What will it take to stabilise public debt in advanced countries?

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Abstract

This paper analyses the prospects for debt stabilization in European Union countries, Japan, the United Kingdom, and the United States using stochastic debt sustainability analysis and estimated fiscal reaction functions. We find that (1) debt-stabilizing primary balances are generally within historical precedent; (2) fiscal adjustment required to reach such balances is very high in several countries, including France, the United Kingdom and the United States; (3) the feedback coefficient from debt to the primary balance has significantly declined since the global financial crisis. These findings imply that debt stabilization is uncertain and countries with exceptionally high adjustment requirements will likely face continued increases in their debt ratios – and will thus be vulnerable to a loss of market confidence – for a protracted period.

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1 Introduction

Across most advanced economies, the aftermath of the COVID-19 pandemic resulted in public debt-to-GDP ratios reaching their highest levels since the Second World War. While the inflationary episode of 2022-23 and the rebound in economic activity have helped stabilize debt ratios, substantial fiscal sustainability challenges persist. Debt burdens remain elevated, and the factors shaping future debt dynamics have shifted in an unfavorable direction.[1] Interest rates have increased, growth in the European Union remains tepid, working populations are projected to shrink, and the fiscal costs of pensions and long-term care are rising. Whether governments can stabilize their debt, and at what cost, has returned to the center of macroeconomic debate.

Official projections offer only partial reassurance. The International Monetary Fund projects that the median public debt ratio across advanced countries will stabilize over its five-year forecast horizon. However, this projection does not necessarily dispel all concerns. First, these projections ignore uncertainty surrounding growth, interest rates, and fiscal balances. Second, a five-year horizon may be too short to capture the impact of debt drivers that are likely to push debt back up in the long run, such as demographic trends and rising average borrowing costs. Third, the IMF continues to project rising public debt ratios in several advanced economies, including some countries where debt levels are already elevated. Assessing public debt sustainability therefore requires careful country-specific analysis over a long horizon, with an explicit focus on risk sources that could affect future debt dynamics.

This paper examines the fiscal adjustment required to stabilize public debt in advanced economies and assesses the feasibility of implementing such adjustments. We provide a country-by-country debt sustainability assessment for European Union countries, Japan, the United Kingdom, and the United States, based on two approaches that have been used in the empirical literature on debt sustainability since the late 1990s.

Each approach carries a substantial literature of its own, but the two are rarely combined, in spite of the fact that they offer complementary methodological strengths and weaknesses. The first is based on a stochastic forecast of the debt ratio, conditional on growth, interest-rate and exchange-rate expectations and assumptions about future fiscal policy, as summarized by the annual structural primary balance (SPB, the difference between cyclically adjusted non-interest spending and revenues, adjusted for one-time fiscal measures). In 2025, the structural primary balance was in deficit in 24 of the 30 countries in our main sample. In many of these countries, failure to reduce these deficits could lead to exploding debt. This does not mean that debt is necessarily unsustainable, but it means that countries need to adjust. To see by how much, we compute the structural primary balance that would be required by the end of a six-year adjustment period to stabilize the debt ratio with 70 percent probability at the end of a 20-year horizon. We then evaluate the feasibility and plausibility of reaching this SPB against a variety of benchmarks, including countries' medium term fiscal plans, past episodes of fiscal adjustment and IMF forecasts.

The second approach involves the estimation of a fiscal reaction function – that is, the feedback from higher debt to the primary balance. A sufficiently large and positive feedback (where higher debt induces fiscal adjustment) rules out explosive debt paths. We compare the strength of fiscal reactions over time and across countries using multiple specifications, including a cubic reaction function to allow for the possibility that the reaction of the primary surplus to higher debt declines for high debt levels (*"fiscal fatigue"*, as in Ghosh *et al*, 2013).

The two approaches have different strengths and weaknesses. The main advantages of stochastic debt sustainability analyses (SDSAs) are the explicit treatment of uncertainty, its forward-

[1] See, among others, Auerbach (2025), IMF (2024), Jiang *et al* (2024), Darvas *et al* (2024b), Summers (2023) and Zettelmeyer *et al* (2023).

looking aspect, including the consideration of expected growth, interest rate and demographic developments, and its flexibility to adapt to country-specific circumstances. However, it can be sensitive to the assumed growth and interest-rate forecasts, the stochastic projection methods used, historical shock distributions, and the definition of the time horizon at which debt is required to stabilize. Moreover, SDSAs do not address whether governments would be likely to implement the necessary adjustments. The strengths of the fiscal reaction function approach include that it does not depend on long-term projections, relies instead on observed historical fiscal behavior, can be estimated relatively straightforwardly with few assumptions, and yields a key feedback parameter that is directly linked to debt sustainability. However, the approach also has significant limitations. Most importantly, it assumes that policymakers would respond to rising debt levels in the future in the same way they have in the past, an assumption that may not hold, particularly in changing economic or political environments. In addition, the estimated feedback parameter may vary over time, while panel estimates could be dominated by observations from countries with moderate debt levels, thereby providing only limited guidance for assessing fiscal sustainability in highly indebted countries. Our work addresses some of these weaknesses.

The paper makes five main contributions. First, it combines stochastic debt sustainability analyses and fiscal reaction functions estimations as complementary approaches to assessing debt sustainability, using the degree of convergence or divergence between their conclusions as a gauge for the robustness of the assessment. Second, it improves on existing SDSA frameworks developed by the IMF and the European Commission by employing a long, twenty-year horizon debt stabilization criterion. Our framework also incorporates information on bond maturity data and uses a bootstrap method for the debt drivers that allows for asymmetric shock distributions. Third, the paper provides a systematic assessment of the feasibility of the fiscal adjustments implied by the SDSA, drawing on national medium-term fiscal plans, evaluations by independent fiscal institutions, historical adjustment episodes, and IMF World Economic Outlook projections. Fourth, we allow the main feedback parameter of fiscal reaction functions to be time-varying and country-specific, allowing us to examine how fiscal responsiveness evolved during and after the COVID-19 pandemic that earlier studies could not assess. Finally, to our knowledge, this is the first study to apply both approaches in a consistent framework to the full set of EU countries, Japan, the United Kingdom, and the United States, using up-to-date data and a sufficiently long horizon to capture the structural forces currently placing upward pressure on public debt.

Our central finding is that public debt in advanced economies generally remains sustainable, in the sense that the primary balance required to stabilize the debt ratio appears achievable and is typically below 3 percent of GDP. However, in several countries, the fiscal adjustment needed to reach such a stabilizing primary balance is exceptionally large. As a result, debt ratios are likely to continue rising for an extended period. This prolonged accumulation of debt may leave some countries exposed to shifts in market sentiment and, consequently, vulnerable to episodes of declining investor confidence.

The remainder of the paper is organized as follows. Section 2 situates our contribution within the related literature. Section 3 defines debt sustainability for the purposes of our analysis and presents the two methodological approaches in detail. Section 4 derives the medium-term fiscal adjustment requirements implied by the stochastic analysis. Section 5 evaluates the feasibility and plausibility of these requirements using fiscal plans, assessments by independent fiscal institutions, historical fiscal adjustment episodes, and IMF World Economic Outlook projections. Section 6 estimates and analyzes fiscal reaction functions. Section 7 concludes.

2 Literature review

Our paper engages with four complementary strands of the sovereign debt literature. The first concerns competing definitions of debt sustainability, which differ according to whether the emphasis is placed on debt dynamics, vulnerability to self-fulfilling crises, or the political feasibility of fiscal adjustment. The second and third strands encompass the two principal methodologies used to assess sustainability: stochastic debt projections and fiscal reaction functions. Finally, our analysis contributes to the growing macroeconomic literature examining the fundamentals that shape debt sustainability in advanced economies.

The literature offers several distinct concepts of debt sustainability. One tradition focuses directly on the debt path, defining debt as unsustainable when it follows an ever-increasing trajectory. This approach underpins the commonly used practical requirement that the debt-to-GDP ratio be stabilized over time (Kremers, 1988; D'Erasmo, Mendoza and Zhang, 2016). A second perspective emphasizes the possibility of self-fulfilling crises. In such models, even fundamentally solvent governments may be pushed into default by a sudden loss of creditor confidence (Calvo, 1988; Cole and Kehoe, 2000). This source of vulnerability is particularly relevant for members of monetary unions, such as the euro area, that borrow in a currency they do not fully control and that may lack a guaranteed lender of last resort (De Grauwe and Ji, 2013). In such monetary unions, highly indebted countries could be particularly vulnerable to shifts in market sentiment. A third perspective stresses political and economic feasibility: debt may be serviceable in a purely accounting sense, yet unsustainable if the primary surpluses required for repayment are beyond what policymakers can realistically deliver (Eichengreen and Panizza, 2016; Zettelmeyer, Kreplin and Panizza, 2017). Our work adopts the definition of Willems and Zettelmeyer (2022), under which debt is sustainable if it can be serviced without default, restructuring, or hyperinflation under at least one feasible policy path.

Our paper draws on the debt sustainability assessment methodologies developed in two major branches of the literature. The first relies on stochastic projections of future debt trajectories. Rather than focusing on a single baseline scenario, this approach models the full probability distribution of debt outcomes by simulating shocks to the main drivers of debt dynamics, including economic growth, interest rates, primary balances, and exchange rates. Sustainability is then evaluated according to whether a sufficiently large share of simulated debt paths remains non-explosive. This methodology originates in the fan-chart framework of Celasun, Debrun and Ostry (2006) and has since become a core element of the debt sustainability frameworks used by the IMF (2021, 2022) and the European Commission (2024). It has also been incorporated into a growing academic literature examining debt dynamics within optimization and simulation frameworks, particularly in environments characterized by low interest-growth differentials (Consiglio and Zenios, 2017; Zenios et al., 2021; Blanchard, 2021).

The appeals of stochastic debt projections lie in their forward-looking nature, as they incorporate expectations regarding growth, interest rates, demographics, and other structural developments; explicitly account for uncertainty; and can be tailored to country-specific circumstances. Rather than producing a single deterministic debt path, they generate probabilistic estimates of the primary balance required to stabilize debt. At the same time, their conclusions are sensitive to assumptions regarding macroeconomic forecasts, stochastic projection techniques, historical shock distributions, and the time horizon over which debt is expected to stabilize. Our contribution extends existing IMF and European Commission frameworks by adopting a longer, twenty-year stabilization horizon. Unlike the European Commission method, we allow for asymmetric rather than Gaussian shock distributions, and incorporate information on sovereign bond maturities.

The second approach assesses sustainability through the behavior of fiscal policy itself. According to the government's intertemporal budget constraint, the primary balance must respond positively to increases in public debt, implying a positive debt-feedback coefficient in the fiscal reaction function (Bohn, 1998, 2008). This literature has estimated such feedback coefficients across a wide range of countries, including European economies (Mauro, Romeu, Binder and Zaman, 2015; Plödt and Reicher, 2015; Berti et al., 2016; Checherita-Westphal and Žďárek, 2017), examined the possibility of fiscal fatigue, whereby the fiscal response weakens at high debt levels (Ghosh et al., 2013), and distinguished between alternative fiscal regimes, including ”active” and ”passive” policy frameworks (Leeper, 1991; Davig and Leeper, 2007; Aldama and Creel, 2019; Bouabdallah, Jacquinot and Patella, 2026; Maćkowiak and Schmidt, 2025; Gomes and Seoane, 2024).

The principal advantage of this approach is that it relies on observed fiscal behavior rather than forecasts of future macroeconomic conditions. The methodology can be implemented relatively parsimoniously and delivers an estimate of a key parameter directly linked to debt sustainability. However, it rests on the assumption that past fiscal behavior provides a reliable guide to future policy. Moreover, debt-feedback coefficients may vary over time, and estimates based on panel data may be disproportionately influenced by countries with moderate debt burdens, limiting their usefulness for assessing sustainability in highly indebted economies. Our analysis contributes to this literature by allowing fiscal reaction coefficients to be both country-specific and time-varying. Using data through 2025, we also provide evidence covering the pandemic period and its aftermath.

A central contribution of our paper is to combine these two approaches within a unified framework and apply them to a broad sample of advanced economies. Their limitations are complementary: stochastic debt sustainability analyses are forward-looking and reflect current economic conditions but depend heavily on projections, whereas fiscal reaction functions avoid projection dependence but require assumptions about the persistence of past fiscal behavior. Agreement between the two approaches therefore strengthens confidence in sustainability assessments, while divergence highlights areas where conclusions may be particularly sensitive to model assumptions.

Finally, our paper contributes to the extensive literature examining how macroeconomic fundamentals shape debt dynamics. Following the global financial crisis, interest-growth differentials became negative in many advanced economies, prompting a reassessment of fiscal space and debt sustainability (Blanchard, 2019; Mauro and Zhou, 2021). More recently, however, rising real interest rates and weaker growth have altered this environment. Concerns are further amplified by the ongoing debate over the relationship between high public debt and economic growth (Reinhart and Rogoff, 2010; Cecchetti, Mohanty and Zampolli, 2011; Pescatori, Sandri and Simon, 2014), as well as by mounting long-term spending pressures stemming from population ageing and, increasingly, from climate-related and defence expenditures (Darvas, Welslau and Zettelmeyer, 2024b). Rather than seeking to resolve these debates, we take prevailing macroeconomic fundamentals as given. Our estimates of debt-stabilizing primary balances and debt limits therefore speak directly to the fiscal-space questions at the center of contemporary literature.

3 Debt sustainability: what it means and how it can be measured

We begin by drawing a distinction between debt sustainability and the sustainability of fiscal policy. The latter is unsustainable if debt cannot be repaid based on *current* fiscal policy – for example, if high deficits lead to ever-higher debt levels, to the point that markets refuse to roll over maturing debt. In contrast, debt is unsustainable if it cannot be repaid under *any feasible* fiscal policy. Hence, the statement that debt is unsustainable is much stronger than the statement that fiscal policy is unsustainable.

Our working definition of debt sustainability is that debt is sustainable when the fiscal effort required to stabilize the debt path appears economically and politically feasible[2]. The key challenge is determining what constitutes a feasible adjustment. We follow two approaches.

3.1 Plausibility of reaching the debt-stabilizing primary balance

The first approach is used by organizations including the IMF, the European Commission, the European Central Bank and the European Stability Mechanism, as well as in academic literature that includes Celasun *et al* (2006), Consiglio and Zenios (2017), Zenios *et al* (2021) and Blanchard (2021). This computes the medium-term fiscal adjustment required to stabilize the debt with some probability, using stochastic debt projections that assume that the parameters of fiscal policy under the direct control of governments – tax rates, discretionary spending and the parameters governing entitlement spending – remain unchanged after the adjustment period. At the IMF, this is normally three to four years (the maximum length of an IMF program), while the European fiscal rules require adjustment within four to seven years.

The primary indicator used to assess the feasibility of adjustment is the level of the (permanent) primary balance required to stabilize the debt. While there are episodes of high primary surpluses over short periods (for example, Belgium and Italy achieved primary surpluses of over 5 percent of GDP in the run-up to the euro, and Greece and Cyprus achieved primary surpluses of over 4 percent in the aftermath of their debt crises in the last decade), sustained high primary surpluses in excess of 3 percent are rare. The record holder in the EU is Belgium, which achieved this level in 15 of the last 45 years, followed by Italy and Cyprus, with seven of the last 45 years (see section 4.2, and Eichengreen and Panizza, 2014, and Zettelmeyer *et al*, 2017, for historical analyses). Hence, a debt-stabilizing primary surplus above 3-3.5 percent of GDP would typically be regarded as a signal of heightened fiscal risk.

A secondary indicator is the required adjustment over the medium term, i.e. the difference between the primary surplus 'target' (the debt-stabilizing surplus) and the primary balance prior to adjustment. The feasibility of this adjustment can again be assessed using the historical record. In addition, medium-term budgetary plans may indicate the willingness (or lack thereof) of the current government to make the adjustment.

Importantly, feasibility assessments based on the level of the debt-stabilizing primary surplus are generally on firmer ground than those based on the total size of the adjustment that needs to be undertaken to reach that level. This is because the latter is much more sensitive than the former to the assumed time horizon of adjustment. While the assumed adjustment horizon influences the level of the debt-stabilizing primary balance – because slower adjustment leads to higher debt at the end of the adjustment period – the impact is typically in the low decimal range[3]. In contrast, for countries with large deficits, adjustment over short periods might be politically and economically unfeasible but could become feasible, from the debtor country's perspective, if stretched over time. The feasibility of stretching adjustment over time will depend on the

[2] This is a simplified version of the debt sustainability definition used by the IMF: *"Public debt can be regarded as sustainable when the primary balance needed to at least stabilize debt under both the baseline and realistic shock scenarios is economically and politically feasible, such that the level of debt is consistent with an acceptably low rollover risk and with preserving potential growth at a satisfactory level."* See IMF (2013, 2021, p. 6). Unlike the IMF's Sovereign Risk and Debt Sustainability Framework (SRDSF) for market access economies (IMF, 2021, 2022), our analysis ignores rollover risk. Like the IMF's SRDSF, we do not address whether lowering debt, rather than merely stabilizing it, might generate growth benefits (on the relationship between debt and economic growth, see Pescatori *et al*, 2014, and Cecchetti *et al*, 2011).

[3] This relates to the fact that the debt-stabilizing primary balance is defined as a *permanent* fiscal balance to stabilize the debt. Hence, so long as the differential between interest rates and growth rates is low, even a substantial increase in the debt ratio can be paid off with a modest increase in the structural primary balance. For example, if the impact of a longer adjustment period is to raise the debt by 10 percentage points and the interest-growth differential is 2 percent, then the debt-stabilizing primary balance will increase by approximately $0.02 * 10 = 0.2$ percent of GDP.

patience of private and/or official lenders, which is very difficult to assess.

3.2 Reaction of the primary balance to debt level

Our second approach follows a methodology first applied by Bohn (1998), consisting of estimating a fiscal reaction function (FRF) of the type:

$s_t = \phi d_{t-1} + z_t + \epsilon_t$ (1)

where s_t is the primary surplus as a share of GDP, d_{t-1} is debt as a share of GDP, z_t is a set of controls, and ε_t is the error term. If the feedback parameter ϕ is large enough – specifically, if $1 + \phi$ is larger than $\frac{1+r_t}{1+g_t}$ (or equivalently, $\phi \gtrsim r_t - g_t$) then the debt ratio will stabilize[4]. Bohn (1998) estimated the feedback parameter ρ to be about 0.05. Since $r_t - g_t$in advanced countries has historically been negative or in the order of a few basis points, this is more than enough for debt stabilization[5]. A positive response of the primary surplus to an increase in debt would indicate ”passive” or “Ricardian” fiscal policy (as per Leeper, 1991), where the government adjusts the budget to keep debt on a stable path.

There is a potential problem, however. What if the feedback from debt to the primary surplus weakens at high debt levels? Ghosh *et al* (2013) referred to this phenomenon as *“fiscal fatigue”*. Once fiscal fatigue sets in, primary surpluses may not be high enough to offset debt-interest payments and the debt dynamics become explosive, especially if the risk premium rises with the debt level. To allow for this possibility, we follow Ghosh *et al* (2013) by estimating a third-order polynomial fiscal reaction function of the form:

$s_t = f(d_{t-1}) + z_t + \epsilon_t$ (2)

where $f(d_{t-1})$ is a cubic function of lagged debt. This specification also allows the estimation of a ‘debt limit’, the level of the debt ratio above which debt would not be stabilized because of the inability to raise the primary surplus further and the rising risk premium. We compare current debt and fiscal positions to the estimated debt limits.

The advantage of the fiscal reaction function approach is that it does not require an assumption that fiscal adjustment must happen within a pre-determined timeframe, nor does it depend on future growth and interest rate assumptions. But it makes some strong assumptions of its own, particularly that the average response of the primary balance to the debt ratio in the past will continue in the future. We return to these issues in section 5.

4 Medium-term fiscal adjustment requirements

We determine medium-term fiscal adjustment requirements with a stochastic debt sustainability analysis (SDSA). For each country, we compute the structural primary balance that would be required by the end of the adjustment period to stabilize the debt ratio with a given probability over a long horizon, together with the fiscal adjustment that reaching it would entail. This is a conditional, normative calculation: it asks what fiscal effort would be needed to stabilize debt, not whether fiscal policy would likely reach this goal, which we take up separately in Section 5. Our approach is similar to that used by the European Commission (2024) and to the fanchart

[4]To see this, start with the debt dynamics identity $d_{t+1} = \frac{1+r_t}{1+g_t} d_t - s_{t+1}$ and substitute $s_{t+1} = \phi d_t + z_{t+1} + \epsilon_{t+1}$. Solving for d_{t+1} leads to $d_{t+1} = \left[\frac{\frac{1+r_t}{1+g_t}}{(1+\phi)}\right] d_t - v_{t+1}$, where $v_{t+1} \equiv \frac{-(z_{t+1}+\epsilon_{t+1})}{(1+\phi)}$. Hence, if $\frac{1+r_t}{1+g_t} d_t < 1$, and z_t is stationary, the debt ratio will revert to a stationary mean. See Willems and Zettelmeyer (2022) for a discussion.
[5]Auerbach (2003, 2025) proposed a closely related approach: estimating fiscal reactions to *projected* deficits. This works well for the US, where the Congressional Budget Office undertakes such projections twice a year.

module of the IMF's (2021, 2022) debt sustainability framework for market-access countries and builds on a longer literature on stochastic debt projections (Celasun et al, 2006; Medeiros, 2012; Berti, 2013; Bouabdallah et al, 2017). It differs from these frameworks in several respects, which we set out in Section 4.2.

4.1 Applying the stochastic debt sustainability analysis

Our methodology starts with a deterministic projection of the debt ratio, based on assumptions about the future evolution of the primary balance, nominal growth, inflation, interest rates and exchange rates. Medium-term macroeconomic and fiscal projections are taken from the IMF's April 2026 *W*orld Economic Outlook (WEO), from which we derive the variables the projection requires, including the structural primary balance, the output gap, the implicit interest rate on debt and the stock-flow adjustment. Long-term potential growth, from 2035 onward, is taken from the EU Working Group on Ageing Populations and Sustainability for EU countries, the Congressional Budget Office for the US, the Office for Budget Responsibility for the UK, and the OECD projections for Japan. Interest rates, inflation and exchange rates are based on market data: nominal interest rates are assumed to converge to 10-year-ahead financial market expectations, with long- (short-) term rates subsequently converging to 4 (2) percent in the long run, and inflation converges linearly to 10-year-ahead market expectations and thereafter to national inflation targets (2 percent, except for Poland, Romania and Hungary). We use bond-level data on the maturity structure of each country's debt to project the average interest rate on the debt stock. Full details of our data sources are presented in Annex I of the supplementary material.

The debt ratio evolves according to the standard accounting identity

$d_t = \alpha^n \, d_{t-1} \, \frac{1+iir_t}{1+g_t} + \alpha^f \, d_{t-1} \, \frac{1+iir_t}{1+g_t} \, \frac{e_t}{e_{t-1}} - s_t + f_t$, (3)

where α^n and α^f are the shares of government debt denominated in domestic and foreign currency, iir_t is the implicit interest rate on the debt stock, g_t is the nominal growth rate of GDP, e_t is the nominal exchange rate (national currency per unit of foreign currency), s_t is the primary balance and f_t is the stock-flow adjustment, both as ratios to GDP. The implicit interest rate is projected as a weighted average of short- and long-term market rates, with the transmission of market-rate changes occurring gradually as outstanding debt is rolled over at maturity (Annex I).

For the primary balance, the projection distinguishes between two periods. During the adjustment period, which runs for six years from 2026 to 2031, the primary balance is a policy variable. After it, the primary balance is held constant except for changes in expenditures and revenues arising from demographic developments ('ageing costs'). The primary balance excluding future changes in ageing costs might be held fixed at 1 percent of GDP, for example, while the fiscal implications of demographic change, via education, pension or long-term care costs, drive the overall primary balance into deficit over time. Ageing-cost projections come from the EU Working Group on Ageing Populations and Sustainability for EU countries and the United Kingdom, from Congressional Budget Office projections of social and health spending for the US, and from OECD projections for Japan. These are no-policy-change projections conditional on legislated policy: enacted reforms are reflected in full, including legislated increases in statutory retirement ages, while announced but unlegislated reforms are not.

We take 2025 as the starting year and assume that the fiscal adjustment begins in 2026 and is completed by 2031. This implies a six-year adjustment period, which is sufficiently long for fiscal planning and lies within the four- to seven-year horizon permitted under the EU's fiscal framework. An advantage of using 2031 as the terminal year is that it coincides with the final year of the WEO projection, allowing a direct comparison between our estimated adjustment requirements and the IMF's fiscal projections. Extending the adjustment period to seven years, the maximum under the reformed EU fiscal rules, has only a negligible effect on the required primary balance, for the reason discussed in Section 4.2.

During the adjustment period, the primary balance is treated as an exogenous policy variable and is assumed to adjust without uncertainty. After the adjustment period, the baseline path of the primary balance remains exogenous (except for changes arising from projected ageing-related spending), while stochastic shocks to the primary balance are allowed to covary with shocks to growth, interest rates and exchange rates through our bootstrap procedure (see below). We do not incorporate a fiscal reaction function into the SDSA. Likewise, the baseline projections for interest and exchange rates are independent of the assumed fiscal adjustment path. Only the stochastic shocks to these variables are correlated with primary-balance shocks through the bootstrap-based simulation methodology.

Our baseline growth projections through 2031 are taken from the April 2026 WEO, which are conditional on the fiscal policy IMF staff anticipate. Consequently, only the deviations of our simulated structural-primary-balance path from the WEO baseline path affect growth relative to the WEO growth projection. To capture these effects, we apply a fiscal multiplier of 0.75 in line with the European Commission's debt sustainability framework (Carnot and de Castro, 2015), instead of varying the multiplier according to the business cycle, the type of financing, or country characteristics (Batini, Eyraud, Forniand Weber, 2014). A fiscal consolidation relative to the IMF baseline widens the output gap in the year of the adjustment, , with the effect gradually dissipating over the subsequent two years:

$o_t = o_t^{BL} - \varepsilon_t - \frac{2}{3}\,\varepsilon_{t-1} - \frac{1}{3}\,\varepsilon_{t-2}$ (4)

where o_t denotes the output gap in our simulations, o_t^{BL} is the baseline output gap in the WEO, and

$\varepsilon_t = 0.75\,(\Delta spb_t - \Delta spb_t^{BL})$ (5)

with Δspb_t representing the fiscal adjustment implied by our simulations (that is, the change in the structural primary balance) and Δspb_t^{BL} the corresponding fiscal adjustment in the WEO baseline. Real growth is then determined by the output gap and potential output. Potential output is taken from the WEO projections and is assumed to be invariant to any differences in fiscal adjustment between our simulated scenarios and the IMF baseline.

We quantify the uncertainty around the projected debt path by simulating shocks to the debt drivers. Let x_t denote the vector of quarterly shocks to the primary balance, nominal GDP growth, the short- and long-term nominal interest rates, and the euro and dollar exchange rates. Each shock is defined as the first difference of the corresponding historical series over 2000–2025 and winsorized at the 5th and 95th percentiles. We estimate a vector autoregression,

$x_t = A\,x_{t-1} + u_t$ (6)

with a single lag selected by the Schwarz criterion. Future shocks are simulated by resampling the residuals u_t jointly across variables by bootstrap and combining them with the estimated coefficients A. We generate 100,000 draws following the approach of Bouabdallah *et al* (2017).

This methodology has two important advantages. First, it preserves the correlation structure observed in the data. Shocks to growth, interest rates, exchange rates and the primary balance are correlated, contemporaneously through the joint resampling of residuals and dynamically through the VAR coefficients. As a result, an adverse growth draw tends to be associated with a weaker primary balance and a higher interest rate, mirroring historical experience. Second, because the residuals are resampled rather than drawn from a fitted symmetric distribution, the simulated shock distributions can be asymmetric. This allows downside and upside risks to differ in magnitude and probability. Long-term interest-rate shocks are transmitted to the average interest rate only gradually, reflecting the progressive repricing of the debt stock as maturing securities are refinanced (Annex I).

We estimate the shock process under two alternative specifications: separately for each country and by pooling observations across the euro-area members that did not receive emergency financial assistance during the euro-area crisis. The country-specific specification fully reflects each country's historical experience, but may overstate future volatility if it extrapolates exceptional events that are unlikely to recur. The pooled specification imposes a common volatility that may understate genuine differences in national macroeconomic volatility. In the main text, we report results based on the country-specific specification, while Annex III presents results for both approaches.

The final step is to determine the structural primary balance target for the end of the adjustment period, denoted as SPB* which is defined as the minimum structural primary balance required to stabilize public debt with a specified probability p. We set p to 70 percent, following the convention of the EU fiscal rules, under which a debt path is considered 'plausibly downward' when a stochastic DSA implies at least a 70 percent probability that the debt ratio declines (Regulation (EU) 2024/1263). The threshold should be viewed as a prudential benchmark rather than a parameter derived from welfare considerations. Because it is the single most consequential assumption in the exercise, Annex IV reports results for alternative probability thresholds of 50, 60, 80 and 90 percent.

Conceptually, debt stabilization is an asymptotic property, $\lim_{t\to\infty} d_t = d$, where d is a finite non-negative constant. However, uncertainty accumulates over time, making fanchart projections increasingly unreliable at long horizons. We therefore adopt a practical approximation and require the p-th percentile of the simulated debt distribution to be flat over the last five years of the 2026–2045 projection horizon. Formally, SPB* is defined as the smallest end-of-adjustment structural primary balance s for which the p-th percentile of the debt distribution does not rise between 2041 and 2045,

$SPB^* = \min\{\ s : d_{2045}^{(p)}(s) \leq d_{2041}^{(p)}(s)\ \}$ (7)

where $d_T^{(p)}(s)$ is the p-th percentile of simulated debt in year T conditional on the structural primary balance reaching s by 2031. This criterion can also be interpreted in probabilistic terms. The 70th percentile is the debt level exceeded in exactly 30 percent of simulations. Requiring this percentile to be no higher in 2045 than in 2041 implies that the debt level associated with a 70 percent probability remains stable over time. In this sense, debt is considered stabilized with 70 percent probability. Importantly, the criterion requires debt to stay below a ceiling, not to decline in every draw.

4.2 Comparing our stochastic debt sustainability analysis methodology to the methodologies of the European Commission and the IMF

Our SDSA shares the core architecture of the European Commission's Debt Sustainability Monitor (European Commission, 2024) and the fanchart module of the IMF's debt sustainability framework for market-access countries (IMF 2021 and 2022). It differs, however, in six important aspects, each reflecting a deliberate methodological choice that we consider justified on its merits. Table 1 summarizes these differences.

The first difference concerns the maturity structure of public debt. Like the IMF, we use bond-level data for the exact maturity of public debt components, while the Commission adopts simplifying assumptions about the maturity structure of debt. This distinction can make a significant difference. Our calculations indicate that the Commission methodology could imply

Table 1: Comparison of stochastic DSA methodologies

Category	IMF	European Commission	Our methodology
Maturity structure of public debt	Bond-level data	Simplifying assumptions based on average maturity of debt stock	Bond-level data
Modelling of uncertainty	Block bootstrap (consecutive historical debt driver realizations, allows asymmetric distributions)	Normal shock distribution (based on estimated variance-covariance matrix, symmetric distributions)	VAR-Bootstrap (coefficients and residual draws from VAR(1) estimated on historical data, allows asymmetric distributions)
Uncertainty during adjustment period	All debt drivers stochastic from outset	Uncertainty only after adjustment period	All debt drivers stochastic from outset (primary balance s.t. uncertainty after adjustment period)
Fanchart length	5 years (10 years in debt restructuring contexts)	5 years	20 years
Debt sustainability requirement	Debt-risk score (low/moderate/high) based on fanchart width, probability of debt non-stabilization, and terminal debt level	Debt at 5-year fanchart end lower with 70% probability than adjustment period end, continuous 10-year decline under deterministic stress tests	Debt stabilization with probability 70% at 20-year horizon end (flat slope of 70th percentile in last 5 years)
Deterministic stress tests	No deterministic stress tests	Three deterministic stress tests (SPB decline, interest rate-growth differential increase, temporary borrowing cost rise)	Stress scenario (growth −0.5pp, rates +1pp), applied in addition to the stochastic analysis

Source: Authors, based on European Commission (2024) and IMF (2021, 2022). Note: our stress scenario is run in addition to the stochastic analysis, not as a substitute for it.

an average interest rate that differs by as much as half percentage point from estimates based on actual bond-level data. Such a discrepancy is economically significant, as a difference of this magnitude in the average interest rate can materially affect projected debt dynamics and, consequently, the estimated fiscal adjustment required to ensure debt sustainability.

Second, we differ from both the IMF and the Commission in terms of uncertainty modeling. =We use a VAR-based bootstrap approach similar to Bouabdallah et al (2017), as introduced in the previous section. The Commission instead assumes shocks are normally distributed and estimates their variance-covariance matrix. The IMF (2021, 2022) uses a block bootstrap, directly drawing consecutive historical realizations of debt drivers to construct the debt paths. We prefer the VAR bootstrap because this preserves cross-variable and serial correlation without imposing symmetry or a fixed block structure.

Third, we depart from the Commission's approach in the treatment of uncertainty during the adjustment period. As in the IMF framework, we consider all debt drivers to be stochastic from the outset, except for the primary balance which we treat as a policy variable during the adjustment period. This differs from the approach of the European Commission, which considers uncertainty only after the adjustment period. We consider our approach more appropriate given the considerable uncertainty surrounding macroeconomic developments over a fiscal adjustment horizon that may extend from four to seven years under the EU fiscal framework. As a result, our SDSA is more conservative than the Commission's SDSA because incorporating uncertainty from the start generates a wider fanchart once the adjustment period ends, and therefore requires a larger fiscal adjustment to achieve a given probability of debt reduction.

Fourth, we deviate from both institutions in terms of fanchart length. Since debt sustainability is a long-term concept, we use a 20-year fanchart – the longest horizon that we believe can be estimated with reasonable reliability. By contrast, the European Commission uses five years as the IMF does in standard application, though the IMF extends this to 10 years in debt-restructuring contexts. Furthermore, our bootstrap approach allows asymmetric distributions – that is, risks skewed either to the upside or the downside. By contrast, the Commission methodology relies on the assumption of normally distributed shocks and therefore cannot capture such asymmetries.

Fifth, we require debt stabilization rather than an expected decline in debt. The European Commission's methodology requires debt at the end of the five-year fanchart horizon to be lower with a 70 percent probability than at end of the adjustment period, and for debt to fall continuously for at least 10 years under three deterministic stress tests (see below). In contrast, we require debt stabilization with probability p (where p is 70 percent in our baseline specification) at the end of a 20-year horizon, as discussed in the previous section. This criterion is motivated by our focus on debt sustainability, for which debt stabilization is a sufficient condition. In principle, our approach could allow a higher expected debt level at the end of the 20-year horizon relative to its level at the end of the adjustment period. However, even in our approach, the requirement that debt stabilizes with 70 percent probability typically implies that median debt (i.e. debt at the 50th percentile) will fall.

Finally, we do not use deterministic stress tests. Like the IMF, we adopt a fully stochastic approach and do not rely on deterministic debt sustainability criteria evaluated under stress scenarios. By contrast, the European Commission supplements its stochastic analysis with three deterministic stress scenarios: a permanent decline of SPB* by 0.5 percent of GDP following the end of the adjustment period, a permanent increase in the interest rate-growth differential by 1 percentage point above the baseline assumption, and a temporary rise in borrowing costs. We do not rely on these deterministic stress tests for two main reasons. First, although they are simple and easy to communicate, their numerical calibration is inherently ad hoc. A given shock magnitude is unlikely to represent the same degree of stress across countries, as macroeconomic and financial volatility varies substantially, implying that the probability of experiencing a uniformly specified shock differs across countries. Second, our stochastic framework provides a more comprehensive assessment than the Commission's methodology and can capture the full distribution of potential outcomes, including tail risks and extreme events. We note that even in the Commission's methodology, the requirement that debt declines with 70 percent probability is typically more demanding than the deterministic stress scenarios (Darvas et al, 2024a). However, we analyze the sensitivity of our stochastic results to adverse baseline growth or financial stress scenarios in Annex IV for robustness.

4.3 Results

Table 2 reports our results for the 27 EU member states, Japan. the United Kingdom, and the United States. Columns (1) to (3) show 2025 outcome for the gross public debt-to-GDP ratio, the fiscal balance and the structural primary balance. Column (4) reports SPB*, the structural primary balance that countries would need to reach by 2031 to stabilize debt with 70 percent probability over 2041–2045, while column (5) indicates the adjustment required relative to the 2025 structural primary balance. Columns (6) to (9) compare SPB* with the targets in countries' medium-term fiscal plans and with the structural primary balance projected by the IMF for 2031. All differences between structural primary balances are expressed in percentage points of GDP.

The starting position is one of widespread structural deficits: the structural primary balance was negative in 25 of the 30 countries in 2025. Nevertheless, the fiscal positions required to stabilize debt are generally well within historical experience. The median SPB* is 1.4 percent of GDP, and 29 of 30 countries require less than 3 percent, the threshold above which sustained primary surpluses have historically been uncommon. The exception is Greece with an SPB* of 3.4 percent,

Table 2: Fiscal adjustment requirements

	2025 outcomes			Structural primary balances to stabilise debt with $p \geq 70\%$		Structural primary balances in fiscal plans	
	Gross public debt (1)	Fiscal balance (2)	SPB (3)	SPB* (2031) (4)	SPB* (2031) − SPB (2025) (5)=(4)−(3)	SPB (MTP) (6)	SPB* (2031) − SPB (MTP) (7)=(6)−(3)
Japan	206.5	-1.1	-1.0	0.3	1.3	1.0	0.7
Greece	145.7	1.3	3.8	3.5	-0.3	2.3	-1.2
Italy	137.1	-3.1	0.1	2.6	2.5	3.2	0.6
United States	123.9	-6.8	-3.6	0.9	4.5	-1.9	-2.8
France	116.0	-5.1	-3.1	1.5	4.6	1.8	0.3
Belgium	106.3	-5.3	-3.6	1.9	5.5	1.6	-0.3
United Kingdom	102.3	-5.4	-2.4	1.9	4.2	1.2	-0.6
Spain	100.4	-2.5	-0.5	2.2	2.7	2.3	0.1
Portugal	89.9	0.3	1.9	2.3	0.5	2.9	0.6
Finland	89.3	-3.9	-2.4	0.6	3.0	2.6	2.0
Austria	80.5	-4.5	-2.8	0.8	3.6	1.2	0.4
Hungary	75.2	-4.7	-0.5	2.9	3.4	2.8	-0.1
Slovenia	65.9	-2.4	-1.3	1.8	3.1	0.5	-1.3
Germany	62.9	-2.7	-1.2	0.5	1.7	1.1	0.6
Slovakia	61.6	-5.0	-3.2	1.7	4.9	1.0	-0.7
Romania	60.6	-7.6	-4.4	2.6	7.1	1.7	-0.9
Poland	58.8	-7.0	-3.8	2.1	5.9	0.4	-1.7
Croatia	55.9	-2.9	-2.7	0.5	3.2		
Cyprus	55.3	3.0	3.8	1.4	-2.4	2.4	1.0
Latvia	46.9	-4.0	-0.9	1.2	2.0		
Malta	46.8	-3.1	-2.1	0.4	2.5		
Czechia	44.6	-2.0	-1.2	1.4	2.6		
Netherlands	43.3	-1.8	-1.5	0.9	2.4		
Lithuania	39.8	-2.2	-1.8	1.6	3.4		
Sweden	34.9	-1.4	-0.8	-0.3	0.4		
Ireland	32.9	1.5	-1.5	0.8	2.3		
Denmark	27.5	2.9	0.2	-0.8	-1.0		
Bulgaria	27.1	-3.0	-3.0	0.7	3.7		
Luxembourg	27.0	-1.0	-1.8	0.4	2.2		
Estonia	24.2	-1.3	-0.7	0.0	0.7		

Source: Authors' calculations based on April 2026 IMF World Economic Outlook data, the April 2024 EU Ageing report, Bloomberg, ECB, Refinitiv Eikon, US Congressional Budget Office, UK Office for Budget Responsibility, Japan Cabinet Office. Note: SPB* (column 4) refers to the structural primary balance at the end of a six-year adjustment period that stabilises debt with 70 percent probability in 2041-2045, based on country-specific probability distributions. SPB (MTP) in column 6 indicates the end-of-adjustment period SPB target in EU countries' medium-term fiscal structural plans prepared in 2024-2025; January 2026 Cabinet Office projections for Japan; November 2025 Office for Budget Responsibility projections for the United Kingdom; and the February 2026 projections of the Congressional Budget Office for the United States.

which result reflects the interaction of our long-horizon criterion with the exceptional volatility of Greek debt drivers during the debt crisis or the early 2010s. When shocks are drawn from the pooled distribution of non-crisis euro-area countries instead of from Greece's own history, Greece's required SPB* falls to 1.7 percent (see Annex III for an explanation of the underlying mechanism). Moreover, Greece is among the three countries where the 2025 SPB exceeded the SPB*, implying that Greece could even embark on some fiscal expansion without risking long-term debt stabilization. The second highest SPB* estimate is for Hungary (3.0 percent), followed by Romania (2.7), Italy (2.5), Portugal (2.4), Spain (2.2) and Poland (2.1).

However, the weak 2025 fiscal positions of several countries imply that the adjustments needed to reach SPB* are substantial. The median required adjustment is 2.8 percentage points of GDP. Thirteen countries need 3 points or more, and seven need at least 4: Romania (7.1), Poland (5.9), Belgium (5.5), France (4.6), Slovakia (4.9), the United States (4.5), and the United Kingdom (4.3). Romania's requirement, the largest in the sample, reflects a 2025 overall fiscal deficit of 7.6 percent of GDP and a structural primary deficit of 4.4 percent of GDP, rather than a high debt ratio. In Section 4 we will scrutinize how often advanced countries have implemented such fiscal adjustments in the past.

Required adjustment and the debt ratio are only loosely related. Romania, Poland and Slovakia, with debt ratios around 60 percent of GDP, face some of the largest adjustment requirements in the sample, because they combine large structural deficits with unfavorable interest-growth differentials. Annex II illustrates this mechanism by comparing Spain and Finland, two countries with similar debt ratios and very different requirements. Greece, Cyprus and Denmark already maintain structural primary balances above the level required to stabilize their debt, and Greece does so at a debt ratio of 146 percent, the second highest in our sample of countries. These examples underscore that the required fiscal effort depends primarily on the gap between the current structural balance and the balance consistent with debt stabilization, rather than in the debt stock itself.

Japan illustrates the same point at the top of the debt distribution. It combines the highest debt ratio in the sample, 207 percent of GDP, with a 2025 structural primary balance of −1.0 percent and an SPB* of 0.3 percent, implying an adjustment of 1.3 percentage points. That is much smaller than the requirements for France or the United States at much lower debt ratios, because Japan's persistently negative interest-growth differential has allowed the country to sustain a very high debt ratio with only a modest primary surplus requirement. Another factor contributing to Japan's relatively low fiscal adjustment requirement is its historical shock distribution, which is characterized by persistently low rates.

We assessed the sensitivity of our estimates in several dimensions, with detailed findings reported in Annex IV.

The results are particularly sensitive to the chosen probability threshold: lowering it from 70 percent to 50 percent reduces the average SPB* from 1.4 percent of GDP to 0.7 percent of GDP, while increasing it to 90 percent raises SPB* to 2.1 percent of GDP. The impact is more pronounced for countries with volatile debt drivers than those with more stable ones.

Changes in the deterministic macroeconomic assumptions also have substantial impacts. A permanent reduction in potential growth of half a percentage point raises SPB* by 0.33 percentage points, while a one percentage point increase in market interest rate raises it by 0.40 percentage points.

The treatment of tail risk matters primarily for countries whose own histories contain severe crisis episodes. When shocks are derived from a pooled VAR estimated for non-crisis euro-area countries rather than from country-specific VARs, the average SPB* is 0.18 percentage points of GDP lower. When country-specific VARs are retained but the winsorization of historical shocks are removed, the SPB* estimate is higher in every country, by 0.28 points on average. While this effect is economically meaningful, it remains modest relative to the overall fiscal adjustment implied by the baseline estimates.

Finally, results are largely insensitive to the sample period used for shock estimation. Restricting the sample to end in 2019, thereby excluding the pandemic and the energy-price shock, moves the average SPB* by only 0.02 points, indicating that estimates are not driven by recent extreme events.

5 The plausibility of meeting medium-term fiscal adjustment requirements

We now address the question of whether the fiscal adjustments shown in Table 2 look feasible. We present evidence from three angles.

The first is simply to compare adjustment requirements with adjustment intentions. A necessary but by no means sufficient condition for fiscal adjustment is that countries want to adjust in line with what is required – as reflected in relevant multi-year fiscal plans. Most EU countries formulated such plans in autumn 2024, and some in the first half of 2025, in line with the requirements of the new EU fiscal framework. This facilitates a comparison. For the UK and US, we use the latest projections made by the independent fiscal institutions of those countries, while for Japan, we use Cabinet Office projections[6].

Second, we look at historical precedents: (1) how frequently countries have met the target structural primary balances implied by our SDSA, (2) what the length of the longest time period during which the target SPB was maintained on average, and (3) how frequently countries have undertaken the adjustment that would be needed to reach those targets.

Third, we compare the required adjustments with the adjustments that are being projected by the IMF's *World Economic Outlook*, which generally represent the IMF's best guess about how fiscal variables will evolve. Specifically, we ask how likely it is that countries will adjust in line with the requirement in Table 2 based on a stochastic forecast centered on IMF projections about the evolution of the primary balance.

5.1 Willingness and plans to undertake the required adjustment

EU governments submitted national medium-term fiscal plans to the European Commission in 2024-2025, in line with the requirements of the EU fiscal framework[7]. With only two exceptions, the plans were approved by the European Commission as submitted by the respective countries[8]. Comparable plans are not available for the non-European countries in our sample. For Japan, we rely on projections by the Cabinet Office, for the United Kingdom, on the November 2025 fiscal projections of the Office for Budget Responsibility (2025), and for the United States, on the February 2026 projections of the Congressional Budget Office (2026).

Column 6 of Table 2 reports these medium terms plans and projections, while column 7 compares these targets with our estimate for *SPB**. Of the 30 countries analyzed, 12 have adopted plans

[6]As highlighted by Miyazaki, Lappe and Dom (2026), the Cabinet Office is part of the executive branch, while Japan lacks an independent fiscal institution.

[7]Twenty-two countries submitted their plans in late 2024, with the remaining five countries (Austria, Belgium, Bulgaria, Germany and Lithuania) submitting between February and July 2025.

[8]Hungary's plan was significantly revised after negotiations with the Commission, while the approved trajectory for the Netherlands was based on reference information prepared by the Commission because the plan did not meet the requirements (see Boivin and Darvas, 2025).

with structural balance targets in line with or above the *SPB**, while two additional countries have gaps of less than 0.3 percentage points of GDP. Among the remaining 16 countries, eight have public debt ratios below 50 percent of GDP. For these countries, some shortfall in medium-term fiscal adjustment is less concerning because their relatively low debt burdens provide greater scope for temporary debt increases. They could therefore stabilize their debt ratios later than our assumed 2031 endpoint for the adjustment period. This leaves eight countries for which fiscal targets fall materially short of the debt-stabilizing balance and may therefore warrant greater attention. Among these countries, Greece is less problematic.

We argued earlier that the significant volatility of Greek macroeconomic variables throughout the Greek fiscal crisis of the early 2010s might exaggerate the SDSA requirements for Greece. Greece plans an SPB of 2.3 percent of GDP which is higher than the 1.7 percent value resulting from an estimate of non-crisis euro-area countries (Annex III).

The greatest concern relates to the United States, for which the February 2026 projections of Congressional Budget Office (2026) predict a primary balance of -1.9 percent of GDP in 2031 in its extended baseline scenario. This projected primary balance hence falls well short – by over 3 percent of GDP – of the 0.9 percent primary surplus that would be required to stabilize the debt (Table 2, columns 4, 6 and 7).

For the remaining six countries, fiscal plans (or, in the case of the United Kingdom, the Office for Budget Responsibility (2025) projection) fall short of SPB* by between 0.6 and 1.7 percentage points of GDP: the United Kingdom (0.6), Croatia and Slovakia (0.7 each), Romania (0.9), Slovenia (1.3) and Poland (1.7). However, since the five central and eastern European countries have relatively low debt, the fact that the adjustments that are planned over the next few years fall short of achieving debt sustainability is not overly concerning. For the United Kingdom with a public debt ratio of 102 percent of GDP in 2025, the 0.6 percentage point gap is more meaningful, although it remains within a range that could plausibly be addressed by future policy adjustments[9].

The overall conclusion is that, among the 30 fiscal plans and projections analyzed in this paper, only that of the US raises a major concern regarding public debt stabilization. Although several other countries would not stabilize their debt ratio if their current plans were implemented as projected, most of these countries have relatively low debt levels, while for six countries with moderate debt levels the discrepancy between the fiscal plan and the SPB* needed to stabiles debt is also moderate.

5.2 Plausibility of adjustment based on historical patterns

We assess the plausibility of the adjustment needs using three indicators. First, we examine the frequency with which the required SPB^* has been observed in the past (Table 3, columns 2 and 3). Second, we analyse the length of the longest period over which SPB^* has been sustained on average (Table 3, columns 4 and 5). Third, we calculate how often the required adjustments to *SPB** have been achieved over six-year periods (Table 3, columns 7 and 8). All calculations are based on data for 1970-2025[10,11]. Column (2), (4) and (7) are based on a sample that contains

[9]The November 2025 fiscal projections of the UK Office for Budget Responsibility (2025) present cyclically adjusted primary balances, not structural primary balances. The cyclically adjusted primary balance is expected to improve from a deficit of 2.25 percent of GDP in fiscal year 2024-2025, to a surplus of 1.25 percent in 2030-2031.

[10]Extending the period to 1950-2022 does not meaningfully change the results. Reducing it to 1990-2022 also does not have a significant impact on the relative frequencies reported in the table (columns 2, 3, 7, and 8), but does shorten the maximum length of spells reported in columns 4 and 5. Note that for some countries, notably the formerly planned economies of central and eastern Europe, the sample periods are shorter because of the lack of data; for these economies, the samples typically start in 1995.

[11]We use overlapping samples (i.e. 1970-1976, 1971-1977, 1972-1978, and so on), implying that annual fiscal adjustments in the years 1976, 1977, 1978, ..., 2018, 2019, 2020 appear six times in the combined sample, while

data for all countries shown in the table, while column (3), (5) and (8) are based only on data from the country itself. To help interpret the results, column (1) of Table 3 reproduces SPB^* from column (4) of Table 2 (the structural primary balance in 2031 that will lead to falling debt with a 70 percent probability in 2041-2045), while column (6) of Table 3 shows the adjustment needed from 2025-2031 to reach SPB^*.

Unfortunately, the structural primary balance (SPB) is not available for the full 1970-2025 period. We therefore construct a combined series that merges SPB data from the IMF's April 2026 WEO with our own estimates of the cyclically adjusted primary balance (CAPB). To estimate the CAPB, we first derived output gaps using the Hodrick-Prescott filter with a smoothing parameter of 100, as the WEO output gap series is also unavailable for the full sample period. We then estimated country-specific regressions of the primary balance on the output gap and removed the estimated cyclical component from the primary balance to obtain the CAPB[12]. The final series uses the IMF's SPB estimates for all years in which they are available and extends them backward using our CAPB estimates. The IMF SPB data are available for all 38 countries in our sample from 2005 to 2025. Coverage declines further back in time, with data available for 34 countries in 2000, 13 countries in 1990, 5 countries in 1980, and none before 1980.

When evaluating the results, it is important to recognize that the reference period covers the entire 1970-2025 history, including episodes during which countries were actively pursuing adjustment efforts as well as periods when no such efforts were underway. Consequently, relative frequencies should not be expected to approach 100 percent. At the same time, there is no obvious benchmark for determining whether the observed frequencies should be considered high or low, but some judgment is warranted. For example, a frequency below 10 percent would suggest that the adjustment event was relatively rare, whereas a frequency above 50 percent would indicate that it occurred quite frequently.

The main result for this exercise is that, with some exceptions, structural primary balances required by our SDSA have not been unusual historically, fiscal adjustments needed to reach those levels have been considerably less common.

With regards the level of SPB*, for Greece, Italy and the United States, the SPB* was reached or exceed in about one-quarter of the years in 1970-2025 when considering the own sample of these countries (column 3 of Table 3), suggesting that such SPBs were not uncommon. Looking instead at the pooled sample of 38 advanced economies (column 2), the SPB* required for Greece and Italy was achieved in approximately 10 percent of observations, while the lower SPB* required for the United States was reached in 31 percent of cases. By contrast, the SPB* levels required for France, Spain, Hungary, Slovakia, Romania, Poland, and Lithuania were attained in less than 10 percent of their own historical observations, and in the cases of Poland and Lithuania, the required SPB* has never been observed.

The relative frequencies reported in columns (2) and (3) do not tell us whether countries have managed to sustain primary balances at the level of SPB^* or higher over extended periods. To shed light on that question, columns (4) and (5) show the maximum number of years that countries have managed to keep their average primary balances above the level indicated in column (1), after this had been exceeded for the first time[13]. Column (4) shows the average of

adjustments in 1975 and 2021 appear five times, adjustments in 1974 and 2022 four times, and so on.

[12]The median estimated coefficient of the output gap in the primary balance equation was 0.29, with an interquartile range of 0.13 to 0.65. Thus, in most countries, an improvement in economic conditions was associated with a stronger primary balance, as expected. However, for four countries, Bulgaria, Greece, Hungary, and Romania, the estimated coefficient was negative, implying a counterintuitive relationship between the output gap and the primary balance. For these countries, we therefore did not apply a cyclical adjustment and used the unadjusted primary balance instead for the period when the SPB is not available.

[13]More precisely, the duration of the spells shown in columns (4) and (5) of Table 3 is the period from the first year in which the primary balance exceeded SPB* to the last year in which the average primary balance since

Table 3: Historical precedents for SPB* and adjustment requirements, 1970-2025

	SPB* (% GDP)	Relative frequency (percent)		Maximum length of spell (years)		Adjustment to reach SPB* (% GDP)	Relative frequency (percent)	
		Whole sample	Own country	Av. whole sample	Own country		Whole sample	Own country
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Japan	0.3	40	13	23	11	1.3	31	32
Greece	3.5	8	25	4	13	-0.3	51	54
Italy	2.6	13	27	7	29	2.5	19	22
United States	0.9	31	23	18	18	4.5	10	4
France	1.5	23	9	14	4	4.6	10	0
Belgium	1.9	19	36	11	36	5.5	7	6
United Kingdom	1.9	19	11	11	5	4.2	11	8
Spain	2.2	15	4	9	4	2.8	18	18
Portugal	2.3	14	16	8	7	0.5	40	44
Finland	0.6	35	32	19	23	2.9	16	20
Austria	0.8	33	23	19	6	3.6	14	2
Hungary	2.9	10	6	6	2	3.5	14	24
Slovenia	1.8	20	13	11	4	3.1	16	24
Germany	0.5	37	43	20	18	1.7	26	24
Slovakia	1.7	20	3	12	1	4.9	9	16
Romania	2.6	13	3	7	1	7.0	4	7
Poland	2.1	17	0	10	0	5.9	6	0
Croatia	0.5	37	26	21	15	3.3	15	29
Cyprus	1.4	24	29	15	10	-1.7	67	84
Latvia	1.2	27	13	16	3	2.0	24	28
Malta	0.4	39	45	21	20	2.5	19	28
Czechia	1.4	23	16	14	7	2.6	19	32
Netherlands	0.9	32	46	18	27	2.4	20	18
Lithuania	1.6	21	0	12	0	3.4	14	20
Sweden	-0.3	50	57	29	27	0.4	41	54
Ireland	0.9	32	38	18	38	2.4	20	32
Denmark	-0.8	58	91	32	55	-1.0	59	64
Bulgaria	0.7	35	52	19	30	3.7	13	4
Luxembourg	0.4	38	74	21	29	2.2	21	4
Estonia	0.0	44	42	25	13	0.7	37	32

Source: Authors' calculations based on IMF Public Finances in Modern History and World Economic Outlook databases, and the European Commission's AMECO database. Note: 'Whole sample' refers to 38 advanced and EU countries, consisting of all EU countries, plus Australia, Canada, Hong Kong SAR, Iceland, Israel, Japan, Korea, New Zealand, Switzerland, the United Kingdom and the United States. 'Own country' only contains observations of the country shown in the left column. Red shaded cells denote relative frequencies of less than 10 percent, pink shaded cells relative frequencies below 30 percent.

the maxima across the entire sample, and hence represents the behavior of an average economy. Column (5) shows the maximum length of a primary balance spell exceeding SPB^* on average for each country.

For example, the maximum duration of a primary balance spell of 1.5 percent – the debt-stabilizing level for France – was 14 years on average across the 38 countries, but the maximum period for which France managed to maintain its average primary balance at that level was only four years (from 1974 until1977). The reverse is true for Italy. On average, the cross-country average of the maximum periods for which countries were able to maintain their primary balances above 2.6 percent – the debt stabilizing level for Italy – was 7 years, but Italy managed to pull off a 29-year spell during which its primary balance remained at that level on average. This picks up Italy's pre-euro accession adjustment effort, as well as the post-euro crisis high balances, resulting an average SPB above 2.6 percent of GDP for the 1993-2021 period.

Finally, columns (7) and (8) shows the relative frequency of the *adjustment* needed – shown in column (6) – to reach SPB^*. For example, a fiscal adjustment of 2.5 percent, the increase in the SPB required of Italy over six years if it wants to stabilize its debt, was observed in 19 percent of all time intervals of seven years or less for the pooled sample, and 22 percent in the Italy sample, suggesting that adjustments of this magnitude are far from unprecedented. The picture is less encouraging for countries facing larger adjustment needs. France's required adjustment of 4.6 percent of GDP has been observed in only 10 percent of six-year episodes in the pooled sample and has never been achieved in France's own historical experience. Similarly, the United States would need an adjustment of 4.5 percent of GDP, but increases of this magnitude occurred in only 4 percent of six-year episodes in U.S. history and in 10 percent of episodes across the pooled sample of 38 countries.

The bottom line is that the *level* of primary balances required to stabilize debt levels in advanced and emerging European countries appear feasible, in the sense that they have historical precedents, even for protracted periods. However, *adjustments* of the type required in the handful of countries subject to the greatest fiscal pressures have very rarely happened in periods of six years, particularly in those countries themselves. This does not imply that the adjustments are unfeasible, but it does imply that they will likely take longer than the six-year period assumed in Tables 2 and 3.

5.3 Adjustment probabilities based on IMF projections

A third potential way to evaluate the feasibility of the fiscal adjustment requirements is assessing their likelihood conditional on the adjustment effort that countries are expected to make today. This could be captured by computing the probability of reaching SPB^* conditional on IMF projections for medium-term fiscal adjustment, taken from the April 2026 WEO projections. The latter generally represent *"a judgment about policies' most likely path"* by IMF staff (IMF, 2025). That is, unlike European Commission fiscal forecasts, IMF forecasts incorporate expected fiscal adjustment, rather than being conditional on current policies[14]. That said, many IMF desk economists take a conservative view of expected adjustment, including only consolidation measures that are identified by the country authorities (rather than targets declared by the authorities).

We proceed in two steps. First, we create a probability distribution for the structural primary balance in 2031, the last year of the IMF's April 2026 projection, centered on the IMF's projection

that first year still exceeded *SPB**. Thus, temporary setbacks (if any) are included if the average since the first year still exceeds *SPB**.

[14]For the countries covered in this paper, the main exception is France, for which IMF forecasts are conditional on legislated rather than expected policies.

for the 2031 structural primary balance – denoted as $SPB(WEO, 2031)$, using bootstrapped errors from a vector autoregression (see for example Medeiros, 2012; Bouabdallah *et al*, 2017). Second, for each percentile level of the structural primary balance in this probability distribution, we calculate the probability of debt stabilization 15 to 20 years from now, applying the same methodology (projections for growth, interest rates and the exchange rates, and bootstrapped errors) that we used in our stochastic DSA analysis in section4. One can then select the percentile levels of the probability distribution for the 2031 structural primary balance that leads to debt stabilization with a 70 percent probability. We refer to these as Prob $\{SPB(2031) > SPB^{*}(2031)|WEO\}$.

Columns (1) of Table 4 reports the realized structural primary balance in 2025, column (2) 4 shows $SPB(WEO, 2031)$, while $SPB^{*}(2031)$ from column (4) of Table 2 is shown in column (3). Finally, column (4) shows the main result: the probability that the 2031 structural primary balance will exceed SPB* conditional on IMF projections.

Table 4: Probability of reaching debt stabilising primary balance by 2031 if countries adjust in line with IMF projections

	SPB (2025) (1)	SPB (WEO, 2031) (2)	SPB* (2031) (3)	Prob {SPB(2031)>SPB*(2031)|WEO} (4)
Japan	-1.0	-2.3	0.3	6
Greece	3.8	2.7	3.5	47
Italy	0.1	3.2	2.6	76
United States	-3.6	-3.0	0.9	13
Belgium	-3.6	-3.1	1.8	0
United Kingdom	-2.4	1.5	1.9	44
Spain	-0.5	0.4	2.2	17
Portugal	1.9	0.0	2.4	26
Finland	-2.4	-2.9	0.6	2
Austria	-2.8	-1.8	0.8	11
Hungary	-0.5	-0.9	3.0	10
Slovenia	-1.3	-1.8	1.8	4
Germany	-1.2	-2.2	0.6	4
Slovakia	-3.2	-3.6	1.7	2
Romania	-4.4	-1.6	2.6	7
Poland	-3.8	-1.8	2.1	1
Croatia	-2.7	-1.5	0.5	26
Cyprus	3.8	2.2	1.4	57
Latvia	-0.9	-2.6	1.2	10
Malta	-2.1	-1.3	0.3	29
Czechia	-1.2	-2.4	1.4	5
Netherlands	-1.5	-1.5	0.9	5
Lithuania	-1.8	-3.2	1.6	2
Sweden	-0.8	-0.7	-0.3	39
Ireland	-1.5	-1.9	0.8	26
Denmark	0.2	-1.2	-0.8	44
Bulgaria	-3.0	-2.4	0.7	28
Luxembourg	-1.8	-2.5	0.4	9
Estonia	-0.7	-2.9	0.0	14

Source: Authors' calculations and IMF World Economic Outlook, April 2026. Note. Values are in percent of GDP except in last column, which is expressed in percent. Light pink shaded cells denote probabilities of less than 30 percent, darker pink shaded cells denote probabilities of less than 30 percent. France is missing from the table because IMF fiscal projections for France are based on legislated policy rather than expected policy.

The bottom line from Table 4, which uses the same shading conventions as Table 3, is that IMF projections generally do not justify greater optimism, as far as the probability of reaching $SPB^{*}(2030)$ is concerned, than the assumption that the structural balance will evolve in line with average historical patterns (Table 3). Conditional on WEO forecasts, these probabilities are particularly low for Japan, Belgium, Finland, Slovenia, Germany, Slovakia, Romania, Poland, Czechia, the Netherlands, Lithuania, and Luxembourg. This correlates with probabilities based on the historical track reported in Table 3, but with significant exceptions. Most notably, Germany has a reasonable chance of stabilizing its debt ratio in the medium term based on its historical adjustment performance (about 25 percent, according to Table 3) but a much lower chance based on IMF WEO projections (just 4 percent).[15] The opposite is true for the United Kingdom: about 10 percent probability based on historical precedents, but 44 percent based on IMF projections. For the United States, both approaches lead to low probabilities: 4 percent probability based on historical precedents and 13 percent based on IMF projections.

6 Fiscal reaction functions

Even if fiscal adjustment does not happen within the timeframe assumed by our DSA, debt might still be sustainable provided a sufficient strong adjustment happens at a later stage. As set out in Section 3, a sufficient condition is that the primary surplus responds systematically and positively to increases in the debt ratio by an amount that exceeds the equilibrium interest-growth differential. The coefficient we estimate is the one that distinguishes passive from active fiscal policy in the sense of Leeper (1991), as discussed in the literature review in Section 2.

6.1 Specification and Data

We estimate a fiscal reaction function, introduced in equation (1) in Section 3, in the tradition of Bohn (1998), controlling for country-specific conditions, a measure of the business cycle, and the autocorrelation of primary surpluses:[16]

$$s_{it} = \rho s_{it-1} + \phi d_{it-1} + \gamma o_{it} + \theta' x_{it} + \alpha_i + \varepsilon_{it} \quad (8)$$

where s_{it} denotes the primary balance of country i in year t, d_{it-1} the lagged debt-to-GDP ratio, o_{it} the output gap, x_{it} a vector of controls, α_i a country fixed effect and ε_{it} an error term.

We estimate equation (8) on an annual panel of 17 advanced economies for the 1990–2025 period: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the United Kingdom and the United States. We exclude Eastern EU members for two reasons. First, their historical economic transitions, as well as the process of EU accession and euro adoption, introduce substantial structural breaks in the relationship between debt and the primary balance, and pooling these countries with the advanced economies makes the joint estimate considerably noisier. Second, some data series for Eastern Europe are only available from 2000 onwards. Annex VI reports fiscal results for a separate sample of eastern European countries.

We include, as controls, a measure of the output gap, an irregular expenditure term, trade openness, inflation, political stability, expected growth, a banking crisis dummy, and lagged short and long-term interest rates. These additional regressors control for the fact that simultaneous realizations of debt and the primary balance will often reflect the conditions under which debt is increasing rather than a fiscal response to debt itself.

The irregular expenditure variable, which is intended to capture the component of the primary balance that is emergency spending, warrants further explanation. For each country in our

[15]See Zettelmeyer, Darvas and Welslau (2025) for an analysis of Germany's medium-term fiscal structural plan that corroborates the view of a low chance for the medium-term debt stabilization.

[16]Because equation (1) omits the lagged primary balance, its ϕ corresponds to $\varphi/(1-\rho)$ in our specification rather than to φ. The two coincide only when $\rho = 0$.

sample, it is defined as the component of the annual change in the expenditure-to-GDP ratio that lies outside of that country's 5th to 95th percentile range of annual changes. This variable is therefore zero in most years, and takes non-zero values in extraordinary times, such as the global financial crisis of 2008 and the COVID-19 pandemic (Annex V, Figure A4).

Banking crises are identified using the database of Laeven and Valencia (2026). Expected growth is measured by the WEO forecast of average real growth over a five-year horizon. Lagged interest rates reflect debt service pressures and, in the case of the long rate, expectations of future short rates and the risk premium, thereby providing a forward-looking measure of borrowing costs.

Following Plödt and Reicher (2015) and Checherita-Westphal and Žďárek (2017), we instrument the output gap to address simultaneity, using its own lag, the second lag of the debt ratio, and the first and second lags of the output growth gap, $(\frac{\overline{Y}_{t,i}}{\overline{Y}_{t-1,i}} - \frac{Y_{t,i}}{Y_{t-1,i}})$, where $\overline{Y}_{t,i}$ denotes the level of potential output and $Y_{t,i}$ the level of actual output. We report Blundell-Bond system GMM estimates with standard errors clustered at the country level, to address the issue of Nickell bias[17]. We set the instrument lag length at three, selected on an Arellano-Bond AR(2) test. Annex V reports robustness checks.

To evaluate whether the relationship varies over time, we follow two approaches. First, like Auerbach and Yagan (2025), we split the sample into a pre-global financial crisis period (1990–2007) and a period starting in 2008, which encompasses the euro-area crisis and the COVID-19 pandemic. Second, we report rolling estimates based on 15-year windows, allowing the debt-response coefficient to evolve more gradually over time.

Our estimates should be interpreted as conditional correlations rather than causal effects, since public debt is not exogenous to expected fiscal policy, growth prospects or borrowing costs. However, our interest is to determine whether the primary balance responds positively to lagged debt conditional on spending and the output gap, regardless of other causal channels behind this change, which could include financial market reactions, institutional rules, or other domestic considerations.

6.2 Results

Over the full sample, a one percentage point increase in the debt ratio is associated with an increase in the primary balance of 0.016 percentage points of GDP in the following year, in a fixed effects panel estimate without country-specific slope coefficients (Table 5, column 1). Because the primary balance is persistent, this coefficient understates the ultimate response. With an estimated autoregressive coefficient of 0.65, a permanent one-point increase in the debt ratio raises the primary balance by 0.016 percentage points in the first year, by an additional 0.64x0.018 in the second year, and so on, converging to $\frac{\phi}{(1-\rho)} = \mathit{0.046}$. It is this long-run coefficient that is relevant for the debt stabilization condition derived in Section 3, where it is compared with the interest-growth differential. This long-run impact is comparable to the value of about 0.05 Bohn (1998) estimated in a specification without a lagged dependent variable. Annex V sets out the relationship between our and Bohn's specifications more formally.

Splitting the sample at the global financial crisis reveals only a substantial decline in the estimated fiscal response to debt, as the impact coefficient falls from 0.029 to 0.010, while the long-run response falls from 0.058 before to 0.028 after (Table 5, columns 3 and 5) . Three additional exercises indicate reduced responsiveness in more recent years: rolling window estimates, excluding

[17]The so-called Nickell bias is a downward bias in the standard fixed-effects estimator for the coefficient on a lagged dependent variable in a dynamic panel model, when the time dimension is small relative to the number of observations entities. This bias arises because the demeaned lagged dependent variable is correlated with the demeaned error term. The Arellano-Bond GMM estimator addresses the Nickell bias by using appropriately lagged values of the dependent variable and other regressors as instruments to correct for the endogeneity.

Table 5: Fiscal reaction function estimates

	1990–2025		1990–2007		2008–2025	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged debt ratio	0.0163***		0.0289**		0.00990**	
	(0.00455)		(0.0117)		(0.00454)	
Austria		0.0784***		0.113**		0.107***
		(0.0297)		(0.0456)		(0.0309)
Belgium		0.0286*		0.0548***		0.0415
		(0.0151)		(0.0175)		(0.0401)
Germany		0.0369		0.0533		0.0586
		(0.0344)		(0.0478)		(0.0675)
Denmark		0.0976***		0.0823***		0.201***
		(0.0324)		(0.0190)		(0.0646)
Spain		0.0422***		0.0954***		0.0755***
		(0.0105)		(0.0304)		(0.0152)
Finland		0.0576**		0.0707*		0.0814**
		(0.0237)		(0.0366)		(0.0363)
France		0.0328		0.0585		0.0444*
		(0.0237)		(0.0722)		(0.0264)
Greece		0.0272***		0.0307**		0.0406***
		(0.00939)		(0.0129)		(0.00659)
Ireland		0.0367***		0.0908***		0.0617***
		(0.00833)		(0.0197)		(0.0102)
Italy		0.0506***		0.0709***		0.0647**
		(0.0186)		(0.0175)		(0.0289)
Luxembourg		0.283***		0.0372		0.464***
		(0.0715)		(0.687)		(0.144)
Netherlands		0.0594**		0.101***		0.0730
		(0.0272)		(0.0255)		(0.0882)
Portugal		0.0580***		0.113**		0.0694***
		(0.0200)		(0.0471)		(0.0165)
Sweden		0.126***		0.165***		0.269***
		(0.0392)		(0.0511)		(0.0823)
United Kingdom		0.0724***		0.104		0.103***
		(0.0223)		(0.0759)		(0.0384)
USA		0.0273		0.0989**		0.0466**
		(0.0188)		(0.0397)		(0.0219)
Japan		0.0210***		0.0226**		0.0282***
		(0.00513)		(0.0113)		(0.00927)
L.Primary balance	0.645***	0.655***	0.502***	0.534***	0.644***	0.642***
	(0.0432)	(0.0485)	(0.0524)	(0.0489)	(0.0547)	(0.0656)
Output gap	0.262***	0.323***	0.335***	0.427***	0.199***	0.227***
	(0.0458)	(0.0556)	(0.0709)	(0.0622)	(0.0693)	(0.0615)
Irregular expenditures	-1.131***	-1.112***	-1.102***	-1.229***	-1.105***	-1.002***
	(0.0517)	(0.0498)	(0.159)	(0.168)	(0.0415)	(0.0605)
Trade	0.0225***	0.0231**	0.0212**	0.0127	0.0199*	0.0169
	(0.00615)	(0.00924)	(0.00945)	(0.0127)	(0.0116)	(0.0170)
Inflation	-0.302***	-0.216***	-0.418***	-0.0516	-0.211**	-0.143
	(0.0722)	(0.0742)	(0.103)	(0.113)	(0.0993)	(0.0892)
Political stability	-0.0169	0.0766	0.0242	0.186**	-0.158	-0.0898
	(0.0647)	(0.0726)	(0.0790)	(0.0939)	(0.144)	(0.162)
Banking crisis	-2.372***	-1.531***	-2.432***	-0.879	-2.013***	-0.541*
	(0.330)	(0.232)	(0.575)	(0.796)	(0.517)	(0.313)
Expected growth (t+1 to t+5)	-0.0816	0.151	0.0459	-0.175	-0.427	-0.645**
	(0.152)	(0.200)	(0.223)	(0.313)	(0.327)	(0.278)
Lagged short-term interest rate	-0.106*	-0.140**	-0.0222	-0.00804	-0.222	-0.210
	(0.0579)	(0.0586)	(0.0730)	(0.0831)	(0.149)	(0.133)
Lagged long-term interest rate	0.361***	0.397***	0.312**	0.0484	0.296***	0.316***
	(0.0489)	(0.0659)	(0.128)	(0.111)	(0.0776)	(0.0888)
Constant	-2.592***	-6.805***	-3.729**	-6.837***	-0.389	-6.455***
	(0.882)	(1.088)	(1.489)	(1.711)	(1.068)	(2.195)
Long-run coef.	0.046		0.058		0.028	
(s.e.)	0.014		0.027		0.014	
PB persistence	0.645		0.502		0.644	
Observations	575	575	269	269	289	289

Source: Authors' calculations based on IMF World Economic Outlook, IMF Direction of Trade Statistics, OECD Main Economic Indicators, Eurostat, JBA TIBOR Administration (JBATA), the PRS Group International Country Risk Guide (ICRG), and Laeven and Valencia (2026). Note: The table reports fiscal reaction coefficients using a panel of 17 advanced economies. Estimates are obtained with the Blundell–Bond system GMM estimator. The output gap is treated as endogenous and instrumented with its own lag, the second lag of the debt ratio, and lagged output growth gaps. Columns (1), (3) and (5) referring to "Common slope" are based on equation (8), which constrains the debt-response coefficient () to be identical across countries. Columns (2), (4) and (6) are based on equation (9), which extends equation (8) by interacting the lagged debt ratio with country-specific dummy variables, thereby allowing the debt-response coefficient () to vary across countries. Robust standard errors clustered at country level in parentheses (* $p<0.10$, ** $p<0.05$, *** $p<0.01$).

the COVID-19 pandemic period from the sample, and the inclusion of time fixed effects.

Figure 1 reports the estimated debt coefficient and its 90 percent confidence interval from rolling fifteen-year estimation windows, using the same specification and estimation method as the baseline model. Fifteen years is short enough that the final window, 2011–2025, contains no pre-global financial crisis observations, yet long enough for primary-balance persistence to remain in a range in which the implied long-run coefficient remains economically meaningful. Annex V presents analogous results using ten- and twenty-year windows.

The estimated coefficient for the panel estimates rises to a peak of 0.047 in the window ending in 2011, which estimation period includes pre-global financial crisis years and the initial years of the following European fiscal consolidation episode (Figure 1, panel 1). Thereafter, the estimated coefficient declines steadily. The coefficient remains significantly positive for windows ending between 2008 and 2015, but subsequently the point estimates fall and loses its statistical significance. In the final window, the point estimate is -0.002. The implied long-run coefficient follows the same path, indicating a marked weakening in the fiscal reaction to debt over time.

When the sample is restricted to 2008–2019, thereby excluding the pandemic and its aftermath, the estimated debt coefficient is essentially zero and insignificant, suggesting that the positive coefficient obtained in the 2008-2025 sample is driven largely by the most recent years rather than fiscal behavior during the decade preceding the pandemic.

Adding time fixed effects leaves the pre-crisis coefficient positive and significant at 0.016, but reduces the post-2008 coefficient to -0.0018 and renders it insignificant. This finding indicates that after 2008, most of the covariation between debt and primary balances is common across countries, i.e., the pandemic-related increase in debt and the subsequent fiscal consolidation, rather than country-specific fiscal responses to debt accumulation. While the post-global financial crisis sample estimate does not remain statistically significant under these robustness checks, the pre-crisis results remain robust.

We estimate country-specific ϕ_i parameters by interacting lagged debt with country dummies (Table 5, columns 2, 4 and 6):

$s_{it} = \rho s_{it-1} + \phi_i d_{it-1} + \gamma o_{it} + \theta' x_{it} + \alpha_i + \varepsilon_{it}$ (9)

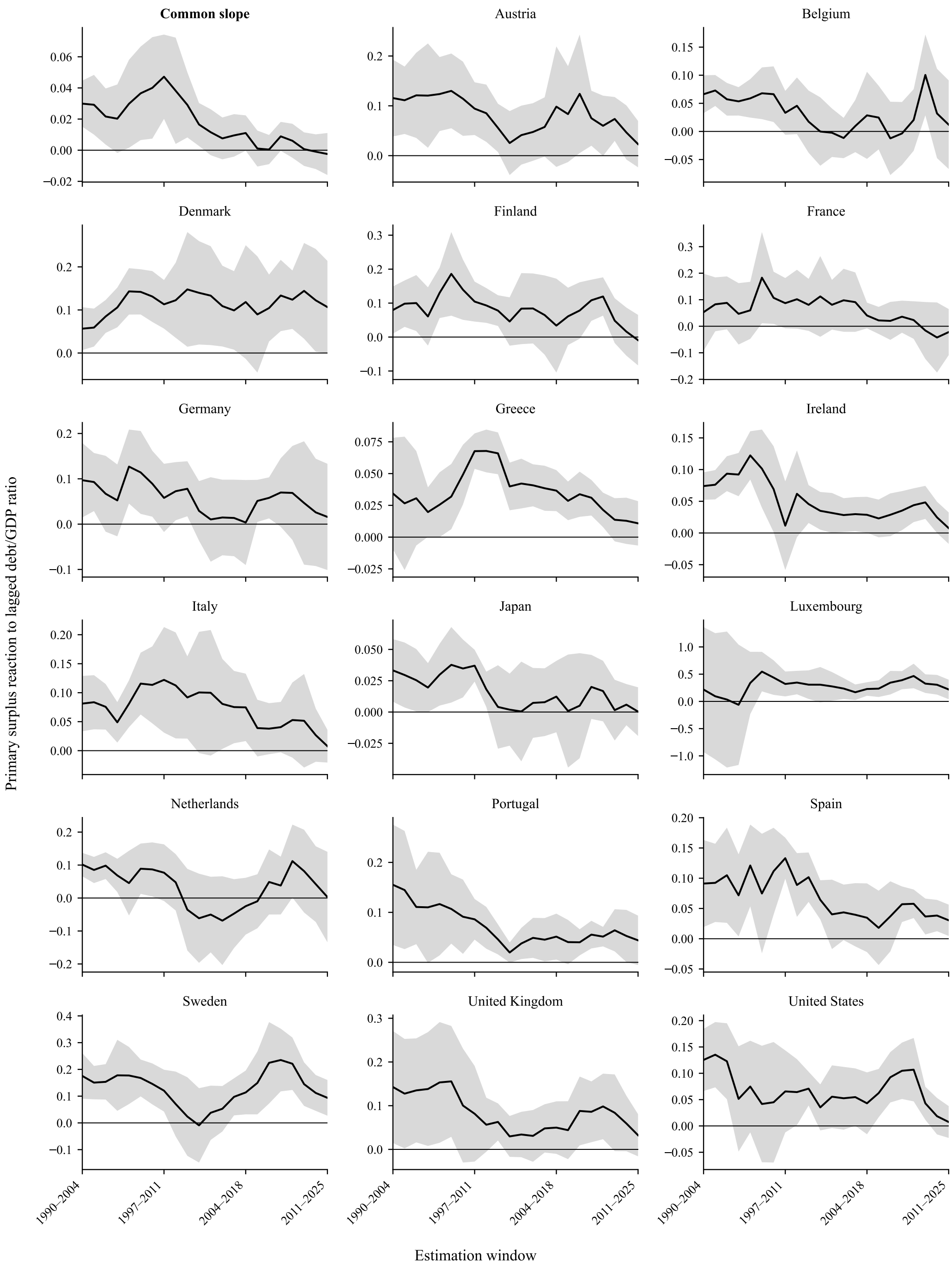
The estimated country coefficients are positive for all 17 countries in every period. Over the full sample, 14 of 17 estimated ϕ_i parameters are significant, ranging from 0.021 for Japan to 0.2831 for Luxembourg. In the 1990-2007 subsample, 13 are significant and in the 2008-2025 subsample 14.[18] The country-specific estimates based on rolling 15-year windows reveal a broad decline in the debt-feedback coefficient across countries, with statistical significance disappearing in most cases, with the except of Luxembourg, Portugal, Spain and Sweden (Figure 1).

6.3 Persistence and dynamics of fiscal reactions

The estimates presented so far quantify the magnitude of the primary balance response to debt, both at the one-year horizon and in the long run, as the latter is captured by the long-run coefficient implied by our estimation, $\frac{\phi}{(1-\rho)}$. However, the dynamics of this response are similarly important for public debt sustainability, as well as whether the long-run estimate is robust to a possible bias in the estimate of ϕ. To answer these questions, we estimate debt responses using local projection at horizons of up to six years. The output gap is instrumented as in the baseline specification. Annex V reports the local projection results, their comparison with the baseline specification, and the diagnostic tests.

[18] Luxembourg's estimated reaction coefficient is the largest in the panel by far, however, it's inclusion does not drive aggregate estimates. Dropping it from the sample only changes the full-sample estimate at the third decimal.

Figure 1: Reaction of the primary surplus to lagged debt



Source: Authors' calculations based on IMF World Economic Outlook, IMF Direction of Trade Statistics, OECD Main Economic Indicators, Eurostat, JBA TIBOR Administration (JBATA), the PRS Group International Country Risk Guide (ICRG), and Laeven and Valencia (2026). Note: The figure reports fiscal reaction coefficients estimated over rolling 15-year windows using a sample of 17 advanced economies. Solid lines denote point estimates of the effect of the lagged public debt-to-GDP ratio on the primary surplus-to-GDP ratio. Shaded bands represent 90 percent confidence intervals based on cluster-robust standard errors. Estimates are obtained with the Blundell–Bond system GMM estimator. The output gap is treated as endogenous and instrumented with its own lag, the second lag of the debt ratio, and lagged output growth gaps. All specifications include country fixed effects, the lagged primary balance, the output gap, irregular expenditure, trade openness (exports plus imports as a share of GDP), inflation, political stability, a banking-crisis dummy, expected real growth over the following five years, and the lagged short- and long-term interest rates. The first panel labelled "Common slope" is based on equation (8), which constrains the debt-response coefficient () to be identical across countries. The remaining 17 panels are based on equation (9), which extends equation (8) by interacting the lagged debt ratio with country-specific dummy variables, thereby allowing the debt-response coefficient () to vary across countries.

Over the full sample period and the period before the global financial crisis, local projections closely track the response implied by our baseline dynamic panel specification in equation (8), with mean absolute differences between just 0.004 and 0.014. By contrast, in the 2008-2025 period, the local projection estimate initially exceeds the path implied by the baseline specification, before falling below the path and becoming indistinguishable from zero beyond the fourth year. The mean absolute difference between the two approaches doubles.

While the close correspondence between the baseline specification and the local projections for the full sample and the pre-crisis subsample provides reassuring evidence of robustness, the divergence observed in the post-crisis subsample warrants a more cautious interpretation. First, the local projections indicate a less persistent response than implied by the autoregressive process assumed in our main specification, and hence a potentially lower cumulative response. Second, because the subsamples span only 17 years, there are fewer than three non-overlapping 6-year projection windows. This reduces the effective sample size at longer horizons, which may limit the reliability of the dynamics inferred by local projections. Consequently, the discrepancy between the two approaches should be interpreted with caution and not necessarily as definitive evidence against the baseline specification.

6.4 Fiscal fatigue and debt limits

The reduction in the strength of fiscal reaction observed in the second half of our sample could also be driven by overall higher debt levels during this period. Ghosh *et al* (2013) proposed to test whether fiscal adjustment diminishes at high debt levels using a fiscal reaction regression with a third-order polynomial in the debt ratio. A negative and significant coefficient of the cubic term implies the presence of *"fiscal fatigue"*. We augment our baseline specification with quadratic and cubic terms of lagged debt to look for evidence of fiscal fatigue in our sample:

$s_{it} = \rho s_{it-1} + \phi_1 d_{it-1} + \phi_2 d_{it-1}^2 + \phi_3 d_{it-1}^3 + \gamma o_{it} + \theta' x_{it} + \alpha_i + \varepsilon_{it}$ (10)

For a sample including the fifteen EU countries, the UK and the US, the joint null is not rejected for 1990–2007 (p=0.31), but is rejected at p<0.001 after 2008, with the signs of coefficients in line with fiscal fatigue ($\phi_2 > 0$, $\phi_3 < 0$). Fiscal fatigue thus appears to be a post-crisis phenomenon for these countries. Japan has been excluded from these calculations for a reason explained below.

Ghosh *et al* (2013) further showed that the presence of fiscal fatigue implies a *"debt limit"*, above which debt becomes unsustainable. This is given by the highest debt level $\overline{d}$ that solves:

$\mu + f\left(\overline{d}\right) = (r - g)\overline{d}$ (11)

where μ summarizes the determinants of the primary balance that are independent of the debt level (that is, the level of the intercept and controls in Z_i). The debt limit is the level of debt at which the primary surplus is exactly sufficient to cover the growth-adjusted interest service of an extra unit of debt. When $d > \overline{d}$, the primary surplus is not sufficient to meet interest payments, the debt grows continuously and the government defaults. To evaluate the non-debt part of the fiscal reaction function, we assume a closed output gap, no banking crisis and no irregular expenditure, and set the remaining controls at their sample means. This calibration emphasizes that a debt limit should describe what a country can sustain in normal times rather than under the average output gap realized over a crisis-heavy decade.

Assuming a zero interest-growth differential, the estimated debt limit is about 157 percent for the pre-pandemic period of 2008–2019, and 195 percent of GDP for 2008–2025. Because the debt limit is a function of the estimated coefficients, we test the robustness of limits by resampling the joint distribution of estimated coefficients. We take 20,000 draws from the joint distribution, solve for the debt limit, and report the share of draws in which a limit exists. For the post-2008 sample, a debt limit exists in 98 to 100 percent of draws; for 1990–2007, consistent with the joint test, in 38 percent of the draws. Appendix VI additionally reports the 5th to 95th percentile of existing debt limits.

Every country in the estimation sample is currently below its estimated debt limit. However, the 2008–2025 estimate of 195 percent is located at the edge of the observed data: the highest debt ratio observed in the fifteen-country sample is Greece at 210 percent of GDP value in 2020 and observations around this level are sparse. Importantly, estimates are sensitivity to the interest-growth differential: raising it from zero to two percentage points lowers the limit from 195 to 171 percent of GDP.

An important caveat to these estimates is that they exclude Japan. Fourteen Japanese observations are above 195 percent of GDP (2012-2025). Under a common cubic slope, Japan therefore determines the estimated shape of the reaction function in exactly the region where the debt limit lies. Since there was a long subperiod when Japan behaved in the opposite way to the fatigue hypothesis, including Japan eliminates the fiscal fatigue result: the country's primary balance increased from -8.7 to -1.7 percent of GDP between 2009 and 2018, while its debt ratio rose from 179 to 204 percent. Moreover, after a temporary increase in Japan's primary deficit to 8.4 percent in 2021, this deficit fell to 0.9 percent by 2025, signalling a strong fiscal correction when the country's debt level exceeded 200 percent og GDP. When Japan is included in the panel estimation sample, the cubic coefficient turns positive, indicating that no debt limit exists. By contrast, excluding any of the other sixteen countries from the estimation leaves the main result unchanged. Annex V reports the full set of estimates, a sensitivity analysis with respect to the interest-growth differential, and the fitted reaction functions.

7 Conclusion

In this paper, we have examined debt sustainability in EU countries, Japan, the United Kingdom and the United States. We employed two methodologies: one focusing on the feasibility of the medium fiscal adjustment required to stabilize the debt ratio, and one based on estimating the response of the primary balance to changes in the debt ratio. Our findings lead to two main conclusions.

First, we do not consider debt in any of the countries studied to be unsustainable. This conclusion is based on three pieces of evidence: (1) historical precedent for the primary surpluses that countries in our sample would need to; (2) the fact that, except for the US, all countries have announced plans to adjust in line with, or not far from, what is required; and (3) there is no fiscal fatigue result when Japan is included in the sample, and when Japan is excluded, the public debt levels of the remaining countries in our sample are below the level ('debt limit') at which the average response of the fiscal surplus to higher debt would be unable to cover the interest cost of the extra debt.

Second, seven countries –Belgium, France, Poland, Romania, Slovakia, the United Kingdom and the United States – face adjustment needs more than 4 percentage points of GDP, while six other countries should adjust between 3-4 percentage points. Based on the historical record and IMF forecasts, these adjustments are unlikely to happen.

While our analysis takes into account fiscal pressures related to ageing populations, it ignores pressures from higher defense spending. It is unclear how these will be addressed, but one risk is clearly that deficits will widen, and fiscal adjustment will fall significantly short of what is needed to stabilize the debt. This could lead to a feedback loop of higher debt and higher borrowing costs, or worse, to a sudden jump in borrowing costs that could trigger debt distress.

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Supplementary material

What will it take to stabilise public debt in advanced countries?

Supplementary material

What will it take to stabilize public debt in advanced countries?

Annex I. Stochastic debt sustainability analysis methodology

This Annex describes the data sources and implementation of the stochastic debt sustainability analysis (SDSA). The methodology itself is set out in Section 3 and is not repeated here. The code and all publicly available data for reproduction are available from the GitHub repository accompanying this publication[19].

A.I.1. Data

A complete variable-by-variable description, including indicator codes and URLs, is in the accompanying repository. The dataset has three components: historical data and medium-term macroeconomic and fiscal projections, longer-term projections, and financial market data.

Historical data and medium-term baseline projections for nominal and real GDP, GDP deflators, primary and overall fiscal balances and total gross debt are sourced from the IMF World Economic Outlook (WEO) database, April 2026 vintage. Structural balances, output gaps, debt ratios and stock-flow adjustments are derived from these series, as is medium-term potential GDP[20]. Exchange rates come from the European Commission's AMECO database.

Sovereign debt structures, including the shares of short-term, domestic and foreign-currency-denominated debt, are primarily from the ECB Data Portal. Non-EU debt structures and issue-level sovereign bond repayment schedules for all countries are constructed from Refinitiv Eikon, supplemented by the ESM programme database where applicable.

Historical yield curve data come from the respective monetary authorities: ECB Data Portal aggregates for EU short- and long-term rates, the US Treasury's Daily Treasury Yield Curve, the Bank of England's archived spot yield curves, and the Bank of Japan's nominal yield curve. Interest rate and inflation projections are based on market-implied expectations from Bloomberg.

Budget balance semi-elasticities for EU member states and the UK are from Mourre*et al* (2019); for the US and Japan we use the OECD expenditure elasticity estimates (Price *et al*, 2015).

Long-term potential growth is from the European Commission's 2024 Ageing Report for EU countries, the Congressional Budget Office's Long-Term Economic Projections (February 2026) for the US, the Office for Budget Responsibility's long-term economic determinants (March 2025) for the UK, and Japan Cabinet Office projections for Japan.

Projected fiscal costs of ageing for the EU rely on the 2024 Ageing Report. US estimates aggregate Medicare, Medicaid, CHIP and Social Security from the CBO's February 2026 baseline. UK estimates are from the European Commission's 2015 Ageing Report, the last year available.

[19] To access the repository, visit https://github.com/... [to be added to the final manuscript]. Bloomberg data can be downloaded via a Bloomberg Terminal. The README file details all data sources.

[20] We model debt dynamics differently for euro members and non-members. For euro members, euro- and US dollar-denominated debt are considered. For non-euro members, including the UK and Japan, local currency, euro and US dollar debt are considered. For the US, euro and US dollar debt are considered.

Japanese estimates are based on OECD projections of age-related spending. All are no-policy-change projections conditional on legislated policy.

The fiscal multiplier is 0.75 (Carnot and de Castro, 2015), applied to deviations of the structural primary balance from its WEO baseline path, with the effect on the output gap unwinding over two subsequent years, as described in Section 3.1. After 2031, potential growth converges linearly to the long-term projections cited above. For euro-area countries, Bulgaria, Czechia, Denmark and Sweden, and for the UK, the US and Japan, inflation is based on the WEO GDP-deflator forecast to 2031, interpolated with market expectations for 2035 implied by inflation swaps[21], converging to the 2 percent targets by 2054 in line with the Commission's methodology[22]. For Hungary, Poland and Romania we assume half of the spread vis-à-vis euro-area inflation observed in the base year remains by 2035, converging to national targets by 2054.

The primary balance ratio is the sum of the structural primary balance ratio, a cyclical component, a property income component and an ageing-cost component. The ageing-cost component, net of pension tax revenues, is not separated out during the adjustment period. Afterwards the structural primary balance excluding the change in ageing costs is held constant, so the change in ageing costs drives the overall structural primary balance. The cyclical component is the product of country-specific semi-elasticities and the output gap.

A.I.2. Deterministic Debt Projection

The debt ratio in a given year, d_t, is calculated as

$$d_t = \alpha^n \cdot d_{t-1} \cdot \frac{1 + iir_t}{1 + g_t} + \alpha^f \cdot d_{t-1} \cdot \frac{1 + iir_t}{1 + g_t} \cdot \frac{e_t}{e_{t-1}} - s_t + f_t,$$

with variables as defined in Section 3.1. The implementation follows the European Commission's Debt Sustainability Monitor (DSM) 2022 (European Commission, 2023), Annex A3 of which describes debt dynamics and the projection of the implicit interest rate.

The implicit interest rate on the debt stock is the weighted average of the short-term market rate i_t^{ST} and the long-term implicit rate iir_t^{LT}:

$$iir_t = \alpha_{t-1} \cdot i_t^{ST} + (1 - \alpha_{t-1}) \cdot iir_t^{LT},$$

Where α_{t-1} is the share of short-term debt in the total stock in t-1, and

$$iir_t^{LT} = \beta_{t-1} \cdot i_t^{LT} + (1 - \beta_{t-1}) \cdot iir_{t-1}^{LT},$$

where β_{t-1} is the share of new long-term issuance in the total long-term stock in t-1. Long-term market rates are projected by interpolating from Bloomberg 10-year benchmark rates to 10Y10Y forward rates[23]. Between t+10 and t+30 they converge linearly to 2 percent plus national inflation targets, giving 4.5 percent for Poland and Romania, 5 percent for Hungary and 4 percent elsewhere. Short-term rates use 3-month benchmark rates, 3M10Y forward rates, and 0.5 times the country-specific long-term rate in t+30.

To project the implicit interest rate forward we calculate new issuance and the stock of short- and long-term debt in each period. Gross financing needs are the sum of interest and amortization

[21] Inflation expectations are based on averages of daily Bloomberg data over the month preceding the data cut-off.
[22] Further details of the inflation projection methodology are in Box I.2.1 of European Commission (2022).
[23] Interest rate expectations are based on averages of daily Bloomberg data over the month preceding the data cut-off.

payments and the primary balance. Short-term debt is redeemed entirely each period; the share of long-term debt maturing each year is based on bond-level data together with the maturing of projected new issuance. Given gross financing needs, the split between new short- and long-term issuance holds the short-term share constant. The resulting stocks then determine the implicit interest rate in t+1[24].

A.I.3. Stochastic debt projections

Section 3.1 describes the VAR bootstrap. This section documents the data and the aggregation of shocks to annual frequency.

Quarterly shocks are first differences of the historical quarterly series, estimated over 2000–2025, and winsorized at the 5th and 95th percentiles. Bilateral exchange rates (EUR and USD) are from Eurostat. Short-term rates are from Eurostat, supplemented by the OECD for Bulgaria and Japan; long-term rates likewise, with exceptions for Estonia (ECB) and the US, UK and Japan (OECD). Nominal GDP for the EU is from Eurostat; for the UK, the US and Japan from the Office for National Statistics, the Bureau of Economic Analysis and the Cabinet Office. Primary balances for EU member states are from Eurostat; for the UK, the US and Japan we construct them by stripping interest payments from the overall fiscal balance.

Quarterly shocks for nominal GDP growth, the primary balance, the exchange rate and the short-term interest rate are transformed to annual frequency by summing within each year. Shocks to the long-term rate are treated the same way in the first projection year. Thereafter, because a change in the long-term rate affects the interest bill until the debt issued in that quarter matures, the aggregation accounts for that persistence: a shock in year t carries over in proportion to the share of maturing debt progressively rolled over,

$$\varepsilon_t^{i^{LT}} = \frac{t}{T} \sum_{q=-4t}^{4} \varepsilon_q^{i^{LT}},$$

where T is the average maturity of long-term debt in years, calculated as one over the historical average share of long-term debt maturing. Shocks to the implicit interest rate are the weighted average of annualized short- and long-term shocks,

$$\varepsilon_t^{iir} = \alpha^{ST} \varepsilon_t^{i^{ST}} + \left(1 - \alpha^{ST}\right) \varepsilon_t^{i^{LT}},$$

with $\alpha^{ST}$the share of short-term debt in total government debt, based on ECB data.

Annex II. The SDSA methodology illustrated for Spain and Finland

Figures A1 and A2 illustrate the mechanics of the methodology using Spain and Finland, chosen because the two countries sit at opposite ends of the range of outcomes: Spain requires one of the larger adjustments in the sample, Finland one of the smaller, despite similar debt ratios in 2025.

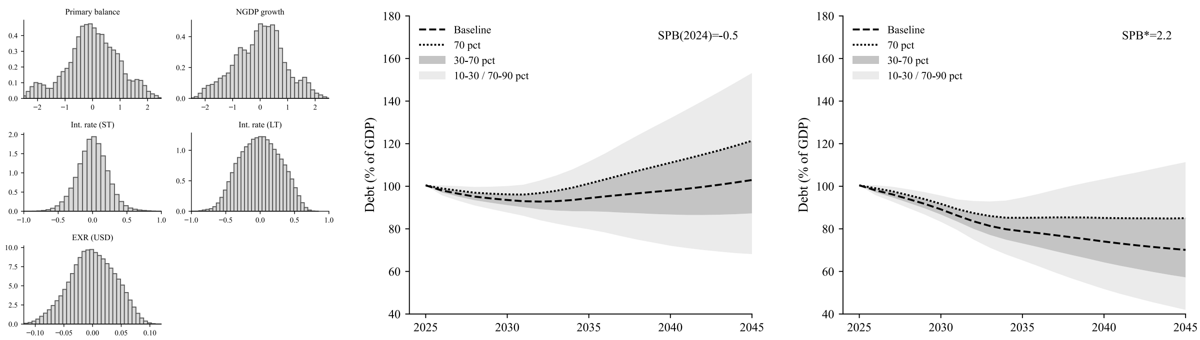
Each figure has three panels. Panel (a) shows the distribution of simulated shocks to the primary balance, nominal GDP growth, the short- and long-term interest rate and the €/$ exchange rate, drawn as described in Section 3.1. Panel (b) shows the deterministic and stochastic debt

[24]Up to the base year, the implicit interest rate is assumed to equal the WEO projections, and the implicit long-term interest rate is constructed consistently with that.

projections conditional on holding the structural primary balance at its 2025 level, except for changes in ageing costs. Panel (c) shows the projection conditional on raising the structural primary balance by 2031 to SPB*, the level required to stabilize debt with 70 percent probability.

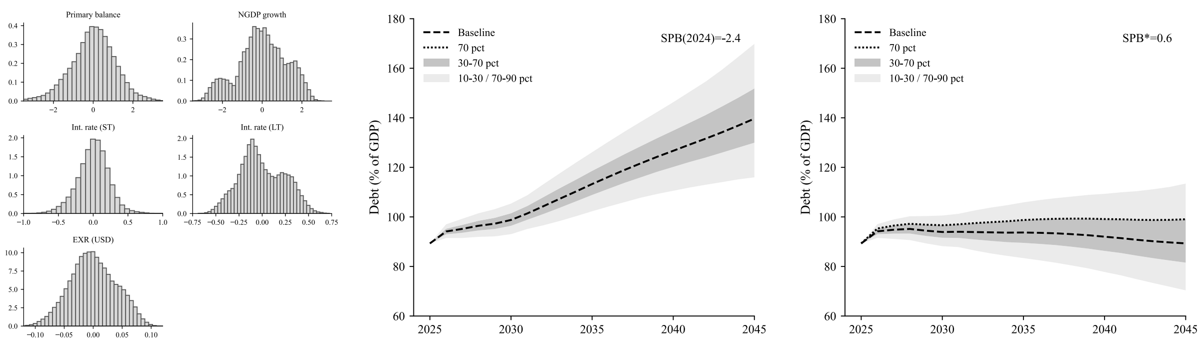
The comparison brings out what drives the difference between the two countries, and it is the width of the fanchart rather than the central projection. The no-policy-change fanchart for Spain in panel (b) widens substantially towards the end of the horizon, so the 70th percentile is still rising steeply over the final five years. Flattening it requires a large fiscal effort. The Finnish fanchart widens considerably less, because the underlying shocks are less volatile, and the growth of the median and the 70th percentile slows over the projection[25]. Flattening the 70th percentile for Finland therefore requires much less. This is the mechanism behind the observation in Section 3.3 that required adjustment and the debt ratio are only loosely related: what matters is the volatility of a country's debt drivers alongside the gap between its current balance and the balance consistent with stable debt.

Figure A1. Spain



Source: Authors' calculations based on the IMF April 2026 World Economic Outlook, the 2024 EU Ageing Report, Bloomberg and the ECB.*Notes*: Panel (a) shows the distribution of shocks used to construct the fancharts, from bootstrapped residuals of a vector autoregression in the exchange rate, short- and long-term interest rates, nominal growth and the primary balance. Panel (b) shows deterministic and stochastic debt projections for 2026–2045 conditional on maintaining the structural primary balance at its 2025 level, except for changes in ageing costs. Panel (c) shows the fanchart conditional on raising the structural primary balance by 2031 to the level required to stabilize debt with 70 percent probability over 2041–2045.

Figure A2. Finland



Source and notes: see Figure A1.

[25]In Finland, the main driver of gross public debt increases, historically and over the next two decades, is the accumulation of state pension surpluses as financial assets, which produces upward stock-flow adjustments (see Darvas and Boivin, 2025). The slower growth of the median and 70th percentiles towards the end of the projection reflects the expectation that this contribution will decline.

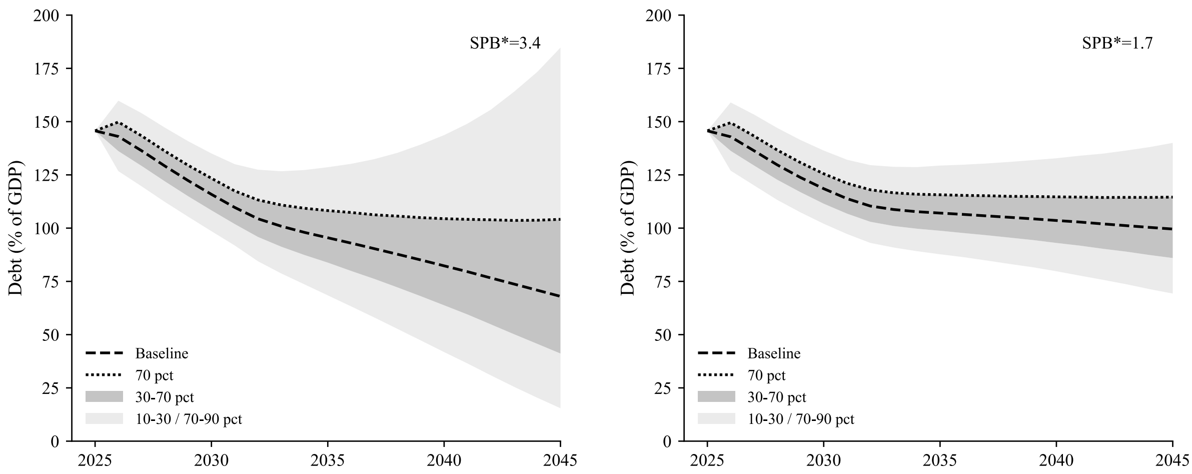
Annex III. The SPB* estimate for Greece

Greece is the only country in our sample whose required structural primary balance exceeds 3 percent of GDP, and the estimate depends on whether shocks are drawn from Greece's own history or from the pooled distribution. Figure A3 shows why.

Panels (a), (b), and (c) show the histogram of stochastic shocks, as well as fancharts for a no-policy-change, and a debt-stabilizing scenario. With shocks drawn from Greek data, the fanchart widens sharply from the mid-2030s, reflecting the volatility of Greek macroeconomic and fiscal variables during the crisis of the early 2010s. Because our criterion requires the 70th percentile to be flat over the last five years of a 20-year horizon, this widening translates directly into a high required balance: SPB* reaches 3.4 percent of GDP. Panels (d), (e), and (f) repeat the exercise with shocks drawn from the pooled distribution estimated on the euro-area members that did not receive emergency financial assistance. The fanchart is substantially narrower and the required balance falls to 1.7 percent.

The choice between them is a judgment about whether the volatility Greece experienced during its debt crisis is informative about the volatility it will face over the next two decades. Greece's own history contains an episode that followed a period of undetected fiscal misreporting and ended in the largest sovereign debt restructuring on record, and the institutional environment has changed substantially since. Against that, a pooled distribution assumes Greek volatility will converge to that of the more stable euro-area members, which is an assumption rather than a finding. We report both and treat the country-specific estimate as the baseline. The same consideration applies with less force to Portugal, Hungary and Romania, and to Japan, whose country-specific shock distribution is drawn from three decades of deflation and near-zero policy rates.

Figure A3. Greece under country-specific and pooled shocks



Notes: see Figure A1. Panel (a)-(c) draws shocks from Greek data and panel (c)-(d) from the pooled euro-area distribution; in each the structural primary balance is raised by 2031 to the level required to stabilize debt with 70 percent probability over 2041–2045 under that shock distribution.

Annex IV. Sensitivity of the stochastic debt sustainability analysis

All variants use the baseline specification (2025 base year, six-year adjustment to 2031, 20-year fanchart, stabilization judged over 2041–2045, country-specific shocks), changing one element at a time.

Table A1. Sensitivity of SPB*

	p=50	p=60	p=70	p=80	p=90	Pooled shocks	Shocks to 2019	No winsorizing	Growth -0.5pp	Rates +1pp
JPN	-0.01	0.12	0.25	0.43	0.68	–	0.22	0.28	1.00	1.44
GRC	1.04	2.33	3.49	4.63	6.31	1.71	3.74	4.83	3.90	3.67
ITA	1.58	2.03	2.62	3.13	3.99	2.36	2.40	2.90	3.26	3.51
USA	0.58	0.72	0.88	1.08	1.37	–	0.88	0.99	1.49	1.78
FRA	0.76	1.15	1.53	1.94	2.50	1.70	1.43	1.72	2.09	2.37
BEL	0.79	1.33	1.87	2.44	3.15	1.88	1.76	2.02	2.32	2.54
GBR	1.18	1.52	1.90	2.26	2.85	–	1.69	2.12	2.36	2.47
ESP	1.51	1.88	2.20	2.62	3.18	2.15	2.17	2.46	2.63	2.77
PRT	1.15	1.75	2.37	3.01	3.76	1.74	2.51	2.72	2.66	2.71
FIN	0.13	0.36	0.58	0.89	1.27	0.81	0.52	0.77	1.05	1.31
AUT	0.35	0.55	0.76	0.99	1.33	0.85	0.71	0.89	1.12	1.33
HUN	1.62	2.27	2.96	3.72	4.69	2.34	2.81	3.24	3.37	3.45
SVN	1.05	1.40	1.81	2.21	2.70	1.60	1.78	2.04	2.06	2.09
DEU	0.36	0.44	0.55	0.66	0.85	0.66	0.49	0.62	0.85	1.01
SVK	1.06	1.38	1.73	2.12	2.56	1.67	1.71	2.00	2.01	2.10
ROU	1.78	2.21	2.66	3.20	3.95	2.18	2.65	3.09	2.97	3.07
POL	1.51	1.76	2.07	2.42	2.85	2.02	2.10	2.49	2.43	2.55
HRV	-0.11	0.19	0.49	0.83	1.30	0.26	0.44	0.82	0.72	0.85
CYP	0.82	1.09	1.36	1.69	2.08	1.14	1.36	1.78	1.52	1.58
LVA	0.38	0.76	1.14	1.63	2.77	0.58	1.22	1.49	1.39	1.43
MLT	0.01	0.18	0.39	0.59	0.89	0.34	0.26	0.53	0.58	0.68
CZE	1.12	1.27	1.43	1.63	1.88	1.41	1.43	1.43	1.62	1.70
NLD	0.52	0.68	0.86	1.06	1.31	0.96	0.79	0.93	1.05	1.15
LTU	1.19	1.40	1.64	1.89	2.28	1.41	1.66	2.26	1.80	1.87
SWE	-0.45	-0.39	-0.33	-0.27	-0.20	-0.35	-0.34	-0.29	-0.22	-0.11
IRL	0.54	0.70	0.84	0.99	1.22	0.63	0.90	1.01	0.92	0.87
DNK	-0.98	-0.91	-0.85	-0.75	-0.62	-0.86	-0.85	-0.78	-0.75	-0.85
BGR	0.02	0.34	0.69	1.07	2.15	0.30	0.60	0.87	0.82	0.90
LUX	-2.64	0.37	0.45	1.11	0.65	0.46	0.42	0.54	0.52	0.55
EST	-0.19	-0.11	0.03	1.11	1.18	-0.09	0.02	0.11	0.15	0.21

Note: SPB* in percent of GDP. Columns 1–5 vary the probability threshold under the baseline shock specification. The remaining columns are all at the baseline 70 percent threshold: 'Pooled shocks' draws from a common distribution estimated across euro-area members that did not receive emergency financial assistance; 'Shocks to 2019' ends the shock sample before the pandemic and energy-price shocks; 'No winsorizing' leaves the tails of the shock distribution untouched; the last two columns impose a permanent 0.5 percentage point reduction in potential growth and a permanent 1 percentage point increase in market interest rates from 2026. Countries are ordered by 2025 debt ratio; means exclude Japan.

The probability threshold is the most consequential assumption. The cross-country average SPB\rises from 0.7 percent of GDP at a 50 percent threshold to 1.0 at 60 percent, 1.3 at 70 percent, 1.7 at 80 percent and 2.1 at 90 percent, so moving from the least to the most demanding threshold roughly triples the requirement. Dispersion widens with the threshold and does so much more for countries with volatile debt drivers: Greece moves from 1.1 to 5.0 percent of GDP, Italy from 1.6 to 3.9, Spain from 1.5 to 3.2 and France from 0.8 to 2.6, while Germany moves only from 0.3 to 0.9 and the United States from 0.6 to 1.4. SPB.

The remaining columns vary the treatment of extreme observations and of countries' own volatility histories, all at the baseline 70 percent threshold. Drawing shocks from the pooled euro-area distribution lowers SPB\in about seven countries in ten, by 0.18 percentage points on average, and by far the most where national histories contain severe crisis episodes: Greece falls by 1.8 points, Portugal by 0.6 and Hungary by 0.6. Removing the winsorizing raises SPB in every country, by 0.28 points on average, again with the largest effect for Greece (+1.4), so the baseline treatment of outliers is the less demanding choice rather than a device for generating large requirements. Ending the shock sample in 2019 changes almost nothing: the difference is smaller than 0.2 percentage points for 97 percent of countries and never exceeds 0.3, and the average requirement falls by 0.02 points. The recent period of large shocks, once winsorized, does not inflate the estimated tail.

The last two columns impose a permanent reduction in potential growth of 0.5 percentage points and a permanent increase in market interest rates of 1 percentage point. Both raise SPB* in every country, by 0.33 and 0.40 percentage points on average, which is more than any of the shock-specification variants. Neither is uniform: the growth shock costs Estonia 0.9 points and Luxembourg 0.1, and the interest-rate shock costs Italy 1.0 points and Ireland almost nothing, depending on the debt ratio and the maturity of the stock. Read against the threshold columns, a permanent 1 point rise in market rates is worth roughly the same to the required balance as moving the probability threshold from 70 to 80 percent.

Annex V. Fiscal reaction function: estimates, robustness and diagnostics

The sample throughout is the seventeen advanced economies listed in Section 5.1 over 1990–2025, except in A.IV.4, where the fiscal-fatigue and debt-limit estimates are reported both for the sixteen EU, UK and US countries and for the full seventeen including Japan.

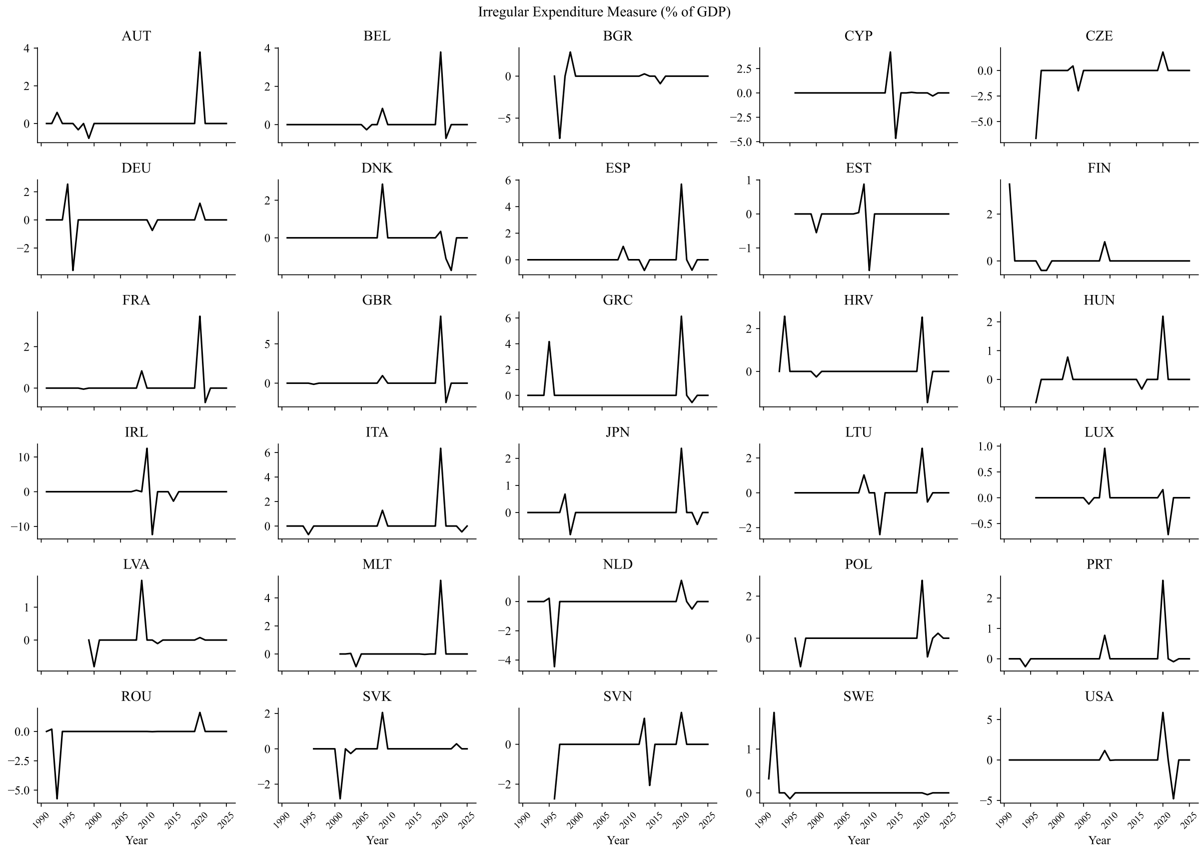
A.V.1. Main estimates

Table A2 = Table 5 of the manuscript: Fiscal reaction function estimates

	1990–2025		1990–2007		2008–2025	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged debt ratio	0.0163***		0.0289**		0.00990**	
	(0.00455)		(0.0117)		(0.00454)	
Austria		0.0784***		0.113**		0.107***
		(0.0297)		(0.0456)		(0.0309)
Belgium		0.0286*		0.0548***		0.0415
		(0.0151)		(0.0175)		(0.0401)
Germany		0.0369		0.0533		0.0586
		(0.0344)		(0.0478)		(0.0675)
Denmark		0.0976***		0.0823***		0.201***
		(0.0324)		(0.0190)		(0.0646)
Spain		0.0422***		0.0954***		0.0755***
		(0.0105)		(0.0304)		(0.0152)
Finland		0.0576**		0.0707*		0.0814**
		(0.0237)		(0.0366)		(0.0363)
France		0.0328		0.0585		0.0444*
		(0.0237)		(0.0722)		(0.0264)
Greece		0.0272***		0.0307**		0.0406***
		(0.00939)		(0.0129)		(0.00659)
Ireland		0.0367***		0.0908***		0.0617***
		(0.00833)		(0.0197)		(0.0102)
Italy		0.0506***		0.0709***		0.0647**
		(0.0186)		(0.0175)		(0.0289)
Luxembourg		0.283***		0.0372		0.464***
		(0.0715)		(0.687)		(0.144)
Netherlands		0.0594**		0.101***		0.0730
		(0.0272)		(0.0255)		(0.0882)
Portugal		0.0580***		0.113**		0.0694***
		(0.0200)		(0.0471)		(0.0165)
Sweden		0.126***		0.165***		0.269***
		(0.0392)		(0.0511)		(0.0823)
United Kingdom		0.0724***		0.104		0.103***
		(0.0223)		(0.0759)		(0.0384)
USA		0.0273		0.0989**		0.0466**
		(0.0188)		(0.0397)		(0.0219)
Japan		0.0210***		0.0226**		0.0282***
		(0.00513)		(0.0113)		(0.00927)
L.Primary balance	0.645***	0.655***	0.502***	0.534***	0.644***	0.642***
	(0.0432)	(0.0485)	(0.0524)	(0.0489)	(0.0547)	(0.0656)
Output gap	0.262***	0.323***	0.335***	0.427***	0.199***	0.227***
	(0.0458)	(0.0556)	(0.0709)	(0.0622)	(0.0693)	(0.0615)
Irregular expenditures	-1.131***	-1.112***	-1.102***	-1.229***	-1.105***	-1.002***
	(0.0517)	(0.0498)	(0.159)	(0.168)	(0.0415)	(0.0605)
Trade	0.0225***	0.0231**	0.0212**	0.0127	0.0199*	0.0169
	(0.00615)	(0.00924)	(0.00945)	(0.0127)	(0.0116)	(0.0170)
Inflation	-0.302***	-0.216***	-0.418***	-0.0516	-0.211**	-0.143
	(0.0722)	(0.0742)	(0.103)	(0.113)	(0.0993)	(0.0892)
Political stability	-0.0169	0.0766	0.0242	0.186**	-0.158	-0.0898
	(0.0647)	(0.0726)	(0.0790)	(0.0939)	(0.144)	(0.162)
Banking crisis	-2.372***	-1.531***	-2.432***	-0.879	-2.013***	-0.541*
	(0.330)	(0.232)	(0.575)	(0.796)	(0.517)	(0.313)
Expected growth (t+1 to t+5)	-0.0816	0.151	0.0459	-0.175	-0.427	-0.645**
	(0.152)	(0.200)	(0.223)	(0.313)	(0.327)	(0.278)
Lagged short-term interest rate	-0.106*	-0.140**	-0.0222	-0.00804	-0.222	-0.210
	(0.0579)	(0.0586)	(0.0730)	(0.0831)	(0.149)	(0.133)
Lagged long-term interest rate	0.361***	0.397***	0.312**	0.0484	0.296***	0.316***
	(0.0489)	(0.0659)	(0.128)	(0.111)	(0.0776)	(0.0888)
Constant	-2.592***	-6.805***	-3.729**	-6.837***	-0.389	-6.455***
	(0.882)	(1.088)	(1.489)	(1.711)	(1.068)	(2.195)
Long-run coef.	0.046		0.058		0.028	
(s.e.)	0.014		0.027		0.014	
PB persistence	0.645		0.502		0.644	
Observations	575	575	269	269	289	289

Source: Authors' calculations based on IMF World Economic Outlook, IMF Direction of Trade Statistics, OECD Main Economic Indicators, Eurostat, JBA TIBOR Administration (JBATA), the PRS Group International Country Risk Guide (ICRG), and Laeven and Valencia (2026). Note: The table reports fiscal reaction coefficients using a panel of 17 advanced economies. Estimates are obtained with the Blundell–Bond system GMM estimator. The output gap is treated as endogenous and instrumented with its own lag, the second lag of the debt ratio, and lagged output growth gaps. Columns (1), (3) and (5) referring to "Common slope" are based on equation (8), which constrains the debt-response coefficient (ϕ) to be identical across countries. Columns (2), (4) and (6) are based on equation (9), which extends equation (8) by interacting the lagged debt ratio with country-specific dummy variables, thereby allowing the debt-response coefficient (ϕ_i) to vary across countries. Robust standard errors clustered at country level in parentheses (* p<0.10, ** p<0.05, *** p<0.01).

Figure A4. Irregular expenditure by country



Note: The component of the annual change in the expenditure-to-GDP ratio falling outside each country's own 5th-to-95th percentile range of annual changes. Zero in most years by construction; the 2020 spike is the pandemic response.

A.V.2. Robustness

Table A3. Robustness of the debt coefficient

Specification	1990-2025 beta	1990-2025 long-run	1990-2025 N	1990-2007 beta	1990-2007 long-run	1990-2007 N	2008-2025 beta	2008-2025 long-run	2008-2025 N
Baseline	0.0163***	0.046	575	0.0289**	0.058	269	0.00990**	0.028	289
No controls	0.0429***	0.132	590	0.0663**	0.239	284	0.0616***	0.122	289
Original controls only	0.0266***	0.112	589	0.0481***	0.138	283	0.0224***	0.080	289
Time fixed effects	0.00797*	0.035	575	0.0164**	0.037	269	-0.00180	-0.008	289
Fixed-effects IV	0.0104**	0.042	575	0.0320***	0.077	269	0.0228***	0.087	289
Official output gap	0.0162***	0.046	570	0.0295**	0.060	264	0.00990**	0.028	289
HP-filtered output gap	0.0199***	0.053	571	0.0365***	0.077	265	0.0157***	0.041	289
Excluding 2020-2025							-0.00346	-0.017	187

Note: each row is the baseline equation with one element changed, estimated on each of the three periods, so every row asks whether the fall in the debt coefficient between the sample halves survives that change. 'No controls' keeps only lagged debt and the lagged primary balance; 'original controls' adds the output gap, irregular expenditure, trade openness, inflation and political stability; the baseline adds the banking-crisis dummy, expected growth and the lagged short and long rates. The two output-gap rows are estimated on the observations where both measures exist, so they isolate the measure rather than the sample. Long-run coefficients and observation counts are in the source file.

Table A4. Rolling-window length

	10-year	15-year	20-year
windows	27	22	17
first window	1990-1999	1990-2004	1990-2009
last window	2016-2025	2011-2025	2006-2025
mean obs.	229.000	363.182	495.294
instruments per panel	2.495	3.481	4.567
mean s.e. of beta	0.013	0.011	0.009
share |t|>1.645	0.593	0.955	1.000
persistence min	0.287	0.501	0.629
persistence max	0.829	0.775	0.752
long-run coef. min	-0.017	0.021	0.060
long-run coef. max	0.289	0.235	0.173
AR(2) rejections at 10%	0.037	0.000	0.000
beta, last window	-0.002	0.010	0.028

Note: The window length trades time resolution against precision. At ten years the AR(1) coefficient is poorly pinned down: persistence reaches 0.98 in some windows, the implied long-run response ranges from -0.03 to 1.07, and fewer than half the coefficients are significant. At twenty years the estimates are precise, but consecutive windows overlap by nineteen of twenty years and the final window still begins in 2006, so its endpoint estimate reflects pre-crisis observations the figure is meant to shed. Fifteen years resolves the post-crisis period, keeps persistence in a range where the long-run coefficient stays interpretable, and leaves 59 percent of window coefficients significant at the 10 percent level.

A.V.3. Local projection and GMM-implied dynamic fiscal reaction

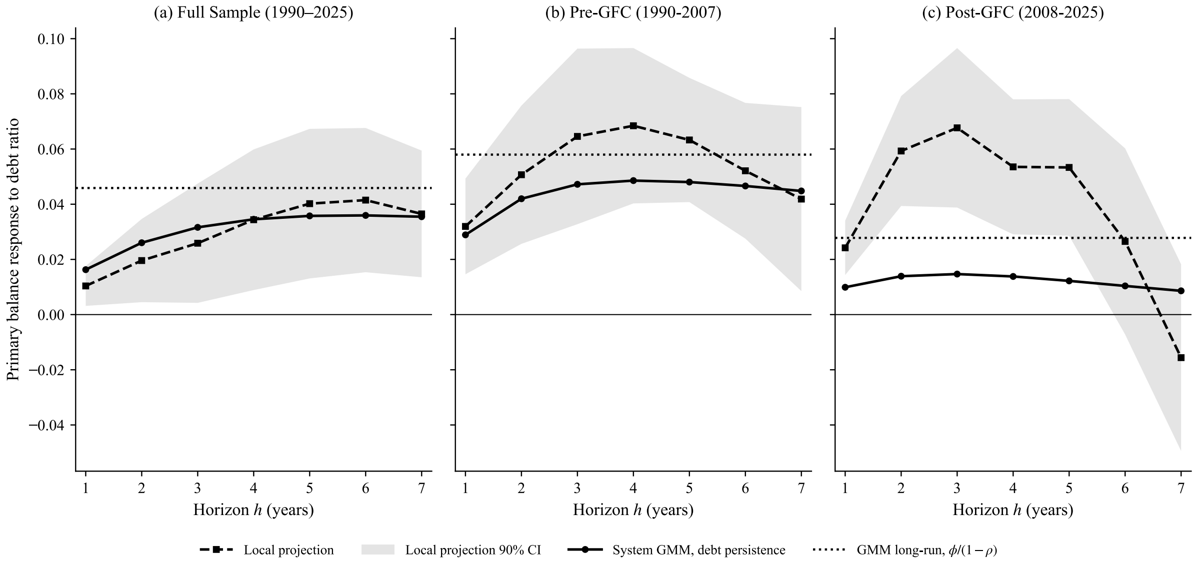
Section 5.3 compares the local projections with the path the estimated reaction function implies. This section reports the underlying coefficients, the construction of the comparator, the choice of horizon, and what remains of the difference between the two estimators.

Table A5. Local projections and the GMM-implied dynamic response

window	h	lp_b	lp_lo90	lp_hi90	gmm_persistence_adj	gmm_lo90	gmm_hi90	gmm_transitory_decay	phi	long_run	lp_significant
1990-2025	0	0.01038	0.00315	0.01761	0.01628	0.0088	0.02377	0.01628	0.9541	0.04587	+
1990-2025	1	0.01958	0.0045	0.03466	0.02604	0.01393	0.03814	0.0105	0.9541	0.04587	+
1990-2025	2	0.02586	0.00425	0.04748	0.03162	0.01667	0.04656	0.00678	0.9541	0.04587	+
1990-2025	3	0.03438	0.00889	0.05986	0.03454	0.01792	0.05116	0.00437	0.9541	0.04587	+
1990-2025	4	0.04021	0.0131	0.06731	0.03577	0.01826	0.05329	0.00282	0.9541	0.04587	+
1990-2025	5	0.04149	0.01535	0.06763	0.03595	0.01807	0.05382	0.00182	0.9541	0.04587	+
1990-2025	6	0.03649	0.01353	0.05944	0.03547	0.0176	0.05335	0.00117	0.9541	0.04587	+
Pre-GFC (199	0	0.03195	0.01461	0.04929	0.0289	0.00961	0.04819	0.0289	0.95138	0.05797	+
Pre-GFC (199	1	0.05069	0.02564	0.07574	0.04198	0.01251	0.07146	0.01449	0.95138	0.05797	+
Pre-GFC (199	2	0.06458	0.03276	0.09639	0.04721	0.01277	0.08165	0.00727	0.95138	0.05797	+
Pre-GFC (199	3	0.06844	0.04028	0.0966	0.04856	0.01215	0.08498	0.00365	0.95138	0.05797	+
Pre-GFC (199	4	0.06328	0.04077	0.0858	0.04803	0.01133	0.08473	0.00183	0.95138	0.05797	+
Pre-GFC (199	5	0.05212	0.02752	0.07672	0.04661	0.01055	0.08268	0.00092	0.95138	0.05797	+
Pre-GFC (199	6	0.04186	0.00852	0.07521	0.04481	0.00987	0.07975	0.00046	0.95138	0.05797	+
Post-GFC (20	0	0.0242	0.01435	0.03405	0.0099	0.00244	0.01737	0.0099	0.76086	0.0278	+
Post-GFC (20	1	0.05929	0.03936	0.07922	0.01391	0.0032	0.02462	0.00638	0.76086	0.0278	+
Post-GFC (20	2	0.06768	0.03879	0.09658	0.01469	0.00309	0.02629	0.0041	0.76086	0.0278	+
Post-GFC (20	3	0.05354	0.02907	0.078	0.01382	0.0026	0.02503	0.00264	0.76086	0.0278	+
Post-GFC (20	4	0.05333	0.02856	0.0781	0.01221	0.00201	0.02241	0.0017	0.76086	0.0278	+
Post-GFC (20	5	0.02651	-0.00721	0.06023	0.01039	0.00146	0.01932	0.0011	0.76086	0.0278	
Post-GFC (20	6	-0.01561	-0.04945	0.01823	0.00861	0.001	0.01622	0.0007	0.76086	0.0278	

Note: * denotes a local-projection coefficient significant at the 10 percent level. 'LP' is the local projection of the primary balance at t+h on the debt ratio at t-1, estimated by LP-IV with the output gap instrumented as in the baseline and the lagged primary balance included as a control. 'GMM, debt persistence' is $\phi \sum_{j=0}^{h} \rho^{h-j} \rho_{debt}^{j}$, the response the estimated reaction function implies when debt follows its own autoregressive process; 'GMM, transitory decay' is $\phi\rho^h$, the response to a debt increase that is immediately reversed. 'Long-run' is $\phi/(1-\rho)$, the limit of the persistence-adjusted path as$\rho_{debt} \to 1$. Confidence intervals on the GMM paths are delta-method and reflect uncertainty inϕ and ; $\rho_{debt}$is treated as fixed Local projections are significant at every horizon out to *six* years before the crisis, and only out to four years after 2008.

Figure A5. Local projections and GMM-implied dynamic response



Note: Dashed line, local projection of the primary balance at $t+h$ on the debt ratio at $t-1$ with the shaded band giving the 90 percent confidence interval. Solid line, the response implied by the estimated fiscal reaction function when debt follows its own autoregressive process, $\phi \sum_{j=0}^{h} \rho^{h-j} \rho_{debt}^{j}$, where ϕ is the estimated response of the primary balance to the lagged debt ratio and ρ is the autoregressive coefficient of the primary balance. Dotted line, the long-run coefficient $\phi/(1-\rho)$, which is the limit of the solid line as $\rho_{debt} \to 1$. The debt ratio's own autoregressive coefficient ρ_{debt} is estimated on the same sample by a fixed-effects regression of the debt ratio on its own lag, and equals 0.95 in panels (a) and (b) and 0.76 in panel (c).

Table A6. Choice of horizon

window	h	obs	countries	last_start_year	last_outcome_year	share_of_window	obs_rel_h0
1990-2025	0	575	17	2025	2025	1.0	1.0
1990-2025	1	558	17	2024	2025	0.9722	0.9704
1990-2025	2	541	17	2023	2025	0.9444	0.9409
1990-2025	3	524	17	2022	2025	0.9167	0.9113
1990-2025	4	507	17	2021	2025	0.8889	0.8817
1990-2025	5	490	17	2020	2025	0.8611	0.8522
1990-2025	6	473	17	2019	2025	0.8333	0.8226
1990-2025	7	456	17	2018	2025	0.8056	0.793
1990-2025	8	439	17	2017	2025	0.7778	0.7635
1990-2025	9	422	17	2016	2025	0.75	0.7339
1990-2025	10	405	17	2015	2025	0.7222	0.7043
1990-2007	0	269	17	2007	2007	1.0	1.0
1990-2007	1	252	17	2006	2007	0.9444	0.9368
1990-2007	2	235	17	2005	2007	0.8889	0.8736
1990-2007	3	218	17	2004	2007	0.8333	0.8104
1990-2007	4	201	17	2003	2007	0.7778	0.7472
1990-2007	5	184	17	2002	2007	0.7222	0.684
1990-2007	6	167	17	2001	2007	0.6667	0.6208
1990-2007	7	150	17	2000	2007	0.6111	0.5576
1990-2007	8	133	16	1999	2007	0.5556	0.4944
1990-2007	9	117	16	1998	2007	0.5	0.4349
1990-2007	10	101	16	1997	2007	0.4444	0.3755
2008-2025	0	306	17	2025	2025	1.0	1.0
2008-2025	1	289	17	2024	2025	0.9444	0.9444
2008-2025	2	272	17	2023	2025	0.8889	0.8889
2008-2025	3	255	17	2022	2025	0.8333	0.8333
2008-2025	4	238	17	2021	2025	0.7778	0.7778
2008-2025	5	221	17	2020	2025	0.7222	0.7222
2008-2025	6	204	17	2019	2025	0.6667	0.6667
2008-2025	7	187	17	2018	2025	0.6111	0.6111
2008-2025	8	170	17	2017	2025	0.5556	0.5556
2008-2025	9	153	17	2016	2025	0.5	0.5
2008-2025	10	136	17	2015	2025	0.4444	0.4444

Note: Share of each window's starting years still contributing a projection at horizon h, with both the starting year and the outcome year required to lie inside the window. The two subsamples are the same length, so they lose starting points at the same rate.

We set the horizon to seven on three grounds. It is the last horizon at which the pre-crisis response is still significantly positive, so it captures that response in full, including its peak at h=6. It covers the post-crisis response well past its peak at h=2 and through the horizons where it falls to zero. And it retains a majority of starting points in both subsamples. Beyond seven the estimates begin to reflect which starting points survive rather than how the response evolves. The post-2008 coefficient turns sharply positive and significant again at h=10, on 44 percent of the window: that is the immediate post-crisis consolidation projecting into the 2020s, not a revived fiscal response. The full sample shows the same signature, dipping to insignificance at h=9 before jumping back at h=10. The pre-crisis path is likewise flat and insignificant from h=8 on fewer than half the starting points.

A.V.4. Fiscal fatigue and debt limits

Table A7. Cubic fiscal reaction functions and the joint test for fiscal fatigue

sample	window	N	countries	instruments	max_debt_in_sample	debt	debt_se	debt_stars	debt2	debt2_se	debt2_stars	debt3	debt3_se	debt3_stars	L_pb	L_pb_se	L_pb_stars	p_joint_sq_cub	AR1_p	AR2_p
EU+UK+US	1990-2007	258	16	125	138.9	0.224911833	0.200941757		-0.002074335	0.002716228		6.70237E-06	1.07452E-05		0.594330394	0.055233775	***	0.312159899	0.004934361	0.851393789
EU+UK+US	2008-2019	176	16	83	189.6	-0.197783074	0.072625893	***	0.002518991	0.000705266	***	-8.90454E-06	2.18366E-06	***	0.786999825	0.098985533	***	0.000116391	0.017560174	0.329960499
EU+UK+US	2008-2025	272	16	125	209.9	-0.137428648	0.071861064	*	0.001616048	0.000639529	**	-5.05562E-06	1.58317E-06	***	0.612900645	0.05655892	***	7.13844E-05	0.009983771	0.07997161
EU+UK+US	1990-2025	546	16	251	209.9	0.084538701	0.059373235		-0.000443968	0.000597233		6.27516E-07	1.84346E-06		0.675765417	0.048795926	***	0.019654453	0.000870141	0.039945947
incl. Japan	1990-2007	269	17	125	174.6	0.216687745	0.127549299	*	-0.001815017	0.001460034		4.56364E-06	4.9116E-06		0.567327551	0.055697299	***	0.003655275	0.002842008	0.767020298
incl. Japan	2008-2019	187	17	83	233.3	0.020188115	0.087537166		-2.4406E-05	0.00095966		-4.34543E-07	3.03572E-06		0.812072824	0.080824018	***	0.443247557	0.01602233	0.134160518
incl. Japan	2008-2025	289	17	125	258.4	0.014527901	0.064289527		-7.88061E-06	0.0005579		-5.30443E-08	1.39276E-06		0.63892366	0.053541898	***	0.945114969	0.008406996	0.05338517
incl. Japan	1990-2025	575	17	251	258.4	0.11618565	0.042678831	***	-0.000804912	0.00035165	**	1.75209E-06	8.48568E-07	**	0.674165572	0.044573475	***	0.029066417	0.00049116	0.113642925

Note: Blundell-Bond system GMM of the baseline reaction function augmented with quadratic and cubic terms in lagged debt, with the same controls and instrument set as Table A2. 'Max debt in sample' marks the edge of the region over which the cubic is identified.

Table A8. Estimated debt limits

sample	window	conditioning	N	p_joint_sq_cub	pb_persistence	intercept	max_debt_in_sample	limit_rg-1.0pp	limit_rg-0.5pp	limit_rg+0.0pp	limit_rg+0.5pp	limit_rg+1.0pp	limit_rg+1.5pp	limit_rg+2.0pp	P_limit_exists	limit_p5	limit_p95
EU+UK+US	1990-2007	cycle-neutral	258	0.312159899	0.594330394	-6.869282395	138.9								0.382	94.80858013	239.3556546
EU+UK+US	2008-2019	cycle-neutral	176	0.000116391	0.786999825	3.406204145	189.6	161.5096573	159.24172	156.7730948	154.0402569	150.9370289	147.2589463	142.4925887	0.98345	118.9403412	184.2301466
EU+UK+US	2008-2025	cycle-neutral	272	7.14E-05	0.612900645	2.83482182	209.9	203.2525641	199.2949836	194.9965986	190.2531942	184.8937689	178.5990308	170.6170907	0.99995	161.37753	225.6296856
EU+UK+US	1990-2025	cycle-neutral	546	0.019654453	0.675765417	-3.417606346	209.9	290.4987528	260.0534257	238.7038349	220.8426011	204.8385523	189.8840814	175.426377	0.57395	166.7549912	264.1027105
incl. Japan	1990-2007	cycle-neutral	269	0.003655275	0.567327551	-6.722496155	174.6				150.9474188	138.4210772	128.5374052	119.7149924	0.6973	113.2475696	190.5535717
incl. Japan	2008-2019	cycle-neutral	187	0.443247557	0.812072824	-1.350553836	233.3	145.8978445	133.6313582						0.77075	30.29835015	185.2173384
incl. Japan	2008-2025	cycle-neutral	289	0.945114969	0.63892366	-1.155913557	258.4			399.9717958	354.5569031	297.2146653			0.648	88.45712777	343.8197745
incl. Japan	1990-2025	cycle-neutral	575	0.029066417	0.674165572	-4.246688679	258.4						171.9493584	150.4751046	0.19295	143.5106892	314.2598339

Note: The debt limit is the highest debt ratio at which the steady-state primary balance implied by the estimated reaction function still meets the debt-stabilizing primary balance$rg \cdot d$ from above. We assume closed output gap, no banking crisis, no irregular expenditure, remaining controls at sample means. P(limit exists) and the interval come from a parametric bootstrap over estimated coefficients of the reaction function.

Table A9. Leave-one-country-out

window	dropped	debt3	debt3_se	p_joint_sq_cub	N	max_debt_in_sample	debt3_stars	fatigue_signature
2008-2019	(none: all 17)	-4.34543E-07	3.03572E-06	0.443247557	187	233.3		no
2008-2019	AUT	-3.12769E-07	2.92393E-06	0.50449457	176	233.3		no
2008-2019	BEL	-3.39307E-07	2.67139E-06	0.558127529	176	233.3		no
2008-2019	DEU	-6.68935E-07	2.98638E-06	0.658225958	176	233.3		no
2008-2019	DNK	2.73505E-07	2.78784E-06	0.208077907	176	233.3		no
2008-2019	ESP	-6.20844E-07	3.12603E-06	0.522935829	176	233.3		no
2008-2019	FIN	-4.99867E-08	2.99673E-06	0.357196377	176	233.3		no
2008-2019	FRA	-6.48526E-07	3.03211E-06	0.408087724	176	233.3		no
2008-2019	GRC	-6.58936E-07	2.35497E-06	0.852288653	176	233.3		no
2008-2019	IRL	2.38583E-07	2.18274E-06	0.969831659	176	233.3		no
2008-2019	ITA	-1.13865E-06	3.19941E-06	0.735554703	176	233.3		no
2008-2019	LUX	1.62678E-06	2.9355E-06	0.118041309	176	233.3		no
2008-2019	NLD	-6.69627E-07	2.98111E-06	0.485809564	176	233.3		no
2008-2019	PRT	5.98588E-07	2.80159E-06	0.052180909	176	233.3		no
2008-2019	SWE	-3.36492E-07	2.86822E-06	0.46685524	176	233.3		no
2008-2019	GBR	-2.74468E-07	3.01507E-06	0.463160979	176	233.3		no
2008-2019	USA	-3.6713E-07	2.82434E-06	0.613622476	176	233.3		no
2008-2019	JPN	-8.90454E-06	2.18366E-06	0.000116391	176	189.6	***	yes
2008-2025	(none: all 17)	-5.30443E-08	1.39276E-06	0.945114969	289	258.4		no
2008-2025	AUT	1.19321E-07	1.30311E-06	0.988773105	272	258.4		no
2008-2025	BEL	2.78225E-07	1.3275E-06	0.905541217	272	258.4		no
2008-2025	DEU	-2.58911E-07	1.39356E-06	0.98237688	272	258.4		no
2008-2025	DNK	-1.65793E-07	1.66529E-06	0.709364015	272	258.4		no
2008-2025	ESP	-4.92395E-07	1.36942E-06	0.932963038	272	258.4		no
2008-2025	FIN	-2.30477E-07	1.39778E-06	0.935394992	272	258.4		no
2008-2025	FRA	1.81538E-07	1.3957E-06	0.878348093	272	258.4		no
2008-2025	GRC	-1.9033E-07	1.82866E-06	0.992499747	272	258.4		no
2008-2025	IRL	8.28558E-08	1.31243E-06	0.998006009	272	258.4		no
2008-2025	ITA	-1.09812E-06	1.45426E-06	0.751819601	272	258.4		no
2008-2025	LUX	1.44126E-06	1.58472E-06	0.117748484	272	258.4		no
2008-2025	NLD	-5.82427E-08	1.41668E-06	0.934163358	272	258.4		no
2008-2025	PRT	5.21181E-07	1.34316E-06	0.822551707	272	258.4		no
2008-2025	SWE	-1.14571E-08	1.3415E-06	0.929384291	272	258.4		no
2008-2025	GBR	-3.4274E-07	1.55863E-06	0.930488771	272	258.4		no
2008-2025	USA	3.38644E-07	1.32628E-06	0.930460602	272	258.4		no
2008-2025	JPN	-5.05562E-06	1.58317E-06	7.13844E-05	272	209.9	***	yes

Note: The cubic re-estimated on the seventeen-country sample, dropping each country in turn, for the 2008–2019 and 2008–2025 windows. Only the exclusion of Japan produces the fiscal-fatigue signature, a negative cubic with the joint test rejected. Dropping any of the other sixteen countries leaves the Japan-inclusive result standing in both windows.

Figure A6. Estimated reaction functions and debt limits, excluding Japan

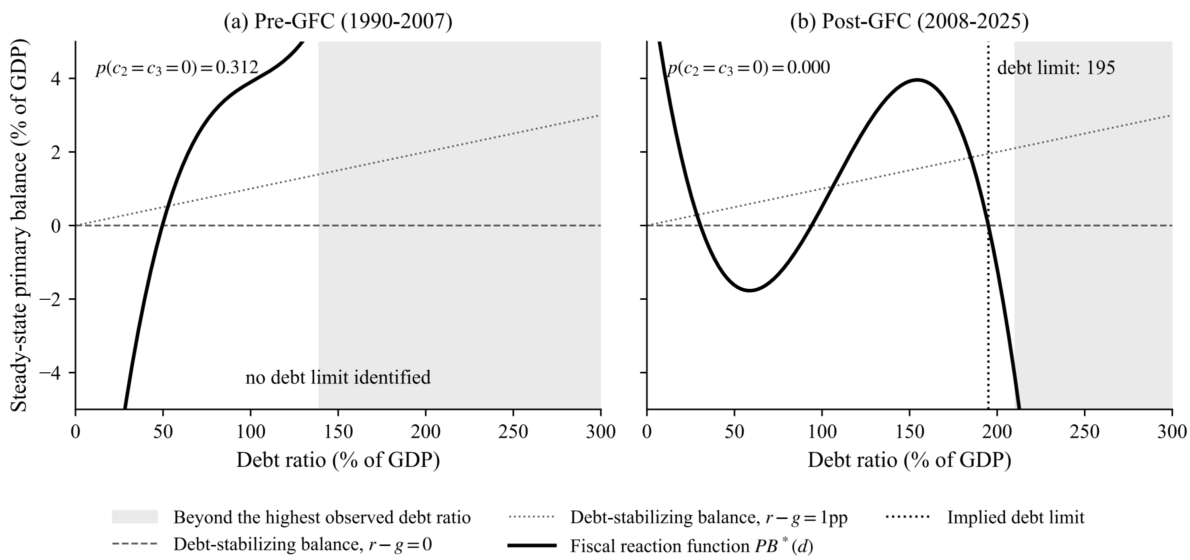


Figure A7. Sensitivity of the debt limit to the interest-growth differential

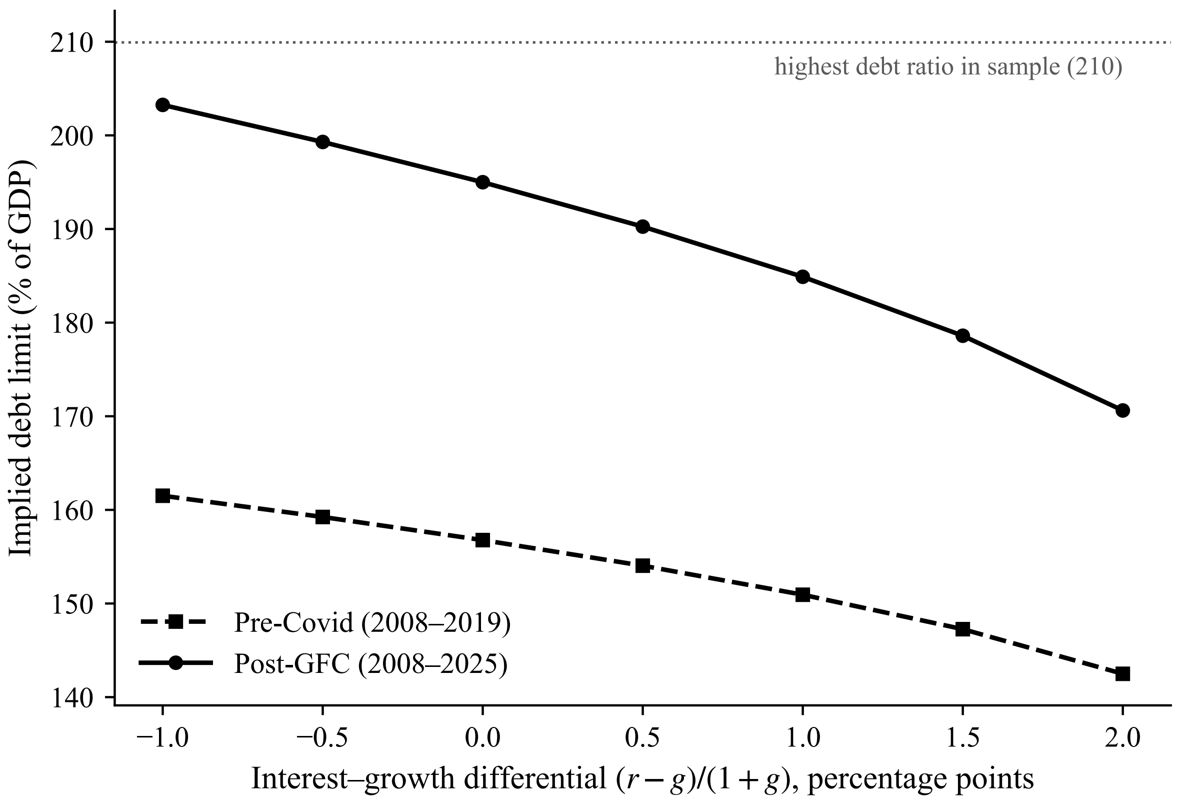
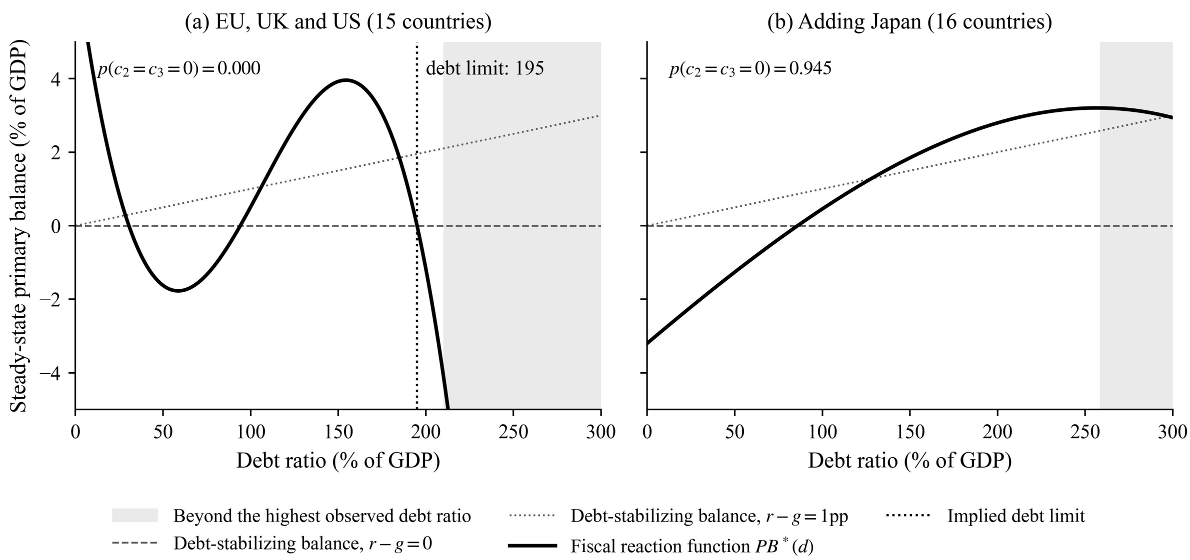


Figure A8. The effect of including Japan



Annex VI. The fiscal reaction of the other EU members

Section 6 estimates the fiscal reaction function on seventeen advanced economies. This annex runs the same specification on the remaining EU members: the central and eastern European countries together with Cyprus and Malta.

Three departures from the main-sample setup are forced by the data. The output gap is the European Commission's Output Gaps Working Group series, with an HP-filtered gap from WEO real GDP where that is missing, because the WEO publishes an official gap for only 193 of these country-years against 395 for the Commission. Short and long interest rates are taken from Eurostat, the three-month money-market rate and the Maastricht ten-year benchmark yield, where the OECD series used elsewhere has no coverage at all for Cyprus and Malta and no short rate for Croatia. Because Estonia has no benchmark government bond yield before 2020, its long rate is the European Central Bank's MFI interest rate on new euro loans of over one year to non-financial corporations. Level differences between government and corporate loans are absorbed by the country fixed effect.

Table A10. Fiscal reaction function estimates, other EU members

Eastern EU: main GMM estimates				
	2001-2025	Country betas (2001-2025)	2008-2025	Country betas (2008-2025)
Lagged debt ratio	0.0377***		0.0369***	
	(0.00929)		(0.00996)	
Bulgaria		0.128***		0.152**
		(0.0451)		(0.0615)
Croatia		0.0402*		0.0257
		(0.0227)		(0.0454)
Cyprus		0.0448***		0.0539***
		(0.0108)		(0.00966)
Czechia		0.0832**		0.176**
		(0.0339)		(0.0836)
Estonia		0.266***		0.219**
		(0.0887)		(0.104)
Hungary		0.0478**		0.0239
		(0.0204)		(0.0364)
Latvia		0.107**		0.153**
		(0.0456)		(0.0685)
Lithuania		0.115***		0.131***
		(0.0362)		(0.0323)
Malta		0.0743***		0.112***
		(0.0195)		(0.0321)
Poland		0.0443		0.0771*
		(0.0275)		(0.0404)
Romania		0.0600**		0.0780***
		(0.0296)		(0.0282)
Slovakia		0.0491*		0.0151
		(0.0259)		(0.0468)
Slovenia		0.0684***		0.0771***
		(0.0236)		(0.0230)
L.Primary balance	0.515***	0.490***	0.484***	0.444***
	(0.0778)	(0.0727)	(0.0796)	(0.0740)
Output gap	0.215***	0.271***	0.337***	0.351***
	(0.0700)	(0.0737)	(0.0692)	(0.0710)
Irregular expenditures	-1.379***	-1.210***	-1.207***	-1.060***
	(0.344)	(0.299)	(0.295)	(0.255)
Trade	0.0186***	0.00798	0.0220***	0.0127
	(0.00652)	(0.0132)	(0.00850)	(0.0183)
Inflation	-0.158**	-0.197***	-0.196***	-0.221***
	(0.0749)	(0.0657)	(0.0744)	(0.0613)
Political stability	-0.235*	-0.140	-0.406**	-0.256
	(0.138)	(0.122)	(0.173)	(0.182)
Banking crisis	-0.405	0.0488	1.114	1.262
	(0.577)	(0.552)	(0.945)	(0.880)
Expected growth (t+1 to t+5)	-0.158	-0.223	-0.610*	-0.883***
	(0.243)	(0.232)	(0.338)	(0.315)
Lagged short-term interest rate	-0.0353	0.0618	0.0925	0.180**
	(0.0955)	(0.0851)	(0.115)	(0.0805)
Lagged long-term interest rate	0.303***	0.262***	0.217**	0.142**
	(0.0720)	(0.0400)	(0.0907)	(0.0709)
Constant	-2.622*	-3.354***	-0.371	-1.598
	(1.366)	(1.202)	(2.133)	(2.401)
Long-run coef.	0.078		0.072	
(s.e.)	0.021		0.019	
PB persistence	0.515		0.484	
Observations	289	289	221	221

Note: as for Table A2, with the Commission output gap and the interest-rate sources described above.

The fiscal response to debt is more than twice as large as in the advanced-economy sample. The impact coefficient is 0.038 over the full sample and 0.037 from 2008, against 0.016 and 0.010 for the advanced economies. The long-run response is 0.078 and 0.072, against 0.046 and 0.028. Twelve of the thirteen country coefficients are significant over the full sample, all but Poland, and ten of thirteen after 2008; all are positive, ranging from Croatia at 0.040 to Estonia at 0.266.

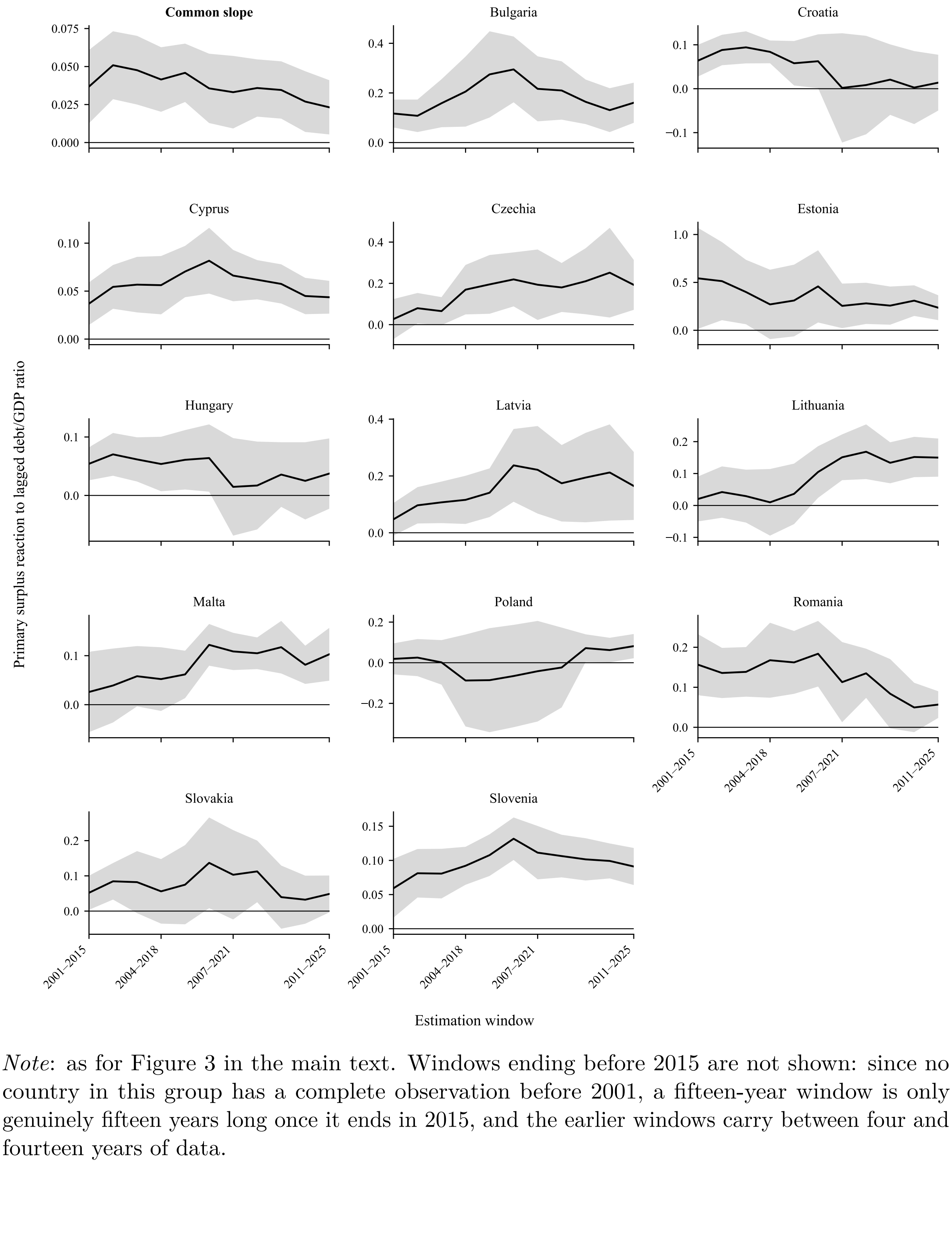
Primary balance persistence is lower in these countries, 0.52 against 0.65, so a given impact coefficient cumulates into a smaller long-run response than it would in the advanced sample. In addition, debt ratios are far lower, 4 to 114 percent with a median of 43, making a one-point change in debt a larger shock in proportion to the total debt stock.

Because the pre-2008 part of the sample holds only 57 observations across 11 countries, with Cyprus and Malta contributing none, we do not report a 1990-2007 sample. Instead, we report 2008–2025 as a contrast with the full sample and draw no conclusion about how the response has changed over time from the level estimates.

Table A11. Robustness, other EU members

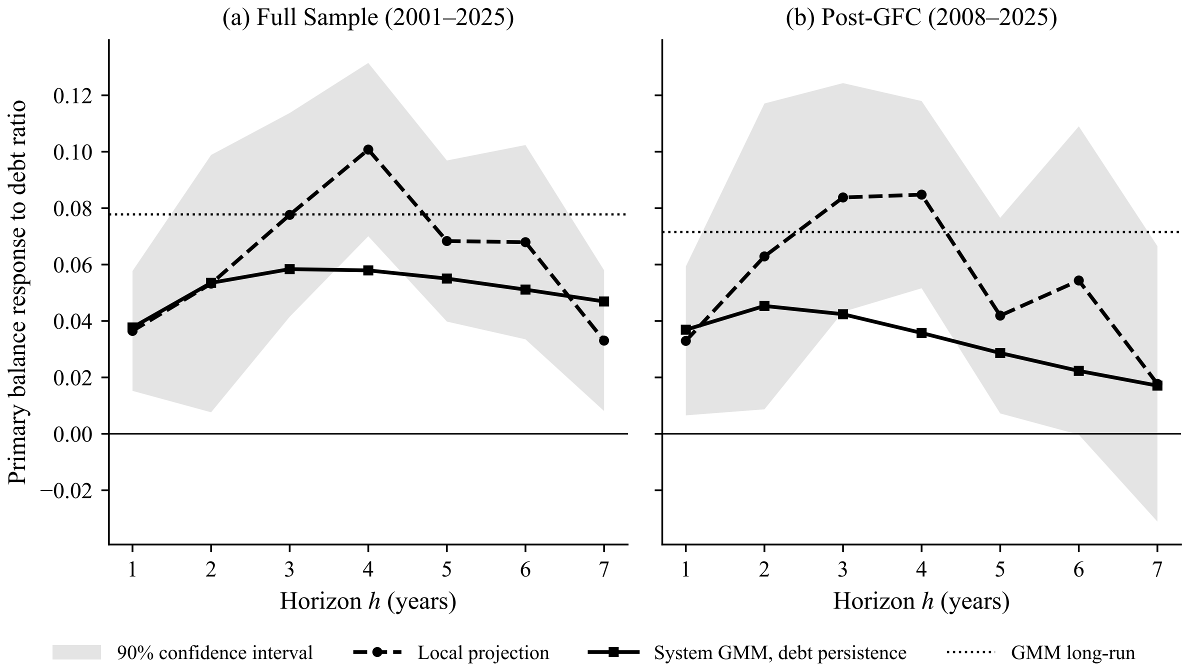
Eastern EU: robustness					
	Time FEs (2001-2025)	IVFE (2001-2025)	Time FEs (2008-2025)	IVFE (2008-2025)	Pre-Covid (2008-2019)
Lagged debt ratio	0.0283***	0.0622***	0.0341***	0.0516***	0.0427***
	(0.00704)	(0.0128)	(0.00797)	(0.0150)	(0.0136)
L.Primary balance	0.529***	0.574***	0.447***	0.506***	0.499***
	(0.0600)	(0.0426)	(0.0544)	(0.0333)	(0.124)
Output gap	0.0851	0	0.254***	0.299***	0.225**
	(0.0664)	(.)	(0.0945)	(0.0791)	(0.0984)
Output gap		0.229***			
		(0.0602)			
Output gap				0	
				(.)	
Irregular expenditures	-1.127***	-1.490***	-1.029***	-1.305***	-1.343***
	(0.200)	(0.294)	(0.168)	(0.241)	(0.332)
Trade	0.0150**	0.00224	0.0151*	0.00777	0.0206***
	(0.00669)	(0.0101)	(0.00773)	(0.00962)	(0.00741)
Inflation	-0.0577	-0.154***	0.218**	-0.254***	-0.164
	(0.112)	(0.0357)	(0.110)	(0.0403)	(0.158)
Political stability	-0.0931	-0.0357	-0.246	-0.367***	-0.316
	(0.0998)	(0.161)	(0.221)	(0.140)	(0.192)
Banking crisis	0.527	0.330	0.696	0.876	1.171
	(0.501)	(0.339)	(0.843)	(0.557)	(1.051)
Expected growth (t+1 to t+5)	0.364*	-0.135	0.0853	-0.700***	-0.263
	(0.220)	(0.163)	(0.465)	(0.196)	(0.478)
Lagged short-term interest rate	0.0349	0.0675	0.0839	0.176**	-0.0432
	(0.110)	(0.0616)	(0.131)	(0.0725)	(0.115)
Lagged long-term interest rate	0.209***	0.200***	0.121	0.140	0.141
	(0.0638)	(0.0677)	(0.0937)	(0.0867)	(0.212)
Constant	-7.513***	-3.313**	-5.456*	0.753	-1.586
	(1.411)	(1.465)	(3.268)	(1.413)	(2.604)
Long-run coef.	0.060	0.146	0.062	0.104	0.085
(s.e.)	0.011	0.032	0.013	0.032	0.023
PB persistence	0.529	0.574	0.447	0.506	0.499
Observations	289	289	221	221	143

Figure A9. Rolling-window fiscal reaction coefficient, other EU members



Note: as for Figure 3 in the main text. Windows ending before 2015 are not shown: since no country in this group has a complete observation before 2001, a fifteen-year window is only genuinely fifteen years long once it ends in 2015, and the earlier windows carry between four and fourteen years of data.

Figure A10. Local projections against the GMM-implied path, other EU members



Note: Dashed line, local projection of the primary balance at $t+h$ on the debt ratio at $t-1$, with the shaded band giving the 90 percent confidence interval. Solid line, the response implied by the estimated fiscal reaction function when debt follows its own autoregressive process, $\phi \sum_{j=0}^{h} \rho^{h-j} \rho_{debt}^{j}$, where ϕ is the estimated response of the primary balance to the lagged debt ratio and ρ is the autoregressive coefficient of the primary balance. Dotted line, the long-run coefficient $\phi/(1-\rho)$, which is the limit of the solid line as $\rho_{debt} \rightarrow 1$. The debt ratio's own autoregressive coefficient ρ_{debt} is estimated on the same sample and equals 0.90 in panel (a) and 0.74 in panel (b).

Table A12. Cubic reaction functions, other EU members

sample	window	N	countries	instruments	max_debt_in_sample	debt	debt_se	debt_stars	debt2	debt2_se	debt2_stars	debt3	debt3_se	debt3_stars	L_pb	L_pb_se	L_pb_stars	p_joint_sq_cub	AR1_p	AR2_p
Eastern EU	2008-2019	143	13	83	113.0	-0.07643247	0.09768463		0.001942937	0.001831779		-8.94421E-06	9.69753E-06		0.496497656	0.137697492	***	0.444218933	0.015234554	0.582754303
Eastern EU	2008-2025	221	13	125	113.6	0.175975465	0.0967433	*	-0.002732591	0.001647796	*	1.58096E-05	7.90028E-06	**	0.552954098	0.081279657	***	0.029388224	0.013646993	0.493595652
Eastern EU	1990-2025	289	13	184	113.8	0.069237371	0.046825502		-0.00088416	0.000852334		6.42047E-06	4.74759E-06		0.590944357	0.072322955	***	0.235212563	0.004052282	0.56692267

No debt limit is identified for Eastern Europe. Debt ratios in the group run from 4 to 114 percent of GDP with a median of 44, only Cyprus has ever passed 100, and it does so in six of 325 observations. Debt limits estimated for the advanced economies, 157 and 195 percent of GDP, lie well outside the Eastern European sample. The cubic is therefore fitted entirely to the rising part of the curve. The weakening of the fiscal reaction documented in Section 6 appears to be a feature of the advanced economies, not of the EU as a whole. The newer member states respond to debt more strongly, more persistently, and with no sign of the post-crisis decline.

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