio

[44] International Monetary Fund, *People's Republic of China: 2025 Article IV Consultation*, Country Report 26/44 (Washington, DC: International Monetary Fund, February 2026), Table 1 and Appendix V, accessed 22 August 2026; International Monetary Fund, *World Economic Outlook Database*, April 2026, series GGXWDN_NGDP, GGXWDG_NGDP, and GGXONLB_NGDP, accessed 3 October 2026.

[45] Òscar Jordà, Moritz Schularick, and Alan M. Taylor, "Macrofinancial History and the New Business Cycle Facts," *NBER Macroeconomics Annual* 31 (2017): 213–263; database release 6, accessed 23 August 2026.

differs in 30 years, by at most 0.007 of a percentage point of GDP in 2015. The estimation windows below run to the end of the release, so every estimate reads the full record the database supplies; the post-1950 window ending in 2016 is one further row of Table 2, where the sample effect can be read apart from the revision effect. The database carries no interest bill, so the primary balance is constructed as the overall balance plus the prior year's long-term rate applied to the prior year's debt, a construction that overstates the bill where the debt is short and understates it where rates have fallen; the interest-growth differential is the prior year's long-term rate less nominal GDP growth.

Table 2: Response of the U.S. primary balance to lagged debt. Each row is an ordinary least squares regression of the primary balance (percent of GDP) on the debt ratio of the prior year, a cyclical control (real growth less its centered five-year mean), and, in the JST rows, a temporary-spending control (government expenditure less its centered nine-year mean, in percent of GDP), with Newey–West standard errors (four lags) in parentheses. In the JST rows, in the years where a centered mean would run past either end of the series, the cyclical control is real growth less its mean over the sample and the spending control is zero; the primary balance is the overall balance plus an interest bill proxied by the long-term rate applied to the prior year's debt; the OECD row uses the general government primary balance and net financial liabilities of the OECD Economic Outlook 119 database; the federal row uses the Office of Management and Budget federal primary balance (surplus plus interest outlays, fiscal years) with the JST debt ratio and cyclical control, on a sample whose end in 2014 is a choice of the estimation and not a limit of the series. Sources: Jordà, Schularick, and Taylor, Macrohistory Database, release 6, accessed 23 August 2026; OECD Economic Outlook 119 database and Office of Management and Budget via the Federal Reserve Economic Data service, accessed 22 August 2026; author's calculations.

Source and sample	b	(SE)	Cyclical	(SE)	Spending	(SE)	R^2	N
JST, 1871 through 2020	−0.019	(0.012)	−0.048	(0.067)	−0.916	(0.137)	0.55	150
JST, 1916 through 2020	−0.016	(0.018)	−0.084	(0.103)	−0.926	(0.133)	0.56	105
JST, 1950 through 2020	−0.049	(0.020)	0.101	(0.254)	−0.978	(0.455)	0.31	71
JST, 1950 through 2016	−0.027	(0.024)	−0.192	(0.067)	−1.107	(0.443)	0.32	67
OECD, 1963 through 2024	−0.065	(0.016)	0.376	(0.158)	—	—	0.24	62
Federal, 1950 through 2014	−0.016	(0.036)	0.021	(0.144)	—	—	0.01	65

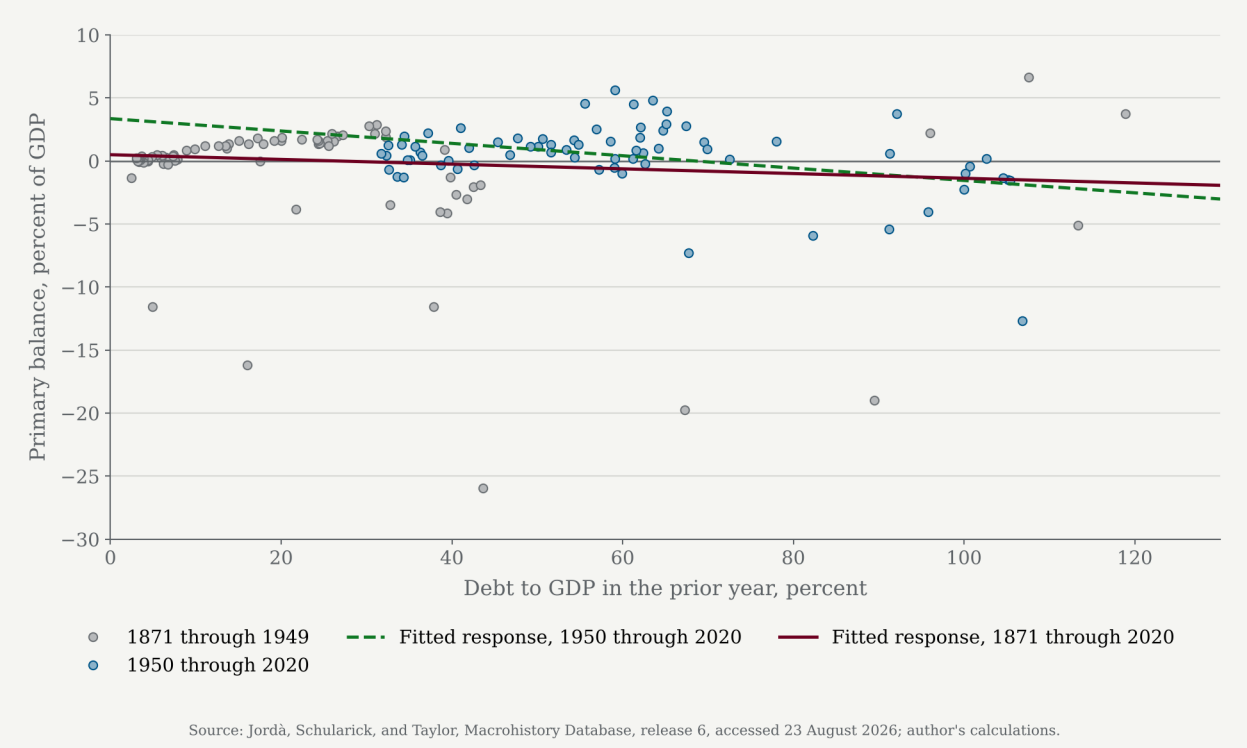


Figure 1: The U.S. primary balance against the debt ratio of the prior year, both in percent of GDP, 1871 through 2020, with observations before 1950 in gray and from 1950 in deep blue. Two fitted responses are drawn at the sample means of the controls: the first row of Table 2, 1871 through 2020, in maroon, and the third row, 1950 through 2020, in green dashed. The primary balance is the overall balance plus an interest bill proxied by the prior year's long-term rate applied to the prior year's debt. Source: Jordà, Schularick, and Taylor, Macrohistory Database, release 6, accessed 23 August 2026; author's calculations.

Table 2 and Figure 1 report the Bohn regression for the United States. Under this construction the response of the primary balance to lagged debt is −0.019 (SE 0.012) over 1871 through 2020 and −0.049 (SE 0.020) over 1950 through 2020: the data show no stabilizing response, against the positive response of about 0.03 through 0.05 that Bohn reported on his own series. Ending the post-1950 window four years earlier moves the response to −0.027 (SE 0.024) over 1950 through 2016, so the four years 2017 through 2020 are what carry the post-1950 estimate past two standard errors from zero, and they are 6 percent of the sample. Neither estimate enters the model. The two external series in the final rows of the table remove the interest proxy: on the OECD general government primary balance with the OECD's net financial liabilities, 1963 through 2024, the response is −0.065 (SE 0.016), a fall in the primary balance as debt rose, and over 1963 through 2007 it is 0.044 (SE 0.033); on the federal primary balance of the Office of Management and Budget, 1950 through 2014, it is −0.016 (SE 0.036). The JST construction itself is measured against the OECD series where the two overlap: the proxied primary balance exceeds the OECD's by 2.1 percentage points of GDP on average for the United States over 1961 through 2020, by 0.9 for Italy, and by 5.6 for the United Kingdom, whose JST fiscal series are on a narrower perimeter, and the proxied interest bill differs from the OECD's net interest by between −0.3 and 1.6 percentage points of GDP; the levels the JST construction produces are therefore not used in the model, and the estimates it yields, the absence of a response and the interest-growth moments, are reported where the external series confirm them and are parameters of nothing in the model.

The response of the primary balance to debt, b of equation (2), is set to zero in every economy, as a stated assumption, and is not drawn in the stochastic simulation. The evidence beside the assumption is a panel of the seven economies on the OECD's general government accounts (Table 3). The pooled slope of the primary balance on net financial liabilities at the end of the year before, with an intercept for each economy and a cyclical control, is -0.008 (SE 0.020, clustered by economy) over 1963 through 2022 and 0.046 (SE 0.029) over 1963 through 2007. With seven clusters an interval from a clustered standard error and a normal critical value is not to be read, so each null is tested by a wild cluster bootstrap with every weight vector enumerated, under two sets of weights. On neither sample is a response of zero or one of 0.04 rejected at the 0.05 level under either set: the record separates the response from neither value. Of the other rows of the table one rejects one null, the sample common to the seven economies through 2022, on which a response of 0.04 is rejected under the six-point weights and not under the two-point ones. The panel does not establish the response on the model's debt concept, its regressor being net financial liabilities rather than net debt and, for the United States, general government rather than federal; nor does it establish the response to debt above the hazard-free path, which is the object the rule carries. A positive response, at the estimate through 2007, is carried as a deterministic variant (Table 23).

Table 3: The response of the general government primary balance to lagged debt in the seven economies: the slope b of a pooled regression of the primary balance, in percent of GDP, on net financial liabilities at the end of the year before, with one intercept for each economy and a cyclical control (real growth less its centered five-year mean), standard errors clustered by economy in parentheses, and the number of observations. The final four columns are wild cluster bootstrap p-values of the nulls $b = 0$ and $b = 0.04$, each under Rademacher weights (R) and under Webb's six-point weights (W), every weight vector enumerated. The first two rows are the specification of record on its two samples; the others are carried beside it. The model sets the response to zero as an assumption. Sources: OECD Economic Outlook 119 database, accessed 22 August 2026; author's calculations.

				$b = 0$		$b = 0.04$	
Specification and sample	b	(SE)	N	R	W	R	W
Specification of record, 1963 through 2022	−0.008	(0.020)	333	0.688	0.690	0.141	0.116
Specification of record, 1963 through 2007	0.046	(0.029)	228	0.266	0.288	0.828	0.776
With year effects, 1963 through 2022	−0.007	(0.013)	333	0.656	0.653	0.141	0.132
With year effects, 1963 through 2007	0.011	(0.030)	228	0.750	0.728	0.359	0.388
Specification of record, 1963 through 2019	0.005	(0.025)	312	0.828	0.831	0.375	0.385
Specification of record, 2008 through 2022	0.000	(0.033)	105	1.000	0.994	0.438	0.408
Common sample, 1994 through 2022	−0.024	(0.021)	203	0.219	0.199	0.062	0.042
Common sample, 1994 through 2007	0.010	(0.019)	98	0.547	0.562	0.500	0.478

Neither share of equation (1) is fitted. The short-rate share ω_i and the central bank's share h_i are measured for each economy at 31 December 2025 (Table 4). The short-rate share is the bills and short-rate floaters over the stock the central bank does not hold, read from each debt office's record, with inflation-indexed debt in the long leg: 26.89 percent for the United States, 9.86 for Germany, 9.45 for France, 12.21 for Italy, 4.56 for the United Kingdom, 20.32 for Canada, and 7.19 for Japan. For Germany, France, and Italy the value is the upper end of a measured range: the Eurosystem's holdings under the PSPP and the pandemic emergency purchase programme (PEPP) are published by country and program and not by instrument, the value carried is the reading on which it holds no bill and no floater, and the same instruments over the whole stock, 5.24, 7.16, and 9.62 percent, are the lower reading, carried as a deterministic variant (Table 23). Japan's financing bills fund the foreign reserves, which lie outside the net-debt perimeter, and are not counted; with

them its share would be 21.23 percent. The central bank's share is its holdings over the stock, each on the object its own record carries, with no common definition imposed. The Federal Reserve's is the CBO's 14.15 percent of debt held by the public, against 13.98 percent on the record on which the short-rate share is measured. China's short-rate share, 3.47 percent, is over the stock of book-entry treasury bonds, the People's Bank of China's holdings not being available from the sources consulted, and its central-bank share is held at zero. The share matters to the limit as well as to the financing rate: the lower the short-rate share, the more of the limit's rate side is the real 10-year yield, and with it the long-rate residual of 2026, which the model moves only with the debt and the limit capitalizes. A variant that sets every economy's share to the United States' is reported with the others in Table 23.

Table 4: The measured composition of government debt at 31 December 2025, by economy, in percent. The short-rate share is bills and short-rate floaters over the stock the central bank does not hold, the share the model carries; the third column is the same instruments over the whole stock, which for Germany, France, and Italy is the lower reading, the Eurosystem's holdings being published by country and program and not by instrument, so that the share the model carries for the three is the reading on which the Eurosystem holds no bill and no floater. Inflation-indexed debt is in the long leg, and Japan's financing bills, which fund the foreign reserves, are in neither term (with them its share would be 21.23 percent). The fourth column is the central bank's holdings over the stock, each on its own object, with no common definition imposed. [a] The Federal Reserve's share is the Congressional Budget Office's, holdings over debt held by the public at the end of fiscal year 2026; measured on the record of the third column's stock it is 13.98 percent. [b] China's short-rate share is over the stock of book-entry treasury bonds, the People's Bank of China's holdings not being available from the sources consulted, and its central-bank share is held at zero. Author's calculations from the sources of the final column.

Economy	Short-rate share	Over the whole stock	Central bank's share	Central bank	Source
United States	26.89	23.96	14.1[a]	Federal Reserve	U.S. Treasury, Monthly Statement of the Public Debt, Table 1, 31 December 2025; Federal Reserve Bank of New York, System Open Market Account holdings, 31 December 2025
Germany	9.86	5.24	28.6	Eurosystem	Bundesministerium der Finanzen, Monatsbericht Februar 2026, Kreditaufnahme des Bundes und seiner Sondervermoegen, stocks at 31 December 2025; ECB, PSPP and PEPP net purchases by country; Eurostat, gov_10dd_edpt1
France	9.45	7.16	19.2	Eurosystem	Institut national de la statistique et des études économiques (INSEE), Banque de donnees macro-economiques, negotiable debt of the State (the series the Agence France Tresor's monthly bulletin prints in billions), December 2025; ECB, PSPP and PEPP net purchases by country; Eurostat, gov_10dd_edpt1
Italy	12.21	9.62	18.1	Eurosystem	Ministero dell'Economia e delle Finanze, Dipartimento del Tesoro, Composizione dei titoli di Stato in circolazione al 31 dicembre 2025; ECB, PSPP and PEPP net purchases by country; Eurostat, gov_10dd_edpt1
United Kingdom	4.56	3.75	17.6	Bank of England	Office for National Statistics, Public Sector Finances, August 2026, Appendix A, tables PSA8A_1 and PSA9A, December 2025
Canada	20.32	18.00	11.9	Bank of Canada	Bank of Canada, Government of Canada direct securities and loans, tables G4 (distribution of holdings) and G6 (by remaining term and type), month-end December 2025
Japan	7.19	3.41	43.1	Bank of Japan	Ministry of Finance, Central Government Debt as of 31 December 2025, and Debt Management Report 2026 (the Bank of Japan's Flow of Funds Accounts at December 2025); Bank of Japan Accounts, 31 December 2025
China	3.47[b]	3.47	0.0[b]	People's Bank of China	China Foreign Exchange Trade System (ChinaMoney), records of the Treasury bonds issued in 2025; China Central Depository and Clearing, monthly statistics, December 2025, table 4; People's Bank of China, Balance Sheet of Monetary Authority (November 2025)

The projected path of equation (2) is the CBO's projected primary balance by fiscal year for the United States and, for each of the other seven economies, its 2026 balance held in every year of the horizon. The IMF publishes a projected path for the six, and the baseline does not carry it, on the record of such projections (Table 5). Across the 11 autumn editions of the WEO of 2010 through 2020, the primary balance of the six five years ahead came in below the projection in 45 of 66 cases, by −2.40 percentage points of GDP on average, and by −1.40 without the target years 2020 and 2021; the projections had the balance rising by 3.26 percentage points of GDP over the five years on average, against a realized change of −0.11. The mean error is negative for Germany, France, Italy, the United Kingdom, and Canada and not for Japan, and it is largest in magnitude for Italy, the United Kingdom, and France, at −4.25, −3.95, and −3.44 percentage points of GDP. The record does not establish why a projection was missed, whether through a policy not delivered, growth below its projection, or a revision of the accounts between the edition and the database of April 2026, on whose definitions the outturns are read; and its windows overlap, so the 11 editions are not as many independent observations. The IMF's projected path, held after its final projected year, is carried as a deterministic variant (Table 23). The U.S. path is the CBO's projection under current law, which has a record of errors of its own; the CBO's five-year-ahead errors of the primary deficit are not available from the sources consulted.

Table 5: The World Economic Outlook's projections of the general government primary balance five years ahead against the outturns, in percent of GDP, autumn editions of 2010 through 2020. For each economy: the number of editions; the number in which the balance of the fifth year came in below the projection; the mean error, realized less projected; and the mean projected and the mean realized change of the balance over the five years. The final three columns repeat the count, the number below, and the mean error without the target years 2020 and 2021. The realized values are those of the database of April 2026, on its own definitions; the windows overlap, so the editions are not independent observations. The Congressional Budget Office's own record of five-year-ahead errors of the primary deficit is not available from the sources consulted. Sources: International Monetary Fund, World Economic Outlook databases, October 2010 through October 2020 and April 2026; author's calculations.

	All target years					Without 2020 and 2021		
Economy	Editions	Below	Mean error	Projected change	Realized change	Editions	Below	Mean error
Germany	11	7	−1.65	1.06	−1.25	9	5	−0.98
France	11	10	−3.44	3.33	−0.30	9	8	−2.60
Italy	11	9	−4.25	2.80	−1.71	9	7	−3.15
United Kingdom	11	10	−3.95	5.07	0.69	9	8	−2.60
Canada	11	5	−1.24	3.55	0.11	9	3	−0.06
Japan	11	4	0.10	3.71	1.79	9	2	0.97
The six pooled	66	45	−2.40	3.26	−0.11	54	33	−1.40

Table 6 reports the interest-growth differential by economy and the pass-through of U.S. long rates. The U.S. differential since 1950 averages −0.8 percentage points with a standard deviation of 3.5 and an autocorrelation of 0.48, and it was negative in 62 percent of years; the other six economies show the same sign and comparable persistence. Japan's interest-growth differential since 1950 averages −2.4 percentage points, the most negative of the seven. The 1950 through 2020 sample, however, spans the adoption of inflation targeting, and the moments of a nominal differential computed across the years before and after it are not the moments of either. The lower block of Table 6 therefore recomputes the moments and the pass-through on the OECD series over 1996 through 2024, a sample common to the seven that opens after the numerical targets of

Canada (1991) and the United Kingdom (1992) and before those of the euro area (1999), the Federal Reserve (2012), and the Bank of Japan (2013). Under the targeting regime the U.S. autocorrelation of the differential is 0.40, against 0.52 over 1962 through 2024 and 0.48 on the JST sample, and its mean for the United States is −1.0 percentage points, negative in 69 percent of years; for Italy the mean turns positive, at 1.5. On the formal adoption dates alone the samples are too short to use, 12 years for Japan and 13 for the United States, and the regime sample starts in 1996 for every economy instead. The model adopts the regime estimates of the pass-through: the coefficients under targeting, 0.72 for Germany, 0.67 for France, 0.71 for Italy, 0.85 for the United Kingdom, 0.76 for Canada, and 0.26 for Japan, are the model's β_i, drawn in the stochastic simulation from the estimates and their standard errors with a common factor; the moments of the differential are the record against which the paths of Section 3.4 are read and are parameters of nothing in the model; China is in neither database, and its pass-through of 0.2 is an assumption that reflects capital controls and a domestic investor base. The same applies to the capacity windows below: five of the seven, those of the United States, Germany, France, the United Kingdom, and Japan, close before the economy's numerical target, and Italy's spans the start of its own, so the nominal growth that accompanied those surpluses did not occur under a numerical target of 2 percent; Canada's alone lies under its target throughout.

Table 6: The interest-growth differential and the pass-through of U.S. long rates. The upper block is the JST macrohistory database, 1950 through 2020; the lower block is the OECD Economic Outlook 119 database over the inflation-targeting period, 1996 through 2024, the sample common to the seven once every central bank but the Federal Reserve and the Bank of Japan had a numerical target (the Federal Reserve adopted one in 2012 and the Bank of Japan in 2013). The differential is the prior year's long-term rate less nominal GDP growth, in percentage points; the columns give its mean, standard deviation, first-order autocorrelation, and the share of years in which it was negative. The pass-through is the coefficient of an ordinary least squares regression of the annual change in the economy's long-term rate on the annual change in the U.S. long-term rate, with Newey–West standard errors (two lags) in parentheses. China is in neither database and its pass-through is the assumption of Table A.10. Sources: Jordà, Schularick, and Taylor, Macrohistory Database, release 6, accessed 23 August 2026; OECD Economic Outlook 119 database, accessed 22 August 2026; author's calculations.

Economy	Mean	Std. dev.	Autocorr.	Negative, %	Pass-through	(SE)
JST macrohistory database, 1950 through 2020						
United States	−0.8	3.5	0.48	62	—	—
Germany	−0.5	4.4	0.53	52	0.53	(0.07)
France	−0.9	4.5	0.71	55	0.74	(0.12)
Italy	−0.9	5.7	0.71	52	0.57	(0.17)
United Kingdom	−0.8	3.2	0.62	61	0.46	(0.12)
Canada	−0.8	4.8	0.60	61	0.83	(0.09)
Japan	−2.4	6.1	0.56	62	0.40	(0.12)
OECD series, inflation-targeting period, 1996 through 2024						
United States	−1.0	3.1	0.40	69	—	—
Germany	−0.1	3.8	0.55	52	0.72	(0.13)
France	0.1	3.1	0.28	48	0.67	(0.16)
Italy	1.5	4.1	0.31	24	0.71	(0.30)
United Kingdom	−0.6	3.6	0.31	59	0.85	(0.15)
Canada	−1.0	4.3	0.11	69	0.76	(0.07)
Japan	0.5	2.7	0.42	41	0.26	(0.08)

The fiscal capacity is measured from the record rather than assumed, and what the record supplies is the largest surplus each government has run rather than the largest it could run, as Section 2.3 sets out. For each of the seven economies it is the largest average of 10 consecutive years, the Eichengreen and Panizza horizon, of the balance before net interest on the economy's long official record: general government by calendar year for the six, and for the United States the federal government by fiscal year, the basis that matches debt held by the public, constructed from the Office of Management and Budget's surplus and net interest series, which joins the CBO projection without a break (a primary deficit of 2.7 percent of GDP in fiscal 2025 against the CBO's 2.6 percent for 2026). Each record is read from 1950, or from its own first year where that is later, 1951 for Italy and 1955 for Japan; no window runs across a join of two sources; and every receipt from abroad that a source of the record identifies is excluded from the balance. For France, Italy, the United Kingdom, and Canada the long record is read on the definition under which it reproduces, over the years both cover, the IMF's or the OECD's series of the primary balance, to a mean or a largest difference of at most 0.002 percentage point of GDP.[46] Table 7 reports the result: 1.91 percent of GDP for the United States (1993 through 2002, when the federal primary balance reached 4.5 percent in fiscal 2000), 2.18 for Germany (1952 through 1961), 1.06 for France (1958 through 1967), 3.27 for Italy (1993 through 2002), 1.43 for the United Kingdom (1950 through 1959), 3.52 for Canada (1997 through 2006), and 1.31 for Japan (1984 through 1993). The readings of Germany and the United Kingdom are lower bounds on the balance before net interest in the years of their windows and are named so: Germany's record for the former federal territory does not separate interest received from other property income, so its reading nets all property income received, and the United Kingdom's early record nets the local authorities' imputed rental income with interest. Japan's record from 1955 through 1979 is read on another vintage, the account of the 1968 System of National Accounts, which carries no separate interest received: the balance read there nets all property income received and is a lower reading of the balance before net interest, and the balance before interest paid, which nets none, is an upper one. On the lower reading no 10-year window of those years reaches Japan's capacity of 1.31 percent of GDP; on the upper, the windows that begin in 1955 through 1962 exceed it, and over 1980 through 1993, where the two vintages overlap, the 1968 account lies above the series of record. That Japan's early windows stay below 1.31 on the reading of record is therefore not established.

[46] Statistisches Bundesamt, *Der Staat in den Volkswirtschaftlichen Gesamtrechnungen 1950 bis 1997*, Arbeitsunterlage (March 1998), and the issue for 1950 bis 1998 (March 1999), tables 1.1, 7.1, 8.1, and 11.1; INSEE, comptes nationaux annuels, base 2020, tables 1.101, 7.301, and 7.601; Istituto Nazionale di Statistica (ISTAT), "I conti economici nazionali dell'Italia, nuova serie, anni 1951–1968," *Supplemento straordinario al Bollettino mensile di statistica*, no. 1 (January 1970), Tav. 6 and 35; Office for National Statistics, public sector finances time series (release of 22 September 2026) and gross domestic product at market prices, current prices (release of 13 August 2026); Central Statistical Office, *Annual Abstract of Statistics*, nos. 93 and 98 through 101 (London: Her Majesty's Stationery Office, 1956 and 1961 through 1964); Statistics Canada, tables 36-10-0104-01, 36-10-0177-01, 36-10-0182-01, 36-10-0201-01, and 36-10-0477-01; Cabinet Office, Economic and Social Research Institute, *National Accounts for 1998* (68SNA) and *National Accounts for 2009*; Eurostat, government revenue, expenditure and main aggregates (gov_10a_main), series D74REC; OECD, archived national accounts, table 14A on the 1993 System of National Accounts (SNA); each accessed 5 October 2026. Office of Management and Budget, federal surplus or deficit and interest outlays as percent of GDP, fiscal years, Federal Reserve Economic Data service, Federal Reserve Bank of St. Louis (series FYFSDFYGDP and FYOIGDA188S), accessed 22 August 2026; OECD, *Economic Outlook No. 119* database (OECD.ECO.MAD, DSD_EO, edition 2026/1), series NLGXQ, accessed 22 August 2026; International Monetary Fund, *World Economic Outlook Database*, April 2026, series GGXONLB_NGDP and GGR_NGDP, accessed 3 October 2026; National Bureau of Statistics of China, *China Statistical Yearbook 2024* (Beijing: China Statistics Press, 2024), Tables 3-1 and 7-1, accessed 22 August 2026.

Table 7: Fiscal capacity by economy, in percent of GDP. The capacity is the largest average of 10 consecutive years of the general government balance before net interest (the federal balance for the United States) on the economy's long record, read from 1950 or the record's first year where it starts later, no window running across a join of two sources, with every receipt from abroad that a source of the record identifies excluded (Table 8); the second column is the first year read and the third the window of the maximum. The fifth column is the same statistic with nothing excluded. The readings of Germany and the United Kingdom are lower bounds on the balance before net interest in the years of their windows. The final three columns give, for the baseline and for each regime, the largest capacity at which the economy carries a year on the crisis equilibrium when its capacity alone is set to that value from 2027 and every other parameter is as in the central calibration: read on a grid in steps of 0.25 percentage point of GDP up to 12 percent of GDP and located within 0.001 percentage point of GDP by bisection, each trial a full model run; *none*: no such year at any capacity of the grid. China has no long record and its capacity is scaled from revenue (Section 2.9). The capacity column carries four decimals; the text prints the capacity at two. Sources: Office of Management and Budget via the Federal Reserve Economic Data service; Statistisches Bundesamt; INSEE; ISTAT; Office for National Statistics; Statistics Canada; Cabinet Office of Japan; OECD Economic Outlook 119 database; IMF World Economic Outlook database, April 2026; author's calculations.

Economy	Read from	Window	Capacity	Nothing excluded	Crisis year at or below		
					Baseline	Regime M	Regime F
United States	1950	1993–2002	1.9107	1.91	0.81	2.74	2.66
Germany	1950	1952–1961	2.1809	3.40	1.05	2.63	1.62
France	1950	1958–1967	1.0612	1.13	1.72	4.91	3.16
Italy	1951	1993–2002	3.2664	3.31	1.64	4.69	2.98
United Kingdom	1950	1950–1959	1.4259	1.96	2.49	6.62	4.27
Canada	1950	1997–2006	3.5186	3.54	0.37	2.36	1.43
Japan	1955	1984–1993	1.3089	1.31	none	2.30	1.86

A transfer a government receives from abroad is not a surplus it raised, and the balance the capacity is read on leaves such receipts out. Table 8 lists every item excluded, capital or current, with the years over which the source gives it and its size. The exclusions move two capacities by more than a tenth of a percentage point of GDP, those of Germany and the United Kingdom. For the United Kingdom the items are the capital transfers from abroad of 1948 through 1955, which are grants under the European Recovery Programme, the gifts of the Australian and New Zealand governments, and other receipts of the central government, and Defence Aid, a current grant, of 1951 through 1958: 0.315 and 0.219 percent of GDP a year over the window; with them left in, the reading would be 1.96 in place of 1.43. For Germany they are the capital transfers received from the rest of the world, 0.668 percent of GDP a year over 1950 through 1961, of which 6.39 percent in 1953 and no more than 0.54 in any other year, and the current receipts from the rest of the world, 0.447 percent of GDP a year over the window. With nothing excluded Germany's reading is 3.40, on the window 1951 through 1960; with the capital transfers excluded and the current receipts left in it is 2.63; with both excluded it is the 2.18 the model carries. The German items are derived and not printed: the source gives one column of receipts from the rest of the world, of every kind, and the amounts excluded are its transfers received less those it shows as received from enterprises and from households. The source does not say what the current receipts consist of. Its rows through 1959 and its first row for 1960 are without the Saarland and Berlin (West), and between its two rows for 1960 the column falls; whether the receipts are flows from those territories is not established, no statement of the Statistisches Bundesamt on the composition of the column being available from the sources consulted. The receipts are excluded in every year the tables give them, and the payments to the rest of the world stay in the balance. For France, Italy, Canada, and

Japan the receipts that fall inside the window are current and average less than a tenth of a percent of GDP a year, and the exclusion lowers the reading by 0.07, 0.05, and 0.02 percentage point of GDP for the first three and by less than a hundredth for Japan; Italy's receipts of the first two years of its window are read on an earlier vintage of its accounts, and with those years as recorded its reading would be the same to the second decimal. The federal record of the United States does not separate receipts from abroad, and nothing is excluded from it. For the other six economies no year of a window lies among the years in which no source consulted identifies current receipts from abroad; for Germany, Italy, the United Kingdom, and Japan there are such years outside the windows, and that such a year carries no receipt is not established.

The first year of the reading is a convention, and Table 9 gives each capacity under every first year of a grid. The capacities of the United States, Italy, Canada, and Japan are the same read from 1980, their windows opening in that year or later; those of Germany, France, and the United Kingdom are lower. Germany's window opens in 1952, and read from 1955 its capacity is 1.44; the United Kingdom's window opens with the reading, so that its capacity is 1.12 read from 1955 and 1.94 read from 1948, the first year of its record; and France's is 0.60 read from 1960. The table does not establish which first year is the right one; it shows how much of three capacities rests on the years before 1960.

Table 8: The receipts from abroad excluded from the balance the capacity is read on, by economy: each item as the long record identifies it, capital or current, the years over which the source gives it, its mean over those years, and its mean over the 10 years of the capacity's window, both in percent of GDP; a dash in the final column marks an item none of whose years lies in the window. For each economy but Germany the window means sum to the difference between the two readings of Table 7; Germany's reading with nothing excluded falls on another window, 1951 through 1960. Sources: Office for National Statistics, public sector finances, and the Annual Abstract of Statistics; INSEE, national accounts; Statistisches Bundesamt, working paper on general government in the national accounts; Eurostat, government finance statistics; ISTAT, national accounts of 1970; OECD, archived national accounts; Statistics Canada; Cabinet Office of Japan, national accounts; author's calculations.

Economy	Receipt excluded	Kind	Years	Mean	Window mean
United States	none: the federal record identifies no receipt from abroad	—	—	—	—
Germany	capital transfers received from the rest of the world	capital	1950–1961	0.668	0.720
	current receipts from the rest of the world: other current transfers received, not from enterprises or households	current	1951–1964	0.345	0.447
	current international cooperation receivable, from 1995	current	1995–2025	0.063	—
France	current international cooperation received	current	1949–2025	0.220	0.071
Italy	capital transfers from the rest of the world	capital	1951–1958	0.476	—
	current transfers from the rest of the world	current	1951–1960	0.141	—
	current transfers from the rest of the world, 1961 through 1968	current	1961–1968	0.061	—
	current international cooperation received, 1990 through 1994 (European System of Accounts [ESA] 95 vintage)	current	1990–1994	0.034	0.008
	current international cooperation receivable, from 1995	current	1995–2025	0.084	0.039
United Kingdom	capital transfers from abroad	capital	1948–1955	0.976	0.315
	Defence Aid	current	1951–1958	0.273	0.219
	current transfers received from abroad (D74)	current	1997–2025	0.008	—
Canada	other current transfers from non-residents (2008 SNA)	current	1961–2024	0.025	0.023
Japan	current transfers not elsewhere classified from the rest of the world (1968 SNA), 1955 through 1979	current	1955–1979	0.010	—
	current international cooperation receivable (1993 SNA), 1980 through 2009	current	1980–2009	0.005	0.004

Table 9: Fiscal capacity by the first year the record is read from, in percent of GDP: the largest average of 10 consecutive years of the series of Table 7 over the windows whose first year is not before the year shown. The second column is the first year of the record, and the third the reading from that year where it lies before 1950, the first year of the rule, which is a convention; the column for 1950 is the capacity the model carries, except for Italy and Japan, whose records start later and whose capacities are read from their first years. A dash marks a first year before the record's own, or a record that starts no earlier than the rule. Author's calculations on the records of Table 7.

Economy	Record starts	From its start	1950	1955	1960	1970	1980	1990	2000
United States	1940	1.91	1.91	1.91	1.91	1.91	1.91	1.91	−0.69
Germany	1950	—	2.18	1.44	1.44	1.44	1.44	1.44	1.44
France	1949	1.06	1.06	1.06	0.60	−0.18	−0.18	−0.18	−0.94
Italy	1951	—	—	3.27	3.27	3.27	3.27	3.27	1.54
United Kingdom	1948	1.94	1.43	1.12	0.70	0.24	0.24	0.24	−1.48
Canada	1926	3.52	3.52	3.52	3.52	3.52	3.52	3.52	2.00
Japan	1955	—	—	1.31	1.31	1.31	1.31	−1.94	−3.30

China has no record of this kind. On the IMF's series the largest 10-year average of its general government primary balance is −0.19 percent of GDP (2005 through 2014), and on the general public budget of the National Bureau of Statistics, an overall balance and not a balance before interest, it is −0.50: that budget has been in deficit in every year since 1978 but four, the largest surpluses being 0.8 percent of GDP in 1981 and 0.6 in 2007; its balances were −6.2 in 2020 and −4.6 in 2023. A capacity that has never been exercised is unobserved rather than zero, and the model scales China's from revenue: the median across the six economies with a general government record of capacity relative to revenue, 4.2 percent, applied to China's revenue of 25.8 percent of GDP in 2024, gives 1.09. The United States is left out of the median because its record is federal, so that its capacity and its revenue would stand on two perimeters.

The final three columns of Table 7 state the distance of each reading from the capacity at which the economy's result would change: the largest capacity at which the economy carries at least one year on the crisis equilibrium, in the baseline and under each regime, when its capacity alone is set to that value and every other parameter is as in the central calibration. For the United States the thresholds are 2.74 percent of GDP under regime M and 2.66 under regime F, above its capacity of 1.91 by 0.83 and 0.75 percentage point of GDP, and 0.81 in the baseline, below it by 1.10. The narrowest margin of the table is Italy's under regime F: a capacity of 3.27 against a threshold of 2.98, so that Italy's carrying no crisis year under that regime rests on 0.28 percentage point of GDP of capacity. A threshold moves one economy's capacity with the others as of record, from the first year of the horizon, and is not an announced capacity; Section 4 solves for those.

A 10-year maximum is an extreme statistic and overstates a repeatable capacity; the stochastic simulation draws each capacity uniformly within 1.0 percentage point of GDP of its reading, for every economy and with no floor. The width is a convenience and is not read from a record, and for six of the seven economies the draw's dispersion is smaller than that of the statistic on the economy's own record: simulated under a first-order autoregression fitted to that record, with innovations resampled from its residuals, the largest 10-year average has a standard deviation of 0.54 percentage points of GDP for France through 1.34 for Italy, against 0.58 for the uniform draw. The lowest support is France's, which starts at 0.06 percent of GDP, so no support reaches zero.

Eichengreen and Panizza, enumerating large and persistent primary surplus episodes across 54 advanced and emerging-market economies between 1974 and 2013, find that an average primary

surplus of at least 5 percent of GDP is reached in 12 of 235 non-overlapping five-year periods, and that over 10 years three episodes reach it.[47] Against an average a government can repeat, a capacity estimated as a 10-year maximum on an economy's own record is an upper reading, not a level it can be assumed to reach on demand; against the largest surplus the government could run, it is the lower bound of Section 2.3.

The remaining structural parameters are listed in Tables A.1 through A.13 of Appendix A; the model carries 30 of them outside the initial conditions, and the stochastic simulation varies 12 quantities and the regime, the 13 that Section 3.6 ranks. The inflation target is 2 percent for every economy, on each central bank's own statement: the Federal Reserve's 2 percent on the personal consumption expenditures index, the ECB's symmetric 2 percent on the harmonized index under its 2021 strategy, the Bank of England's 2 percent remit, the Bank of Canada's 2 percent midpoint of its 1 through 3 percent control range, and the Bank of Japan's 2 percent of January 2013; for China the figure is the consumer price increase of around 2 percent that the Government Work Report of 5 March 2026 sets as an annual objective, lowered from around 3 percent in 2024, which is a government target rather than a central-bank mandate and which the IMF's projection has the deflator approaching only in 2029, at 1.9 percent, and reaching in 2030.[48] The bound on the default hazard of 10 percent, the loss given default of 40 percent, and the dispersion of the fiscal limit of 30 percentage points of GDP are assumptions. The loss given default has a record beside it, though not a record of an economy of this kind. Cruces and Trebesch measure the loss of investors, in present value, in 180 restructurings of sovereign debt with foreign banks and bondholders in 68 countries from 1970 through 2010: the mean loss is 37 percent, and one half of the losses lie below 23 percent or above 53.[49] The central value lies near that mean, and the range the simulation draws, 0.25 through 0.55, near the middle half of that distribution. Blanchard, Martínez-Bruera, and Huertas report a median haircut of 6 percent and a mean of 10 over credit events in 110 countries from 1948 through 2023, and take 10 percent in their illustration.[50] Neither sample holds a default of a G7 sovereign, so the value remains an assumption, and the results are conditional on it: Section 3.6 reports the deterministic scenarios at a loss given default of 10 and of 6 percent and the stochastic simulation at 10. In 2026, the year of initial conditions, inflation stands at its target, the output gap and the sovereign spread at zero, and the corporate spread at cs_0; the years solved are 2027 through 2036. The baseline holds every economy on its low root where one exists. For the United Kingdom it exists in no year: at a capacity of 1.43 percent of GDP, a corner boundary of 34 percent, and an operative boundary of 52.8 against net debt of 95.5, the real financing rate at a neutral policy rate exceeds the real trend, the limit falls from 38 percent of GDP in 2027 to 25 in 2036, and in all 10 years the crisis root is the only root, so the U.K. baseline carries a spread that rises from 3.7 to 4.1 percentage points and, read against its hazard-free path, an output gap of -8.7 percent by 2036; its crisis scenarios are read against the same hazard-free path, so a U.K. scenario

[47] Eichengreen and Panizza, "A Surplus of Ambition," NBER Working Paper 20316, Tables 3 and 5.

[48] The Bank of Canada's agreement runs through 31 December 2026 and is under renewal for a further five years; the Bank has stated that the renewed agreement will be published before the end of 2026 and the Governor that the 2 percent target is not part of the review, so the target the model carries for Canada is the one in force and the one the Bank has said it will keep. The renewed agreement had not been published at the access date; a renewal that moved the target would move Canadian nominal growth and with it the interest-growth differential of equation (3), which is the channel the target reaches. Bank of Canada, "Inflation-control target" and "Renewing Canada's Monetary Policy Framework," accessed 23 August 2026; on the target itself, Tiff Macklem, remarks at the Bank of Mexico, 26 August 2025. State Council of the People's Republic of China, "China sets 2026 economic growth target at 4.5–5 pct," 5 March 2026, accessed 22 August 2026.

[49] Juan J. Cruces and Christoph Trebesch, "Sovereign Defaults: The Price of Haircuts," CESifo Working Paper 3604 (Munich: CESifo, 2011).

[50] Blanchard, Martínez-Bruera, and Huertas, "Debt Sustainability," 5.

result is a difference between two paths on the crisis equilibrium. France's baseline carries the benign root beside the crisis root in 2027 through 2031 and stays on it, at a spread of no more than 0.02 percentage point; from 2032 the crisis root is the only root. The Eurosystem's ceiling holds the spread at 1.5 percentage points in 2032 and is withdrawn from 2033, the debt of 2032 standing above the limit at the capped rate (equation (11)); the spread rises in every year after, to 4.1 percentage points in 2036, and the output gap is −6.4 percent by then. The other five baselines carry no year on the crisis equilibrium: where a crisis root exists beside the benign one, as it does in every year for the United States and Japan, the baseline, on which the market does not coordinate, stays on the benign one, and none carries a spread above 0.0001 percentage point.

The baseline is set beside the published projections, and it is fitted to none of them. For the United States, Table 10 gives it against the CBO's: debt in 2030 of 108.3 percent of GDP against 107.7, in 2036 120.1 against 120.2, and net interest of 4.4 against 4.6, the model's net interest being the year's effective rate on the debt entering the year, over the same year's GDP; the primary deficit of 2.1 is the CBO's, since the rule's projected path is the CBO's and the baseline's output gap is nil. Year by year over 2027 through 2036 the root-mean-square difference is 0.41 percentage point of GDP for debt and 0.18 for net interest, and the largest difference 0.63 and 0.24 (Table 11). On that path the limit is unbounded through 2028 and finite from 2029, at 683 percent of GDP in 2036 and at least 5.7 times the year's debt in every year in which it is finite; the debt stays below it throughout, and the convenience yield declines from 0.25 to 0.23 percentage points as debt rises along the demand curve.

For the other six economies, Table 12 sets the baseline's debt in 2031, the final year the IMF projects, against the net debt the IMF projects for that year, and splits the gap into terms that sum to it. The model's debt is the higher for each of the six, by 0.6 percentage point of GDP for Italy through 28.5 for the United Kingdom. For Germany, France, Italy, and the United Kingdom the largest term is the primary balance, the model's balance, held at its 2026 value, lying below the one the IMF projects; for Canada and Japan it is the projection's own residual between its flows and the change in its stock, which the model, carrying the debt identity alone, does not have. The comparison does not establish that either path is right, and another order of substitution would give other terms with the same sum.

Table 10: The model's baseline against the Congressional Budget Office projection. Debt, the primary deficit, and net interest are in percent of GDP; the yield is in percent. The model's net interest is the consolidated government's, the year's effective rate applied to the debt entering the year, over the same year's GDP, the Federal Reserve's 14.1 percent share of the stock costing the policy rate, whereas the CBO's net interest counts the coupons paid to the Federal Reserve in outlays and its remittances in receipts, which accounts for part of the difference in that row. Model values are author's calculations on the low equilibrium under the initial conditions of Table 1; CBO values are from the baseline data files of *The Budget and Economic Outlook: 2026 to 2036* (February 2026), accessed 3 October 2026.

Quantity	Model baseline	CBO
Debt held by the public, 2030	108.3	107.7
Debt held by the public, 2036	120.1	120.2
Primary deficit, 2036	2.1	2.1
Net interest, 2036	4.4	4.6
10-year Treasury yield, 2027	4.1	4.3

Table 11: The model's baseline for the United States against the Congressional Budget Office projection, by year: debt held by the public and net interest, in percent of GDP, and the model's value less the CBO's. The model's net interest is the year's effective rate on the debt entering the year over the same year's GDP. The model's ratios are over calendar-year GDP at its own nominal growth and the CBO's over fiscal-year GDP. Nothing in the model is fitted to the projection, and its primary balance is the CBO's path. Sources: Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036* (February 2026), baseline data files, accessed 3 October 2026; author's calculations.

	Debt held by the public			Net interest		
Year	Model	CBO	Difference	Model	CBO	Difference
2027	102.5	102.1	0.5	3.38	3.33	0.05
2028	104.7	104.1	0.6	3.49	3.51	−0.03
2029	106.4	105.8	0.6	3.61	3.68	−0.07
2030	108.3	107.7	0.6	3.71	3.83	−0.12
2031	110.0	109.6	0.5	3.82	3.99	−0.17
2032	111.8	111.5	0.3	3.92	4.15	−0.23
2033	114.2	114.0	0.2	4.03	4.27	−0.24
2034	116.2	116.2	0.0	4.15	4.39	−0.24
2035	117.9	118.0	0.0	4.27	4.49	−0.21
2036	120.1	120.2	−0.1	4.38	4.59	−0.21
Root mean square			0.41			0.18

Table 12: The model's baseline debt against the published projection at the projection's final year, and the gap split into terms that sum to it before rounding, in percentage points of GDP: the United States against the Congressional Budget Office's debt held by the public, the six against the general government net debt the IMF's World Economic Outlook database of April 2026 projects. Interest is the model's effective rate against the published net interest; growth is the model's nominal growth against the published one (for the United States, 0.41 against the CBO's calendar-year growth and 0.23 for the CBO's calendar-year against its fiscal-year GDP); the primary balance is the model's balance against the published one, positive where the model's is the lower; the final column is what the published path's own residual between its flows and the change in its stock, which the model does not carry, contributes to the gap. Each year's terms are carried to the final year at the model's growth-adjusted rate. Author's calculations.

Economy	Year	Model	Published	Gap	Interest	Growth	Primary balance	Published residual
United States	2036	120.1	120.2	−0.1	−1.6	0.6	0.0	0.8
Germany	2031	61.7	60.7	1.0	−0.8	0.7	1.1	0.0
France	2031	120.6	112.6	8.0	−0.6	−1.3	8.7	1.1
Italy	2031	127.3	126.7	0.6	−1.2	0.6	3.9	−2.6
United Kingdom	2031	123.1	94.5	28.5	5.0	12.2	15.4	−4.0
Canada	2031	22.2	10.4	11.8	−1.6	0.1	5.4	7.8
Japan	2031	133.9	122.8	11.2	1.5	1.6	−1.5	9.6

3 Results

This section reports the fixed point and the crisis zone, with the counterfactual in which the fiscal limit is formed without the spread; the central scenarios, for the United States and for the other six economies; the interest-growth differential along the paths; the stochastic simulation; the sensitivity of its outcomes to the drawn parameters and to an AI-adoption productivity path; and a variant

of the calibration in which the central banks' holdings follow their announced run-off paths, carried both in the central scenario and across the stochastic paths. China, whose spread is administered, stands outside the G7, the set of economies the paper studies, and is reported in the addendum.

3.1 The Fixed Point and the Crisis Zone

This subsection places each economy relative to its crisis zone and reads what the second solution of the pricing equation rests on. Figure 2 shows the map the solver iterates, the spread residual of the U.S. pricing equation in 2027 against the candidate spread, at three initial debt ratios, each of them the $d_{i,0}$ at which the long-rate residual and the convenience yield of equation (7) are evaluated, so the benign root of each curve lies at a spread of zero and at the observed initial yield to within a hundredth of a percentage point, and the corner boundary of equation (8) as a function of the fiscal capacity. With the historical capacity of 1.91 percent of GDP the map has one solution at 85 percent of GDP, the benign root, and three at 101 and at 120, two of them stable, the benign root and the high root, with an unstable one between them; the high root lies at a yield of 7.5 percent at the first of the two and 8.1 at the second: the crisis equilibrium comes into existence between the first and the second of the three debt ratios, and the second is the U.S. debt of 2026 to the nearest percentage point of GDP. The corner boundary of equation (8) is 53 percent of GDP, the Federal Reserve's 14.1 percent share of the stock at the policy rate included, and the operative boundary is 97.5, so the United States lies 48 percentage points of GDP above its corner boundary and 3 percentage points above its operative boundary at its 2026 debt of 100.6 percent: the pricing equation of 2027 carries both roots, and the United States is inside its zone from the first year of the horizon. That distance is measured in debt. Measured in capacity, the United States carries at least one year on the crisis equilibrium at any capacity up to 2.74 percent of GDP under regime M and 2.66 under regime F, against 1.91 (Table 7); the corner boundary would be 83 at a capacity of 3 percent and 138 at 5. The right panel shows the corner boundary rising in proportion to the capacity for all seven economies, the lines differing through the neutral rate, the long-rate residual, the terminal trend, and the two shares of the stock of each, and marks each economy's operative boundary at its historical capacity; at those capacities the corner boundaries are 73 percent of GDP for Germany, 30 for France, 82 for Italy, 34 for the United Kingdom, 105 for Canada, and 67 for Japan, and the operative boundaries are 178.4, 68.7, and 167.8 with the Eurosystem's ceiling in place (121.0, 52.2, and 129.4 without it), 52.8 for the United Kingdom, 165.2 for Canada, and 125.7 for Japan; Japan's net debt of 134.3 percent of GDP lies 9 percentage points of GDP above its operative boundary, and its gross debt of 204.4 percent would lie 79 percentage points above it. For China no boundary exists: with the spread administered, the real financing rate lies below the real trend in every year of the baseline and of both regimes, and the limit is unbounded; priced as a market issuer, China would carry a corner boundary of 150 percent of GDP and an operative boundary of 264.5, against augmented debt of 135.3, which the addendum reports. At their 2026 net debt the United States, France, the United Kingdom, and Japan lie above their operative boundaries, by 3, 42, 43, and 9 percentage points of GDP, and Germany, Italy, and Canada lie below theirs, by 129, 39, and 155 percentage points, the first two with the ceiling in the boundary. In the terms of Section 2.5, the United States, France, and Japan are inside their zones in 2027, the benign root standing beside the crisis root, and the United Kingdom is beyond its own, its pricing equation carrying the crisis root alone in that year; the other three are below theirs. The limit of equation (4) is a present value discounted at the differential between the real marginal financing rate and trend growth, so it rises without bound as that differential approaches zero and is unbounded below it. Where the financing rate lies close to trend growth, as the United States' does at a zero spread, the level of the limit is not a quantity

the model measures: in the U.S. baseline the limit is unbounded through 2028 and stands at 683 percent of GDP in 2036. What the model reports in those cases is whether the crisis root exists, and the effect of a ceiling is read from the years on the crisis equilibrium and from the shares of Table 17, in Section 3.3, rather than from the level of the limit.

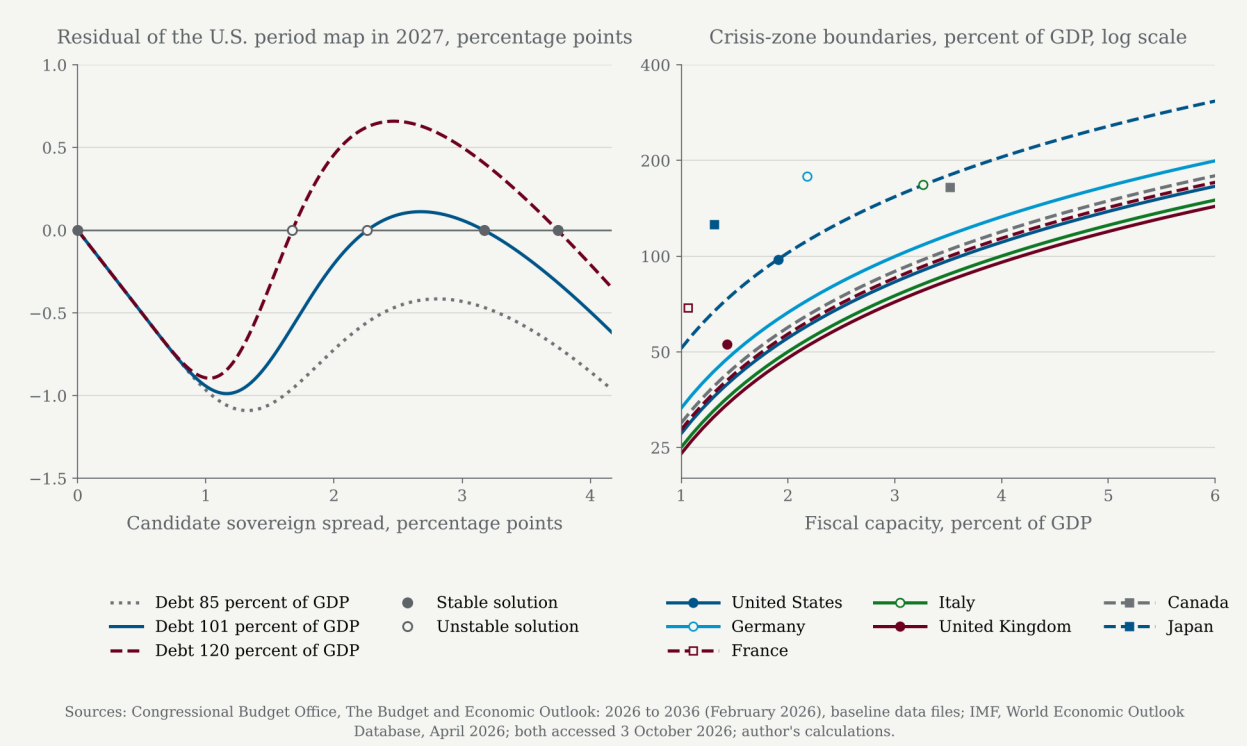


Figure 2: The pricing fixed point and the crisis zone. The left panel shows the map the solver iterates for the United States in 2027: the spread residual $S(s) - s$, in percentage points, against the candidate sovereign spread s over the interval $[0, s^{\max}]$ that the solver searches, where $S(s)$ is the spread the hazard prices at the state that clears the pricing equation at the candidate spread, at initial debt ratios of 85 (gray dotted), 101 (deep blue solid), and 120 percent of GDP (maroon dashed). A filled circle marks a solution at which the residual crosses zero from above, which is stable and is an equilibrium the solver reports; an open circle marks a crossing from below, which is unstable; the solution at a spread of zero is the benign root of all three curves. At the smallest candidate spreads the real financing rate of equation (4) lies below the terminal real trend, the limit is unbounded, the hazard prices no spread, and the residual is minus the candidate spread; above them the limit is finite and falls as the spread rises. The residual turns upward where the limit has come close enough to the debt for the hazard to price a spread, which it does on all three curves: on the two higher curves it rises through zero and falls back through it at the high root, and on the lowest it stays below zero. The right panel shows the corner boundary of equation (8), in percent of GDP, against the fiscal capacity, one line per economy (dashed for Canada, France, and Japan), on a logarithmic vertical scale, on which lines proportional to the capacity are parallel, and marks the operative boundary of each economy at its historical capacity, a filled marker where the central calibration carries no ceiling and an open one where it does, a square on the three dashed lines and a circle on the others; the lines are drawn without a ceiling, and each marker lies above its economy's line. Author's calculations under the central calibration.

The second solution exists because the rate at which the limit is discounted carries the candidate spread on the stock the market holds. Table 13 reads the U.S. period map of 2027, the first year of the crisis under regime M, in four ways. With the limit as equation (4) forms it, the map has three solutions, at spreads of 0.00, 2.28, and 3.14 percentage points: the benign root, the unstable

crossing between the two roots, and the crisis root, at which the limit is 70.3 percent of GDP against debt entering the year of 100.6. With the limit held at that value while the candidate spread varies, the map has one solution, the crisis root. With the limit held at the value it takes at the benign root, which is unbounded, the map has one solution, at a spread of zero, and with the limit discounted without the candidate spread on either leg of the financing rate it again has one, at zero. The slope of the map at the crisis root is 0.608, and with the limit held it is 0.022, 3.7 percent of it: that part is the route from the spread through the year's financing rate and output gap to the debt the hazard reads, and the rest of the slope runs through the limit. Table 14 carries the fourth reading over whole paths, with every economy's limit discounted without the spread in every year: no economy is on the crisis equilibrium in any year of the baseline or of either regime except the United Kingdom in 2036, and U.S. debt ends 2036 at 120.1 percent of GDP in all three runs, the baseline's value. The crisis equilibrium of the results below is therefore a property of a limit discounted at a rate that carries the spread being priced; a limit discounted at a rate without the spread has the benign solution alone on these paths, the one exception named. The four readings are devices for reading the map and are not alternative models: holding the limit at a value while the spread varies describes no economy; the first table is one economy, one regime, and one year, on a grid of 4,001 candidate spreads that locates a solution to its cell, so that two solutions inside one cell would be read as none; the slope is a difference over a span of grid cells and not a derivative; and the whole paths change every economy's limit at once.

Table 13: The period map of the United States in 2027, the first year of the crisis under regime M, read four ways: the solutions of the pricing equation on a grid of 4,001 candidate spreads, their spreads in percentage points, and the fiscal limit at the solution with the largest spread, in percent of GDP, against debt entering the year of 100.6 percent. As coded, the rate side of the limit carries the candidate spread on the market-held stock; in the second and third rows the limit is held at the value it takes at one solution while the spread varies, a device for reading the map and not a model; in the fourth the limit is discounted without the candidate spread on either leg. As coded the middle solution is unstable. The slope of the map at the crisis root is 0.608 as coded and 0.022 with the limit held, 3.7 percent of it. Each slope is a central difference of the return map over 20 grid cells either side of the grid point nearest the root. Author's calculations.

Reading of the map	Solutions	Spreads	Limit at the largest spread
As coded	three	0.00; 2.28; 3.14	70.3
Limit held at its value at the crisis root	one	3.14	70.3
Limit held at its value at the benign root	one	0.00	unbounded
Limit discounted without the candidate spread	one	0.00	unbounded

Table 14: Years on the crisis equilibrium, 2027 through 2036, in the baseline and under each regime: as coded, and with the fiscal limit of every economy discounted without the candidate spread in every year. Author's calculations.

Economy	As coded			Limit without the spread		
	Baseline	Regime M	Regime F	Baseline	Regime M	Regime F
United States	0	10	10	0	0	0
Germany	0	2	0	0	0	0
France	5	10	10	0	0	0
Italy	0	5	0	0	0	0
United Kingdom	10	10	10	1	1	1
Canada	0	0	0	0	0	0
Japan	0	10	10	0	0	0

3.2 The United States under the Two Regimes

This subsection follows the United States through the crisis under each regime. Figure 3 shows the U.S. paths, and Table 16 collects the outcomes for all seven economies. The United States is inside its zone when the sunspot of 2027 arrives, and under regime M the first year on the crisis equilibrium is 2027: in that year the spread opens at 3.1 percentage points, the 10-year yield rises to 7.5 percent, the convenience yield falls to 0.06 percentage points, and the limit at the crisis financing rate is 70 percent of GDP, below the debt. The recession that follows lowers inflation in every year, to −0.8 percent in 2036, and the Taylor rule cuts the policy rate to the zero bound in 2030, where it stays for the rest of the horizon. The cuts do not reach the limit, which is real and discounts at the neutral rate, and the margin by which the crisis equilibrium exists is 0.100 percentage points at the onset and widens to 3.645 by 2036 as the debt accumulates, the margin being the largest amount, across the candidate spreads of the solver's grid above zero, by which the spread the hazard prices exceeds the candidate. The benign root stands beside the crisis root in 2027 through 2032, so the crisis is one of coordination in 6 of its 10 years; in 2033 through 2036, with debt entering the first of those years at 144.6 percent of GDP and the long-rate residual risen with it, the benign root no longer exists, and the crisis is one of sole survival. The output gap reaches −9.2 percent of potential, the yield 9.6 percent, and debt held by the public 195.1 percent of GDP in 2036 against 120.1 in the baseline, the fiscal rule's response to the spread being more than offset by the automatic stabilizers, so that the primary deficit averages 3.7 percent of GDP over the decade. Placed against the record of Section 2.7 by year after the onset, the loss lies inside the interquartile band of the 37 banking crises at every year the horizon covers, nine under regime M and nine under regime F. It is shallower than the record's median in the first eight of those years, at 46 through 91 percent of it; in the ninth it is 117 percent of the median under regime M and equals the median, at the precision of the table, under regime F (Table 15). The response coefficients of equation (10), which are assumptions, therefore produce a loss inside the interquartile band of that record at every year compared, and one that deepens in every year, where the record's median is deepest in the fourth; what they decide is the depth of the loss and the debt it leaves, not whether the crisis occurs (the eleventh limitation of Section 5). The cumulative probability of a credit event along the path is 62 percent; the path is conditional on the event not occurring.

Table 15: The output loss of the central scenario against the record it is read beside, by year after the onset (the year after the onset is year 1), in percent. The first three columns are the lower quartile, the median, and the upper quartile of the deviation of log real GDP per head from its 10-year pre-crisis linear trend across the 37 banking crises of the Jordà–Schularick–Taylor chronology of Section 2.7; the final two are the output gap of the United States against its baseline, from the year after the first year on the crisis equilibrium under each regime, blank where the horizon ends. Sources: Jordà, Schularick, and Taylor, Macrohistory Database, release 6, accessed 23 August 2026; author's calculations.

Year	Lower quartile	Median	Upper quartile	Regime M	Regime F
1	−10.0	−5.9	−1.2	−2.9	−2.7
2	−11.1	−7.4	−1.8	−4.8	−4.0
3	−11.0	−8.3	−3.7	−5.6	−5.0
4	−14.7	−10.3	−3.2	−6.4	−5.8
5	−13.1	−9.6	−2.3	−7.1	−6.4
6	−13.3	−9.2	−3.0	−7.7	−6.8
7	−12.4	−9.2	−2.4	−8.2	−7.2
8	−13.4	−9.6	−2.9	−8.7	−7.6
9	−13.1	−7.9	−1.2	−9.2	−7.9

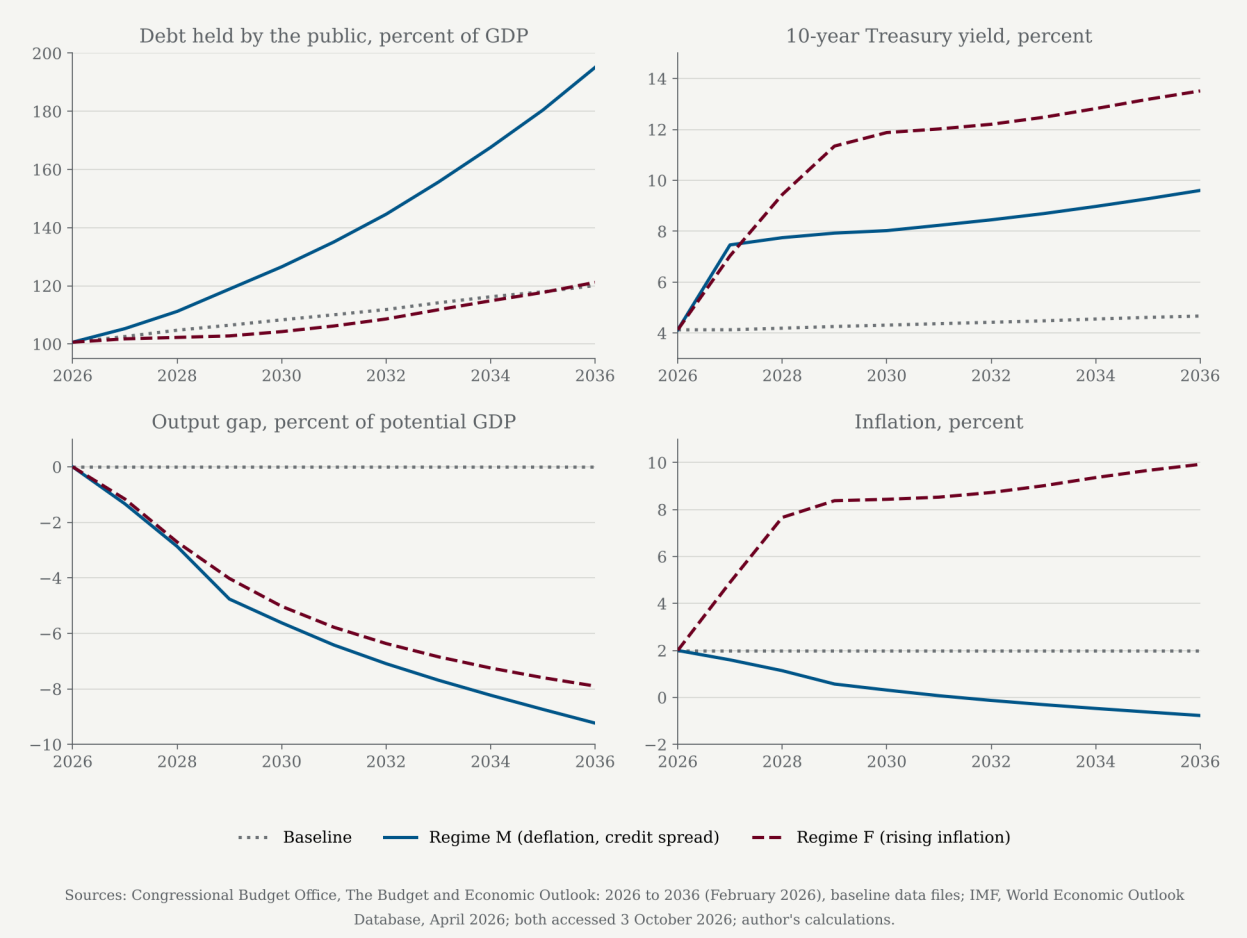


Figure 3: U.S. paths under the baseline (gray dotted), regime M (deep blue solid), and regime F (maroon dashed), 2026 through 2036: federal debt held by the public in percent of GDP, the 10-year Treasury yield in percent, the output gap in percent of potential GDP, and inflation in percent. The baseline is set beside the CBO projection of February 2026 in Table 10. Sources: Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036* (February 2026), baseline data files, accessed 3 October 2026; author's calculations.

Table 16: Crisis outcomes by economy under the central calibration, 2027 through 2036. Onset is the first year on the crisis equilibrium and Years the number of years on it, whether the market holds it while the benign equilibrium exists or it is the only equilibrium of the year; Coord. is the subset of those years in which the benign equilibrium exists beside it; the largest 10-year yield and the largest sovereign spread are in percent and percentage points, and the lowest output gap in percent of potential GDP, each in 2036 but Italy's yield under regime F, which is largest in 2027; debt in 2036 is in percent of GDP (net debt: debt held by the public for the United States, general government net debt for the others, and for China the IMF staff's augmented measure); the final column is the cumulative probability of a credit event by 2036 implied by the annual hazards along the path, in percent. Author's calculations.

Economy	Onset	Years	Coord.	Largest yield	Largest spread	Lowest gap	Debt 2036	Default prob.
Regime M								
United States	2027	10	6	9.6	4.1	−9.2	195.1	62
Germany	2035	2	0	8.3	3.4	−7.4	98.2	16
France	2027	10	1	10.6	4.2	−12.7	236.7	64
Italy	2032	5	1	9.1	4.1	−10.3	179.9	39
United Kingdom	2027	10	0	11.3	4.2	−14.9	213.3	64
Canada	—	0	0	5.0	0.1	−10.7	65.1	0
Japan	2027	10	6	8.0	4.2	−12.5	232.1	64
Regime F								
United States	2027	10	8	13.5	3.9	−7.9	121.2	59
Germany	—	0	0	3.7	0.0	−2.9	85.9	0
France	2027	10	2	9.2	4.2	−11.1	223.8	64
Italy	—	0	0	3.9	0.0	−2.1	136.2	0
United Kingdom	2027	10	0	9.6	4.2	−12.7	197.9	64
Canada	—	0	0	3.6	0.0	−8.2	57.5	0
Japan	2027	10	7	7.4	4.2	−11.6	225.4	64

Under regime F, as under regime M, the sunspot of 2027 moves the United States to its crisis root: the first year on the crisis equilibrium is 2027, the benign root stands beside the crisis root in 2027 through 2034, 8 of the 10 years, and the crisis root is the only one in 2035 and 2036. The price-level adjustment of equation (9) does not lift the limit, which is real and falls with the crisis financing rate that discounts it, from 81.0 percent of GDP at the onset to 45.0 in 2036. Of that fall 7.3 percentage points of GDP are the regime's own inflation acting on the limit: expected inflation above target adds an inflation risk premium of 1.0 percentage point to the real long yield by 2036, and on the same path without it the limit would stand at 52.3. The adjustment therefore does not close the excess: each year's inflation is that year's excess as a share of the debt, spread over the maturity of the stock, and the excess widens from 19.6 percentage points of GDP to 72.7, or 62 percent of the debt entering 2036, which is why the required inflation rises through the horizon rather than subsiding. Inflation rises to 9.9 percent by 2036, the fiscal rule carries no response to the spread, the primary balance is −5.2 percent of GDP in 2036 as the recession deepens to −7.9 percent of potential, and the yield reaches 13.5 percent; the cumulative default probability, one less the product over 2027 through 2036 of one less the hazard each year prices, is 59 percent. The two regimes therefore differ in the central scenario in the outcome of the crisis and not in its first year or its length. Under regime F the price level carries the adjustment: the debt ratio, eroded each year by the inflation the excess over the limit requires, ends at 121.2 percent of GDP, 73.9 percentage points of GDP below regime M and 1.1 percentage points above the baseline, having run below that baseline in 2027 through 2035 by up to 4.1 percentage points. The inflation does

not close the excess, since the limit at the spread on the crisis equilibrium stays below the debt, so the adjustment is a persistent inflation that holds the ratio within 4.1 percentage points of GDP of its baseline rather than a one-time rise in the price level that ends the crisis. Under regime M the crisis runs all 10 years of the horizon, because the quantity that would end it, a fiscal limit above the debt, is set by a capacity the regime does not change, and the real crisis financing rate never falls below trend growth. The finding is consistent with Corsetti and Dedola's result that the central bank's power to remove the self-fulfilling equilibrium rests on its willingness to act as the backstop rather than on the inflation it would generate, and it is the reason the backstops of Section 2.8 matter for the other economies.[51]

3.3 Transmission

Figure 4 shows the 10-year yields of the seven economies with the Eurosystem's ceiling and the central-bank holdings of Section 2.8 in place, and Table 17 sets, for the three euro-area economies and for Japan, the shares of paths carrying a crisis with a ceiling on the spread beside the same shares without one. The sunspot is common, and when it arrives each economy is in the position its own pricing equation sets (Table 16). France, the United Kingdom, and Japan are, with the United States, on the crisis equilibrium in every year of both regimes; Germany and Italy reach theirs under regime M, Germany in 2035 and 2036 and Italy in 2032 through 2036, and in no year of regime F; and for Canada no crisis root exists in any year of either regime.

The United Kingdom's crisis is one of sole survival in every year, as in its baseline: with a capacity of 1.43 percent of GDP and no backstop it reaches a yield of 11.3 percent under regime M, its debt at 213.3 percent of GDP in 2036. France's is one of coordination for one year under regime M and two years under regime F and of sole survival from 2028 and 2029; its baseline loses the benign root in 2032 without a sunspot (Section 2.9), and the central scenarios place it on the crisis equilibrium from 2027. Japan's is one of coordination in 2027 through 2032 under regime M and 2027 through 2033 under regime F and of sole survival after; its yield rises to 8.0 percent in 2036 under regime M, and its debt ends 2036 at 232.1 percent of GDP, against 225.4 under regime F. Italy's crisis root first exists in 2032 under regime M, and the market coordinates on it in that year; the benign root stands beside it in 2032 and not after. Germany's pricing equation carries one root in every year, and from 2035 under regime M that root is the crisis root, the hazard it carries exceeding half of its bound (the reading of Section 2.5), its spread held at the Eurosystem's ceiling in that year; the yields reach 8.3 percent for Germany and 9.1 for Italy in 2036. The regime describes U.S. policy, and the rules of the other economies are the same under both, so what separates regime M from regime F for Germany and Italy is the U.S. path they receive: their debt ends 2036 at 98.2 and 179.9 percent of GDP under regime M against 85.9 and 136.2 under regime F. Of the readings of the seven economies under the two regimes, Italy's under regime F lies nearest its threshold: its capacity is 3.27 percent of GDP against 2.98, the largest capacity at which it would carry a crisis year under that regime, a distance of 0.28 percentage point of GDP, taken before rounding (Table 7). Canada alone carries no year on the crisis equilibrium under either regime: what it carries is the pass-through and the trade channel rather than a sovereign repricing of its own, its yield reaching 5.0 percent and its output gap −10.7 percent of potential in 2036 under regime M, against the U.S. gap of −9.2 in the same year. The size of the transmission where the sovereign does not reprice is set by the pass-through of the U.S. yield and by the disinflation the recession produces.

[51] Giancarlo Corsetti and Luca Dedola, "The Mystery of the Printing Press: Monetary Policy and Self-Fulfilling Debt Crises," *Journal of the European Economic Association* 14, no. 6 (2016): 1329–1371.

Table 17: The central-bank ceilings across the stochastic paths: the share of the simulated paths carrying at least one year on the crisis equilibrium and the share on which the market coordinates on it, without a ceiling on the economy's spread and with one, for the four economies that carry a ceiling in the central calibration or in a variant. The ceiling is stated in percentage points of sovereign spread and is available while the two conditions of equation (11) hold. The final column names the simulation the central calibration carries: the Eurosystem's ceiling is a standing instrument and is central for Germany, France, and Italy; the Bank of Japan has no standing ceiling, so the central calibration carries none for Japan and the simulation with one is a variant. Author's calculations.

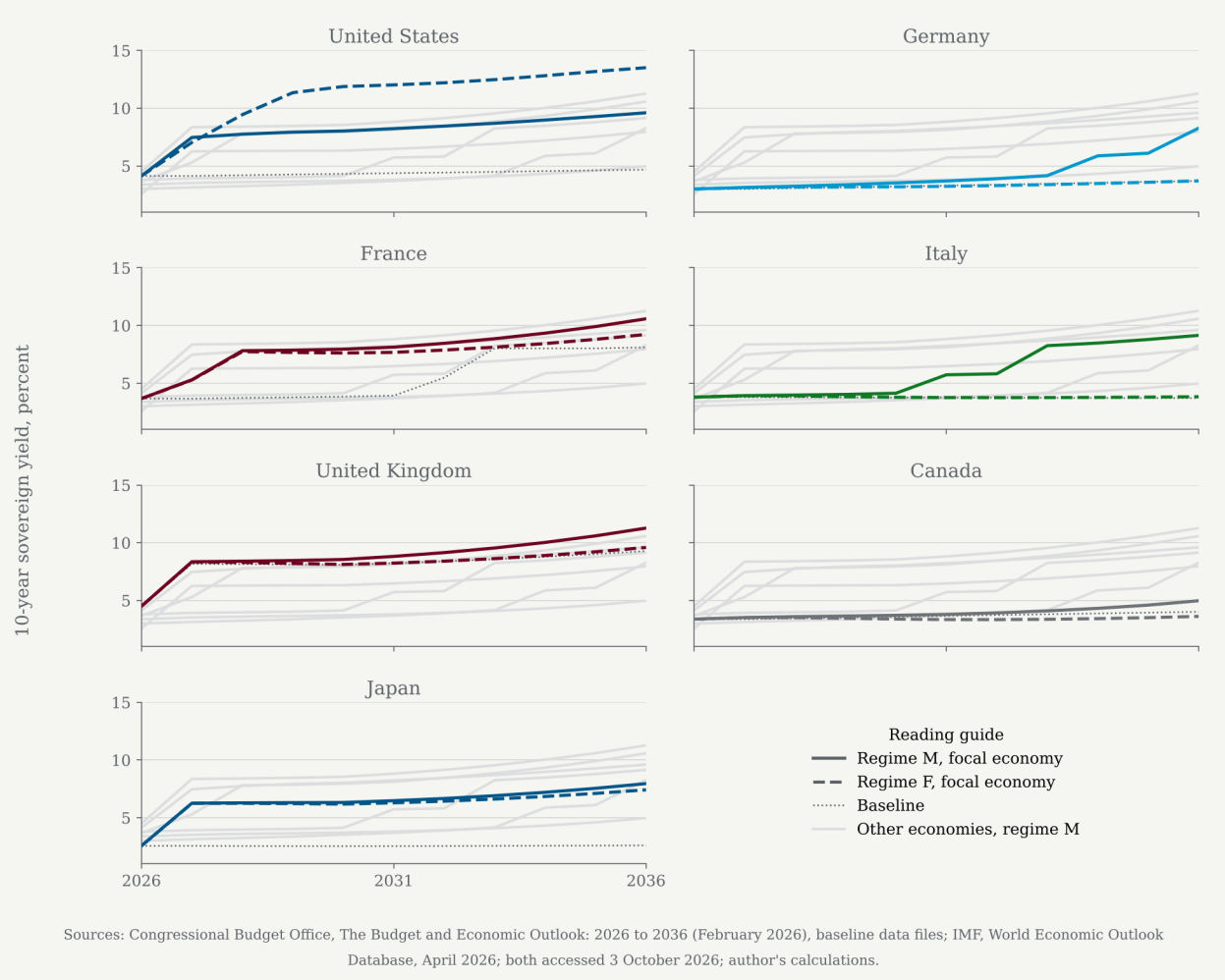
	Without ceiling		With ceiling			
Economy	Crisis share, %	Coordination, %	Crisis share, %	Coordination, %	Ceiling, pts	Central
Germany	29	5	24	0	1.5	with
France	81	25	77	20	1.5	with
Italy	46	13	40	3	1.5	with
Japan	44	25	27	5	1.0	without

On the deterministic paths of regime M the Eurosystem's ceiling binds for France in 2027, for Italy in 2031 and 2032, and for Germany in 2034 and 2035, and holds the spread at 1.5 percentage points in those years. For each economy, the final year of the span is its first year on the crisis equilibrium. Before it the ceiling binds without a crisis root, in 2031 for Italy and in 2034 for Germany: the hazard prices a spread above the ceiling and does not exceed half of its bound. The ceiling is withdrawn in 2028 for France, 2033 for Italy, and 2036 for Germany, the debt of the year before standing above the limit at the capped rate, which is the second condition of equation (11); the first condition holds in every year of the three paths. From the year of the withdrawal the spreads stand above the ceiling, at their largest in 2036, 4.2, 4.1, and 3.4 percentage points, and the largest one-year rise in each of the three yields of Figure 4 falls in the year of its withdrawal. Read by the years on the crisis equilibrium with the ceiling and without it, France is on it in every year either way; Italy is on it in 2032 through 2036 with the ceiling and in 2028 through 2036 without it, four years more; and Germany is on it in 2035 and 2036 either way.

How often each economy carries a crisis across the drawn parameters and shocks is the statement of the simulation of Section 3.5. At least one year on the crisis equilibrium occurs on 80 percent of paths for the United Kingdom, 77 for France, 54 for the United States, 44 for Japan, 40 for Italy, 24 for Germany, and 10 for Canada; among the paths that carry any such year the median count is 10 years for the United Kingdom, 10 for France, 9 for the United States, 8 for Japan, 10 for Italy, 3 for Germany, and 2 for Canada, with coordination on 14, 20, 21, 25, 3, 0, and 0 percent of paths respectively. The shares of paths with a crisis year fall in the order in which the economies are listed, which is also the order of the years each spends on the crisis equilibrium in the central scenario of regime M, the four economies that spend every year on it standing first.

Across the stochastic paths the Eurosystem's ceiling lowers the share of paths carrying coordination from 13 to 3 percent for Italy, from 25 to 20 for France, and from 5 to 0 for Germany, and lowers the share of paths carrying at least one year on the crisis equilibrium by 6.5 percentage points for Italy, 4.6 for France, and 4.5 for Germany: the ceiling raises the limit at which the hazard is assessed, which removes the high root on the paths where the lifted limit crosses the debt and bounds the spread paid on the rest, at 1.5 rather than free to reach its bound, for as long as its condition is met. Differences between shares are taken before rounding, here and below. A Bank

of Japan ceiling of 1.0 percentage points, the variant of Table 17, would lower Japan's coordination share from 25 to 5 percent and its crisis-state share by 17.3 percentage points; across the four economies of Table 17 the fall runs from 4.5 through 17.3 percentage points, the largest Japan's; and on the deterministic path of regime M Japan carries no year on the crisis equilibrium with the variant's ceiling, against all 10 without it: no crisis root exists in any year, the spread is zero, and the ceiling is not reached, the limit being unbounded through 2034 and above the debt after. The ceiling is withdrawn the year after an economy is first priced on a crisis root (Section 2.8), so the years in which it binds on a path are the years the economy is held at it before that year, and that year. For France the median is one year per path, the upper quartile 1, the 95th percentile 1, and the mean 0.8; for Italy the median is no years, the upper quartile 1, the 95th percentile 1, and the mean 0.5; and for Germany the median is no years, the upper quartile 1, the 95th percentile 3, and the mean 0.5.



Sources: Congressional Budget Office, The Budget and Economic Outlook: 2026 to 2036 (February 2026), baseline data files; IMF, World Economic Outlook Database, April 2026; both accessed 3 October 2026; author's calculations.

Figure 4: The 10-year sovereign yield of each economy under regime M (solid) and regime F (dashed), in percent, 2026 through 2036, with the economy's baseline as a gray dotted line and the regime-M paths of the other six economies as light gray lines in every panel. All seven panels share the vertical scale, the eighth cell of the grid carrying the reading guide. The regime labels describe U.S. policy; the policy rules of the other economies are the same under both regimes. Author's calculations under the central calibration.

3.4 The Interest-Growth Differential along the Paths

This subsection splits the change in the debt into the part the interest-growth differential contributes and the part the primary balance contributes. Figure 5 and Table 18 read the paths through equation (3). In the baseline the effective rate lies below nominal growth in 2027 through 2034 and above it in 2035 and 2036, by at most 0.1 percentage point; the differential averages -0.1 percentage points and contributes -1.4 percentage points of GDP to the change in the debt ratio, while the cumulative primary deficit contributes 20.9. Under regime M the differential turns positive at the onset and rises to 4.2 percentage points, dips to 3.6 in 2030, the year the policy rate reaches its floor and the marginal rate stops falling with it, and rises again to 5.5 in 2036, its largest value. It contributes 57.4 percentage points of GDP over the decade. The debt-stabilizing balance follows the same course, from 4.7 percent of GDP to 4.3 in 2030 and to 9.9 in 2036, against a delivered balance of -4.7, and the gap between the two is what the primary balance would have to close. Under regime F the differential is negative in every year, averaging -2.3 percentage points and standing at -1.7 in 2036, because the inflation the adjustment requires lifts nominal growth above an effective rate that reprices only at the rate $1/m$; it contributes -22.2 percentage points of GDP, and the stabilizing balance in 2036 is -1.8 percent of GDP, a deficit, against a delivered balance of -5.2. The contrast is the non-stationarity of Section 2.2 in the model's own terms: with the response of the primary balance to debt at zero, the condition of Section 2.2 holds only where the differential is negative, which under regime M ceases at the onset; under regime F the differential stays negative, so the ratio is stationary at any constant primary deficit, as Section 2.2 states, and it rises in a year whose primary deficit exceeds the stabilizing one, as the delivered deficit of 2036 does.

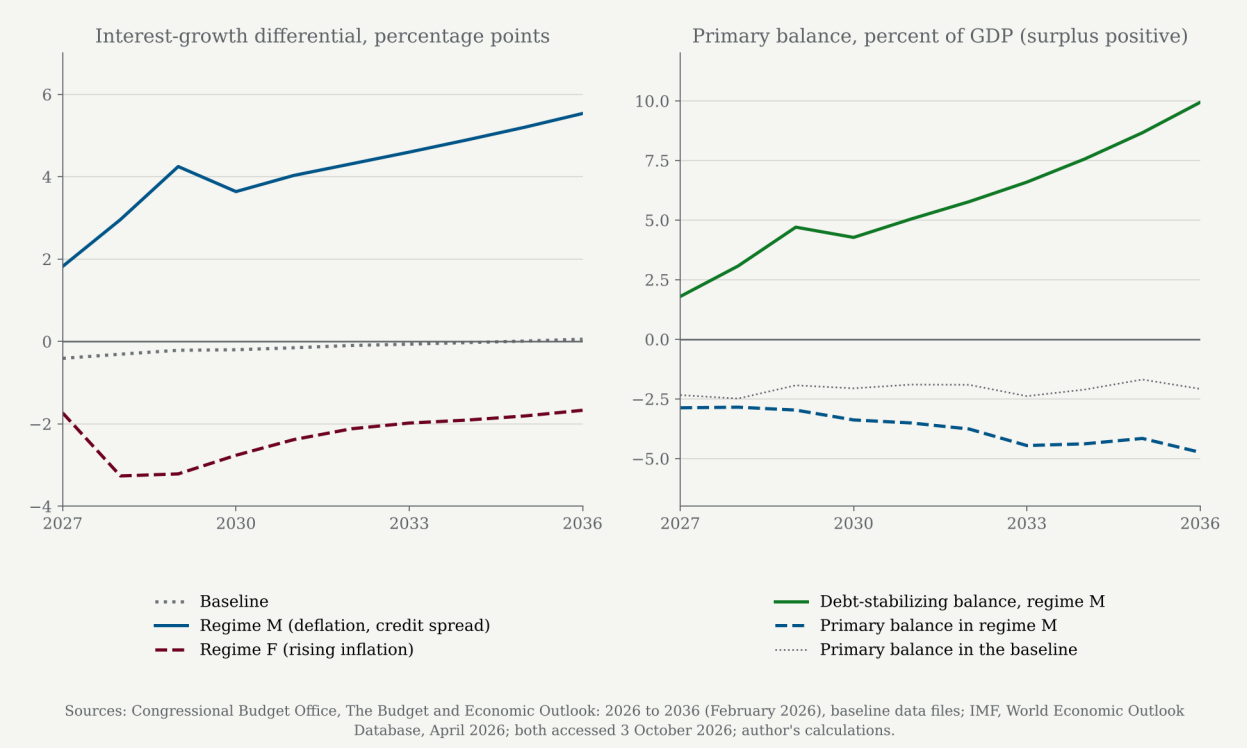


Figure 5: The U.S. interest-growth differential and the primary balance, 2027 through 2036. The left panel shows the effective nominal interest rate on debt held by the public less nominal GDP growth, in percentage points, under the baseline (gray dotted), regime M (deep blue solid), and regime F (maroon dashed). The right panel shows, in percent of GDP with a surplus positive, the debt-stabilizing primary balance of equation (3) under regime M (green solid), the primary balance the model delivers under regime M (deep blue dashed), and the baseline primary balance (gray dotted). Author's calculations under the central calibration.

Table 18: Decomposition of the change in the debt ratio from 2026 through 2036 into the contribution of the interest-growth differential and the cumulative primary deficit, in percentage points of GDP, by economy and scenario. The differential is the effective nominal interest rate on the stock less nominal GDP growth, averaged over 2027 through 2036 in percentage points; its contribution is the sum over years of the differential applied to the prior year's debt and divided by one plus nominal growth, the form of equation (3); the primary contribution is the sum of primary deficits. The model carries no stock-flow adjustment. Author's calculations.

Economy	Mean differential	Differential contribution	Primary contribution	Total change
Baseline				
United States	−0.1	−1.4	20.9	19.5
Germany	−0.4	−2.1	28.3	26.2
France	1.3	18.3	31.4	49.6
Italy	0.4	4.9	−7.9	−2.9
United Kingdom	3.8	47.1	27.8	74.9
Canada	−0.4	−0.7	24.3	23.6
Japan	−1.2	−15.3	17.4	2.0
Regime M				
United States	4.1	57.4	37.1	94.5
Germany	1.2	10.0	38.8	48.8
France	4.7	77.2	49.3	126.5
Italy	3.2	46.8	4.2	51.0
United Kingdom	5.4	77.9	39.9	117.8
Canada	2.2	7.9	46.8	54.7
Japan	3.2	57.3	40.5	97.8
Regime F				
United States	−2.3	−22.2	42.7	20.6
Germany	0.2	1.6	34.9	36.5
France	4.2	66.7	46.8	113.5
Italy	0.8	10.5	−3.3	7.2
United Kingdom	4.8	66.1	36.4	102.4
Canada	1.5	4.8	42.4	47.2
Japan	3.0	52.1	39.0	91.1

Set against the record of Section 2.2, the surplus that would stabilize the ratio under regime M in 2036, 9.9 percent of GDP on debt entering the year of 180.4 percent, exceeds the 5 percent that three episodes in the Eichengreen and Panizza sample sustained for a decade and is 5.2 times the 1.91 percent the federal record shows for 1993 through 2002. The post-1945 reductions from comparable debt levels ran with a negative differential produced by growth, inflation, and capped nominal rates; the Taylor rule of regime M, bounded at zero, cannot supply it against a spread near its bound, and regime F supplies it through inflation running ahead of an effective rate that reprices slowly. Among the other economies the mean differential under regime M is positive for all six and largest for the United Kingdom, at 5.4 percentage points against the U.S. 4.1; it is 4.7 for France and 3.2 for Japan, each on its crisis equilibrium in every year, 3.2 for Italy and 1.2 for Germany, which reach theirs inside the horizon, and 2.2 for Canada, which carries no such year; for China, on its low root at the administered rate, it is −1.7. Under the model's regime F the differential is negative throughout the decade, as it was in the post-1945 reductions, there produced by growth, inflation, and capped nominal rates and here by inflation against an effective rate that reprices at the rate $1/m$.

3.5 The Stochastic Simulation

The central scenario conditions on a sunspot in every year from 2027 (Section 2.5) and on the central parameters. The stochastic simulation removes both conditions. Each of 10,000 paths draws the fiscal capacity of each economy, uniformly within 1.0 percentage point of GDP of its value of record, the trend-growth factor, the bound on the default hazard, the loss given default, the convenience yield, the annual sunspot probability, the pass-through coefficients from the estimates of Table 6, the five parameters of Table 21 on the ranges it states, and the regime with equal probability, 13 quantities in all. The response of the primary balance to debt, which is zero in the central configuration, and the short-rate share of each economy, which is measured, are not drawn (Section 2.9). Each year a path draws output innovations for the seven economies and for China, a common sunspot that coordinates every economy inside its zone, and the credit event itself with the hazard of equation (5). Figure 6 shows the distribution of the U.S. debt ratio and the 10-year yield across paths, and Table 19 reports the outcomes conditional on a crisis. Each share reported below is the share of the 10,000 paths on which the event occurs at least once over the 10 years solved, 2027 through 2036: a path that carries one year on the crisis equilibrium and a path that carries eight count alike, so the shares state nothing about duration, which the conditional medians of Table 19 carry separately. The shares are properties of the model's draw structure under the distributions Appendix A states and are not annual rates, nor rates observed in a historical sample.

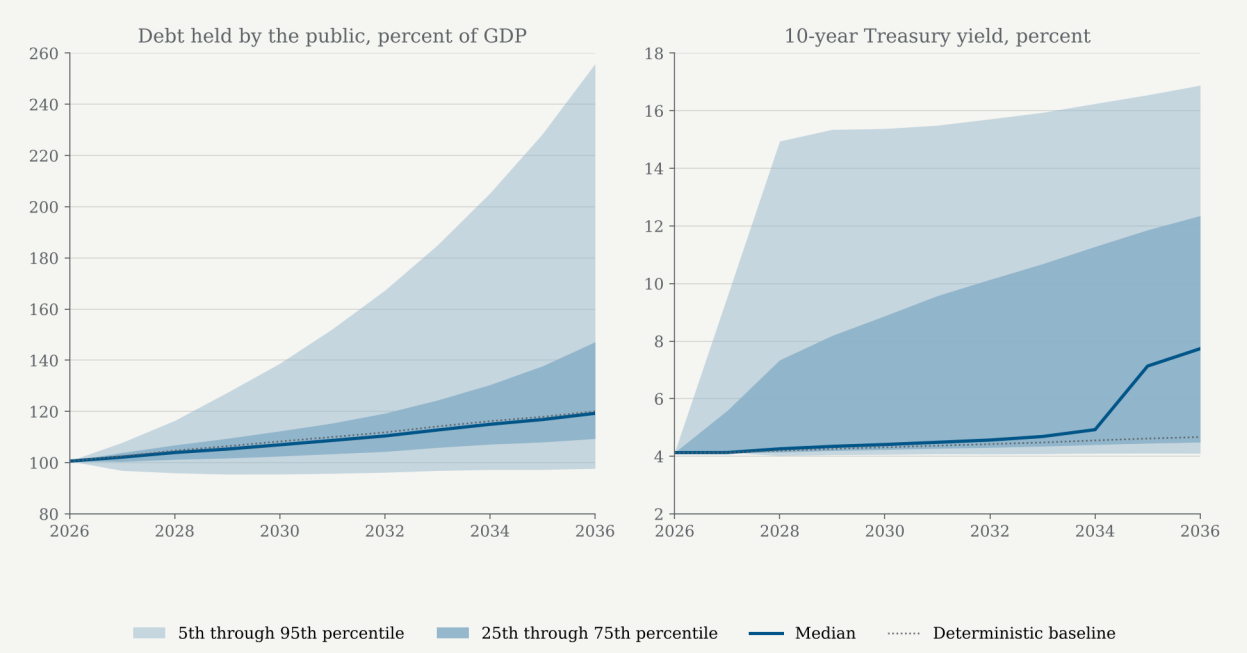


Figure 6: Distribution of the U.S. debt ratio, in percent of GDP, and of the 10-year Treasury yield, in percent, across the 10,000 paths of the stochastic simulation, 2026 through 2036: the 5th through 95th percentile band (light), the 25th through 75th percentile band (dark), the median (deep blue), and the deterministic baseline (gray dotted). Paths on which no crisis occurs are included. Author's calculations.

Table 19: Crisis outcomes conditional on a U.S. crisis occurring, from the stochastic simulation of 10,000 paths. The first three columns are the 5th, 50th, and 95th percentiles across the 2,667 paths under regime M and the 2,709 paths under regime F together; the final two are medians by regime. Each path draws the fiscal capacity of each economy, the trend-growth factor, the bound on the default hazard, the loss given default, the convenience yield, the sunspot probability, the pass-through factor, the five parameters of Table 21, the regime, and annual output innovations (Tables A.1 through A.13). Author's calculations.

Statistic	5th	50th	95th	Regime M	Regime F
Year of onset	1	2	9	2	2
Years on the crisis equilibrium	2	9	10	9	9
Peak 10-year Treasury yield, percent	7.5	12.1	18.1	9.8	14.5
Debt held by the public in 2036, percent of GDP	100.9	141.7	300.4	188.2	118.3
Cumulative output loss, percent of GDP	−126.7	−43.6	−3.9	−45.4	−41.9
Peak inflation, percent	2.0	6.2	14.2	2.0	11.7

In 2027 the United States is inside its crisis zone, the year's map carrying both roots, on 31 percent of paths; beyond it, the crisis root being the year's only one, on 22; and below it on the remaining 47. By 2036 the United States spends at least one year on the crisis equilibrium on 54 percent of paths, with a median of 9 years on it conditional on any. The market coordinates on the crisis root while a benign root exists on 21 percent, and on the remaining 33 percent the crisis equilibrium arrives as the only root, in 2027 on the paths that begin beyond the zone and in a later year on the rest; the median peak yield on those paths is 12.3 percent, against 11.7 on the coordinated ones, so the yields of the two routes are of the same order. Of the paths on which the crisis equilibrium arrives as the only root, 68 percent begin beyond the zone in 2027, no benign root standing beside the crisis root in any year, 23 percent carry a benign root beside the crisis root in 2027, and the remaining 9 percent lie below the zone in 2027. On every path that reaches the crisis equilibrium the United States is on it in each year from the first through 2036, so the share of paths on it in a given year rises from 25.4 percent in 2027 to 53.8 in 2036. That share is 49.6 percent in 2034 and 51.7 in 2035, and the median yield of Figure 6 steps from 4.9 to 7.1 percent between those two years: the median lies among the paths not on the crisis equilibrium through 2034 and among the paths on it from 2035. The selection rule of Section 2.5 does not move the U.S. shares: with selection by the sunspot alone, a market on a sole crisis root returning to the benign root when it reappears, the shares of paths with a U.S. crisis year, with coordination, and with a credit event are the same, and the coordination shares of France, Italy, the United Kingdom, and Japan are lower by at most 0.1 percentage point. A U.S. credit event occurs on 27 percent of paths, on every one of them beside at least one year on the crisis equilibrium, and 51 percent of the paths with a crisis year carry one.

At least one year on the crisis equilibrium occurs on 80 percent of paths for the United Kingdom and on 77 for France, the two economies whose central baselines carry such years, 10 and 5 of the 10. On the paths whose trend growth is drawn at or below its projected path the United Kingdom carries such a year on 99.6 percent and France on 98.6; on the paths whose trend growth is drawn above it, on 61.3 and 54.9. The share is 44 percent for Japan, 40 for Italy, 24 for Germany, and 10 for Canada. Among the paths that carry such a year the median count of years on the crisis equilibrium is 10 for the United Kingdom, 10 for France, 8 for Japan, 10 for Italy, 3 for Germany, and 2 for Canada. The shares carrying coordination are lower: the largest of the six is Japan's, 25 percent, and Germany and Canada coordinate on 19 and 23 paths of the 10,000. A crisis abroad does not require one in the United States. The United States carries no year on the crisis equilibrium on

4,624 of the 10,000 paths, and 70 percent of those carry a year somewhere else, 54 percent a year outside the United Kingdom, and 11 percent a year outside the United Kingdom and France; the common sunspot coordinates each economy that is inside its own zone, so for France, Italy, the United Kingdom, and Japan between 10 and 62 percent of the coordination paths carry no U.S. crisis year, while all 19 of Germany's and all 23 of Canada's fall beside one. The United Kingdom and France are the cases where this matters most: 33 and 31 percent of their crisis paths carry no U.S. crisis year, against at most 9 percent for each of the other four, and on 83 and 74 percent of their crisis paths the benign root is absent rather than the market having moved away from it. For China the benign equilibrium ceases to exist in at least one year on 10 percent of paths, the administered rate holding the observed spread at zero in those years, which is the state the administered reading absorbs; under an administered spread of zero the period map has one root by construction, so investors cannot coordinate on a crisis root on any path. A credit event occurs for at least one of the other seven economies, China included, on 68 percent, the backstopped economies among them. That share is of a union of seven events and is not separated by economy; it stands beside crisis-year shares of 80 percent for the United Kingdom and 77 for France.

Conditional on a U.S. crisis the median onset is year 2 of the horizon, the median peak yield 12.1 percent with a 95th percentile of 18.1, and the median debt ratio in 2036 141.7 percent of GDP; the 95th percentile of the debt ratio, 300.4, lies among paths with at least 7 of the 10 years on the crisis equilibrium: of the 269 paths at or above it, 268 are regime-M paths and 190 carry a drawn credit event, which the simulation records without restructuring the debt, so the ratios on those paths are those of a debt on which the event has occurred and has not been resolved. By regime the medians are these: the peak yield is 9.8 percent under regime M and 14.5 under regime F, and the debt ratio in 2036 is 188.2 and 118.3; inflation separates them, with a median peak of 2.0 percent under regime M and 11.7 under regime F. Across all paths, crisis or not, the median debt ratio in 2036 is 119.3 percent of GDP and the 95th percentile 255.8, against 120.1 on the deterministic baseline.

3.6 Sensitivity

Figure 7 reports, for each drawn parameter, the share of the variance of an outcome across paths that the parameter explains alone (the "first-order sensitivity index" of the global-sensitivity literature[52]), computed as the variance of the conditional mean of the outcome across 20 quantile bins of the parameter divided by the outcome's variance. For a parameter with no effect on the outcome this estimator returns 0.0019 in expectation, so a share at or below that value is not distinguishable from zero. The shares do not sum to one, since the annual shocks and the interactions between parameters carry the remainder. Trend growth is the largest contributor to all three outcomes. Its draw shifts every trend path by a standard normal common to the eight economies, scaled by the economy's root-mean-square projection error, 1.18 percentage points for the United States, and it carries a share of 0.50 of the variance of whether a year on the crisis equilibrium occurs, 0.39 of the peak yield's, and 0.23 of the 2036 debt ratio's. The second contributor to the occurrence is the fiscal capacity, with a share of 0.04, while the sunspot probability carries 0.01, because the sunspot selects between two equilibria where both exist and does not create the years in which only the crisis equilibrium does. The severity is otherwise governed by the bound on the default hazard (share 0.11 for the peak yield) and the loss given default (0.07), the two parameters that set the bound on the spread, and by the regime (0.07); the capacity, drawn within 1.0 percentage point of GDP of its value of record, explains 0.04 of the peak yield's variance, and the convenience yield and the

[52] I. M. Sobol', "Global Sensitivity Indices for Nonlinear Mathematical Models and Their Monte Carlo Estimates," *Mathematics and Computers in Simulation* 55, no. 1–3 (2001): 271–280.

pass-through little. Of the variance of the 2036 debt ratio the regime carries 0.14, the second share after trend growth's. The response of the primary balance to debt and the short-rate share are not drawn, so the figure carries no share for either.

How the variance divides between the parameters together and the shocks is measured by the nested panel of Table 20. It runs 1,000 parameter draws of the central configuration, each under 10 sequences of annual shocks, so that the variance of an outcome across its 10,000 paths divides, by a one-way analysis of variance with the parameter draw as the group, into a part between parameter draws and a part within them, across the sequences of shocks. For the indicator of at least one U.S. year on the crisis equilibrium the share between draws is 0.74 (standard error 0.013), against 0.62 for the sum of the 13 first-order shares of Figure 7; the difference is what the parameters carry jointly, to the precision of two estimates made on different panels. Across the seven economies the share between draws runs from 0.65 for France through 0.85 for Italy: for each of them more than half of the variance of whether a path carries a crisis year lies between the parameter sets drawn and less than half across the shocks. The route divides differently: the share between draws of the coordination indicator is lower than that of the crisis indicator for every economy, 0.46 for the United States, the sunspot's arrival being drawn with the shocks. Of the other U.S. outcomes, the share between draws is 0.82 for the peak yield and 0.90 for the 2036 debt ratio, against sums of first-order shares of 0.70 and 0.52, and 0.35 for the credit event, which is drawn in each year t with the shocks at the hazard $p_{i,t+1}$ of equation (5). The nested panel is a second sample of the central configuration, and its shares of paths with a crisis year lie within 2.2 percentage points of the central simulation's for every economy. What the table does not establish is the share of any one parameter, which Figure 7 reports, or a variance other than the one the stated draw ranges produce: a share between draws is a property of those ranges, several of which are conventions, and its standard error measures the sampling of the 1,000 draws and not the choice of the ranges.

Table 20: The nested panel of the central configuration: 1,000 parameter draws, each under 10 sequences of shocks, 10,000 paths. For each economy: the share of the nested panel's paths with at least one year on the crisis equilibrium, in percent, beside the central simulation's; the share of the variance of that indicator across paths that lies between parameter draws, by a one-way analysis of variance with the draw as the group, with its delete-one-draw jackknife standard error in parentheses; and the same share for the indicator of coordination on the crisis equilibrium. The remainder of each variance lies within draws, across the sequences of shocks. Author's calculations.

	Crisis share, %		Between draws: crisis		Between draws: coordination	
Economy	Nested	Central	Share	(SE)	Share	(SE)
United States	53.0	53.8	0.74	(0.013)	0.46	(0.014)
Germany	24.0	24.1	0.76	(0.015)	0.12	(0.046)
France	75.4	76.7	0.65	(0.016)	0.38	(0.014)
Italy	39.0	39.8	0.85	(0.011)	0.33	(0.032)
United Kingdom	78.2	80.4	0.69	(0.017)	0.50	(0.016)
Canada	10.2	9.9	0.75	(0.024)	0.10	(0.055)
Japan	45.9	44.3	0.67	(0.014)	0.46	(0.013)

A first-order variance share is the part of the variation across paths that a parameter explains alone, a lower bound on its contribution once its interactions with the other parameters are counted, and it does not bound its effect on a reported level. The sunspot probability's variance share for the crisis state is 0.01, and fixing it at the ends of its range puts the share of paths carrying at least one U.S. crisis year at 43.6 percent at the low bound and 60.5 at the high one, a span of 16.9 percentage

points. In two simulations of 10,000 paths the sunspot probability is pinned at 2.5 and at 17.5 percent a year, with the remaining 12 drawn parameters identical path by path; on the paths where the sunspot never arrives, the two simulations carry the same trajectories. The variance share is small because the sunspot probability explains little of the variation across paths within its range, and the level moves because fixing it at a bound shifts the coordination probability of every path in one direction. The two are different questions, and it is the second that bears on a share this paper reports.

The two routes to the crisis equilibrium move in opposite directions under the sunspot probability. Coordination accounts for 7.0 percent of paths at the low bound and 30.1 at the high one, while the paths that reach the crisis equilibrium where the benign root is absent fall from 36.5 to 30.3 percent. The second movement is a counting effect and not a mechanical one: a path joins that class when it reaches the crisis equilibrium without having coordinated in an earlier year, so a higher sunspot probability coordinates paths that would otherwise have arrived there later. The years in which only the crisis equilibrium exists do not depend on the sunspot probability, which is what the small variance share reflects; which paths are recorded as having reached the crisis equilibrium without coordination does depend on it.

The same measurement is made for the four parameters of the twelfth limitation that no record identifies, and for the fiscal multiplier β_f, whose range is one standard error of its estimate rather than a convention (Table 21): each pinned at each end of its draw range on every path and every other parameter drawn as in the central simulation, in 10 simulations of 10,000 paths whose other drawn parameters are identical path by path. None of the five moves the level by as much as the sunspot probability does. The dispersion of the fiscal limit carries the largest span, 2.7 percentage points, from 55.9 percent at 15 percentage points of GDP to 53.2 at 45, and it moves the route and the severity: as the dispersion widens, coordination falls from 29.1 to 15.5 percent of paths, the paths that reach the crisis equilibrium without coordinating rise from 26.8 to 37.7 percent, and the median peak 10-year yield on the crisis paths falls from 12.3 to 11.7 percent. The persistence of the output gap and its two responses move the share by no more than its response to the real long rate does, 0.7 percentage point, and the fiscal multiplier leaves it at 53.8 percent at either end of its range, 0.50 and 1.17, the impulse acting, under regime M, after an onset rather than on it. What the dispersion of the fiscal limit does in the deterministic scenarios, to the range of debt over which two stable solutions exist and to the route of the U.S. crisis, is read from Table 22 below.

Table 21: The level sensitivity of the four parameters drawn on a range of convenience and of the fiscal multiplier, whose range is one standard error of its estimate rather than a convention: the share of the 10,000 paths, in percent, carrying at least one U.S. year on the crisis equilibrium (the crisis share), coordination on it, and a credit event, with each parameter pinned at the low and at the high end of its draw range on every path and every other parameter drawn as in the central simulation, whose crisis share is 53.8 percent. The span is the difference in the crisis share between the two ends, without sign. Author's calculations.

Parameter	Range	Crisis share		Span	Coordination		Credit event	
		Low	High		Low	High	Low	High
Dispersion of the fiscal limit, σ	15–45	55.9	53.2	2.7	29.1	15.5	28.9	26.4
Persistence of the gap, ρ	0.4–0.8	53.5	53.9	0.4	20.6	20.7	27.2	27.7
Gap response to the real rate, β_r	0.2–0.6	53.4	54.1	0.7	20.4	21.1	27.0	27.9
Gap response to the spread, β_s	0.15–0.45	53.6	53.8	0.2	20.7	20.8	27.3	27.7
Fiscal multiplier, β_f (range: the estimate's standard error)	0.50–1.17	53.8	53.8	0.0	20.8	20.8	27.4	27.5

The dispersion of the fiscal limit is the quantity on which the extent of the multiplicity turns in the analysis of Blanchard, Martínez-Bruera, and Huertas (Section 2.5), and Table 22 measures what rests on it in this model. For each economy and each of 10 dispersions, from 7.5 through 240 percentage points of GDP against the central 30, it gives the range of initial debt over which the pricing equation of 2027 has more than one solution. For the United Kingdom, France, and Italy the range closes inside the grid at every dispersion that has one, and their result holds in its full form for the United Kingdom: its range spans 61.9 percentage points of GDP at a quarter of the central dispersion, 30.4 at half of it, and 10.5 at three quarters, and from the central dispersion on its pricing equation has one solution at every debt of the grid. France's range spans 234.0 percentage points of GDP at a quarter of the central dispersion, 156.7 at the central one, and 251.1 at 45 percentage points of GDP, its widest; Italy's spans 234.9, 157.0, and 158.7; and neither economy has a range from a dispersion of 90 percentage points of GDP on. Neither range narrows at every step: each is wider at 45 percentage points of GDP than at 30. For the United States, Japan, Germany, and Canada the range runs to the top of the grid, Germany's at the widest dispersion excepted: a benign root exists at every debt of the grid. For the United States, Japan, and Canada the financing rate at a zero spread does not exceed trend growth in 2027, so the limit is unbounded at the benign root, a case their model, with a safe rate above growth, does not carry. What moves with the dispersion for those economies is the lower end of the range. The U.S. lower end, which at the central dispersion is the operative boundary of 97.5 percent of GDP, is 70.9 at a quarter of the central dispersion and 105.7 at twice it, and falls from there to the floor of the grid at eight times it. For France, Italy, and Germany the range of the table begins below the operative boundary of Section 3.1, since a second solution held at the ceiling is a crisis root only where its hazard exceeds half of its bound.

Along the U.S. path of regime M the dispersion moves the route of the crisis more than its length. The years in which the pricing equation has two stable solutions number seven at a quarter of the central dispersion, six at the central one, and three at eight times it, and rise at no step between; the years with no benign root number three, four, and seven, falling at one step between, to three at twice the central dispersion; and the years on the crisis equilibrium number 8 through 10 at every dispersion of the table. That is the direction of their result in this model's terms: the wider the dispersion, the less of the crisis is a matter of coordination, and at the widest dispersion of the table more of it runs without a benign root than at the narrowest.

Table 22: The range of multiplicity against the dispersion of the fiscal limit. For each dispersion σ, in percentage points of GDP, and each economy: the range of initial debt, in percent of GDP, over which the pricing equation of 2027 has more than one solution, every other initial condition and parameter as in the central calibration, on a grid of debt from 20 through 600 percent of GDP, each end located to 0.1 percentage point of GDP. An entry of two numbers is a range that closes inside the grid; a number followed by a plus sign is the lower end of a range that runs to the top of the grid; "none" is one solution at every debt of the grid. The central dispersion is 30 percentage points of GDP. The final three columns count, along the U.S. path of regime M at that dispersion, the years in which the pricing equation has two stable solutions (Two), the years in which no benign root exists (None), and the years on the crisis equilibrium (Crisis). A second solution is a crisis root only where its hazard exceeds half of its bound, so under a ceiling the range begins below the operative boundary of Section 3.1. Another economy's range is read with the United States on its crisis root where it has one, as the operative boundary is. Author's calculations.

								U.S. years, regime M		
σ	United Kingdom	France	Italy	United States	Japan	Germany	Canada	Two	None	Crisis
7.5	46.3–108.2	63.4–297.4	161.2–396.1	70.9+	88.4+	170.2+	122.2+	7	3	10
15.0	51.6–82.0	59.5–258.0	157.6–360.1	83.2+	103.8+	166.8+	139.5+	6	4	10
22.5	51.6–62.1	56.0–229.9	154.6–332.0	91.6+	115.9+	164.2+	153.4+	6	4	10
30.0	none	52.8–209.5	152.0–309.0	97.5+	125.7+	162.3+	165.2+	6	4	10
45.0	none	49.7–300.8	153.3–312.0	104.1+	142.9+	169.1+	189.6+	5	4	9
60.0	none	38.1–224.3	145.4–256.1	105.7+	153.7+	161.0+	203.0+	5	3	8
90.0	none	none	none	98.6+	164.4+	136.0+	213.1+	5	5	9
120.0	none	none	none	81.6+	169.1+	118.8+	218.6+	4	6	9
180.0	none	none	none	26.7+	164.6+	64.5+	211.1+	3	7	9
240.0	none	none	none	≤20.0+	147.6+	≤20.0–548.4	186.2+	3	7	9

The loss given default is the other assumption on which their paper bears (Section 2.9). At a loss given default of 10 percent, the haircut of their illustration, in place of 40, with every other parameter at its central value, the bound on the spread is 1.01 percentage points against 4.2, and the United States, Germany, Italy, Canada, and Japan carry no year on the crisis equilibrium in the baseline or under either regime. The United Kingdom carries five such years in each of the three runs, and France three or four, at most one of them a year in which a benign root also exists. At 6 percent, the median haircut they report, the United Kingdom and France carry two years each and no other economy any. The crisis years of the United States, Japan, Italy, and Germany in the central scenarios are therefore conditional on a loss given default above the haircuts of their sample, and the United Kingdom and France carry crisis years at each of the three values. That reading is of the central parameters. With the loss given default at 10 percent on every path of the stochastic simulation and every other quantity drawn as in the central simulation, at least one year on the crisis equilibrium occurs on 60 percent of paths for France, 59 for the United Kingdom, 32 for the United States, 24 for Italy, 16 for Japan, 3 for Germany, and 0 for Canada, against 77, 80, 54, 40, 44, 24, and 10 in the central simulation. The market coordinates on a crisis root on 1 percent of paths for the United States, against 21, and on at most 5 percent for another economy, France. The lower haircut lowers each economy's share of paths with coordination in a larger proportion than its share with a crisis year, and on most of the paths that still carry a crisis year the market does not coordinate.

The response of the primary balance to debt and the short-rate share, which are not drawn, are varied in the deterministic scenarios instead, together with two other inputs. Table 23 sets four variants beside the central calibration, each changing one input and leaving every other at its central value, and reports for each economy the first year on the crisis equilibrium and the count of such years in the baseline and under each regime. With the response to debt at 0.046, the pooled

estimate on the sample through 2007, in place of zero, one cell of the table changes: Germany's first year on the crisis equilibrium under regime M is 2036 in place of 2035. With every economy's short-rate share set to the United States' 26.89 percent, the largest of the eight, four cells change, each toward fewer years: France's baseline carries none, the United Kingdom's baseline is on the crisis equilibrium from 2029 in place of 2027, and under regime M Germany carries none and Italy's first year is 2034 in place of 2032. With the six economies other than the United States on the primary balances the IMF's WEO projects, three cells change, again toward fewer years: France's baseline carries none, and under regime M Germany's first year is 2036 and Italy's 2033. With the euro-area members at the lower reading of their short-rate shares, one cell changes, toward more years: France's baseline is on the crisis equilibrium from 2031 in place of 2032. France's baseline is the cell that moves in three of the four variants, and no cell of the United States or of Japan moves in any. The variants are deterministic and move one input at a time: they state the years on the crisis equilibrium with every other parameter at its central value, and they carry no share of paths.

Table 23: The deterministic variants beside the central calibration: for each economy the first year on the crisis equilibrium and, in parentheses, the number of years on it, 2027 through 2036, in the baseline and under each regime; a dash marks no such year. The first variant sets the response of the primary balance to debt above the hazard-free path to 0.0463, the pooled estimate on the sample through 2007 (Table 3), in the baseline and under regime M; the second sets every economy's short-rate share to the United States' 26.89 percent; the third puts the six on the primary balance the World Economic Outlook database of April 2026 projects through its final projected year, held after; the fourth sets the short-rate shares of Germany, France, and Italy to their lower readings (Table 4). Author's calculations.

Variant and run	United States	Germany	France	Italy	United Kingdom	Canada	Japan
Central calibration							
Baseline	—	—	2032 (5)	—	2027 (10)	—	—
Regime M	2027 (10)	2035 (2)	2027 (10)	2032 (5)	2027 (10)	—	2027 (10)
Regime F	2027 (10)	—	2027 (10)	—	2027 (10)	—	2027 (10)
Response to debt at the estimate through 2007							
Baseline	—	—	2032 (5)	—	2027 (10)	—	—
Regime M	2027 (10)	2036 (1)	2027 (10)	2032 (5)	2027 (10)	—	2027 (10)
Regime F	2027 (10)	—	2027 (10)	—	2027 (10)	—	2027 (10)
One short-rate share, the United States'							
Baseline	—	—	—	—	2029 (8)	—	—
Regime M	2027 (10)	—	2027 (10)	2034 (3)	2027 (10)	—	2027 (10)
Regime F	2027 (10)	—	2027 (10)	—	2027 (10)	—	2027 (10)
Primary balances on the WEO's projected path							
Baseline	—	—	—	—	2027 (10)	—	—
Regime M	2027 (10)	2036 (1)	2027 (10)	2033 (4)	2027 (10)	—	2027 (10)
Regime F	2027 (10)	—	2027 (10)	—	2027 (10)	—	2027 (10)
Euro members at the lower short-rate shares							
Baseline	—	—	2031 (6)	—	2027 (10)	—	—
Regime M	2027 (10)	2035 (2)	2027 (10)	2032 (5)	2027 (10)	—	2027 (10)
Regime F	2027 (10)	—	2027 (10)	—	2027 (10)	—	2027 (10)

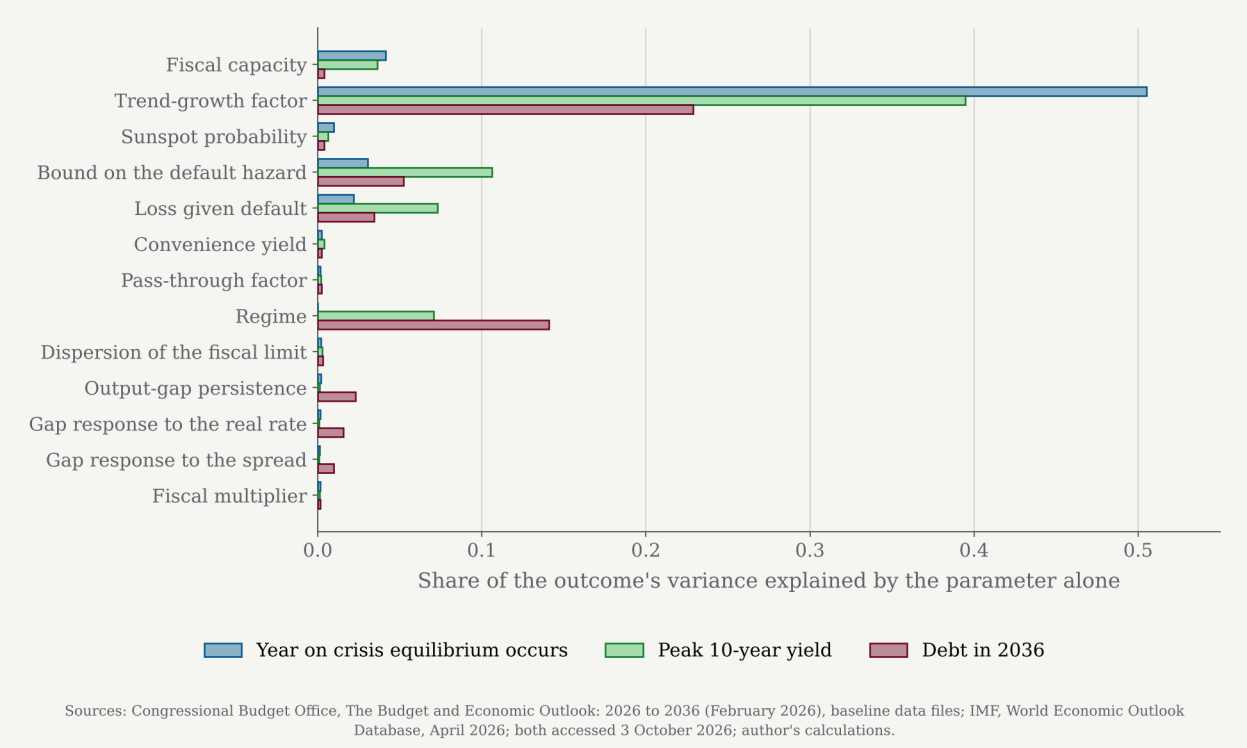


Figure 7: The share of the variance of three outcomes of the stochastic simulation explained by each of the 13 drawn parameters alone: whether at least one year on the crisis equilibrium occurs by 2036 (deep blue), the peak 10-year Treasury yield (green), and debt held by the public in 2036 (maroon). Each share is the variance of the outcome's conditional mean across 20 quantile bins of the parameter, divided by the outcome's variance; the horizontal axis runs to the largest share, the shares being bounded by one. Author's calculations.

3.7 The AI-Adoption Productivity Path

The AI-adoption sensitivity adds a productivity path to the projected trend growth. A period of elevated productivity growth bears on the paper's question: trend growth enters the differential that makes the limit finite, so a sustained rise in it moves the boundary of the crisis zone. It is a sensitivity and not a forecast, and two of its constructions are assumptions rather than estimates: the source's path is a U.S. projection applied to every economy, which assumes an exposure and an adoption path matching the U.S. ones, and the capacity channel maps an estimated effect of growth on the probability of a large-surplus episode into a level response of the capacity, which is a mapping the estimate does not itself supply. The Penn Wharton Budget Model projects the contribution of generative AI to annual total factor productivity (TFP) growth in the United States from 2025 through 2060, relative to a path without it, from the share of work time in each occupation exposed to the technology, an adoption path across firms, and a productivity gain per adopted task, and applies the TFP effect to GDP one for one.[53] The contribution is 0.09 percentage points in 2027, rises to 0.20 in 2032, and is 0.16 in 2036, a level effect of 1.7 percent over the model's years. The sensitivity adds the series to every economy's trend path and takes the source's projection as

[53]Alexander Arnon, *The Projected Impact of Generative AI on Future Productivity Growth* (Philadelphia: Penn Wharton Budget Model, 8 September 2025), Figure 5. The series compounds to a level of TFP 1.55 percent higher by 2035, which the brief states as around 1.5 percent.

additional to the projected trend paths, the CBO and the WEO projections carrying no explicit AI effect; the fiscal limit of equation (4), a perpetuity at the terminal trend, discounts at the source's terminal contribution of 0.039 percentage points in 2060 rather than at the 2036 value, since the contribution peaks in 2032 and a perpetuity at the 2036 value would extrapolate the peak.

The path is carried with the channel the ninth limitation of Section 5 names: the response of fiscal capacity to growth. Eichengreen and Panizza estimate that a percentage point of real growth is associated with a probability higher by 0.0555 (standard error 0.0225) of a 10-year episode with an average primary surplus of at least 3 percent of GDP, on 12 such episodes in 113 non-overlapping windows, the 10-year, 3-percent definition being the one that matches the capacity construction of Section 2.9.[54] The model carries capacity as a level, so the probability effect is converted through the probit index. The 10-year average balance is taken as normal about its conditional mean, with its dispersion set at the unconditional standard deviation the capacity records of Section 2.9 carry, pooled across and within the economies: 1.92 percentage points of GDP over 434 windows of 10 years. That dispersion exceeds the conditional dispersion and so overstates the level response. The level response is the marginal effect times that dispersion over the normal density at the episode share, 0.58 percentage points of GDP per percentage point of growth, with the standard error carried through the same conversion to a band of 0.35 through 0.82. The marginal effect is evaluated at the mean of its estimation sample, a share the source does not publish; the conversion uses the published share of episodes among all windows, and at the highest share the estimation sample admits, 12 episodes among its 79 observations, the response is 0.45 percentage points of GDP, inside the band carried. A check on the model's own data, the 10-year-window average primary balance on the window's average real growth within economy on 30 non-overlapping windows, gives 0.56 with a classical standard error, under economy fixed effects, of 0.34, consistent with the converted estimate and not distinguishable from zero on its own, so the published estimate is the one carried. The channel takes the deviation form: in each year capacity is its historical estimate plus 0.58 times the deviation of 10-year average realized growth from the projected trend path, the years before the horizon carrying no deviation, so the AI increment raises capacity, a crisis's growth loss lowers it, and the recorded maxima stand at trend. The level form, which would read each capacity against the growth of its own window, would extrapolate the linear effect across the 0.6 through 7.0 percentage points by which the average real growth of those windows exceeds the current terminal trends and re-level every capacity downward; the estimate's authors caution that their linear approximations may not hold for large variations in the explanatory variables.

Table 24 reports the central scenario for the United States with the increment alone, the channel alone, and the two together, which is the sensitivity as carried. In the baseline the increment lowers debt in 2036 from 120.1 to 118.2 percent of GDP and raises capacity to 2.01. Under regime M the channel raises the debt: the growth loss lowers capacity to 1.37 by 2036 and the limit with it, and debt reaches 197.2 against 195.1, the peak yield, 9.6 percent, being the central one at the precision shown; with the increment the two together give 193.7, and the band on the channel places it between 192.9 and 194.4. With the increment and the channel together the regime-M onset and the years on the crisis equilibrium are those of the central calibration, 2027 and 10. Under regime F the lower capacity enlarges the gap the price level must close: the onset and the years on the crisis equilibrium are again those of the central calibration, 2027 and 10, inflation reaches 10.8 percent in 2036 against 9.9, and debt ends at 114.9 against 121.2. The increment alone narrows

[54] Barry Eichengreen and Ugo Panizza, "A Surplus of Ambition: Can Europe Rely on Large Primary Surpluses to Solve Its Debt Problem?" NBER Working Paper 20316 (Cambridge, MA: National Bureau of Economic Research, 2014), Table 14, column 5; the episode share from its Table 5. The estimates and table numbers are cited from the working paper; the published version is Eichengreen and Panizza, "A Surplus of Ambition."

the margin at the onset. Under regime M it does so without removing the crisis root: with 0.09 percentage points more trend growth in 2027, the central onset year, the margin by which the crisis equilibrium exists in that year is 0.054 percentage points against 0.100 under the central calibration, the United States is on the crisis equilibrium in the same 10 years, the margin by 2036 is 3.489 against 3.645, and debt ends at 191.5. Under regime F, where the central margin at the onset is 0.018 percentage points, the increment alone removes the crisis root of 2027: the onset comes in 2028, and the crisis runs 9 years against 10. The shares across the stochastic paths, on which the drawn parameters move the margin, are the reading that does not rest on the margin at the onset. Across the 10,000 paths with both parts, the United States spends at least one year on the crisis equilibrium on 52 percent of paths against 54 under the central calibration; coordination occurs on 21 percent and a credit event on 27, each the share of the central calibration at the precision shown. Conditional on a crisis the median debt ratio in 2036 is 138.5 percent of GDP against 141.7, 186.9 under regime M against 188.2 and 114.3 under regime F against 118.3, the median peak yield 12.2 percent against 12.1. Among the other economies Canada's share of paths carrying a crisis is the only one to rise, from 10 to 13 percent; the other six fall, by at most 3.8 percentage points, the largest fall France's, to 73 from 77. The two simulations draw the same parameters and shocks path by path: 278 paths carry a Canadian crisis year under the sensitivity and not in the central simulation, 6 the reverse, and each of the 278 carries a U.S. crisis year in both simulations; the rise is not decomposed between the productivity path and the capacity channel the sensitivity carries. In the deterministic scenarios the sensitivity moves the crisis years of one of the other economies: France's baseline is on the crisis equilibrium from 2034 in place of 2032.

Table 24: The AI-adoption sensitivity in the central scenario for the United States: the Penn Wharton Budget Model's contribution of generative AI to annual productivity growth added to every economy's trend real growth (the increment), the response of fiscal capacity to realized growth at the Eichengreen and Panizza estimate (the channel), and the two together, which is the sensitivity as carried. Debt is held by the public in percent of GDP, the fiscal capacity in percent of GDP, the peak yield in percent, inflation in percent, and crisis years the years on the crisis equilibrium. Sources: Penn Wharton Budget Model (2025); Eichengreen and Panizza (2016); author's calculations.

Quantity	Central	Increment only	Channel only	Both
Baseline debt in 2036	120.1	118.2	120.1	118.2
Baseline capacity in 2036	1.91	1.91	1.91	2.01
Regime M: crisis years	10	10	10	10
Regime M: peak yield	9.6	9.5	9.6	9.6
Regime M: capacity in 2036	1.91	1.91	1.37	1.47
Regime M: debt in 2036	195.1	191.5	197.2	193.7
Regime F: crisis years	10	9	10	10
Regime F: coordination years	8	8	6	7
Regime F: inflation in 2036	9.9	9.6	11.2	10.8
Regime F: debt in 2036	121.2	117.9	114.8	114.9

3.8 Variant: The Announced Central-Bank Portfolio Paths

The central calibration holds each central bank's share of the stock fixed over the horizon. One variant replaces that reading with the run-off paths the central banks have announced. It is carried in the central scenario and across the stochastic paths alike. The Bank of Japan's plan of June 2026 maintains a reduction of about 200 billion yen each calendar quarter in its monthly purchases

until the first quarter of 2027 and about 2 trillion yen a month from April 2027, on which the Bank projects its holdings in March 2030 at 36 through 39 percent below their level of June 2024 against about 17 percent below in March 2027, a decline of 9.0 percent a year between those two readings.[55] The Eurosystem's holdings under the asset purchase programme and the pandemic emergency purchase programme, in full run-off since the end of reinvestments in July 2023 and at the end of 2024 respectively, stood at 3.7 trillion euros at the end of 2025 and are projected on the redemption profile to fall by 0.5 and 0.4 trillion in 2026 and 2027, to around 2.9 trillion at the end of 2027, 11.5 percent a year between the two stated stocks.[56] The Bank of England announced on 17 September 2026 that it would reduce the gilt holdings of the Asset Purchase Facility, 488.2 billion pounds, to the 120 billion of its longest-dated gilts that it retains to back the banknote issue: the 221.7 billion maturing before 2035 are held to maturity, and the 146.5 billion maturing from 2035 through 2049 are sold at an annualized 20 billion a year.[57] Table 25 carries the holdings the notice implies year by year, the redemptions read from the notice's own list of gilts and the sales at the stated pace, so the United Kingdom's path is the announcement itself rather than a rate carried forward: the annual reduction lies between 11.6 percent, in 2033, and 22.4, in 2034, and the holdings reach the retained 120 billion, 24.6 percent of the present stock, in 2034 and stay there.

Table 25: The Bank of England's gilt holdings under the announcement of 17 September 2026, by model year. Redemptions are the gilts held to maturity that mature in the year, the 0.375 percent gilt of October 2026 counted in 2027; sales run at the annualized pace of 20 billion pounds a year against the gilts maturing 2035 through 2049 until that bucket is exhausted; holdings are the year-end stock in purchase-proceeds terms, and the change is the annual percent change the model carries as the United Kingdom's path. All amounts in billions of pounds. Source: Bank of England, Asset Purchase Facility gilt sales market notice of 17 September 2026, Table 1, accessed 17 September 2026; author's calculations.

Year	Redemptions	Sales	Holdings	Change, %
2027	49.3	20.0	418.9	−14.2
2028	42.5	20.0	356.4	−14.9
2029	23.4	20.0	313.0	−12.2
2030	46.0	20.0	247.0	−21.1
2031	11.1	20.0	215.9	−12.6
2032	20.9	20.0	175.0	−18.9
2033	0.3	20.0	154.7	−11.6
2034	28.2	6.5	120.0	−22.4
2035	0.0	0.0	120.0	0.0
2036	0.0	0.0	120.0	0.0

The Federal Open Market Committee concluded the reduction of its securities holdings on 1 December 2025 and directed reserve-management purchases sized to trend growth in the demand

[55] Bank of Japan, "Plan for the Outright Purchases of Japanese Government Bonds," Monetary Policy Meeting of 16 June 2026, accessed 23 August 2026.

[56] Soizic Weber, Tomás Carrera de Souza, and Koen Oosterhek, eds., *The Use of the Eurosystem's Monetary Policy Instruments and Its Monetary Policy Implementation Framework in 2024 and 2025*, Occasional Paper Series No 398 (Frankfurt: European Central Bank, August 2026), 23, accessed 23 August 2026.

[57] Bank of England, "Asset Purchase Facility: Gilt Sales," Market Notice of 17 September 2026, Table 1, accessed 17 September 2026. The notice pauses the Bank's own auctions pending a review, before April 2027, of an arrangement under which the Debt Management Office would buy the gilts at market prices, and states that the agreed pace is implemented under either arrangement; the path assumes the pace from the first year.

for Federal Reserve liabilities, so the variant grows its holdings with nominal GDP.[58] The Bank of Canada's and the People's Bank of China's shares are held at their initial values. The Bank of Japan's plan sets its purchases through March 2027 and a monthly amount from April 2027 with no end date, the rate carried being the Bank's own projection of its holdings through March 2030, and the Eurosystem's projection runs through 2027; each is carried forward at its projection's final rate through 2036, which is an extrapolation of the model's rather than a statement of either central bank, while the Bank of England's runs to its retained stock in 2034 and holds there, so it is not extrapolated. The share the model uses in each year is the prior year's holdings over the prior year's nominal debt stock, so a rising debt ratio lowers the share as well.

Table 26 sets the variant beside the central calibration. The share of the stock financed at the policy rate falls over the horizon from 43.1 to 12.1 percent for Japan, from 28.6 to 4.5 for Germany, and from 14.1 to 7.8 for the United States, and with it the corner boundary of equation (8): Japan's falls from 67 to 38 percent of GDP, Germany's from 73 to 52, Italy's from 82 to 68, and the United States' from 53 to 49. The corner boundaries move; whether the crisis equilibrium exists is read from the paths. Under regime M the run-off adds years on the crisis equilibrium for Germany and Italy: Germany's 4 years against 2 under the fixed share, 2033 through 2036, and Italy's 6 against 5, 2031 through 2036. The economies on the crisis equilibrium in every year of the horizon under either reading are the United States, France, the United Kingdom, and Japan, and Canada is on it in none. For the United States and for Japan the run-off shortens the years in which the benign root stands beside the crisis root: the crisis root is the only one from 2032 in place of 2033. In the baselines the run-off moves the crisis years of one economy: France's baseline is on the crisis equilibrium from 2030 in place of 2032.

The Eurosystem's ceiling holds a spread at 1.5 percentage points in the years in which it binds, and for each of the three euro-area economies those years end with its first year on the crisis equilibrium. With the run-off it binds for Germany in 2032 and 2033, for France in 2027, and for Italy in 2030 and 2031; it is withdrawn in 2034, 2028, and 2032, and the spread then stands above the ceiling, at 3.8, 4.2, and 4.1 percentage points in 2036. Under the fixed share it binds for France as with the run-off, and later for the other two, for Italy in 2031 and 2032 and for Germany in 2034 and 2035. Yields reach 8.6 percent for Germany, 10.7 for France, and 9.5 for Italy in 2036. Debt in 2036 is higher with the run-off for each of the six economies of Table 26: 109.2 percent of GDP for Germany against 98.2 under the fixed share, 243.8 for France against 236.7, 195.1 for Italy against 179.9, 218.2 for the United Kingdom against 213.3, and 197.3 for the United States against 195.1, the difference being largest for Italy. Japan's central bank is the one whose share falls furthest, to 12.1 percent of the stock by 2036; Japan is on the crisis equilibrium in all 10 years under either reading, and its debt in 2036 is 242.8 percent of GDP against 232.1.

The variant is also carried stochastically, over the same 10,000 paths and the same drawn parameters as the central simulation, so the two differ only by the holdings path. A U.S. crisis occurs on 55 percent of paths against 54 and a credit event on 28 against 27, each within a percentage point: the Federal Reserve carries no ceiling, and its share enters only through the consolidated financing rate. The coordination share rises for Japan, from 25 to 33 percent, for Italy, from 3 to 4, and for Germany, from 0 to 1; France's is lower by 0.2 percentage point. The share of paths carrying at least one year on the crisis equilibrium rises by 17.2 percentage points for Germany, 13.3 for Japan, 9.4 for France, 5.2 for Italy, and 5.6 for the United Kingdom, whose gilt sales the variant carries, since the run-off lowers the limit at which the hazard is assessed as the share financed at

[58] Board of Governors of the Federal Reserve System, Federal Open Market Committee statement of 29 October 2025 and Federal Reserve Bank of New York, "Statement Regarding Reserve Management Purchases Operations," 10 December 2025, accessed 23 August 2026.

the policy rate falls; it moves by a percentage point or less for the United States and Canada. Conditional on a U.S. crisis the median peak yield is 12.1 percent with the run-off and without it, and the median debt ratio in 2036 is 141.5 against 141.7. Across the paths the run-off raises the share carrying the crisis state by 5.2 through 17.2 percentage points for the five economies whose central banks reduce their holdings, raises the coordination shares of Japan, Italy, and Germany by 1.1 through 7.1 percentage points, and leaves the U.S. shares within a percentage point of the central calibration's.

Table 26: The central banks' holdings on their announced paths, regime M, 2027 through 2036. The share is the central bank's holdings as a share of the debt stock, at the start of the horizon and in 2036 under the paths of Table A.8; the boundary is the crisis-zone boundary of equation (8) evaluated at each share; crisis years count the years the economy is on the crisis equilibrium and the debt ratio is in percent of GDP in 2036, each under the fixed share of the central calibration and under the announced path. Canada and China carry no path and are omitted. Sources: European Central Bank; Bank of Japan; Bank of England; Federal Open Market Committee; author's calculations.

	Share, %		Boundary		Crisis years		Debt 2036	
Economy	2026	2036	Fixed	Path	Fixed	Path	Fixed	Path
United States	14.1	7.8	53	49	10	10	195.1	197.3
Germany	28.6	4.5	73	52	2	4	98.2	109.2
France	19.2	3.3	30	24	10	10	236.7	243.8
Italy	18.1	4.2	82	68	5	6	179.9	195.1
United Kingdom	17.6	2.2	34	29	10	10	213.3	218.2
Japan	43.1	12.1	67	38	10	10	232.1	242.8

4 The Path to Resolution

The results of Section 3 state what the crisis does under each regime, and neither regime ends it within the horizon. This section states what would end it, solved in the model rather than inferred from its output, one economy at a time. Section 4.1 solves the same question for three instruments, Section 4.2 places the requirement against the record of large primary surpluses, and Section 4.3 against the record of the prior suppliers of the safe asset.

The crisis equilibrium exists in a year in which, at the crisis financing rate, the debt stands high enough against the fiscal limit for the hazard of equation (5) to imply the spread on the crisis equilibrium. Removing it means lifting the limit until the hazard no longer does, and the limit of equation (4) is the fiscal capacity divided by the real interest-growth differential at that rate. Two quantities can lift it. The differential is the first. It cannot make the limit unbounded: the limit is unbounded only where the real marginal financing rate lies below the terminal real trend, and at the crisis yield that rate is 5.44 percent against a U.S. trend of 1.77, a gap the trend growth path of the central calibration does not close. What the differential can do short of that is raise a finite limit, and Section 4.1 solves for the increment to trend growth that suffices, which is at most 0.64 percentage points for the United States, Japan, Italy, and Germany where it is announced in 2027 and between 1.08 and 4.97 percentage points for the United Kingdom and France. The second quantity is the fiscal capacity, and it is the one the model leaves open and this section solves first.

The capacity that ends a crisis cannot be read off the recorded paths. A capacity high enough to lift the limit above the debt in a given year would have raised the limit in every earlier year, which would have lowered the yield, the debt, and the coordination decision that produced that debt;

a requirement computed against the recorded path therefore prices a debt level that the higher capacity would not have produced. Table 27 instead solves for the capacity: for an economy, a regime, and a year in which the higher capacity takes effect, the resolving capacity is the smallest capacity found by bisection under which the crisis equilibrium exists for that economy in no year from that year onward, with a full model run at every trial, so the limit, the yield, the debt path, and the coordination decision all move with the capacity under test, and with every other economy's capacity as in the central calibration. An announced capacity replaces $pb_i^{\max}$ in both places it enters, the ceiling of the fiscal rule of equation (2) and the limit of equation (4), from the announcement year onward, the historical capacity standing before it. The criterion is the existence of the crisis equilibrium and not the years the path spends on it: a capacity under which the path carries no crisis year while the crisis equilibrium still exists has left the multiplicity in place. Bisection finds the smallest such capacity only where the set of capacities that clear the crisis is an upper set—where clearing at one capacity implies clearing at every higher one—and on a grid of capacities in steps of 0.25 percentage point of GDP up to 12 percent of GDP at the central calibration the set is an upper set for every economy, regime, and announcement year of the table (Figure 9), so the reported figure is the smallest clearing capacity. It is solved to a thousandth of a percentage point of GDP and reported at two decimals as the smallest capacity on that grid that clears: a model run at the reported value clears, and one a hundredth of a percentage point of GDP below it does not. The ceilings of Section 4.1 are reported in the same way as the largest that clears, and the growth increments and the delivered surpluses as the smallest. Across the drawn parameter sets of the resolving-capacity simulation no scan is made, so its figures are the bisection's thresholds and are not established as minima of a resolving set.

Table 27: The resolving fiscal capacity, in percent of GDP, by economy and regime and by the year the higher capacity takes effect: the smallest capacity under which the crisis equilibrium exists for the economy in no year from that year onward, every other economy's capacity as in the central calibration. Each value is solved by bisection over the capacity with a full model run at every trial, so the fiscal limit, the yield, the debt path, and the coordination decision move with the capacity, and on a scan of the capacity in steps of 0.25 percentage point of GDP up to 12 percent of GDP the capacities that clear are every capacity above a threshold. Values are reported at two decimals on the clearing side of the solved threshold. The second column is the historical capacity (Table 7). A dash marks a case in which no crisis equilibrium exists for the economy from that year onward in the central scenario, so that there is nothing to remove. Author's calculations.

Economy, regime	Record	From 2027	From 2029	From 2031	From 2033
United States, M	1.91	2.75	3.32	4.10	5.06
United States, F	1.91	2.67	3.04	3.30	3.40
United Kingdom, M	1.43	6.63	7.76	9.09	10.51
United Kingdom, F	1.43	4.28	5.13	6.14	7.24
France, M	1.06	4.91	5.71	7.01	8.47
France, F	1.06	3.17	3.71	4.73	5.88
Japan, M	1.31	2.31	2.84	3.58	4.39
Japan, F	1.31	1.86	2.32	2.97	3.70
Italy, M	3.27	4.70	4.70	4.70	5.08
Italy, F	3.27	—	—	—	—
Germany, M	2.18	2.63	2.63	2.63	2.63
Germany, F	2.18	—	—	—	—

The table covers the United States, the United Kingdom, France, Japan, Italy, and Germany. For the United States the resolving capacity is between 2.67 and 5.06 percent of GDP across the years and regimes of Table 27, against a historical capacity of 1.91. Announced in 2027, the first year of the central scenario's sunspot and the year of the onset under both regimes, 2.75 percent of GDP removes the crisis equilibrium from every year of the horizon under regime M and 2.67 does so under regime F, the former 44 percent above the largest 10-year average primary surplus the United States has sustained since 1950. Across the economies of the table the requirement announced in 2027 under regime M exceeds the historical capacity by 0.45 percentage points of GDP for Germany, the smallest excess, through 5.20 for the United Kingdom, the largest. Germany and Italy are on the crisis equilibrium under regime M alone, in 2035 and 2036 and in 2032 through 2036, so under regime F no requirement is computed for them and their rows carry dashes; under regime M the requirement announced in 2027 is 2.63 percent of GDP for Germany and 4.70 for Italy, against historical capacities of 2.18 and 3.27. Canada carries no year on the crisis equilibrium in either central scenario, and no requirement is computed for it.

Two regularities hold in the table. First, the requirement rises with every announcement that follows the onset. For the United States the onset is 2027 under either regime, so the announcement of 2027 comes in the onset year and every later one follows it: the requirement under regime M is 2.75 percent of GDP from 2027, 3.32 from 2029, 4.10 from 2031, and 5.06 from 2033, and under regime F it rises from 2.67 to 3.40, rises of 2.31 percentage points of GDP under regime M and 0.73 under regime F between the announcements of 2027 and 2033, the debt accumulated in the crisis years raising what the limit must reach. For Italy and Germany, whose crises under regime M begin in 2032 and 2035, the requirement is one figure across the announcements that precede the onset: 4.70 percent of GDP for Italy from 2027, 2029, and 2031 and 5.08 from 2033, and 2.63 for Germany from each of the four years. Second, regime M requires the more. For the United States the two regimes require nearly the same capacity for the announcement of 2027, within 0.08 percentage point of GDP, and differ for the later ones by at most 1.66. Under regime F the price level carries the adjustment, and debt stands at 121.2 percent of GDP in 2036 on the recorded path against 195.1 under regime M; after the onset the lower debt lowers what the limit must reach. The adjustment does not lift the limit, which is real and reads inflation only through the premium on its long leg. For the United Kingdom, France, and Japan the regimes differ already for the announcement of 2027, by 0.45 percentage points of GDP for Japan through 2.35 for the United Kingdom. The regime is a configuration of U.S. policy (Section 2.6), so for an economy other than the United States the difference between its two rows is the difference between the two U.S. crisis paths as the pass-through and trade carry it.

Three properties qualify this reading. First, the requirement is the horizon's: in each of the 40 cases of Table 27 the year that binds is 2036, a capacity just short of the requirement leaving the crisis equilibrium in existence in that year and in no other, so a longer horizon would require no less. Second, the capacity is a record maximum, so a capacity above it is a statement about what a government would sustain and not a measurement of what it has; the paper takes the record as the calibration and reports the requirement against it rather than assuming it is met. Third, the resolution in the model is the removal of the crisis equilibrium, not the return of the debt ratio to its baseline: at the capacities of Table 27 the debt the crisis has already produced remains, and what ends is the multiplicity that allows the market to price a default its own pricing brings about.

Solving the same bisection once for each of 1,000 of the stochastic simulation's drawn parameter sets, for each economy of the resolution, under each regime and announced in 2027, gives the distributions of Table 28 and Figure 8. The bisection searches to 12 percent of GDP, and a set that no capacity in that range resolves is solved again up to 40. Such sets occur for the United Kingdom,

France, Japan, Italy, and Germany; under regime M, 14 of the United Kingdom's sets, 4 of Italy's, and 2 of France's require more than 40 percent of GDP, and under regime F none does. Over the sets that require a capacity, the median requirement is lower under regime F than under regime M in every economy. It is largest for Italy under both regimes, 7.20 percent of GDP under regime M and 5.16 under regime F, and smallest for Japan under regime M, at 3.29, and for Germany under regime F, at 2.51. The economies differ in the upper tail: under regime M the 95th percentile exceeds the bisection's range of 12 percent of GDP for the United Kingdom, France, and Italy, at 22.69, 13.39, and 20.56 percent of GDP respectively, and lies within it for the United States, Japan, and Germany; under regime F it exceeds it for the United Kingdom alone.

For the United States the distribution has two parts, which are counted apart. Under 309 of the 1,000 sets under regime M, and 320 under regime F, no crisis equilibrium exists for the United States in any year from 2027 at the drawn capacity, and those sets require nothing. Over the 691 sets that require a capacity under regime M the median requirement is 3.74 percent of GDP, the interquartile range 2.85 through 5.19, and the 95th percentile 7.60; over the 680 that require one under regime F the median is 3.70. The requirement of the central calibration lies below both medians: 540 of the 691 sets require more than it under regime M and 538 of the 680 under regime F. With the sets that require nothing counted at their drawn capacities, 424 of the 1,000 sets lie at or below the central requirement under regime M and 402 under regime F. Every set resolves within the 12 percent of GDP the bisection searches, the largest requirement being 11.84. The dispersion is not the capacity band of Section 2.9 read back. Over the sets that require a capacity under regime M the requirement's correlation with the drawn capacity is 0.21 and with the drawn trend-growth factor -0.82, its correlation with each of the other drawn quantities being at most 0.20 in magnitude, and it exceeds the drawn capacity by 1.95 percentage points of GDP at the median. The limit of equation (4) capitalizes the surplus at the differential between the crisis rate and trend growth, so a lower drawn trend both widens the differential and lowers the value of a given surplus while the debt the limit must cover does not fall with it. Nor are the sets that require nothing the sets with a high drawn capacity alone: 118 of the 309 carry a drawn capacity below the historical one.

Figure 8: The resolving fiscal capacity over the drawn parameter sets of the stochastic simulation that require a capacity, by economy. Horizontal axis: the capacity announced in 2027, in percent of GDP; vertical axis: the share of those draws whose requirement is at or below it. Solid deep-blue, regime M; dashed maroon, regime F; dotted vertical, the requirement at the central calibration under regime M. A set's requirement is the smallest capacity under which the crisis equilibrium exists for the economy in no year from 2027 on, searched to 12 percent of GDP and, for a set that no capacity in that range resolves, to 40; a set that no capacity up to 40 resolves is not plotted, and its curve ends below one by the share of such sets. A set under which no crisis equilibrium exists at its drawn capacity requires nothing and is left out of the curves; each panel prints the share of the 1,000 sets that require nothing under each regime. Sources: Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036* (February 2026), baseline data files; IMF, *World Economic Outlook Database*, April 2026; both accessed 3 October 2026; author's calculations.

Table 28: The resolving fiscal capacity over the drawn parameter sets, announced in 2027, by economy and regime: of the 1,000 sets solved under each regime, the number under which no crisis equilibrium exists for the economy in any year from 2027 at the drawn capacity, which require nothing; the number that require a capacity, and of those the number whose requirement lies above 40 percent of GDP; over the sets that require a capacity, the 5th, 25th, 50th, 75th, and 95th percentiles of the requirement, in percent of GDP, a percentile that reaches a requirement above 40 being printed as lying above it; the requirement at the central calibration (Table 27); and the number of the sets requiring a capacity whose requirement is at or below it. Each requirement is solved by bisection with a full model run at every trial, searched to 12 percent of GDP and, where no capacity in that range removes the crisis equilibrium, to 40; the scan that verifies a threshold at the central calibration is not repeated for the drawn sets. A dash marks an economy and regime with nothing to remove at the central calibration. Author's calculations.

	Sets requiring			Percentile of the requirement						
Economy, regime	nothing	a capacity	above 40	5th	25th	50th	75th	95th	Central	At or below it
United States, M	309	691	0	1.80	2.85	3.74	5.19	7.60	2.75	151
United States, F	320	680	0	1.76	2.82	3.70	5.16	7.62	2.67	142
United Kingdom, M	112	888	14	1.67	3.23	6.76	10.48	22.69	6.63	430
United Kingdom, F	113	887	0	1.67	2.79	4.34	6.56	12.35	4.28	435
France, M	99	901	2	1.29	2.57	4.85	6.96	13.39	4.91	459
France, F	102	898	0	1.28	2.18	3.08	4.16	6.54	3.17	475
Japan, M	332	668	0	1.10	2.28	3.29	4.80	8.90	2.31	171
Japan, F	368	632	0	1.04	1.96	2.74	3.96	6.49	1.86	142
Italy, M	407	593	4	3.33	4.94	7.20	10.52	20.56	4.70	134
Italy, F	521	479	0	3.04	4.03	5.16	6.90	10.71	—	—
Germany, M	494	506	0	1.92	2.83	3.50	4.85	9.64	2.63	101
Germany, F	773	227	0	1.60	2.07	2.51	3.24	5.49	—	—

Figure 9 shows the scan that verifies the bisection's premise. For each economy of the table and each announcement year it counts the years in which the crisis equilibrium exists, from the announcement year, at each announced capacity of a grid in steps of 0.25 percentage point of GDP up to 12 percent of GDP, which presumes nothing about the shape of the response. In every panel the count reaches zero and stays there: the set of capacities that clear the crisis is an upper set in each of the 40 cases, and each bisection's value lies within one step of the grid below the first clearing capacity of its scan. The question is posed differently for France and the United Kingdom, whose baselines are themselves on the crisis equilibrium. The United Kingdom's benign root exists in no year of the horizon and France's in none from 2032, so resolving the crisis there means making a benign equilibrium appear rather than protecting one that exists, and what the model measures for the two is the size of the requirement and not its attainability.

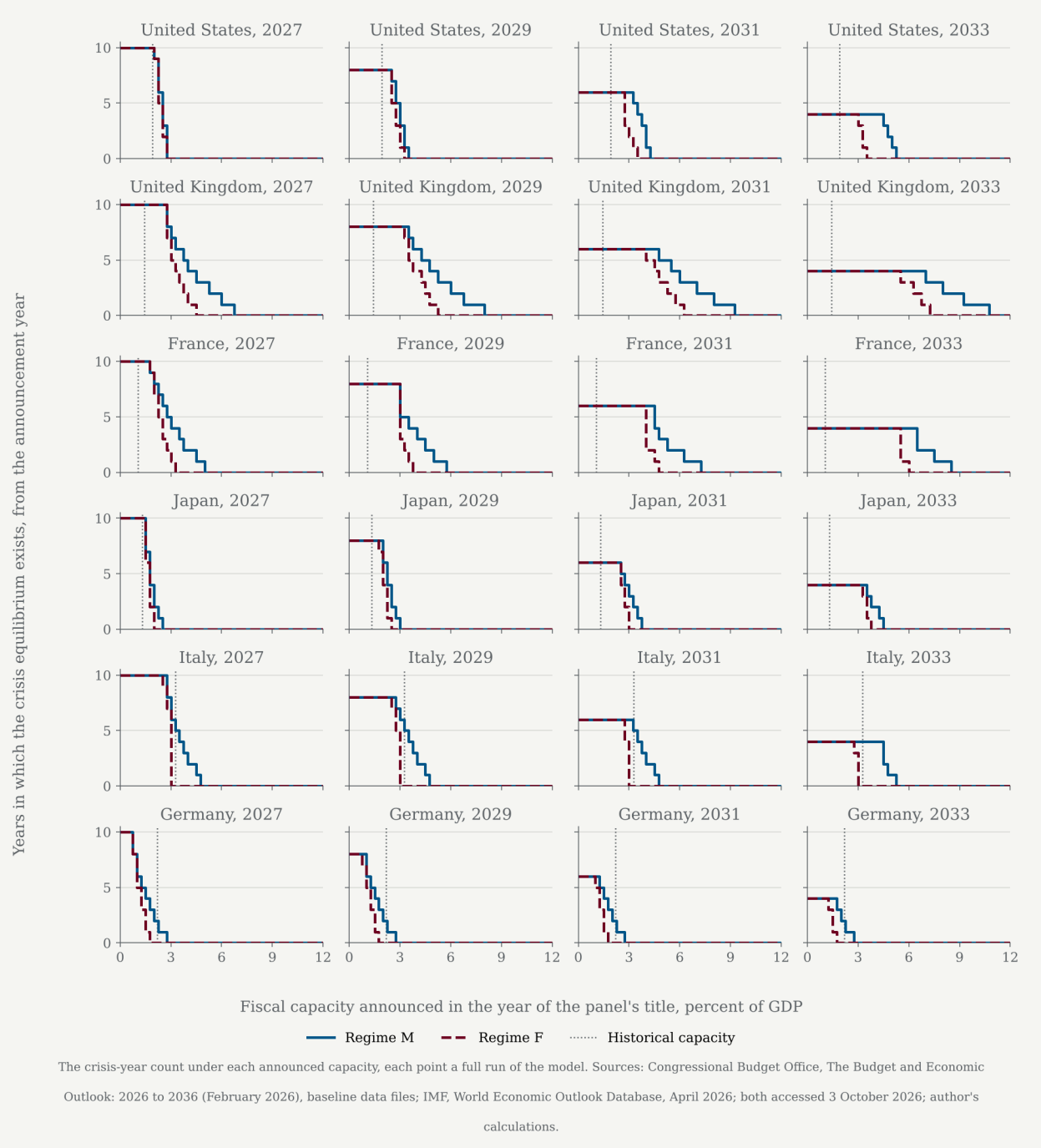


Figure 9: Years in which the crisis equilibrium exists, from the announcement year, against the fiscal capacity announced in that year, in percent of GDP: one row of panels for each economy of Table 27 and one column for each announcement year. Solid deep-blue, regime M; dashed maroon, regime F; dotted vertical, the economy's historical capacity. Each step is a full run of the model, so the limit, the yield, the debt, and the coordination decision move with the announced capacity. In every panel the capacities that leave no such year form an upper set. The panels share both scales, and the count each can reach is the years remaining in the horizon, 10 from 2027 and 4 from 2033. Sources: Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036* (February 2026), baseline data files; IMF, *World Economic Outlook Database*, April 2026; both accessed 3 October 2026; author's calculations.

4.1 The Resolution Map: Three Instruments

Table 27 solves for one instrument. What ends a crisis of this kind is whatever removes the crisis equilibrium, and the fiscal capacity is not the only quantity that reaches it: a central bank can cap the spread the sovereign pays, and the trend growth that enters the limit can be raised. Table 29 solves the same question for three instruments, for the economies of Table 27, under each regime and for each of its announcement years. Each entry is the least intervention, announced in the year shown and held, under which the crisis equilibrium exists for the economy in no year from that year onward: the smallest announced capacity, which is Table 27's figure; the largest ceiling on the sovereign spread, the loosest ceiling being the least intervention; and the smallest permanent increment to trend real growth. The ceiling is unconditional while it stands, defended by purchases without limit and without the fiscal condition of the ceilings of Section 2.8, as the Federal Reserve's peg of 1942 through 1951 and the Bank of Japan's yield curve control were; as under the ceilings of Section 2.8, a candidate spread on $[0, s^{\max}]$ sets the hazard and the hazard factor of the convenience yield, the economy pays the smaller of that spread and the ceiling at every rate it enters, the financing rate of the limit included, and the purchases absorb the remainder; for France, Italy, and Germany, whose central calibration carries the Eurosystem's conditional ceiling, the announced ceiling replaces it. The growth increment enters the year's trend and the terminal trend of the limit from the announcement, the market pricing the announced trend at once. Each entry is solved by bisection with a full model run at every trial. On a grid of 13 settings across the instrument's range the set that clears is a threshold in every one of the 144 cases, each an economy, a regime, an instrument, and an announcement year, so, to the resolution of that grid, each bisection's value is the least intervention.

Whether a ceiling removes the crisis equilibrium divides the economies. One clears the United States, Italy, and Germany in every case. A ceiling of 1.32 percentage points announced in 2027 removes the crisis equilibrium for the United States from every year under regime M, and one of 1.32 does so under regime F. Removing the crisis equilibrium and never being reached are two properties, and the first does not carry the second. A root is a crisis root where its hazard exceeds half of its bound (Section 2.5), so under a ceiling that clears no root's hazard does; the spread a hazard below that prices can still exceed the ceiling, and where it does the economy is held at the ceiling with no crisis root, the purchases carrying the excess. Of the 23 clearing ceilings of the table, 5 are not reached on the path they clear: those announced in 2029 for the United States and for Japan under either regime, and Japan's of 2031 under regime F. On those paths nothing is purchased: a crisis equilibrium in which the market prices a default that its own pricing brings about cannot form where the spread cannot rise to the level that would bring it about, and a ceiling below that level is not called upon, which is the record of the 2012 announcement that Section 2.8 cites. The other 18 are reached, the two U.S. ceilings announced in 2027 among them: two, the United States' under regime F announced in 2031 and in 2033, in the announcement year alone, and the rest in every year from a first year, none earlier than 2033, through 2036, by at most 1.99 percentage points. The figure in the table is the threshold: under a ceiling above it a crisis root exists, priced at the ceiling, and the purchases then absorb the hazard for as long as the economy stays on it. Announced later the ceiling that clears is tighter, 0.05 percentage points from 2033 under regime M and 0.89 under regime F for the United States. For Japan a ceiling clears in every case but one, regime M announced in 2033. For the United Kingdom and France no ceiling clears, at any level down to zero, in any case. They are the two economies whose baselines carry years in which the crisis equilibrium is the only one, every year of the horizon for the United Kingdom and 2032 through 2036 for France: a ceiling caps the spread the sovereign pays, and the purchases

absorb the part of the spread the hazard implies that lies above the ceiling. At a ceiling of one percentage point that part is 1.58 percentage points of spread in 2027 for the United Kingdom under regime M, rising to 3.09 by 2036. For Italy under regime F, which has nothing to remove under the Eurosystem's standing ceiling, an unconditional ceiling in that ceiling's place leaves it so at 1.84 percentage points or below and not above. Across the economies of the table a ceiling removes the crisis equilibrium only where the baseline keeps a benign one. A ceiling on the rate at which the government sells its debt is one of the remedies Calvo gives for the equilibrium at the high rate, beside indexation; in the model of Cole and Kehoe, private agents meet a peg of the interest rate by refusing to buy the government's debt.[59]

The growth increment that clears divides the economies the same way. For the United States, an increment of 0.61 percentage points of trend real growth announced in 2027 removes the crisis equilibrium from every year under regime M, and one of 0.54 does so under regime F; across the United States, Japan, Italy, and Germany, in each case with a crisis equilibrium to remove, the increment announced in 2027 is at most 0.64 percentage points. Each of these increments is larger than the AI-adoption sensitivity's increment of Section 3.7, which averages 0.16 percentage points over the horizon and does not remove the crisis root. Announced later the increment is larger in every case, for the United States 2.11 percentage points from 2033 under regime M and 1.16 under regime F, the debt of the intervening crisis years having raised what the limit must reach. For the United Kingdom and France the increment lies between 1.08 and 4.97 percentage points across their cases, more than a percentage point in every one and held in perpetuity, which is the route through the differential that this section's opening paragraphs describe: where a benign root has to be made to appear, the growth term must lift the limit above the debt at the crisis financing rate, and no trend growth path of the central calibration does that.

For every case in which an instrument removes a crisis equilibrium, the map solves for the smallest withdrawal year at which the instrument, held from the announcement and withdrawn after, still leaves the crisis equilibrium absent from the announcement year onward, and in no case is there one inside the horizon: every instrument of Table 29 must be in force through 2036, the final year solved. Since the limit it lifts is a perpetuity and what the market prices is what is announced, the instrument must hold beyond 2036 as well, which follows from the construction and is not solved.

Table 30 and Figure 10 solve the two instruments together: the smallest capacity that clears at each of five ceilings announced in 2027. For the United States, Japan, and Germany the historical capacity suffices under a tight enough ceiling: for the United States under a ceiling of 1.0 percentage points or below under either regime, for Japan under one of 1.0 percentage points or below under regime M and 1.5 under regime F, and for Germany under one of 0.5 percentage points under regime M; above it the clearing capacity rises toward the figure with no ceiling. For the United Kingdom a ceiling of 2.0 percentage points or below lowers the requirement, from 6.63 percent of GDP with no ceiling to 4.89 at half a percentage point under regime M, and no ceiling on the grid brings it to the historical capacity of 1.43. The same holds of France, whose requirement under regime M falls from 4.91 to 3.70 at half a percentage point against a historical capacity of 1.06, and of Italy under regime M, from 4.70 to 3.55 against 3.27. For France, Italy, and Germany the final column of the table, the capacity with no ceiling announced, is the capacity under the Eurosystem's standing conditional ceiling of 1.5 percentage points, which an announced ceiling replaces, and it is not the largest of the row: an announced ceiling of two percentage points or of three requires more, for France under regime F 3.69 percent of GDP and 3.94 against 3.17 in that column. Under

[59] Calvo, "Servicing the Public Debt," 653, 657, and 659; Cole and Kehoe, "Self-Fulfilling Debt Crises."

regime F Italy and Germany have nothing to remove under the standing ceiling; in its place an unconditional ceiling of two percentage points would require of Italy a capacity of 3.41 percent of GDP and one of three percentage points 3.63, against its historical 3.27, and would require of Germany no more than its record.

Table 29: The resolution map: the least intervention, announced in the year shown and held, under which the crisis equilibrium exists for the economy in no year from that year onward, for each of three instruments—the announced fiscal capacity of Table 27, an unconditional ceiling on the sovereign spread defended by central-bank purchases, and a permanent increment to trend real growth entering the fiscal limit—by economy and regime. Each value is solved by bisection with a full model run at every trial, after a scan of the instrument's range confirms that the clear set is a threshold. Values are reported at two decimals on the clearing side of the solved threshold. *none*: no ceiling clears, down to zero. A dash in a row of settings marks a case with nothing to remove (Table 27). For Italy under regime F, which has nothing to remove under the Eurosystem's standing ceiling, the ceiling shown is the largest unconditional ceiling that leaves it so in the standing ceiling's place. The second column is the historical capacity, the largest 10-year average primary surplus on the economy's record (Table 7). Author's calculations.

Economy, regime	Record	From 2027	From 2029	From 2031	From 2033
Announced fiscal capacity, percent of GDP (smallest that clears)					
United States, M	1.91	2.75	3.32	4.10	5.06
United States, F	1.91	2.67	3.04	3.30	3.40
United Kingdom, M	1.43	6.63	7.76	9.09	10.51
United Kingdom, F	1.43	4.28	5.13	6.14	7.24
France, M	1.06	4.91	5.71	7.01	8.47
France, F	1.06	3.17	3.71	4.73	5.88
Japan, M	1.31	2.31	2.84	3.58	4.39
Japan, F	1.31	1.86	2.32	2.97	3.70
Italy, M	3.27	4.70	4.70	4.70	5.08
Italy, F	3.27	—	—	—	—
Germany, M	2.18	2.63	2.63	2.63	2.63
Germany, F	2.18	—	—	—	—
Unconditional ceiling on the sovereign spread, percentage points (largest that clears)					
United States, M	—	1.32	1.02	0.52	0.05
United States, F	—	1.32	1.10	0.93	0.89
United Kingdom, M	—	none	none	none	none
United Kingdom, F	—	none	none	none	none
France, M	—	none	none	none	none
France, F	—	none	none	none	none
Japan, M	—	1.28	0.81	0.24	none
Japan, F	—	1.87	1.41	0.85	0.32
Italy, M	—	0.28	0.28	0.28	0.07
Italy, F	—	1.84	1.84	1.84	1.84
Germany, M	—	0.78	0.78	0.78	0.78
Germany, F	—	—	—	—	—
Permanent increment to trend real growth, percentage points (smallest that clears)					
United States, M	—	0.61	1.00	1.51	2.11
United States, F	—	0.54	0.81	1.02	1.16
United Kingdom, M	—	3.01	3.56	4.21	4.97
United Kingdom, F	—	1.87	2.36	2.93	3.58
France, M	—	1.92	2.23	2.86	3.88
France, F	—	1.08	1.83	2.49	3.26
Japan, M	—	0.64	0.94	1.32	1.74
Japan, F	—	0.37	0.65	1.02	1.41
Italy, M	—	0.63	0.68	0.74	0.99
Italy, F	—	—	—	—	—
Germany, M	—	0.35	0.37	0.38	0.41
Germany, F	—	—	—	—	—

Table 30: The combination of the two instruments: the smallest announced fiscal capacity, in percent of GDP, under which the crisis equilibrium exists for the economy in no year from 2027 onward when an unconditional ceiling on its sovereign spread of the size shown, in percentage points, is announced in the same year and held. The second column is the historical capacity; the final one is the capacity that clears with no ceiling announced (Table 29), which for France, Italy, and Germany, whose central calibration carries the Eurosystem's conditional ceiling of 1.5 percentage points, is the capacity under that ceiling; an announced ceiling replaces it. Values are reported at two decimals on the clearing side of the solved threshold; a value equal to the historical capacity marks a ceiling under which no higher capacity is needed. A dash in the final column marks a case with nothing to remove under the standing ceiling; its row is what an unconditional ceiling in that ceiling's place requires. A dash marks a case with nothing to remove (Table 27). Author's calculations.

Economy, regime	Record	0.5	1.0	1.5	2.0	3.0	No ceiling
United States, M	1.91	1.91	1.91	2.05	2.49	2.75	2.75
United States, F	1.91	1.91	1.91	2.05	2.49	2.67	2.67
United Kingdom, M	1.43	4.89	5.48	6.01	6.58	6.63	6.63
United Kingdom, F	1.43	2.69	3.25	3.75	4.21	4.28	4.28
France, M	1.06	3.70	4.35	4.91	5.55	5.66	4.91
France, F	1.06	1.97	2.56	3.17	3.69	3.94	3.17
Japan, M	1.31	1.31	1.31	1.50	1.95	2.30	2.31
Japan, F	1.31	1.31	1.31	1.31	1.42	1.85	1.86
Italy, M	3.27	3.55	4.15	4.70	5.31	5.40	4.70
Italy, F	3.27	3.27	3.27	3.27	3.41	3.63	—
Germany, M	2.18	2.18	2.31	2.63	2.96	2.99	2.63
Germany, F	2.18	2.18	2.18	2.18	2.18	2.18	—

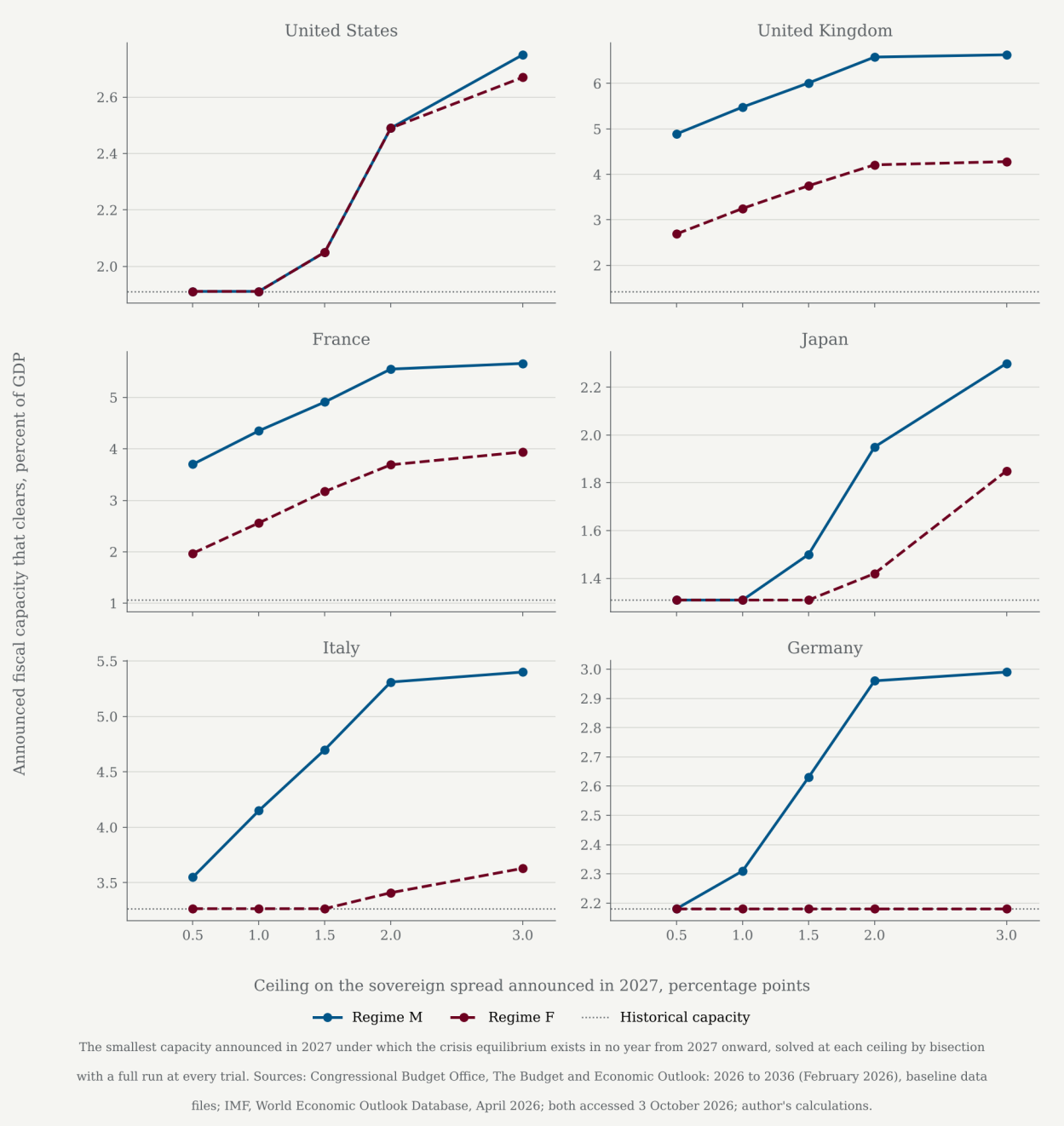


Figure 10: The two instruments together, one panel for each economy of Table 30: the smallest fiscal capacity announced in 2027, in percent of GDP, under which the crisis equilibrium exists for the economy in no year from 2027 onward, against the ceiling on its sovereign spread announced in the same year, in percentage points. Solid deep-blue, regime M; dashed maroon, regime F; dotted horizontal, the historical capacity. Each point is solved by bisection with a full model run at every trial. The vertical scales differ across the panels. Sources: Congressional Budget Office, *The Budget and Economic Outlook: 2026 to 2036* (February 2026), baseline data files; IMF, *World Economic Outlook Database*, April 2026; both accessed 3 October 2026; author's calculations.

Every figure of the map is announced and priced, not delivered. An announced capacity replaces $pb_i^{\max}$ in the ceiling of the fiscal rule and in the limit; on the cleared path the rule's balance does

not reach that ceiling, so the capacity is a statement the market believes, and the consolidation it names is not delivered on the path it clears. The distance of the statement from the projected path, the *swing*, is the consolidation the announcement would have to make credible: from a projected primary balance of −2.34 percent of GDP in 2027 to an announced capacity of 2.75, 5.09 percentage points of GDP for the United States under regime M, and across the economies of Table 32 from 3.91 percentage points of GDP for Italy through 7.86 for the United Kingdom.

The delivered reading, in which the balance moves and output responds through β_f, poses a different question about the surplus. Under it the government delivers a primary balance of at least the setting from the announcement year, the fiscal rule's balance being floored there, and the limit prices the *earned capacity*, the capacity that the definition of Section 2.9 gives on the record extended by the delivered balances: the largest 10-year average of the capacity's own historical series, joined with the balances delivered through the previous year. Nothing moves the limit before a surplus has been delivered, so where the crisis equilibrium exists in the announcement year a delivered balance can remove it from that year only through that year's debt, and the question posed of the announced instruments may have no answer at any setting. Table 31 therefore reports the answer year by year: for each year from the announcement through 2036, the least delivered balance under which the crisis equilibrium exists in no year from that year onward. The column of the announcement year is the map's own question. For the announced instruments the same curve is flat in each of their 204 cases and combinations: the setting that removes the crisis equilibrium from a later year is the setting that removes it from the announcement year.

Delivered from 2027, a balance removes the crisis equilibrium from every year for the United States, Japan, Italy, and Germany and for no other economy of the table. For the United States, whose crisis begins in that year, it is a primary surplus of 1.64 percent of GDP under regime M and of 0.46 under regime F, where the announced reading requires a capacity of 2.75 and 2.67. Either balance lies below the historical capacity and so adds nothing to the earned capacity: the limit stays at its value on the historical capacity, and the delivered balance acts through the debt alone. For Japan the balance is a surplus of 6.35 percent of GDP under regime M and 6.08 under regime F, against a historical capacity of 1.31. For Italy and Germany, whose crises under regime M begin after 2027, a balance delivered from an announcement year that precedes the onset removes the crisis equilibrium as well: for Italy a surplus of 2.80 percent of GDP from 2027, 3.93 from 2029, and 7.28 from 2031, and for Germany a primary deficit held to 2.61 percent of GDP from 2027 and to 0.56 from 2033. After the onset a smaller surplus removes the crisis equilibrium from a later year. Delivered from 2031 under regime M, no U.S. balance of the search, which reaches 12 percent of GDP, removes the crisis equilibrium before 2035; a surplus of 11.31 percent of GDP removes it from that year onward, and one of 8.77 from 2036. Under regime F a surplus of 7.19 removes it from 2033 onward and one of 1.99 from 2036. For the United Kingdom and France no delivered balance inside the model's domain, in which the net debt stays positive, removes the crisis equilibrium from the announcement year; delivered from 2027, the first year from which one removes it is 2031 for either economy under either regime, and a surplus of 3.36 through 4.58 percent of GDP removes it from 2036. A delivered balance need not be held as an announced instrument must. The U.S. surplus of 1.64 percent of GDP under regime M, delivered for four years and withdrawn from 2031, leaves the crisis equilibrium absent through the horizon, the debt it retired staying retired, the U.S. surplus under regime F can be withdrawn from 2033, after six years, Japan's surpluses from 2030 under either regime, and Italy's, delivered from 2031 under regime M, from 2036, the final year of the horizon, after five years.

Table 31: The delivered primary surplus, in percent of GDP, under which the crisis equilibrium exists for the economy in no year from each year shown onward, when the government delivers at least that balance from the announcement year of the row and the fiscal limit rests on the capacity earned on the delivered record. A negative value is a cap on the primary deficit. Each value is solved by bisection with a full model run at every trial. Values are reported at two decimals on the clearing side of the solved threshold. *none*: no delivered balance up to 12 percent of GDP, the bound of the search, and inside the model's domain, in which the net debt stays positive, removes the crisis equilibrium by that year. A dash marks a year before the announcement. Author's calculations.

Economy, regime, from	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
United States, M, 2027	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
United States, M, 2031	—	—	—	—	none	none	none	none	11.31	8.77
United States, F, 2027	0.46	0.46	0.46	0.46	0.46	0.46	0.16	−0.04	−0.12	−0.13
United States, F, 2031	—	—	—	—	none	none	7.19	4.42	2.88	1.99
United Kingdom, M, 2027	none	none	none	none	9.65	7.33	6.36	5.50	4.91	4.58
United Kingdom, M, 2031	—	—	—	—	none	none	none	none	none	none
United Kingdom, F, 2027	none	none	none	none	8.93	6.55	5.54	4.60	3.93	3.52
United Kingdom, F, 2031	—	—	—	—	none	none	none	none	none	9.80
France, M, 2027	none	none	none	none	10.03	7.46	6.15	5.23	4.60	4.23
France, M, 2031	—	—	—	—	none	none	none	none	none	none
France, F, 2027	none	none	none	none	9.47	6.86	5.50	4.52	3.81	3.36
France, F, 2031	—	—	—	—	none	none	none	none	none	10.82
Japan, M, 2027	6.35	6.35	6.35	6.35	6.35	5.00	3.85	3.26	2.91	2.72
Japan, M, 2031	—	—	—	—	none	none	none	none	10.50	8.47
Japan, F, 2027	6.08	6.08	6.08	6.08	5.88	4.74	3.58	2.97	2.59	2.38
Japan, F, 2031	—	—	—	—	none	none	none	none	9.57	7.62
Italy, M, 2027	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80
Italy, M, 2031	—	—	—	—	7.28	7.28	7.28	7.28	7.28	7.20
Italy, F, 2027	—	—	—	—	—	—	—	—	—	—
Italy, F, 2031	—	—	—	—	—	—	—	—	—	—
Germany, M, 2027	−2.61	−2.61	−2.61	−2.61	−2.61	−2.61	−2.61	−2.61	−2.61	−2.61
Germany, M, 2031	—	—	—	—	−2.08	−2.08	−2.08	−2.08	−2.08	−2.08
Germany, F, 2027	—	—	—	—	—	—	—	—	—	—
Germany, F, 2031	—	—	—	—	—	—	—	—	—	—

Table 32 sets the swing against the revenue and expenditure base, as arithmetic on the sources rather than as a result of the model. For the United States the swing from the projected balance to the requirement under regime M, 5.09 percentage points of GDP, is 16.7 percent of the general government revenue of 2027 and 13.4 percent of its expenditure, on the April 2026 WEO's shares of 30.5 and 37.9 percent of GDP, and 1,720 billion dollars a year at that year's nominal GDP. Across the economies of the table the swing is 8.2 percent of revenue for Italy through 19.2 for the United Kingdom. The swing to the historical capacity alone is 4.25 percentage points of GDP for the United States. How the swing would divide between revenue and outlays is the government's choice, and the record of how surpluses of the size were reached is Section 4.2's, in the sources' own terms.

Table 32: The swing the map's first instrument names, against the revenue and expenditure base. In percent of GDP: the primary balance of 2027 on the hazard-free path, the historical capacity, and the capacity that clears when announced in 2027 under regime M (Table 29); the swing from the projected balance to each, in percentage points of GDP; the general government revenue and expenditure (outlays) of 2027, IMF World Economic Outlook database, April 2026; and the swing to the requirement in percent of that revenue and of that expenditure. The shares are on the general government basis of the WEO, while the model's U.S. balance is the federal one of the CBO. Every figure is announced and priced; the table states what a swing of the size would be against the base, not that it is delivered or how it would be split. Author's calculations.

Economy	Balance 2027	Record	Required	Swing to record	Swing to required	Revenue	Outlays	Swing, % of revenue	Swing, % of outlays
United States	−2.34	1.91	2.75	4.25	5.09	30.5	37.9	16.7	13.4
United Kingdom	−1.23	1.43	6.63	2.66	7.86	40.9	44.1	19.2	17.8
France	−2.71	1.06	4.91	3.77	7.62	52.6	57.4	14.5	13.3
Japan	−1.74	1.31	2.31	3.05	4.05	35.5	37.9	11.4	10.7
Italy	0.79	3.27	4.70	2.48	3.91	47.8	50.4	8.2	7.8
Germany	−2.83	2.18	2.63	5.02	5.46	47.8	52.1	11.4	10.5

4.2 The Requirement against the Historical Record

The resolving capacity is a quantity the model requires; whether governments have sustained such surpluses is a question for the record, and the record has been enumerated. Eichengreen and Panizza count non-overlapping episodes of large primary surpluses across high-income and middle-income economies from 1974 through 2013. Of 113 non-overlapping 10-year episodes, 12 carry an average primary surplus of at least 3 percent of GDP, five carry at least 4 percent, and three carry at least 5 percent.[60] Table 33 sets the requirement announced in 2027 against that enumeration and against each economy's historical capacity. For the United States, Japan, and Germany the requirement lies below the least demanding of those thresholds under each regime that carries one, which 12 of the 113 10-year episodes meet. For France and Italy it lies between 4 and 5 percent of GDP under regime M, the former a threshold five of the 113 meet; under regime F France's lies between 3 and 4, and Italy has none. For the United Kingdom it lies at or above the most demanding under regime M, which three of the 113 meet, and between 4 and 5 percent of GDP under regime F. Delay moves the United States across the thresholds: its requirement is at least 3 percent of GDP from the announcement of 2029 under either regime and at least 5 percent from that of 2033 under regime M.

[60] Eichengreen and Panizza, "A Surplus of Ambition"; the enumeration is that of the working-paper version, NBER Working Paper 20316, Tables 3 and 5. The five-year enumeration in the same source counts 36 episodes at 3 percent or more, 18 at 4 percent, and 12 at 5 percent, out of 235 non-overlapping five-year periods.

Table 33: The requirement announced in 2027 against the record, by economy, in percent of GDP: the historical capacity (Table 7); the resolving capacity under each regime (Table 27); the requirement less the historical capacity, in percentage points of GDP; and the highest of the three thresholds of Eichengreen and Panizza's enumeration, 3, 4, and 5 percent of GDP, that lies at or below the requirement, *none* where the requirement lies below 3 percent. Of the 113 non-overlapping 10-year episodes of that enumeration, 12 carry an average primary surplus of at least 3 percent of GDP, five at least 4 percent, and three at least 5 percent. A dash marks a regime with nothing to remove. Sources: Eichengreen and Panizza (2016) for the enumeration; author's calculations.

		Required		Required less record		Threshold reached	
Economy	Record	Regime M	Regime F	Regime M	Regime F	Regime M	Regime F
United States	1.91	2.75	2.67	0.84	0.76	none	none
United Kingdom	1.43	6.63	4.28	5.20	2.85	5	4
France	1.06	4.91	3.17	3.85	2.11	4	3
Japan	1.31	2.31	1.86	1.00	0.55	none	none
Italy	3.27	4.70	—	1.43	—	4	—
Germany	2.18	2.63	—	0.45	—	none	—

The distance between a historical capacity and a requirement can be read for all seven economies from Table 7, whose final three columns give the capacity at or below which an economy carries a year on the crisis equilibrium when its capacity is set to that value from 2027. Under each regime that threshold and the requirement announced in 2027 are one quantity read from two sides, the largest capacity that leaves a crisis year and the smallest that leaves no crisis equilibrium, and for the economies of Table 27 the two differ by at most 0.002 percentage point of GDP before rounding. The thresholds add what the resolution does not cover. Germany and Italy lie on the crisis side of their thresholds under regime M, by 0.45 and 1.43 percentage points of GDP, and on the other side under regime F, by 0.56 and 0.28. The smallest margin of the seven economies under either regime is Italy's under regime F, 0.28 percentage point of GDP of capacity. A capacity is also a reading of a record. With no receipt from abroad excluded Germany's is 3.40 percent of GDP (Table 7), above the 2.63 at or below which it carries a crisis year under regime M, so that Germany's crisis years under that regime depend on the exclusion. In the baseline, which carries no sunspot and no U.S. crisis, the thresholds of France and the United Kingdom are 1.72 and 2.49 percent of GDP, above their historical capacities of 1.06 and 1.43 and below their requirements of 4.91 and 6.63 under regime M: the requirement of Table 27 is the capacity that removes the crisis equilibrium beside a U.S. crisis and under the common sunspot, and the baseline's threshold is the capacity above which the economy stays off the crisis equilibrium without either. Each threshold moves one economy's capacity with every other input at its central value, and a capacity set from the first year of the horizon is not an announced one.

Great Britain averaged a primary surplus of 1.6 percent of GDP for nearly a century after 1815, a period throughout which it held the position of the world's safe-asset supplier, and the United States ran primary surpluses for five decades after 1865.[61] The U.S. requirement announced in 2027 under regime M is 72 percent above the British average, and the model requires it as a standing capacity rather than for a decade: the limit is a perpetuity, so the capacity that lifts it is the surplus a government could sustain indefinitely, not one it delivers for 10 years. Those authors attribute the British episode to the influence of creditors in Parliament, a franchise that was not yet universal, contemporary perceptions of the role of government that limited pressure for public

[61] Eichengreen, El-Ganainy, Esteves, and Mitchener, "Public Debt Through the Ages," 24, 48.

programs and transfers, and the absence of a comparable war between 1815 and 1914. Eichengreen and Panizza, separately, estimate the correlates of a surplus episode: it is more likely where growth is strong, where the current account is in surplus, where the debt ratio is high, and where the governing party controls all legislative houses. This paper reports those findings and does not assess whether the conditions they name obtain in any economy today. What does not follow from the counts is a probability that any economy would meet the requirement: the sample is 113 episodes drawn from many economies, so the counts state what the record contains and not a rate at which a given government would deliver.

Eichengreen and Esteves, on a panel of debt consolidations spanning 220 years and 183 nations, find that the contribution of inflation to consolidation was largest where interest rates failed to keep pace with it, that the frequency of successful consolidation was lower in periods of relatively high inflation, when rates caught up, and that under the classical gold standard and between the wars primary surpluses and growth were the more important routes.[62] In regime F of this model the marginal rate keeps pace with inflation and the rate on the stock does not: the nominal 10-year yield reaches 13.5 percent against an inflation of 9.9, while the effective rate reprices only at the rate $1/m$ and stays below nominal growth in every year (Section 3.4), and the limit, a real object, falls further with the inflation risk premium the inflation adds to its long leg. Table 27 reports what the price-level adjustment does to the requirement: the U.S. resolving capacity under the two regimes is within 0.08 percentage point of GDP for an announcement in the onset year, and for a later one the price-level adjustment lowers the requirement by at most 1.66 percentage points of GDP without removing it.

4.3 The Loss of the Safe-Asset Position and the Record of the Prior Suppliers

The convenience yield of equation (7) is the safe-asset property priced: it is the premium the marginal investor pays for the security's safety and liquidity, it enters the U.S. financing rate directly, and equation (7) makes it erode as debt rises and vanish as the debt loses that property. Whether such a premium can be lost is therefore a question about a parameter of the model, and the record of two economies bears on it. Each was the dominant supplier of a safe asset, each lost that position, and each thereafter carried a debt within its estimated fiscal backing. Chen, Jiang, Lustig, Van Nieuwerburgh, and Xiaolan measure the fiscal backing of the province of Holland, of the United Kingdom, and of the United States across three centuries as the present value of primary surpluses and of the seigniorage revenue the convenience yield earns, discounted at the return on a claim to output, and set it against the market value of the debt.[63]

Table 34 reports their estimates, which describe the province of Holland as a "local" supplier. On those estimates, in the position of dominant supplier each issuer's debt stood above its backing, and the seigniorage from the measured convenience yield does not close the distance: the estimated backing is 63.32 percent of Holland's debt from 1601 through 1794, 70.93 percent of the United Kingdom's from 1729 through 1914, and 31.93 percent of the United States' from 1947 through

[62] Eichengreen and Esteves, "Up and Away?"

[63] Zefeng Chen, Zhengyang Jiang, Hanno Lustig, Stijn Van Nieuwerburgh, and Mindy Z. Xiaolan, "Exorbitant Privilege Gained and Lost: Fiscal Implications," *Journal of Political Economy* 133, no. 12 (2025): 3713–3761. Their present values are computed from a vector autoregression in macroeconomic and financial state variables and are not the fiscal limit of equation (4): the limit capitalizes the largest primary surplus the record shows an economy sustaining, at the real marginal financing rate against the terminal real trend, while their measure capitalizes the surplus path the autoregression projects, at the return on output. The comparison the two draw is the same one, a debt against the present value of what backs it.

2020, the final one on an average debt of 40.09 percent of GDP. After the loss the relation reverses. The Netherlands over the 98 years from 1817 through 1914, which follow a default on the Dutch debt in 1810 that the source records, carried a debt of 59.13 percent of GDP against an estimated backing of 102.41 percent of it, the convenience yield gone and the average primary surplus at 3.33 percent of GDP against 2.39 for the province of Holland before it; the United Kingdom over the 74 years from 1947 through 2020 carried an estimated backing of 159.60 percent of its debt at a surplus of 1.77 percent of GDP.

Three readings of this record bear on the results above. The first is the level and the duration of the requirement. The U.S. resolving capacity announced in 2027, 2.75 percent of GDP under regime M and 2.67 under regime F, held as a standing surplus, lies above the United Kingdom's post-1947 average of 1.77 and below the Netherlands' post-1817 average of 3.33; announced from 2031 under regime M, or from 2033 under regime F, it lies above both. Beside these stand a U.S. historical capacity of 1.91 and a U.S. average primary surplus over 1947 through 2020 of 0.05 percent of GDP. The limit of equation (4) is a perpetuity, so the capacity that lifts it is a surplus held indefinitely, and the two post-loss episodes ran 98 and 74 years.

The second is that, on those estimates, the convenience yield of equation (7) is not the whole of what a supplier loses. The 0.25 percentage points the model carries enter the yield and, through the marginal financing rate, the limit. The estimates above are of a distance between debt and backing that the seigniorage from a measured convenience yield of 0.56 through 1.50 percentage points does not close, and that distance moved with the position rather than with the measured yield. The estimates are of the source's fiscal backing and not of the limit of equation (4), so the record does not measure a fall in the limit to set beside the one the model prices when the convenience yield is lost.

The third is that the two constructions carry different objects under one name. The convenience yield of equation (7) is a price formed within the period: it scales with the hazard the candidate spread carries, falls to nearly nothing on the crisis root, returns on the low root, and retains nothing from the year before. What the estimates above measure is a position, the concentration of investors on one issuer, and on the record the position passed from the Dutch issuer to the United Kingdom and from the United Kingdom to the United States. This model prices each issuer's debt against its own capacity and carries no rival for a position to move to, so it represents the price and not the position; the resolution in the model restores the price. Neither prior supplier regained the position. Whether the loss of the price should be permanent in the same way is carried as a sensitivity. In a variant in which the convenience yield is not restored after the first year the United States spends on the crisis equilibrium, the limit discounts at a higher real rate from that year onward, and the resolving capacity rises where the consolidation follows the onset, which every announcement after 2027 does: under regime M from 3.32 to 3.48 percent of GDP announced in 2029, from 4.10 to 4.24 in 2031, and from 5.06 to 5.17 in 2033, and under regime F from 3.04 to 3.20, from 3.30 to 3.44, and from 3.40 to 3.50, a rise of at most 0.16 percentage points of GDP. The announcement of 2027 takes effect in the onset year of either regime, 2027, and at the capacity it requires the United States spends no year on the crisis equilibrium, so the convenience yield is never lost, and the requirement is the one Table 27 reports.

What the record does not establish is a rate. The record holds two losses of the position, the first dated 1794 and the second 1914, 120 years later. Those authors attribute both losses to a deterioration in the supplier's fiscal fundamentals relative to a rival's, and read the position as one investors concentrate on a single issuer; this paper reports that attribution as they state it and does not assess whether the conditions it names obtain anywhere at present.

Table 34: Fiscal backing of the three dominant suppliers of a safe asset, the province of Holland a "local" one in the source's terms, before and after the loss of that position. The average primary surplus and the average market value of the debt are in percent of GDP; the convenience yield is in percentage points; the final column is the present value of primary surpluses and of the seigniorage revenue from the convenience yield, in percent of the market value of the debt, so a value under 100 is a debt exceeding its fiscal backing. The present values are computed from a vector autoregression in macroeconomic and financial state variables, discounted at the return on a claim to output. Source: Chen, Jiang, Lustig, Van Nieuwerburgh, and Xiaolan (2025), Tables 3 and 5, sample averages of the dynamic estimates.

Issuer and period	Primary surplus	Convenience yield	Debt	Backed
As the dominant supplier of the safe asset				
Province of Holland, 1601–1794	2.39	1.50	118.89	63.32
United Kingdom, 1729–1914	2.39	0.69	86.45	70.93
United States, 1947–2020	0.05	0.56	40.09	31.93
After the loss of that position				
The Netherlands, 1817–1914	3.33	0.00	59.13	102.41
United Kingdom, 1947–2020	1.77	0.00	53.55	159.60

5 Limitations

The reading of the results is subject to 14 limitations. First, the fiscal capacity is a statistic read under conventions, and the results move with each of them. The corner boundary of the crisis zone is proportional to the capacity: the U.S. corner boundary moves from 83 to 138 percent of GDP as the capacity moves from 3 to 5 percent. The capacity is the largest 10-year average on a long record, an extreme statistic, and the U.S. estimate of 1.91 rests on one episode, 1993 through 2002, on the federal record, which is the perimeter of the debt held by the public and not the general government perimeter on which the other six are read. The first year of the reading, 1950, is a convention (Table 9). The windows of Germany and the United Kingdom open their readings, so their capacities fall as the first year moves later: read from 1955, Germany's is 1.44 percent of GDP against 2.18 and the United Kingdom's 1.12 against 1.43, and read from 1948, the first year of its record, the United Kingdom's is 1.94. The same two readings are lower bounds on the balance before net interest in the years of their windows: Germany's source does not separate interest received from other property income, all of which is deducted, and the United Kingdom's record nets the local authorities' imputed rental income with interest in those years. Every receipt from abroad that a source identifies is excluded from the balance (Table 8), which lowers Germany's capacity by 1.22 percentage points of GDP, the United Kingdom's by 0.53, and no other by more than 0.07; a year in which no source consulted identifies such a receipt is read as carrying none. China has no long record, and its capacity is scaled from revenue, a construction rather than an observation, which the addendum takes up.

What those conventions decide is read from Table 7, which gives the largest capacity at which each economy carries a year on the crisis equilibrium when its capacity alone is moved. In 8 of the 20 cells that have such a threshold, the capacity of record lies within 1.0 percentage point of GDP of it, the half-width of the capacity draw. The nearest is Italy's under regime F: at its capacity of 3.27 percent of GDP it carries no crisis year under that regime, and at 2.98 it would carry one, a distance of 0.28 percentage point of GDP; its capacity with nothing excluded, 3.31, lies on the same side. Germany's position depends on the reading. At 2.18 it carries crisis years under regime M and

none under regime F; read from 1955, at 1.44, it lies below the 1.62 at which it also carries one under regime F; with nothing excluded, at 3.40, it lies above the 2.63 at which it carries one under regime M; and with the capital transfers excluded and the current receipts left in, its reading equals that threshold to the second decimal, 2.63. For the United Kingdom and France the conventions do not decide the baseline result: every reading of either, by first year or with nothing excluded, lies below the capacity at which its baseline carries a crisis year, 2.49 and 1.72 percent of GDP. Each threshold moves one economy's capacity with every other input at its central value, and the half-width of the draw is a convenience and not a measure of the statistic's uncertainty.

Second, the Eurosystem's backstop is carried as a spread ceiling with two conditions that stand in for the instrument's criteria; its record is of announcements that were not tested by purchases at scale, and the level of the ceiling, the tolerance of the first condition, and the form of the second are assumptions, so the results for Germany, France, and Italy depend on them. On the deterministic path of regime M the ceiling holds France's spread at 1.5 percentage points in 2027, Italy's in 2031 and 2032, and Germany's in 2034 and 2035, and it is withdrawn in 2028, 2033, and 2036, the debt of the year before standing above the limit at the capped rate, after which the three spreads stand at 4.2, 4.1, and 3.4 percentage points in 2036. The first condition fails in no year of those paths, so its tolerance of 1 percentage point of GDP, which the one-at-a-time test of the twelfth limitation does not vary, decides none of them; the year of each withdrawal is set by the second condition, which adds no parameter and moves with the fiscal limit. The Bank of Japan carries no ceiling in the central calibration, its instrument having been withdrawn, and Japan's results depend on that classification: the variant with a defended ceiling of 1.0 percentage points leaves Japan with no year on the crisis equilibrium under regime M, in place of every year, and lowers its share of paths with a crisis year by 17.3 percentage points.

Third, the hazard is bounded and saturates, so the high root lies close to the bound on the spread, and the severity of a crisis is set by two parameters, the bound on the default hazard and the loss given default. The multiplicity itself comes through the discounting of the limit: the rate side of equation (4) carries the candidate spread on the market-held stock, so a higher spread lowers the limit against which the hazard is assessed. With the limit formed without that spread, the U.S. period map of 2027 has the benign solution alone (Table 13), and on whole paths formed that way no G7 economy carries a year on the crisis equilibrium in the baseline or under either regime, the United Kingdom's 2036 apart (Table 14). Every crisis year the paper reports is conditional on that construction of the limit. The limit is a present value at the differential between the real marginal financing rate and trend growth, so it rises without bound as that differential approaches zero: where the rate lies close to the terminal real trend, as it does under a ceiling that caps it, the capitalized value is a division by a quantity smaller than the uncertainty on either of its terms, and what the model determines in those cases is whether the crisis root exists and not the level the perpetuity returns; the corner boundary of Japan under the variant's ceiling, 819 percent of GDP, is of that kind. The rate side reads each economy's neutral rate at one estimated level, which is not drawn, and its long leg carries the long-rate residual, which reproduces the 2026 yield, holds the term premium and, for France and Italy, their 2026 spreads over the German yield, and is held over the horizon but for its response to debt, so the limit capitalizes that residual in perpetuity, on a larger part of the stock the lower the share that pays the short rate. The corner boundaries of Section 3.1 carry the sensitivity to the neutral rate: a rise of half a percentage point lowers them by 1 through 7 percentage points of GDP and a fall of half a percentage point raises them by 1 through 9, against published uncertainty on the neutral rate wider than half a percentage point. The probability of the sunspot is not priced on the benign root: the spread compensates for the hazard of the root the economy is on, so a holder on the benign root is not compensated for the

chance that the market coordinates on the crisis root, as a holder is in the bond price of Cole and Kehoe inside their zone. Maturity enters the debt path and not the limit or the corner condition: the fraction $1/m_i$ of the stock that reprices in a year sets how fast the effective rate and the debt move on the crisis root, while the limit and equation (8) compare the interest bill on the whole stock at the marginal rate with the capacity; in Cole and Kehoe a long enough maturity removes the crisis for any debt in their one-period zone, so that maturity decides whether the crisis exists.[64]

Fourth, the price-level adjustment of regime F is the slow form with long-maturity debt, and the regime's inflation depends on the gap between debt and the capitalized fiscal capacity, which under the central calibration requires inflation of 9.9 percent by 2036; a regime in which the central bank monetizes the deficit directly produces more inflation and less default risk, and the two are different models under the same label.

Fifth, the response of the primary balance to debt is set to zero as an assumption, because the record separates it from neither zero nor a positive value: the pooled coefficient is -0.008 (standard error 0.020) on 1963 through 2022 and 0.046 (0.029) on 1963 through 2007, and on neither sample does the wild cluster bootstrap reject zero or 0.04 at a level of 0.05 (Table 3). With the response at the estimate through 2007, 0.0463 to four decimals, the years on the crisis equilibrium change in one cell of Table 23, Germany's under regime M, 2036 in place of 2035 and 2036, and U.S. debt under regime M ends 2036 at 186.9 percent of GDP in place of 195.1. The historical moments beside which the model is read carry a limit of their own. The interest-growth moments and the full-sample pass-through estimates of Table 6 and the U.S. regression of Table 2 rest on the JST release 6, whose proxied primary balance exceeds the OECD's by 0.9 through 2.1 percentage points of GDP on average for six of the economies and by 5.6 for the United Kingdom; the regression is reconciled against the OECD and Office of Management and Budget series, the moments and the full-sample pass-through are not, and the pass-through the model carries is the OECD's under inflation targeting.

Sixth, the model carries no exchange rate, and each economy's real exchange rate against the dollar is taken to stay on its hazard-free path. Were a sovereign crisis to depreciate the currency of an economy that borrows in its own currency, as a crisis risk premium implies, the depreciation would raise its output and inflation and lower its debt ratio, so on that channel the omission errs toward severity for an economy in crisis: in the central scenario, France, the United Kingdom, and Japan under either regime and Germany and Italy under regime M. Three of those economies share a currency, so for them the channel as stated runs through the area's exchange rate and not through a member's own. For the dollar in a crisis of the issuer of the safe asset the record of flights to the dollar does not cover the case, and the direction is open. The U.S. equations carry no exchange rate, so no U.S. result depends on the omission.

Seventh, the debt is read at one date and on one perimeter. The net-debt reading nets the government's financial assets at the values the IMF reports, which for Canada and Japan are large relative to the gross stock; the model does not carry the liquidity or the pledgeability of those assets in a crisis, so it reads the net figure as if the assets could be sold at par. The condition under which the cost of the debt applies to the net stock, stated in Section 2.1, rests on a return the model does not carry as a variable, so in a year when a crisis raises that cost without raising the assets' return the modeled net-debt path understates the rise. The composition of the debt, the share of the market-held stock that pays the short rate and the share the central bank holds, is measured at 31 December 2025 and held over the horizon (Table 4). The measured stock is the central government's and stands for the general government debt the model carries; the central banks' shares are each on

[64] Cole and Kehoe, "Self-Fulfilling Debt Crises."

their own object; and Japan's short-rate share leaves out the financing bills that fund its foreign reserves, with which it would be 21.23 percent against 7.19. For Germany, France, and Italy the Eurosystem's holdings are published by country and program and not by instrument, so the short-rate share is a range, and the model carries its upper end; at the lower end France's baseline is on the crisis equilibrium in 2031 through 2036 in place of 2032 through 2036 (Table 23). What the measured shares decide is read from the variant of the same table that gives every economy the United States' share of 26.89 percent: France's baseline then carries no crisis year, the United Kingdom's is on the crisis equilibrium in 2029 through 2036 in place of every year, and under regime M Germany carries none and Italy is on it in 2034 through 2036, in place of 2035 and 2036 and 2032 through 2036. The crisis years of the United States and of Japan move in no variant of the table.

China's debt and deficit are read on the IMF staff's augmented perimeter, a staff estimate rather than an official series, and one the IMF's own headline tables do not report. A crisis in China on that perimeter would be a crisis of local government financing vehicles as much as of the central government, and the model treats the two as one issuer; the narrower perimeter is reported in the addendum. Under the administered spread the model states that no market-priced Chinese crisis occurs and that the augmented debt rises on the deficit to 216.0 percent of GDP by 2036; the constraint that would bind, the banking system's capacity to absorb issuance at a repressed rate and the capital account when depositors respond, lies outside the fiscal-limit mechanism, and the model does not carry it. Every economy carries a 2 percent inflation target, which for China, whose deflator was negative through 2025, is a simplification. The central banks' holdings are carried at fixed shares of the stock in the central calibration; Section 3.8 carries their announced run-off paths as a variant, and since the Bank of Japan's projection of its holdings runs through March 2030 and the Eurosystem's through 2027, the paths beyond those dates are the model's extrapolation of each projection's final rate, the Bank of England's alone running to a stated retained stock, while further purchases are carried in neither.

Eighth, the baseline stays off the crisis equilibrium only where the economy's benign root exists. For the United Kingdom that root exists in none of the 10 years, and for France in none from 2032, so the baselines of France and the United Kingdom are themselves paths on the crisis equilibrium, France's at the Eurosystem's ceiling in 2032 and above it after. The quantities the model reads relative to a reference path are therefore read against the hazard-free path of Section 2.7, which exists for every economy, and not against the baseline, and a scenario result for either of the two is a difference between two paths on the crisis equilibrium, the increment the scenario adds and not the level of the risk the economy carries. The other five baselines carry no year on the crisis equilibrium. Those of the United States, Canada, and Japan are their hazard-free paths; Germany's and Italy's end 2036 with debt 0.16 and 0.23 percentage point of GDP below theirs, the area's policy rate, which reads France's output gap and inflation with their own, standing 1.22 percentage point lower by then.

The baseline is fitted to no projection. The fiscal rule runs against a projected path of the primary balance: the CBO's current-law path for the United States and, for the other seven economies, the 2026 balance held, which is a convention and not a forecast. The alternative for the six, the path the IMF projects, has a record: five years ahead, the balance came in below the projection in 45 of 66 cases, with a mean error of −2.40 percentage points of GDP (Table 5). On that path in place of the held balance, France's baseline carries no crisis year, and under regime M Germany is on the crisis equilibrium in 2036 and Italy in 2033 through 2036 (Table 23). The CBO's own record of five-year errors of the primary deficit is not available from the sources consulted, so the U.S. path is carried without one. Set beside the published projections, the baseline's debt differs from the

CBO's by a root-mean-square 0.41 percentage point of GDP over 2027 through 2036 and its net interest by 0.18 (Table 11), and its debt exceeds the IMF's projection for each of the six at the projection's final year, by 0.6 percentage points of GDP for Italy through 28.5 for the United Kingdom (Table 12).

Ninth, the fiscal capacity of the central calibration is drawn independently of the growth path, and the historical record indicates that it moves with it: Eichengreen and Panizza find that faster growth is associated with a higher likelihood of sustaining a large primary surplus, and a crisis in this model lowers growth for as long as it lasts. Section 3.7 carries the channel at the Eichengreen and Panizza estimate as a sensitivity, where it raises the regime-M debt of the central scenario, 197.2 against 195.1 percent of GDP in 2036, and lowers the regime-F debt, 114.8 against 121.2. It stays out of the central calibration because the estimate is a probability effect converted to the level scale through the dispersion of the 10-year windows of the capacity records, and the model's own panel estimates the level coefficient at 0.56 with a standard error of 0.34, which is not distinguishable from zero.

Tenth, the resolution of Section 4 is solved for the United States, the United Kingdom, France, Japan, Italy, and Germany, every economy that reaches the crisis equilibrium in a central scenario. The distribution of the resolving capacity (Figure 8) is solved for the same economies, and it is a distribution over the drawn parameter sets and not over the shock sequences, so it carries the calibration uncertainty the assumption tables disclose and not the variation of a path's own history; the nested panel of Table 20 puts the part of the variance of whether a path carries a crisis year that lies between parameter draws at 0.65 through 0.85 across the seven economies, and the remainder lies across the shock sequences. In every economy some of the parameter sets carry no crisis equilibrium and require nothing, from 99 of the 1,000 for France to 494 for Germany under regime M and from 102 to 773 under regime F, so the quantiles depend on whether those sets are counted; Table 28 gives them over the sets that require a capacity, and a requirement beyond 40 percent of GDP is known only to exceed that bound. The scans that establish each requirement as the smallest capacity that clears are run at the central calibration, in steps of 0.25 percentage point of GDP; across the drawn parameter sets the scan is not repeated, and a draw's requirement is the bisection's threshold.

Eleventh, the three coefficients of equation (10), the response of the output gap to the real long rate, to the corporate spread, and to its own past, are assumptions. The loss they produce lies inside the interquartile band of the record in every year the horizon covers (Table 15), but the record cannot supply the coefficients: a rule that reads sovereign stress off the spread over the safe asset returns 25 episodes in 13 economies outside the wars, a set that a rule on rates cannot separate from the monetary cycles in it, and a local projection of the gap on the size of the rise across them carries the sign of the policy reaction rather than of the response, so the response is not identified from rates in this panel. For the United States the assumption decides the depth and the debt, not the occurrence: at a response of 0.2 in place of 0.4 the regime-M gap reaches −5.4 percent in 2036, and debt ends 2036 at 167.0 percent of GDP; at 0.8 it reaches −19.6, and debt ends at 281.4; and the crisis years move by at most one in either case. Among the other economies it decides the occurrence at the margin: at half the response Germany carries no crisis year under regime M, and at one and a half times the response Canada carries one.

Twelfth, the results are conditional on ranges and on central values that no record supplies. The quantities that no record identifies are drawn on ranges of convenience centered on their central values, stated as such in Tables A.6, A.7, and A.10: the bound on the default hazard, the loss given default, the sunspot probability, the dispersion of the fiscal limit, σ, and the persistence and the

two responses of the output gap. The capacity is drawn within 1.0 percentage point of GDP of its reading, a width of the same kind, and the two regimes are drawn with equal probability, which no record supports. The ranges are not estimates, and the shares of Section 3.5 carry them. The first-order shares of the variance of the crisis state across paths that the dispersion of the fiscal limit, the persistence of the output gap, and the gap's two responses carry, the four parameters of Table 21 drawn on a range of convenience, sum to 0.01, each lying below 0.0019, the value the estimator returns in expectation for a parameter with no effect, so that none is distinguishable from zero, against 0.04 for the capacity, and the sunspot probability's own share is 0.01. A first-order share is the part of the variation across paths that a parameter explains alone, a lower bound on its contribution once its interactions are counted, and it does not bound the effect of a parameter on a level: pinning the sunspot probability at the ends of its range moves the share of paths carrying a U.S. crisis year from 43.6 to 60.5 percent, a span of 16.9 percentage points (Section 3.6). The same measurement for the five (Table 21) gives a span of 2.7 percentage points for the dispersion of the fiscal limit and, among the others, a largest of 0.7 for the output gap's response to the real long rate; since each range is a convention, a span measures what the share carries from the parameter over its range and is not a confidence band.

The deterministic results hold each quantity at its central value, and a one-at-a-time test measures what that conditions on. Each fixed numeric assumption is halved and raised by half, the neutral real rate moved half a percentage point either side in every economy, and the initial 10-year yield and the initial effective rate a percentage point either side. Of the quantities the test reaches, seven move the U.S. onset under regime M or its count of crisis years, each in one direction only. At a bound on the default hazard of 5 percent in place of 10, or at a loss given default of 20 percent in place of 40, the United States spends no year on the crisis equilibrium; with the initial 10-year yield a percentage point lower the crisis begins in 2035 and runs two years; with the central bank's share raised by half it begins in 2029 and runs eight years; and with the neutral real rate half a percentage point lower, with the dispersion of the fiscal limit at 45 percentage points of GDP in place of 30, or with the short-rate share raised by half, it begins in 2028 and runs nine years. At the other end of each of the seven, and under every other perturbation of the test, the crisis begins in 2027 and runs all 10 years. Of the seven, the stochastic simulation draws three on their ranges and holds four at their values. Beyond the United States the test moves more. France and the United Kingdom are on the crisis equilibrium under regime M in every perturbation; the set of the other economies with a crisis year changes in 17 of them, Germany leaving it in 11, Japan in 4, and Italy in 4, and Canada entering it in 4. The test does not reach the fiscal capacity, whose effect Table 7 and Section 4 give, the initial debt ratios, the trend growth paths, the inflation targets, the policy-rule coefficients that define the regimes, or the tolerance of the backstop's conditionality. Nor does it reach the growth draw, which shifts every trend path by one standard normal common to the eight economies, scaled by each economy's root-mean-square five-year projection error, and which carries a share of 0.50 of the variance of whether a year on the crisis equilibrium occurs against 0.04 for the capacity; the ordering of contributors in Section 3.6 is conditional on that construction and scale of the draw.

Thirteenth, the resolution map of Section 4.1 carries constructions that are conventions of the map rather than features of the record. The ceiling is an administered spread while it stands, and the purchases that would defend it are not carried into the holdings share of the central bank, so where a ceiling is called upon—as it is for 18 of the 23 ceilings that clear, and wherever a ceiling does not remove the crisis equilibrium, which is every case of the United Kingdom and France—the map reports the spread the purchases absorb and not the stock they would come to hold or its financing at the policy rate. The growth increment is announced and priced at once, so the market

believes the trend it is told, and a trend the market discounted would call for a larger increment. Every figure of Table 29 is announced and held in perpetuity: the capacity it names is not delivered on the path it clears, and no withdrawal year inside the horizon leaves the crisis equilibrium absent. The delivered surplus of Table 31 is a floor under the fiscal rule, which delivers more where its own response to the spread calls for more, and the earned capacity joins the model's delivered balances to the capacity's own record, the WEO's projection filling a year between a record's last outturn and 2026. The stochastic simulation of Figure 8 is solved for the capacity alone, so the ceiling, the growth increment, and the delivered surplus carry no distribution across the drawn parameter sets.

Fourteenth, the credit event of the stochastic simulation is drawn and recorded but does not act on the path. Each year an economy that has not yet drawn one draws it at the hazard of equation (5), and the path is marked as carrying a credit event; the debt is not written down or restructured, and no later rate, balance, or output gap depends on the draw, so a path that carries one is the path of a debt on which the event has occurred and has not been resolved. Of the paths with a U.S. crisis year, 51 percent carry a drawn credit event; on them the median U.S. debt ratio in 2036 is 155.6 percent of GDP, against 133.1 on the crisis paths that carry none and 141.7 on all of them.

6 Conclusion

In this model a sovereign debt crisis is a year spent on the crisis equilibrium of a pricing equation. The equation has three solutions, two of them stable, once debt exceeds a boundary. A corner condition is proportional to the fiscal capacity and decreasing in the expected loss on the debt, and the boundary the simulated paths obey lies above it by 45 percentage points of GDP for the United States, 19 for the United Kingdom, 60 for Canada, and 59 for Japan, and below the corner evaluated at the Eurosystem's ceiling by 17 for Germany, 8 for France, and 11 for Italy. The market can coordinate on the higher stable solution while the benign one exists, and a further rise of the debt and the financing rate removes the benign solution and leaves the crisis equilibrium as the only one. The fiscal limit is proportional to the capacity: at the largest 10-year average primary surplus the United States has sustained on the federal basis since 1950, the United States is inside its crisis zone in 2027, and at their capacities of record the United Kingdom is beyond its zone, France and Japan are inside theirs, and Germany, Italy, and Canada are below theirs. The capacity does not bind the primary balance: on the U.S. paths of both regimes the balance is a deficit of at least 2.8 percent of GDP in every year of the horizon, against a capacity of 1.91 percent, so the capacity acts on the outcome through the fiscal limit alone. The interest-growth differential is the object through which the coordination works: the fiscal limit is unbounded while the government borrows in real terms, at a neutral policy rate, at or below its trend growth, finite once it does not. In 2027, the U.S. onset under regime M, the real financing rate of the limit less the terminal real trend is -0.05 percentage points on the benign root and 2.76 on the crisis root. Of the difference between the two, the spread accounts for 2.70 percentage points and the loss of the convenience yield for 0.12: with the convenience yield held at its value on the benign root the differential would be 2.65, and with the spread removed from both legs of the rate 0.07, so that with either part alone the rate exceeds trend growth. On the baseline, where the market holds the benign root, the differential turns positive in 2029 as the debt rises. The realized U.S. differential has been negative in 62 percent of years since 1950.

Which policy authority adjusts decides the outcome of the crisis but, at the capacities the record shows, not whether it occurs. Under regime M the cost falls on output and on the debt ratio, the

policy rate reaching the zero bound without reaching the limit, which discounts at the neutral rate. Under regime F the cost falls on the price level, which absorbs the crisis in the debt ratio without closing the gap between the debt and the limit that produces it. The crisis ends in neither regime within the horizon, and across the stochastic paths trend growth is the largest single contributor to the variance of whether it occurs and of the peak yield. The capacity is where a resolution would come from, and it is not the only instrument that reaches one. For the United States the requirement announced in the onset year is 2.75 percent of GDP under regime M and 2.67 under regime F; it rises with the delay after that year, by 2.31 percentage points of GDP by 2033 under regime M and by 0.73 under regime F; and the central requirement lies below the median of the model's own distribution. A ceiling on the sovereign spread removes the crisis equilibrium only where the baseline keeps a benign one and removes none for the United Kingdom and France; under the one rule that reads a root by its hazard, a ceiling that removes it is still reached in 18 of 23 cases, purchases carrying a spread priced above it while no crisis root exists. An increment to trend growth clears at 0.64 percentage points or less for the United States, Japan, Italy, and Germany where it is announced in 2027 and at between 1.08 and 4.97 percentage points for the United Kingdom and France; every announced instrument must be in force through 2036, the final year solved, and beyond it, since the limit it lifts is a perpetuity, while a delivered surplus is smaller the later the year from which the crisis equilibrium is to be absent. Section 4.2 places the requirement against the record of large primary surpluses, and Section 4.3 against the fiscal history of the two economies that were dominant suppliers of a safe asset before the United States, each of which carried a debt within its estimated fiscal backing after losing that position.

The transmission to the other economies runs through the common sunspot, the pass-through of the U.S. risk-free rate, and trade. A crisis abroad does not require one in the United States: of the stochastic paths with no U.S. crisis year, 70 percent carry one elsewhere, 54 percent one outside the United Kingdom, and 11 percent one outside the United Kingdom and France, whose crisis years rest on their own baselines and on the growth draw common to the eight economies as well as on the common sunspot, which coordinates each economy that is inside its own zone. The Eurosystem's ceiling, modeled from the Transmission Protection Instrument, raises the limit at which the hazard is assessed by bounding the marginal financing rate: on the deterministic paths of regime M it removes four years from the span Italy would spend on the crisis equilibrium without it and none from France's or Germany's, being withdrawn the year after an economy is first priced on a crisis root, and across the stochastic paths it lowers the shares of crisis paths of Germany, France, and Italy; carrying the announced run-off paths of the central banks' portfolios raises the debt carried through each crisis and adds crisis years for Germany and Italy.

Japan, with no standing ceiling, is inside its zone in 2027 and on the crisis equilibrium in every year of the central scenarios; it carries a crisis year on 44 percent of the stochastic paths, a share that a defended ceiling, carried as a variant, would lower to 27, and with that ceiling it carries no crisis year on the deterministic path of regime M. The United Kingdom, with the smallest observed capacity and no backstop, is on its crisis root in every year of the decade, its baseline carrying the state; resolving it takes 6.63 percent of GDP against its record of 1.43, the largest consolidation required of any economy in the model at the central calibration. That result is what the calibration of the United Kingdom's fiscal capacity implies, and it is evidence about that calibration rather than about the United Kingdom. The mechanism of the model has not been validated against the historical record of sovereign stress episodes. China, its spread administered by a state-directed holder base under capital controls, has no crisis root, and its augmented debt rises with the U.S. crisis and without it; priced as a market issuer it is on the crisis equilibrium for 6 of the 10 years. Canada lies below its zone throughout the central scenario. Reading debt net rather than gross is

what places Japan 9 percentage points of GDP above its operative boundary rather than 79; reading capacity from the record rather than assuming it is what places the United States 48 percentage points of GDP above the corner boundary and 3 above the operative one in 2026.

The multiplicity is conditional on two quantities the record does not pin for a G7 sovereign, and Section 3.6 measures both. The range of debt over which the pricing equation has two stable solutions closes once the dispersion of the fiscal limit is wide enough, as Blanchard, Martínez-Bruera, and Huertas show in their model, though here it does not narrow at every step: for the United Kingdom it closes at a dispersion of 30 percentage points of GDP and for France and Italy at 90, France's range being widest at 45, while for the United States, Japan, Germany, and Canada the range runs to the top of the grid at the central dispersion and what moves is the debt at which the second solution appears. At a loss given default of 10 percent, the haircut of their illustration, in place of 40, the deterministic scenarios carry crisis years for the United Kingdom and France alone, while across the stochastic paths the United States carries one on 32 percent against 54, the lower haircut removing coordination in a larger proportion than it removes crisis years.

Addendum: China

China is carried in the computation but stands outside the G7, the set of economies the paper studies. Its sovereign spread is administered by a state-directed holder base under capital controls rather than set by a marginal investor, an insulation from coordination the model imposes as an assumption, through a ceiling of zero on China's spread (Section 2.8), so the coordination the paper measures does not price for it: across the stochastic paths China's coordination share is 0 percent, and the 10 percent of paths that carry a year on the crisis equilibrium carry it because the benign root has disappeared and not because the market has moved. With the spread administered, the real financing rate lies below the real trend in every year of the central scenarios, so no boundary exists, and the limit is unbounded; with China priced as a market issuer, the corner boundary would be 150 percent of GDP against an augmented debt of 135.3. Under regime M the yield ends the horizon at 3.9 percent, the output gap at −3.3 percent of potential through the pass-through and trade channels, and the debt reaches 216.0 percent of GDP in 2036, against 195.7 in its baseline, carried by the augmented primary deficit of 10.0 percent of GDP rather than by any crisis.

Three of China's inputs are not measured as the other economies' are. Its record carries no 10-year window with a positive average primary balance: the largest is −0.19 percent of GDP on the IMF's series, 2005 through 2014, and −0.50 on the overall balance of the general public budget of the National Bureau of Statistics. Its capacity is therefore scaled from revenue: general government revenue of 25.8 percent of GDP in 2024 times the median ratio of capacity to revenue over the six economies read on a general government record, 4.2 percent, which gives 1.09 percent of GDP. The United States, whose record is federal, is left out of the median, and the ratios of the six run from 2.1 through 8.3 percent, at which China's capacity would be 0.53 and 2.15. Under the administered spread the value decides no result: no capacity on the grid of Table 7 gives China a year on the crisis equilibrium. The share of its debt that pays the short rate, 3.47 percent, is measured over the stock of book-entry treasury bonds at 31 December 2025 (Table 4) and applied to the augmented debt, whose composition is not measured. The record of that share does not establish the unit of the issue amounts it reads, whether a discount bond was reopened after its first issue, or the People's Bank of China's holdings at that date and by instrument, and the Ministry of Finance's own statement of the stock by term was not available from the sources consulted. The central bank's share is held at zero; the one reading the sources give, the People's Bank's claims on the central government a month before that date over the stock at it, is 5.4 percent, on two dates and on a claim that may include items other than treasury bonds.

Two further readings are carried. The first prices China as a market issuer, its spread set by a marginal investor as every other economy's is; the second reads China on the general government perimeter of the April 2026 WEO rather than the IMF staff's augmented one: gross debt of 106.9 percent of GDP in 2026 in place of 135.3 and a primary deficit of 7.0 percent in place of 10.0, with the effective interest rate and growth unchanged. Table 35 sets the three readings side by side. Priced as a market issuer, China is on the crisis equilibrium in 6 of the 10 years under regime M. The corner boundary is 150 percent of GDP and the operative boundary 264.5, 129 percentage points of GDP above the augmented debt of 135.3 in 2026, so at its initial conditions China lies below its zone. The operative boundary is read at the long-rate residual that reproduces the 2026 yield, −2.20 percentage points, and the path does not hold that residual, which rises with the debt to −1.35 in 2031. In that year, four years after the U.S. onset and with debt of 163.8 percent of GDP entering it, the crisis root first exists, and the market coordinates on it. Coordination holds in 2031 through 2035, and in 2036 the crisis root is the only one. In each of those years the effective rate on the debt exceeds nominal growth; the yield reaches 8.4 percent in 2036 with inflation at −1.3,

9.7 percent net of that inflation, the output gap stands at −11.1 percent of potential, debt at 278.7 percent of GDP, and the cumulative default probability at 47 percent. The crisis root does not wait on the U.S. crisis: in the market-issuer baseline, on which the market does not coordinate, it exists beside the benign root from 2032. Across the stochastic paths Chinese coordination then occurs on 33 percent, with at least one year on the crisis equilibrium on 39 percent; the shares of the seven G7 economies are those of the central simulation, the U.S. shares 54 and 27 percent, since nothing in China's path feeds back to them. The combination the market-issuer reading produces, a nominal yield near 8.4 percent with deflation, has no counterpart in the Chinese or the Japanese record, and the reading rests on a marginal investor the holder structure of Section 2.8 does not supply; it is what the run mechanism would imply. On the narrower perimeter with the administered spread there is likewise no crisis root, and the perimeter moves the level of the debt alone: 162.0 percent of GDP in 2036 under regime M against 216.0 on the augmented perimeter, which the model carries because it is the basis of the staff's own sustainability assessment.

Table 35: China under three readings, regime M, 2027 through 2036: the administered spread the model carries, the market-issuer variant in which China's spread is priced by a marginal investor as every other economy's is, and the narrow perimeter of the April 2026 World Economic Outlook with the administered spread. Debt is in percent of GDP in 2026 and 2036; the boundary is the corner boundary of equation (8), which does not exist where the marginal financing rate lies below nominal growth; crisis years count the years on the crisis equilibrium; the peak yield is in percent, the gap trough in percent of potential, and the cumulative default probability in percent over the horizon. Author's calculations.

Reading	Debt 2026	Boundary	Crisis years	Peak yield	Gap trough	Debt 2036	Cum. default
Administered spread (central)	135.3	none	0	3.9	−3.3	216.0	0
Priced as a market issuer	135.3	150	6	8.4	−11.1	278.7	47
Narrow perimeter, administered	106.9	none	0	3.2	−3.2	162.0	0

The administered reading is itself conditional on the central values. In three of the one-at-a-time perturbations of the twelfth limitation of Section 5—the projected primary balances scaled up by half, which raises China's deficit by half, the persistence of the output gap raised by half, and the response of the term premium to debt raised by half—the benign root ceases to exist for China in some year under regime M, which is the state the administered spread absorbs on 10 percent of the stochastic paths.

The addendum does not bear on the measurements of the body. Nothing in China's path enters the U.S. block, which reads no foreign quantity, and no other economy's equations read China's; the G7 results are therefore identical whether China is carried or not, and the readings above change no figure of the body. What the addendum records is a property of the mechanism rather than of China: a sovereign whose spread is administered and whose holders are directed is insulated from the coordination that prices the G7, on a debt path that carries it onto the crisis equilibrium once it is priced as they are.

A Assumptions of the Model

Tables A.1 through A.13 list the quantities the simulation uses, each with its value, its unit, the basis for its magnitude, and its treatment in the stochastic simulation. Values given by economy are listed with the economy codes of Section 2. A quantity marked "Assumption" has no empirical basis in the sources consulted and is a choice of the model. The treatment column states what the stochastic simulation does with each: a quantity marked fixed is held at its value on every path, and a drawn quantity carries its distribution, uniform on the range shown where the entry reads U; where the basis names the range one of convenience, the range is centered on the value and is not an estimate. The response of the primary balance to debt and the short-rate share are fixed, the first at zero as an assumption and the second as measured, and the neutral rate is fixed at its estimate. Trend real growth is a path rather than a single value, so it is tabulated by economy and year in Table A.4, and the record of projection errors that sets the standard deviation of its draw is in Table A.5.

For three rows the basis by economy is in a table of the body: the fiscal capacity, with the first year and the window of each reading, in Table 7, and the short-rate share and the central bank's share, with their sources, in Table 4. One input is not a row of these tables: the projected path of the primary balance that the fiscal rule reads, which is the CBO's current-law path for the United States and, for the other seven economies, the initial balance of Table A.3 held in every year. The conditionality of the backstop in Table A.9 is read against that path, which for the three euro-area economies is the initial value the row names. The responses of the primary balance to debt and to the sovereign spread in Tables A.3 and A.6 apply in the baseline and under regime M and, in a regime-F run, to the seven economies other than the United States.

Table A.1: Horizon, neutral rates, and inflation targets of the model: value, unit, basis, and treatment in the stochastic simulation. Values given by economy are listed with the codes US, DE, FR, IT, UK, CA, JP, and CN. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Horizon, years	10	years	Model choice	fixed
Neutral real short rate by economy	US 1.00865; DE 0.0855449; FR 0.0855449; IT 0.0855449; UK 1.21523; CA 1.75916; JP −0.2; CN 2	percent	Holston-Laubach-Williams one-sided estimates for 2026:Q2 (United States, Canada, and the euro area, the euro-area value assigned to its three members); Bank of Japan Review 2026-E-4 (Japan, the midpoint of about −0.9 through 0.5); Sun and Rees (2021) (China, a bit above 2, in a band of 1.5 through 3); Federal Reserve Board staff's estimate of the longer-run real neutral rate for 2026:H2, from the data file of Ferreira, Lott, and Richards, Real-Time Global Longer-Run Neutral Rates, FEDS Notes, 9 April 2025, as retrieved on 5 October 2026 (United Kingdom; the authors' own estimate and not an official view; the New York Fed's file carries no series for the United Kingdom)	fixed
Inflation target by economy	US 2; DE 2; FR 2; IT 2; UK 2; CA 2; JP 2; CN 2	percent	Federal Reserve 2 percent on the personal consumption expenditures index; European Central Bank symmetric 2 percent on the harmonized index of consumer prices (2021 strategy); Bank of England 2 percent consumer price index remit; Bank of Canada 2 percent midpoint of the 1 through 3 percent range (agreement through 31 December 2026, under renewal for a further five years, the renewed agreement to be published before the end of 2026); Bank of Japan 2 percent consumer price index (January 2013); China: consumer price increase of around 2 percent, Government Work Report, 5 March 2026, an annual government objective rather than a central-bank mandate	fixed

Table A.2: Trend growth and initial interest rates of the model: value, unit, basis, and treatment in the stochastic simulation. Values given by economy are listed with the codes US, DE, FR, IT, UK, CA, JP, and CN. The trend-growth row states the first year of each path and the terminal row its 2036 value; the path by year is in Table A.4. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Trend real growth by economy and year, 2026 through 2036	US 2.364; DE 0.791; FR 0.858; IT 0.521; UK 0.797; CA 1.500; JP 0.719; CN 4.413	percent per year	Seven economies: IMF World Economic Outlook April 2026 medium-term projections through 2031, held flat at the 2031 value through 2036, the projection horizon ending there; United States: Congressional Budget Office annual projections of real GDP growth, 2026 through 2036. No correction is applied to the published projections	level shifted by one standard normal common to the eight economies, scaled by the per-economy standard deviation
Terminal trend real growth by economy, the 2036 value	US 1.766; DE 0.623; FR 1.058; IT 0.700; UK 1.411; CA 1.754; JP 0.608; CN 3.291	percent per year	The final year of the trend path. The fiscal limit is a perpetuity that discounts the maximum surplus at one rate, so it has no reading where trend growth varies by year and it takes the terminal value; the debt identity is a year-by-year object and takes the path	moves with the growth draw
Baseline 10-year sovereign yield by economy	US 4.127; DE 2.998; FR 3.663; IT 3.786; UK 4.490; CA 3.377; JP 2.558; CN 1.800	percent	U.S.: CBO 10-year Treasury note rate, 2026 (the U.S. fiscal block's source); Germany, France, Italy, the United Kingdom, Canada, and Japan: OECD Economic Outlook No 119 long-term interest rate, 2026 projection (June 2026); China: assumption	fixed
Effective nominal interest rate on debt by economy	US 3.44; DE 1.92; FR 2.15; IT 2.96; UK 3.39; CA 3.11; JP 0.85; CN 3.5	percent	Price per unit of debt outstanding: interest paid in 2026 over the stock at the end of 2025. U.S.: CBO net interest outlays of fiscal year 2026 over debt held by the public at the end of fiscal year 2025; China: IMF staff effective rate 2026; others: consolidated general government interest paid, OECD Economic Outlook No 119 (June 2026), over consolidated gross debt at the end of 2025, IMF World Economic Outlook April 2026	fixed

Table A.3: Fiscal parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Values given by economy are listed with the codes US, DE, FR, IT, UK, CA, JP, and CN. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Average maturity of debt (years to reprice) by economy	US 6; DE 7; FR 8; IT 7; UK 14; CA 7; JP 9; CN 7	years	Assumption; the U.K. value reflects the long gilt profile	fixed
Initial debt ratio by economy (net debt)	US 100.605; DE 49.388; FR 110.247; IT 128.983; UK 95.47; CA 10.342; JP 134.306; CN 135.3	percent of GDP	U.S.: CBO debt held by the public 2026; China: IMF staff augmented debt 2026 (Country Report 26/44); others: IMF general government net debt 2026, World Economic Outlook April 2026	fixed
Initial primary deficit by economy (positive = deficit)	US 2.55071; DE 2.835; FR 2.711; IT −0.787; UK 1.231; CA 2.431; JP 1.738; CN 10	percent of GDP	U.S.: CBO fiscal year 2026; China: augmented primary deficit 2026 (Country Report 26/44, Appendix V); others: IMF general government primary balance 2026, World Economic Outlook April 2026, sign reversed	fixed
Share of the market-held stock that pays the short rate, by economy	US 0.268947; DE 0.098644; FR 0.0944763; IT 0.122144; UK 0.0455713; CA 0.203176; JP 0.0719033; CN 0.0347125	fraction	Measured, not fitted: bills and short-rate floaters over the stock the central bank does not hold, at 31 December 2025, from each debt office's record; inflation-indexed debt is in the long leg. By economy: Table 4	fixed
Primary-balance response to debt above the hazard-free path (baseline and regime M)	0	per unit of debt/GDP	Assumption; the panel estimate separates it from neither zero nor 0.04	fixed

Table A.4: Trend real growth by economy and year, in percent per year. For the seven economies other than the United States the path is the projection of the IMF's World Economic Outlook database of April 2026 through 2031, held at its 2031 value through 2036, the medium-term projection ending there; for the United States it is the CBO's annual projection of real GDP growth for 2026 through 2036 (*The Budget and Economic Outlook: 2026 to 2036*, February 2026), which covers the horizon end to end. The paths are the published projections, with no correction applied (Table A.5). The debt identity reads the path year by year; the fiscal limit of equation (4) is a perpetuity and reads the terminal value. Sources: International Monetary Fund, World Economic Outlook database, April 2026, and Congressional Budget Office, baseline data files of February 2026, both accessed 3 October 2026.

Economy	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
United States	2.364	1.861	1.805	1.754	1.783	1.776	1.760	1.767	1.769	1.772	1.766
Germany	0.791	1.183	1.196	0.944	0.655	0.623	0.623	0.623	0.623	0.623	0.623
France	0.858	0.876	1.217	1.160	1.106	1.058	1.058	1.058	1.058	1.058	1.058
Italy	0.521	0.500	0.835	0.739	0.716	0.700	0.700	0.700	0.700	0.700	0.700
United Kingdom	0.797	1.297	1.633	1.615	1.539	1.411	1.411	1.411	1.411	1.411	1.411
Canada	1.500	1.896	1.655	1.728	1.665	1.754	1.754	1.754	1.754	1.754	1.754
Japan	0.719	0.623	0.625	0.614	0.614	0.608	0.608	0.608	0.608	0.608	0.608
China	4.413	4.033	4.000	3.665	3.348	3.291	3.291	3.291	3.291	3.291	3.291

Table A.5: The five-year growth-projection error by economy, in percentage points per year, and the standard deviation of the growth draw. The error is the average realized growth over a five-year period less the average projected over the same years, so a negative value is an overprediction, on seven baseline windows from 2008 through 2014 for each of the eight economies. The windows overlap by four years, so the errors are serially dependent within an economy. Each standard error of a mean is a Newey–West estimate with Bartlett weights to lag four, taken on an economy's seven windows or, for the pooled error, on the seven window means; on seven observations overlapping by four years, about two of them independent, that estimate is itself imprecise. The pooled error across the 56 observations is −0.48 with a standard error of 0.20 on the seven window means, and the between-economy standard deviation is 0.35. The posterior mean is the empirical-Bayes estimate of the economy's error, its own mean weighted by its precision against the precision-weighted center of −0.44; the trend paths are the published projections, with no level correction applied (Section 2.7). The standard deviation of the growth draw is the per-economy root mean square of the errors about zero. The trend paths carry no common downturn coefficient; under a window-level jackknife its estimate is −0.69 with a standard error of 0.58, not distinguishable from zero. Sources: International Monetary Fund, World Economic Outlook databases, October 2008 through October 2014 and April 2026; Congressional Budget Office, *CBO's Economic Forecasting Record: 2025 Update*; author's calculations.

Economy	Mean error	Standard error	Posterior mean, not applied	Draw standard deviation
United States	−1.08	0.21	−0.91	1.18
Germany	0.24	0.11	0.18	0.43
France	−0.43	0.16	−0.43	0.58
Italy	−1.00	0.35	−0.72	1.22
United Kingdom	−0.30	0.34	−0.37	0.84
Canada	−0.36	0.11	−0.37	0.52
Japan	−0.31	0.27	−0.36	0.71
China	−0.58	0.17	−0.56	0.80

Table A.6: Fiscal-limit and pricing parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Automatic-stabilizer response of the primary balance to the output gap	0.4	percentage points of GDP per percentage point of gap	Assumption; order of the OECD semi-elasticity	fixed
Primary-balance improvement per percentage point of sovereign spread (wherever fiscal policy is not active: the baseline, regime M, and the other economies under regime F)	0.25	percentage points of GDP per percentage point	Assumption	fixed
Fiscal capacity by economy: the largest 10-year average primary surplus on the record, or revenue-scaled where none	US 1.91; DE 2.18; FR 1.06; IT 3.27; UK 1.43; CA 3.52; JP 1.31; CN 1.09	percent of GDP	The largest average of 10 consecutive years of the balance before net interest on each economy's long record, a window's first year not before 1950 or the record's first year, no window across a join of two sources, and every receipt from abroad that a source of the record identifies excluded. By economy: Table 7	U(value − w, value + w), w 1.0 for every economy, a width of convenience; no floor
Dispersion of the fiscal limit	30	percentage points of GDP	Assumption; the range is one of convenience, centered on the central value	U(15, 45)
Bound on the annual default hazard	0.1	probability	Assumption; the bound on the default hazard is this paper's, and it enters the spread as a default probability enters the bond price of Cole and Kehoe, where that probability is the probability that the sunspot arrives, a separate parameter here (q); the range is one of convenience, centered on the central value	U(0.05, 0.15)
Loss given default	0.4	fraction of face	Assumption; near the mean haircut of 37 percent over 180 sovereign restructurings from 1970 through 2010 (Cruces and Trebesch), none of them a G7 sovereign's; the range is one of convenience, centered on the central value	U(0.25, 0.55)
Term-premium response to debt	0.03	percentage points per percentage point of debt/GDP	Laubach (2009): 3 through 4 basis points	fixed

Table A.7: Convenience-yield, sunspot, and policy-regime parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Treasury convenience yield at the initial debt ratio	0.25	percentage points	Average 10-year premium of nominal Treasuries over synthetic nominal Treasuries constructed from inflation-protected securities, 24 basis points, in a long-bond range of 10 through 40 (Acharya and Laarits 2026); the draw range spans the swap-based measures at its floor and the pre-2020 sample averages at its ceiling	U(0, 0.5)
Proportional fall of the convenience yield per unit of log debt/GDP (its elasticity at the initial ratio)	0.5	fraction per log point	Assumption. Jiang, Richmond, and Zhang (2025) estimate the response of the convenience yield, in percentage points, to the log of a maturity bucket's Treasury supply relative to GDP over 1998:Q1 through 2023:Q4, at -0.376 through -0.545 by ordinary least squares and -0.161 through -1.316 by instrumental variables across the three buckets, larger in magnitude at long maturities; the model's response applies to total debt held by the public, a different quantity, and is not placed inside that range	fixed
Annual probability of coordination on the crisis equilibrium while in the crisis zone	0.1	probability	Assumption; the range is one of convenience, centered on the central value	U(0.025, 0.175)
Taylor-rule inflation response, regime M (active money)	1.5	coefficient	Leeper (1991) determinacy region	fixed
Taylor-rule inflation response, regime F (passive money)	0.8	coefficient	Leeper (1991) determinacy region	fixed
Taylor-rule output-gap response	0.25	coefficient	Assumption	fixed
Probability that a path is drawn under regime F	0.5	probability	Assumption of convenience; no record supports a weighting	fixed

Table A.8: Central-bank holdings in the model: value, unit, basis, and treatment in the stochastic simulation. The holdings-growth row governs the variant of Section 3.8 and is not used in the central calibration; "path" marks the United Kingdom's year-by-year path of Table 25. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Share of the debt stock held by the central bank, by economy	US 0.141463; DE 0.285888; FR 0.191628; IT 0.180573; UK 0.176055; CA 0.118996; JP 0.431148; CN 0	fraction	Measured holdings of the central bank over the stock, at 31 December 2025, each on its own object. By economy: Table 4	fixed
Annual change in the central bank's nominal holdings under the announced-path variant of Section 3.8 (gdp = grows with nominal GDP; none = share held fixed; path = tabled in Section 3.8)	US gdp; DE −11.4684; FR −11.4684; IT −11.4684; UK path; CA none; JP −9.0225; CN none	percent per year; a path for the United Kingdom	Euro area: ECB Occasional Paper 398 (August 2026), asset purchase programme and pandemic emergency purchase programme holdings of 3.7 trillion euro at the end of 2025, projected at 2.9 trillion at the end of 2027; Japan: Bank of Japan, Monetary Policy Meeting of June 2026, holdings in March 2030 36 through 39 percent below June 2024 at monthly purchases of 2 trillion yen, against about 17 percent below in March 2027; United Kingdom: Bank of England, Asset Purchase Facility gilt sales market notice of 17 September 2026, Table 1, the holdings falling by redemption and by sales at 20 billion pounds a year to the 120 billion retained, the path tabled in Section 3.8; United States: reserve-management purchases sized to trend growth in the demand for Federal Reserve liabilities (Federal Open Market Committee, 10 December 2025); Canada and China: share held fixed	variant of Section 3.8, not drawn

Table A.9: Backstop parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Central-bank backstop: ceiling on the sovereign spread the central bank enforces by purchases, by economy (none where absent)	US none; DE 1.5; FR 1.5; IT 1.5; UK none; CA none; JP none; CN 0	percentage points	Euro area: the ECB's Transmission Protection Instrument, a standing instrument, purchases not restricted ex ante; Japan: none, yield curve control having been withdrawn in March 2024 and the Bank's standing commitment being to purchase against a rapid rise in yields rather than to defend a level (a ceiling of one percentage point is carried as a variant); China: an administered spread, the holder base being state-directed banks under capital controls (foreign institutions held 3.8 trillion yuan of Chinese bonds in all, 2.0 trillion of it in treasury bonds against 39.4 trillion outstanding, leaving at most a small fraction of the 53.7 trillion of local government bonds, People's Bank of China, Financial Market Report, October 2025); the ceilings are assumptions	fixed
Administered spread: the ceiling holds without conditionality, the state directing the holders rather than purchasing subject to eligibility, by economy	US no; DE no; FR no; IT no; UK no; CA no; JP no; CN yes	indicator	China: the holder structure stated for the ceiling; the ceiling is not a central-bank purchase program and is retained in the no-backstop variant	fixed
Conditionality: the backstop is available in a year while, in the year before, the primary balance net of the automatic stabilizers stood no more than this amount below its projected path and the debt did not exceed the fiscal limit	1	percentage points of GDP	Assumption standing in for the fiscal-framework criteria of the Transmission Protection Instrument; its sustainability criterion is read as the debt against the fiscal limit and carries no parameter	fixed

Table A.10: Transmission and output-gap parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Pass-through of the U.S. risk-free long-rate change to foreign yields	DE 0.72; FR 0.67; IT 0.71; UK 0.85; CA 0.76; JP 0.26	fraction	Annual regressions on OECD long rates under the inflation-targeting regime, 1996 through 2024; China by assumption	drawn from the estimate and its standard error
Pass-through of the U.S. risk-free long-rate change to Chinese yields	0.2	fraction	Assumption: capital controls and a domestic investor base	fixed
Output spillover from the U.S. output gap	DE 0.12; FR 0.08; IT 0.08; UK 0.15; CA 0.35; JP 0.1; CN 0.1	fraction	Assumption scaled by export exposure to the United States	fixed
Persistence of the output gap	0.6	fraction	Assumption; the range is one of convenience, centered on the central value	U(0.4, 0.8)
Output-gap response to the real long rate	0.4	percentage points per percentage point	Assumption; the range is one of convenience, centered on the central value	U(0.2, 0.6)
Output-gap response to the corporate spread	0.3	percentage points per percentage point	Assumption; the range is one of convenience, centered on the central value	U(0.15, 0.45)
Output-gap response to the lagged change in the structural primary balance relative to the hazard-free path	0.836779	percentage points per percentage point of GDP	Calibrated so the model's two-year response to a consolidation of one percentage point of GDP equals the Guajardo, Leigh, and Pescatori (2014) two-stage least-squares estimate, reproduced from the published data	U(0.504054, 1.169505)
Phillips-curve slope	0.3	percentage points per percentage point of gap	Assumption	fixed

Table A.11: Inflation-expectation, corporate-spread, and equity parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Weight on last year's inflation in expected inflation	0.5	fraction	Assumption: partially anchored expectations	fixed
Inflation risk premium per percentage point of expected inflation above target	0.25	fraction	Assumption	fixed
Baseline investment-grade corporate spread	1	percentage points	Assumption	fixed
Corporate spread response to the sovereign spread	0.6	fraction	Assumption	fixed
Corporate spread response to a negative output gap	0.3	percentage points per percentage point	Assumption	fixed
Duration of equity with respect to the real long rate	10	years	Assumption (dividend-discount value)	fixed
Equity log-value response to the output gap	2	per percentage point	Assumption	fixed

Table A.12: Simulation parameters of the model: value, unit, basis, and treatment in the stochastic simulation. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Paths in the stochastic simulation	10,000	count	Model choice	fixed
Standard deviation of annual output-gap innovations	1	percentage points	Assumption	drawn $N(0, 1)$

Table A.13: Parameters of the AI-adoption sensitivity of Section 3.7, not used in the central calibration: value, unit, basis, and treatment. Author's calculations.

Quantity	Value	Unit	Basis	Treatment
Contribution of generative AI to annual trend real growth under the AI-adoption sensitivity of Section 3.7, by year 2026 through 2036, all economies	2027 0.09; peak 0.20 in 2032; 2036 0.16	percentage points	Penn Wharton Budget Model, The Projected Impact of Generative AI on Future Productivity Growth, 8 September 2025, Figure 5, applied to every economy at the U.S. profile; the TFP effect is applied to GDP one for one as the source applies it, the source's projection is taken as additional to the projected trend paths, and the perpetuity limit discounts at the source's terminal contribution of 2060	sensitivity of Section 3.7, not drawn
Response of the fiscal capacity to growth under the AI-adoption sensitivity of Section 3.7: percentage points of GDP per percentage point of the deviation of 10-year average realized real growth from the projected trend path	0.58 (band 0.35 through 0.82)	percentage points of GDP per percentage point of growth	Eichengreen and Panizza (2016; table numbering of NBER Working Paper 20316), Table 14, column 5, the growth effect on the probability of a 10-year primary surplus of at least 3 percent of GDP, converted to the level scale through the probit index with the pooled dispersion of the 10-year-window balances of the capacity's long records; the band carries the estimate's standard error	sensitivity of Section 3.7, fixed at the estimate; the band is carried as two deterministic runs

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