NBER WORKING PAPER SERIES

FROM STOCKS TO FLOWS:
DEBT SERVICE AND FISCAL SUSTAINABILITY

Barry Eichengreen
Maxime Menuet
Gregory Donnat

Working Paper 35459
http://www.nber.org/papers/w35459

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 2026

The authors have no financial disclosures or relationships bearing on this research. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

From Stocks to Flows: Debt Service and Fiscal Sustainability
Barry Eichengreen, Maxime Menuet, and Gregory Donnat
NBER Working Paper No. 35459
July 2026
JEL No. E62, E66

ABSTRACT

We revisit fiscal sustainability through the lens of the government's budget constraint. What constrains fiscal policy is not the stock of outstanding liabilities per se, but the fiscal cost of servicing debt. Using two centuries of U.S. fiscal data (1800–2023) and a long-run panel of advanced economies, we show that primary surpluses are systematically more closely associated with debt-service burdens, while debt ratios lose explanatory power when debt service is taken into account. Fiscal responses intensify when financing conditions deteriorate, specifically when the interest-growth differential is positive. We rationalize these findings using a simple flow-based framework in which debt stabilization depends on the responsiveness of fiscal surpluses to financing pressures. The results suggest that fiscal sustainability depends less on debt thresholds than on financing regimes and governments' ability to absorb debt-service burdens.

Barry Eichengreen
University of California, Berkeley
Department of Economics
and NBER
eichengr@econ.Berkeley.edu

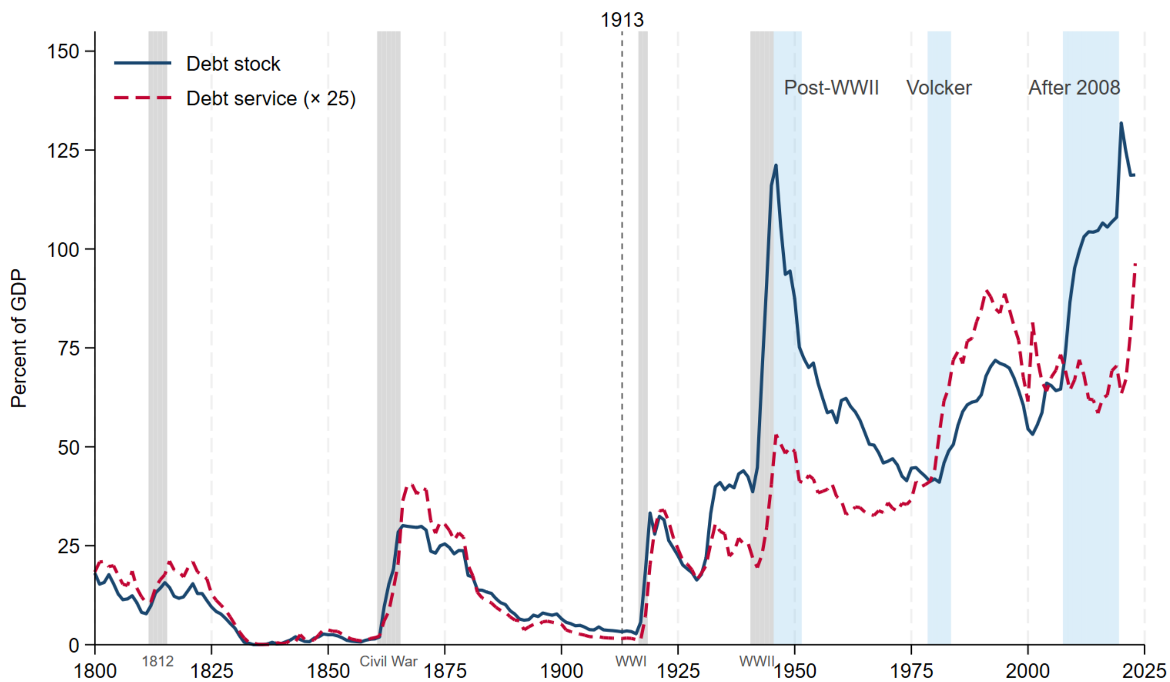
Gregory Donnat
University Côte d'Azur
GREDEG
and CNRS
Gregory.donnat@univ-cotedazur.fr

Maxime Menuet
University Côte d'Azur
GREDEG
and CNRS and Institut Universitaire
de France
maxime.menuet@univ-cotedazur.fr

1 Introduction

Standard debt sustainability analysis typically focuses on debt dynamics and the interest rate-growth rate differential (Debrun et al., 2020). Yet historically, governments have often sustained large debt stocks for prolonged periods under favorable financing conditions, whereas episodes of fiscal stress have sometimes emerged at much lower debt levels (see, e.g. Reinhart and Sbrancia, 2015; Blanchard, 2019; Eichengreen et al., 2021; Mauro and Zhou, 2021). In this paper we seek to reconcile these seemingly contradictory observations.

Figure 1: Public debt and debt-service costs in the United States, 1800–2023



Notes: The figure reports the evolution of the U.S. federal debt-to-GDP ratio (solid blue line) and debt-service costs as a share of GDP (dashed red line) over the period 1800–2023. Debt-service costs are scaled by a factor of 25 for visualization purposes. Gray shaded areas correspond to major wartime periods. The vertical dashed line marks the year 1913, often associated with the emergence of the modern U.S. fiscal and monetary regime. Blue shaded areas highlight the post-World War II adjustment, the Volcker disinflation, and the post-2008 period.

Figure 1 illustrates this tension. After World War II, for example, federal debt exceeded 100% of GDP, yet debt ratios declined despite the absence of large and persistent primary surpluses, largely because strong growth and favorable financing conditions limited debt-service costs. During the Volcker disinflation of the early 1980s, in contrast, debt levels remained comparatively modest while soaring real interest rates sharply increased debt-service costs, coinciding with a major fiscal consolidation episode. More recently, debt ratios surged following the Global Financial Crisis and COVID-19 pandemic, yet historically low interest rates muted fiscal pressures despite persistent deficits. Across these episodes, fiscal adjustment appears to coincide less with peaks in debt itself than with periods in which debt becomes expensive to finance. Our hypothesis is that primary-surplus adjustment occurs not when debt is high, but when servicing debt becomes fiscally costly.

This observation sits uneasily with the dominant empirical framework used to evaluate fiscal sustainability. Following Bohn (1998), the literature typically assesses sustainability through a fiscal reaction function in which governments increase primary surpluses in response to rising debt ratios. This approach has become the benchmark empirical framework for studying fiscal sustainability and fiscal space (e.g. Bohn, 2008; Ghosh et al., 2013; Mendoza and Ostry, 2008; Checherita-Westphal and Zyárek, 2017). It also underlies much of the operational debt sustainability analysis conducted by international policy institutions such as the International Monetary Fund and European Commission.

Yet governments do not service debt stocks per se; they make interest payments. Fiscal pressure therefore stems not from the stock of outstanding liabilities per se, but from the debt-service burden it generates. Unlike debt ratios, debt-service burdens directly absorb fiscal resources and may crowd out other public expenditures. Moreover, they depend not only on debt levels but also on financing conditions, maturity structures, inflation, and sovereign risk premia, so that identical debt ratios can generate markedly different fiscal pressures. The empirical analysis exploits precisely this variation to distinguish the fiscal burden associated with servicing public debt from debt accumulation itself.

This paper revisits fiscal reaction functions through this lens. Our argument is that *primary surpluses are more strongly associated with debt-service costs than with debt ratios*. We formalize this idea in a simple framework in which governments react to realized financing pressures. In this setup, debt sustainability depends on whether fiscal authorities generate sufficiently strong and persistent primary surpluses when debt-service costs rise. Debt stabilization may therefore emerge either through sharp short-run consolidations or through smaller but sustained fiscal corrections.

Our empirical analysis combines long-run U.S. historical evidence with cross-country panel estimation. For the United States, we construct a continuous annual dataset spanning 1800–2023, allowing us to trace fiscal adjustment across major monetary, financial, and institutional regimes. We complement baseline fiscal reaction functions with dynamic time-series evidence based on vector autoregressions and state-dependent local projections to examine how fiscal responses evolve following debt and debt-service shocks. We then extend the analysis to a long-run panel of 12 advanced economies using the IMF's *Public Finances in Modern History database*.[1]

Across specifications, periods, and estimation strategies, the empirical evidence points in the same direction. First, primary surpluses are systematically more closely associated with debt-service costs than with debt ratios. Across specifications, primary surpluses remain positively associated with debt-service costs whereas the coefficient on debt becomes small and statistically insignificant once service is taken into account. Over 1800–2023, a 10% increase in debt-service costs is associated with an increase in the primary surplus of approximately 2.8% in the United States and 1.35% in the cross-country panel. Dynamic estimates further show that debt-service shocks are followed by persistent increases in primary surpluses, whereas debt shocks generate substantially weaker responses.

Second, fiscal responses intensify when financing conditions deteriorate. Governments adjust substantially more when the interest rate-growth rate differential becomes unfavorable and sovereign risk premia rise. State-dependent local projections show that fiscal responses to debt-service shocks become significantly stronger under adverse financing conditions. This pattern is consistent with the intertemporal budget constraint: as financing costs rise relative to growth, stabilizing debt dynamics require stronger fiscal adjustment. These results suggest that debt ratios alone are not sufficient statistics for the fiscal pressures associated with public debt.

Third, the historical evidence points to changes in fiscal adjustment over time. Figure 1 reveals a contrast between two fiscal regimes before and after 1913. Before 1913, debt-service pressures remained closely tied to wartime financing. After 1913, deeper financial markets and modern monetary institutions coincided with a looser link between debt accumulation and immediate fiscal pressure, allowing governments to sustain larger debt ratios, given favorable financing conditions.

Our findings suggest that financing conditions play a central role in shaping fiscal adjustment dynamics and contain important information about debt sustainability beyond debt ratios alone. Rather than being systematically associated with debt accumulation, primary surpluses are more closely associated with the effective budgetary pressures generated by debt-service burdens.

This perspective reconnects fiscal adjustment more directly to the government's in-

[1] Canada, Denmark, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States.

tertemporal budget constraint, insofar as interest-payment obligations constitute immediate claims on fiscal resources. Debt-service costs therefore provide a more direct measure of fiscal pressure than debt ratios alone, which may remain fiscally manageable under favorable financing conditions.[2]

Related literature Our paper contributes to several strands of literature.

The first and most obvious link is to the fiscal reaction literature pioneered by Bohn (1998). His approach, which replaced the traditional focus on debt ratio stationarity with a testable behavioral condition for solvency, became a cornerstone for empirical work (Bohn, 2008; Mendoza and Ostry, 2008; Checherita-Westphal and Rother, 2012).[3] Our contribution is to reinterpret the standard fiscal reaction framework by distinguishing debt exposure from the fiscal burden associated with servicing public debt. Debt-service costs provide a more direct behavioral measure of fiscal pressure than debt stocks themselves.

Second, our paper relates to the literature emphasizing the role of financial conditions in shaping fiscal adjustment. Previous work shows that sovereign spreads, interest rates, and market conditions affect debt stabilization and fiscal behavior(e.g. Favero and Missale, 2012; Maltritz, 2012; Bahaj, 2020; Guichard et al., 2007). This perspective also underlies the central role of the interest-growth differential $(r - g)$ in modern debt sustainability analysis and recent debates on fiscal space under persistently low interest rates (IMF, 2013; Mauro et al., 2015; Blanchard, 2019; European Comission, 2019; Mehrotra and Sergeyev, 2021). Our results provide a behavioral fiscal counterpart to this literature by showing how financing conditions shape the adjustment of primary surpluses.

Finally, our paper connects with the macro-historical literature on the long-run evolution of fiscal regimes and sovereign debt dynamics (Eichengreen, 1990; Reinhart and Rogoff, 2010; Jordà et al., 2017; Eichengreen et al., 2021). We contribute to this literature by documenting a historical transformation in the nature of fiscal adjustment. Before the twentieth century, debt and debt-service costs remained tightly connected, while fiscal stabilization was largely episodic. In the modern era, with institutional and financial development, governments became able to sustain much larger debt stocks for prolonged periods under favorable financing conditions.

[2]Focusing on debt-service costs also addresses the critique of Furman and Summers (2020) that standard Bohn-type specifications combine a stock variable (debt) with a flow variable (GDP). Using debt service relative to GDP restores a flow–flow specification more closely aligned with the government's budget constraint.

[3]Subsequent research has shown that fiscal responses vary across debt levels, business-cycle conditions, and institutional environments (e.g. Ghosh et al., 2013; Checherita-Westphal and Zyárek, 2017).

Plan The remainder of the paper proceeds as follows. Section 2 introduces the conceptual framework motivating our empirical approach. Section 3 presents historical evidence for the United States, analyzing the responsiveness of fiscal adjustment to debt-service pressures. Section 4 extends the analysis to a long-run panel of advanced economies. Section 5 concludes. An online appendix provides detailed information on the data, econometric specifications, robustness exercises, and additional empirical results.

2 Conceptual Framework

To fix ideas and guide the empirical analysis, consider the government's flow budget constraint in continuous time:

$$\dot{b}(t) = (r - g)b(t) - s(t), \tag{1}$$

where a dot denotes a time derivative, $b(t)$ is the public debt-to-GDP ratio, $s(t)$ the primary surplus-to-GDP ratio, r the real interest rate, and g the real GDP growth rate. For simplicity, r and g are treated as constants representing their long-run equilibrium values. Fiscal sustainability is defined as a debt path that remains bounded over time (i.e. $\sup_t b(t) < \infty$). Bohn (1998) proposed a behavioral test based on a linear response of the primary surplus to the debt ratio: $s(t) = \psi b(t) - \alpha$, where $\psi > 0$ measures fiscal responsiveness and α captures non-systematic fiscal pressures. Substituting into (1) yields:

$$\dot{b}(t) = \big(r - g - \psi\big)b(t) + \alpha. \tag{2}$$

Debt follows a stable (non-explosive) path if and only if $\psi > r - g$. When $r < g$, debt dynamics partly stabilize automatically, so even weak or no fiscal adjustment may suffice. By contrast, when $r > g$, stabilizing debt requires sufficiently strong fiscal adjustment to offset the snowball effect.[4]

We posit that governments react not to the stock of debt itself, but to the realized burden generated by debt-service costs, $rb(t)$. Fiscal policy therefore follows a behavioral rule of the form $s(t) = f\big(rb(t)\big)$, where f is increasing, with elasticity $\phi(rb) := rbf'(rb)/f(rb)$.

[4] Formally, any positive response $\psi > 0$ is sufficient to satisfy the no-Ponzi condition, $\lim_{t\to\infty} B(t)e^{-rt} = 0$, where $B(t)$ is the level of public debt—often referred to as the solvency condition. However, solvency alone does not guarantee *stability* of the debt-to-GDP ratio. Stabilizing the debt ratio requires that fiscal adjustment exceeds a positive threshold linked to the snowball effect $(r - g)$, as emphasized in general-equilibrium models (see, e.g. Collignon, 2012; Ghosh et al., 2013; Menuet et al., 2024).

From (1), a steady state b^* satisfies:

$$(r-g)b^* = f(rb^*). \tag{3}$$

As usual, a positive steady-state debt ratio ($b^* > 0$) requires a primary surplus when $r > g$, and a primary deficit when $r < g$. Linearizing around b^*, local stability requires $r - g < rf'(rb^*)$, meaning that fiscal effort must rise sufficiently fast to offset the snowball effect. Using (3), this condition can be rewritten as:

$$f(rb^*) < rb^* f'(rb^*) \quad \iff \quad \phi(rb^*) > 1. \tag{4}$$

Condition (4) shows that debt stabilization depends on whether fiscal effort rises sufficiently fast relative to financing pressures. This condition becomes especially relevant when the snowball effect is unfavorable, since debt dynamics no longer benefit from automatic stabilization.[5]

To obtain an empirically tractable specification, we assume a constant-elasticity form:

$$s(t) = \kappa[rb(t)]^{\phi}, \;\; \kappa > 0. \tag{5}$$

Taking logarithms yields

$$\log s(t) = \alpha + \phi \log\left[rb(t)\right], \;\; \alpha = \log(\kappa). \tag{6}$$

Relative to conventional stock-based fiscal rules, this framework shifts attention from debt stocks to debt-service flows. The key empirical object governing fiscal sustainability is no longer the response of the primary surplus to debt itself, but its elasticity with respect to debt-service costs.

Two implications follow. First, fiscal adjustment should respond more strongly to debt-service costs than to debt levels themselves. Second, fiscal responses depend on the broader macro-financial environment. When financing conditions are favorable—for instance in periods with $r < g$ or strong growth—governments may stabilize debt with limited active fiscal adjustment. By contrast, when financing conditions deteriorate, debt stabilization re-

[5]When $r < g$, debt dynamics partly stabilize automatically. If the government runs a non-negative primary surplus ($s(t) \geq 0$), then $\dot{b}(t) = (r-g)b(t) - s(t) \leq (r-g)b(t)$, with $r - g < 0$. Debt therefore shrinks over time even in the absence of an active fiscal response to debt-service costs. Condition (4) should be interpreted as a condition for stabilization through fiscal adjustment, not as a necessary condition for bounded debt dynamics when the snowball effect is favorable.

quires more aggressive fiscal correction. Our empirical analysis tests these predictions using long-run historical evidence for the United States and a panel of advanced economies.

3 Evidence for the United States

Standard fiscal reaction functions evaluate debt sustainability through the response of primary surpluses to rising public debt. We extend this framework by incorporating debt-service costs directly into fiscal reaction functions to examine whether fiscal adjustment responds more strongly to financing pressures than to debt stocks themselves. We begin with the United States, the benchmark case analyzed by Bohn (1998).

Empirical design Guided by the framework above, we estimate an augmented fiscal reaction function that includes both the debt ratio and debt-service costs:

$$\log PS_t = \alpha + \xi \log PS_{t-1} + \beta \log Debt_t + \gamma \log Service_t + v' X_{t-1} + \varepsilon_t, \tag{7}$$

where PS_t denotes the primary surplus-to-GDP ratio, $Debt_t$ the public debt-to-GDP ratio, $Service_t$ interest payments relative to GDP, X_{t-1} a vector of other determinants of the primary surplus, and ε_t an error term. Our specification (7) should be interpreted as a reduced-form representation of the flow-based fiscal rule (6), rather than as a structural policy rule.

The coefficient γ measures the contemporaneous fiscal response to debt-service costs, while ξ captures persistence in fiscal behavior. The implied long-run elasticity of the primary surplus with respect to debt service is $\phi = \gamma/(1-\xi)$. Thus, debt stabilization may arise either through strong contemporaneous fiscal reactions (high γ) or weaker but persistent adjustments (high ξ). Since condition (4) requires $\phi > 1 \iff \gamma + \xi > 1$, persistent fiscal adjustment may stabilize debt even when the immediate response to debt-service shocks is limited.

Our baseline sample covers the period 1800–2023, allowing us to compare fiscal behavior across institutional regimes. We distinguish the pre-1913 and post-1913 periods, a standard historical divide in the study of U.S. fiscal and monetary institutions. The pre-1913 era was characterized by limited federal fiscal capacity, a narrow tax base, war-driven borrowing, and monetary constraints associated with the gold standard (Sylla, 1969; Wallis, 2000). By contrast, the creation of the Federal Reserve and introduction of the federal income tax in 1913 marked the emergence of the modern U.S. fiscal and monetary state, fundamentally expanding the government's ability to smooth financing conditions, manage debt, and sustain fiscal adjustment over time (Goodhart, 1988; Eichengreen et al., 2021).

Controls and empirical strategy Following the fiscal reaction literature (e.g., Bohn, 2008; Mendoza and Ostry, 2008; Ghosh et al., 2013; Debrun and Kinda, 2016), the control vector X_{t-1} includes the lagged output gap to capture cyclical conditions, inflation to account for price dynamics, trade openness to control for the external environment, and the sovereign risk premium on U.S. government bonds as a proxy for financing conditions and perceived fiscal risk. We also include indicator variables capturing major institutional and historical episodes, including wartime periods (the War of 1812, Civil War, World Wars I and II), the post-1951 Federal Reserve-Treasury Accord period, and the Global Financial Crisis.[6] All specifications include lagged macroeconomic controls, fiscal persistence, and historical and institutional dummies capturing major shifts in fiscal regimes. We estimate alternative specifications using lagged debt-service measures and complement baseline regressions with dynamic methods—including vector autoregressions, time-varying parameter VARs, and state-dependent local projections—to examine how fiscal responses evolve under different macroeconomic and financial conditions. Section 4 extends the analysis to a long-run panel of advanced economies to assess whether the stronger responsiveness of primary surpluses to debt-service flows than to debt stocks also holds beyond the U.S. case.

3.1 Main Results

Full sample Table 1 reports baseline estimates over the full historical sample (1800–2023).

Column (1) starts with a standard debt-based fiscal reaction function in the spirit of Bohn (1998). The coefficient on the debt ratio is small and statistically insignificant, providing limited evidence that primary surpluses respond to debt accumulation alone in the long run. When debt-service costs are added in Column (2), debt ratios remain insignificant, whereas debt-service costs enter positively and significantly. Primary surpluses therefore appear more closely associated with the fiscal cost of servicing public debt than with debt accumulation itself. A 10% increase in debt-service costs is associated with an increase in the primary surplus of approximately 2.8%. Despite this contemporaneous responsiveness, the estimated long-run elasticity remains statistically indistinguishable from

[6] Variable definitions, data sources, and summary statistics are reported in Appendix A. Figure 5 depicts the evolution of the debt-to-GDP ratio and the long-term interest rate in the United States over 1800–2023.

the threshold ($\psi > 1$) required for debt sustainability.

Column (3) examines whether this association strengthens when financing conditions deteriorate. Debt service is interacted with a snowball dummy equal to one when $(r-g) > 0$. The interaction term is positive and statistically significant, whereas the standalone debt-service coefficient loses significance. Fiscal surpluses therefore appear more strongly associated with debt-service costs when financing conditions become less favorable.

Table 1: Fiscal Responses to Debt-Service Pressures, 1800–2023

	(1) Debt	(2) Service	(3) Snowball
Primary surplus$_{t-1}$	0.792***	0.768***	0.764***
	(0.061)	(0.066)	(0.066)
Debt	0.014	-0.216	-0.169
	(0.037)	(0.133)	(0.122)
Service		0.282*	0.105
		(0.154)	(0.164)
Service $\times$ Snowball			0.168**
			(0.071)
Long-run elasticity ($\phi > 1$)			
		1.217	
		(0.570)	
95% CI		[0.283; 2.151]	
Observations	221	221	221
Controls	X	X	X

Notes: Robust standard errors in parentheses. The dependent variable is the primary surplus. All variables are expressed in logs relative to GDP. All specifications include output gap, inflation, trade openness, major wars dummies and a Global Financial Crisis dummy. In column (3), Service is interacted with a dummy equal to one when $(r-g) > 0$. The long-run elasticity is computed as $\phi = \gamma/(1-\xi)$. Statistical significance corresponds to a test of $\phi > 1$. *, **, *** denote significance at the 10, 5, and 1 percent levels.

Robustness Appendix Tables 7 and 8 report several robustness checks. First, the positive association between primary surpluses and debt-service costs remains robust across alternative dynamic specifications, including Newey–West corrections and ARDL estimators. In particular, the interaction between debt service and the Snowball regime remains positive and statistically significant throughout. Second, the results are robust to alternative measures of financing conditions. Replacing debt-service costs with sovereign yields, or using an alternative burden measure defined as interest payments relative to lagged debt, continues to yield a positive and significant association with primary surpluses, while debt ratios remain insignificant. Third, we explicitly control for the long-term interest rate. Once debt-service costs are included, the interest rate itself is no longer statistically significant, indicating that fiscal adjustment is driven not by borrowing costs per se, but by the financing burden they generate. Overall, these robustness exercises reinforce our central conclusion that governments respond to the fiscal cost of servicing outstanding debt rather than to debt accumulation alone.

Historical fiscal regimes Table 2 examines whether the relationship between fiscal adjustment and debt-service costs differs across different historical regimes before and after 1913. Columns (1) and (5) show that the paper's central finding continues to hold in both periods. Debt-service costs are positively associated with primary surpluses, whereas debt ratios remain statistically insignificant throughout. Fiscal surpluses continue to appear more closely associated with debt-service costs than with debt accumulation itself.

Major wars are associated with the largest episodes of debt accumulation, particularly the Civil War and the two World Wars (see Figure 1). Columns (2) and (6) therefore introduce wartime dummies to isolate fiscal dynamics outside periods of direct military mobilization. The positive association between primary surpluses and debt-service costs remains robust before 1913 but becomes insignificant afterward, suggesting that twentieth-century fiscal adjustment became increasingly concentrated around postwar consolidation episodes. This interpretation is reinforced by columns (3) and (7), which interact debt-service costs with postwar periods. The interaction term is positive and significant in both subperiods, though substantially larger before 1913. The corresponding interaction between debt and postwar periods remains insignificant (columns 4 and 8), indicating that postwar fiscal correction responded primarily to debt-service costs rather than to debt accumulation itself.

A key difference across periods is the persistence of primary surpluses. Before 1913, autoregressive coefficients remain relatively low (around 0.3–0.4) and decline further once wartime dynamics are isolated, suggesting that nineteenth-century stabilization relied primarily on sharp but short-lived postwar fiscal corrections rather than on sustained fiscal adjustment. Consistent with this pattern, the estimated long-run fiscal elasticity remains significantly less than one before 1913 ($\psi < 1$), indicating limited evidence that debt stabilization through sustained fiscal adjustment was achieved during this period.

After 1913, primary surpluses become substantially more persistent, with autoregressive coefficients close to 0.8. This period also coincides with the emergence of broader tax systems, central banking, and deeper sovereign debt markets, alongside governments sustaining historically larger debt ratios under more favorable financing conditions (Sylla, 2002; Rockoff, 2015). As illustrated in Figure 4, the postwar period combined high debt levels with persistently favorable interest-growth differentials, reducing the effective fiscal burden of public debt (Hall and Sargent, 2011; Reinhart and Sbrancia, 2015). Consistent with this transformation, the estimated long-run fiscal elasticity becomes statistically indistinguishable from or greater than one.

Together, these results suggest that primary surpluses are more closely associated with debt-service costs than with debt accumulation itself, but that the nature of fiscal stabilization changed across historical regimes. Before 1913, fiscal correction occurred in sharp but short-lived postwar adjustments, whereas the modern fiscal regime combines greater persistence in primary surpluses with financing conditions that sustain larger debt stocks at lower fiscal cost.

Table 2: Fiscal Responses to Debt-Service Pressures Across Historical Regimes

	1800–1912				1913–2023			
	Baseline	War	postwar	Debt× postwar	Baseline	War	postwar	Debt× postwar
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Primary surplus$_{t-1}$	0.463***	0.279*	0.329***	0.367***	0.756***	0.767***	0.764***	0.767***
	(0.145)	(0.146)	(0.081)	(0.116)	(0.083)	(0.086)	(0.086)	(0.087)
Debt	-0.135	-0.151	-0.147	-0.134	-0.621	-0.407	-0.501	-0.407
	(0.100)	(0.093)	(0.090)	(0.089)	(0.407)	(0.409)	(0.423)	(0.386)
Service	0.250**	0.340***	0.328***	0.292***	0.589*	0.524	0.516	0.524
	(0.118)	(0.119)	(0.100)	(0.238)	(0.352)	(0.375)	(0.366)	(0.372)
Service × postwar			3.703***				1.263**	
			(0.666)				(0.621)	
Debt × postwar				0.238				0.001
				(0.327)				(0.192)
Long-run elasticity ($\phi > 1$)	0.465	0.472			2.416	2.253		
	(0.197)	(0.140)			(1.175)	(1.401)		
95% CI	[0.142;0.789]	[0.242;0.702]			[0.489;4.343]	[-0.045;4.551]		
Observations	112	112	112	112	111	111	111	111
Controls	X	X	X	X	X	X	X	X
War		X	X	X		X	X	X

Notes: Robust standard errors in parentheses. The dependent variable is the primary surplus. All variables are expressed in logs relative to GDP. All specifications include output gap, inflation, trade openness, and a Global Financial Crisis dummy. Post-1913 specifications additionally control for Federal Reserve independence. Columns labeled "Service × postwar" include an interaction between debt service and a dummy equal to one in the year following a war. Columns labeled "Debt × postwar" include an interaction between public debt and the postwar dummy. The long-run elasticity is computed as $\phi = \gamma/(1-\xi)$. Statistical significance corresponds to a test of $\phi > 1$. *, **, *** denote significance at the 10, 5, and 1 percent levels.

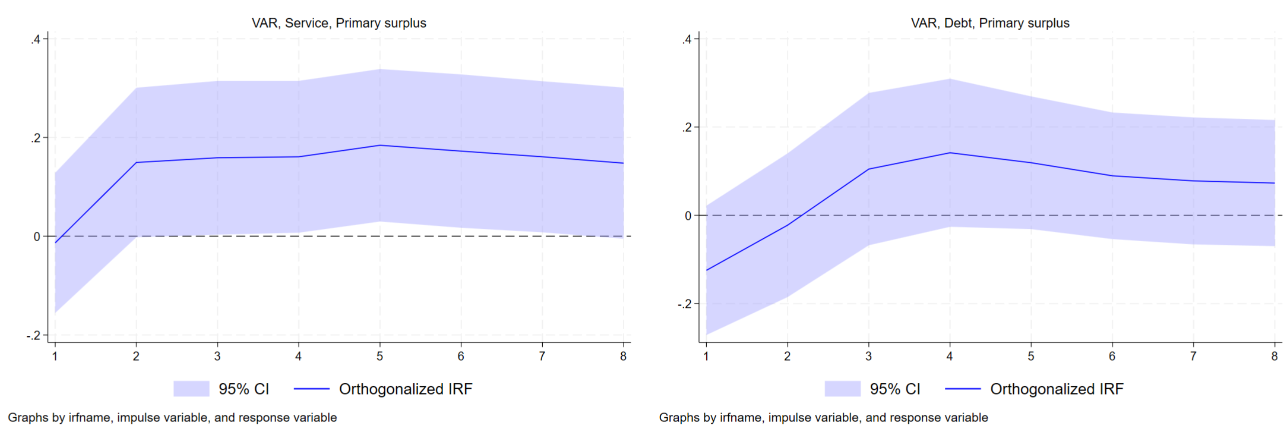
3.2 Dynamic Responses

The baseline regressions document average correlations between fiscal surplus and debt-service costs. We now examine whether fiscal adjustment responds more strongly to debt-service shocks than to debt shocks in a dynamic setting.[7]

We begin by estimating simple vector autoregressions including the primary surplus, debt variables, the output gap, and sovereign risk premia over the full period 1800–2023. Figure 2 reports impulse responses of the primary surplus to shocks in debt-service costs and debt levels. Debt-service shocks are followed by a persistent increase in primary surpluses, statistically significant at the 5% level between two and seven years after the shock. Quantitatively, a one-standard-deviation increase in debt-service costs raises the primary surplus by approximately 0.15 percentage points after two years. In contrast, shocks to debt stocks generate weak and statistically insignificant responses over most horizons. Consistent with this pattern, Granger-causality tests reported in Appendix C indicate that debt-service costs contain predictive information for future primary surpluses, whereas debt stocks do not.

Figure 2: Dynamic fiscal responses to debt and debt-service shocks

(a) Shock to debt service (b) Shock to debt-to-GDP ratio



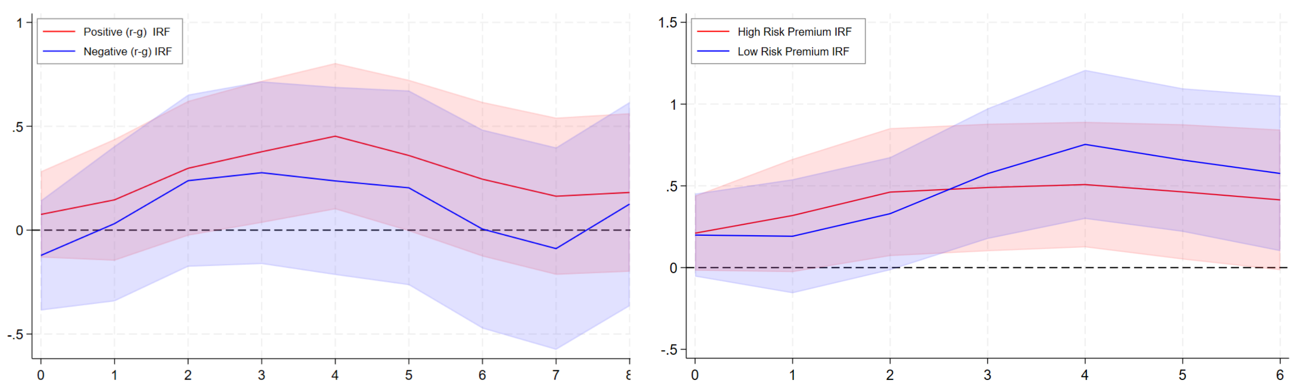
Notes: The figure reports orthogonalized impulse responses of the primary surplus to a one-standard-deviation shock in (a) debt-service costs and (b) the public debt ratio over 1800–2023. Impulse responses are estimated from a VAR including the output gap, sovereign risk premium, the primary surplus, and either debt service or the debt ratio depending on the specification. Shaded areas represent 95% confidence intervals.

[7]These exercises should be interpreted as descriptive dynamic evidence rather than causal identification of exogenous fiscal shocks.

We next examine whether these responses depend on financing conditions using state-dependent local projections following Jordà (2005). Figure 3 shows that fiscal adjustment becomes substantially stronger when debt is more costly to finance. Panel (a) indicates that debt-service shocks generate larger and more persistent fiscal responses when the interest-growth differential is positive. In these periods, the response of the primary surplus peaks at approximately 0.45 percentage points of GDP after four years, whereas the response remains weaker and statistically insignificant at conventional levels when $(r - g) < 0$. Panel (b) reveals a similar asymmetry for sovereign risk premia. When risk premia are low, fiscal adjustment to a debt-service shock is slower but ultimately larger and more persistent, becoming significant after roughly two and a half years and peaking after about four years. By contrast, when risk premia are high, adjustment occurs more rapidly, becoming significant after about two years, but with a smaller overall magnitude. This suggests that tighter financing conditions induce earlier fiscal adjustment, whereas favorable financing conditions allow governments to spread adjustment more gradually over time.[8]

Figure 3: State-dependent fiscal responses to debt-service shocks

(a) Snowball regimes (b) Risk-premium regimes



Notes: The figure reports state-dependent local projection impulse responses of the primary surplus to a debt-service shock (Jordà, 2005). Panel (a) splits the sample according to the interest-growth differential, with high-$(r - g)$ periods defined as years above the 25th percentile of the distribution. Panel (b) distinguishes periods of low and high sovereign risk premia, where high-risk periods correspond to observations above the 75th percentile. Shaded areas represent 90% confidence intervals. Appendix Figure 6 reports the corresponding 95% confidence intervals.

[8] These results are robust to a lag-augmented specification including a second lag of the dependent variable and all control variables—the corresponding impulse responses are reported in Appendix Figure 8.

Complementary dynamic evidence Appendix C provides the econometric details on the VAR and local projection specifications, including stationarity diagnostics and identification assumptions. It also reports complementary dynamic evidence, including time-varying parameter VARs following Primiceri (2005) and additional state-dependent local projections estimated across alternative macroeconomic regimes, including recession and non-recession periods.

These dynamic patterns reinforce the paper's central claim that primary surpluses respond more strongly to financing costs and the budgetary pressures generated by servicing debt than to debt accumulation itself.

4 Cross-Country Evidence

We next examine whether the mechanism identified in the U.S. case extends more broadly across advanced economies. We examine whether the stronger association between primary surpluses and debt-service costs extends across heterogeneous fiscal and financial regimes.

Following the U.S. analysis, we estimate a debt-service-augmented fiscal reaction function on a long-run panel of 12 advanced economies—Canada, Denmark, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States—over the period 1800–2023. We draw annual data from the IMF's *Public Finances in Modern History* database. The baseline specification is:

$$\log PS_{i,t} = \xi \log PS_{i,t-1} + \beta \log Debt_{i,t-1} + \gamma \log Service_{i,t} + v' X_{i,t} + \mu_i + \delta_t + \varepsilon_{i,t}, \qquad (8)$$

where μ_i and δ_t denote country and year fixed effects. The set of controls (X) includes the output gap and dummies taking on a value of 1 during the World Wars and the Global Financial Crisis.[9] We estimate the dynamic panel model using the Least Squares Dummy Variable (LSDV) estimator, which is consistent and efficient when T is large, outperforming GMM or instrumental variables approaches in such contexts (Judson and Owen, 1999; Attanasio et al., 2000; Debrun and Kinda, 2016).

Results Table 3 confirms the central finding of the paper. Column (1) first reports the standard Bohn-type fiscal reaction function and delivers estimates broadly consistent with

[9]The output gap is derived as the deviation of actual GDP from potential output, using the Hodrick-Prescott filter. Summary statistics are reported in Appendix Table 5.

the existing literature on advanced economies: primary surpluses respond positively and persistently to debt accumulation. However, once debt-service costs are introduced (col. 2), the coefficient on debt becomes statistically insignificant, whereas that on debt-service costs is positive and significant. Quantitatively, a 10% increase in debt-service costs is associated with an increase in the primary surplus of approximately 1.35%.

This result remains robust when contemporaneous debt service is replaced by lagged debt service (col. 3). The coefficient remains positive and statistically significant, suggesting that fiscal adjustment responds persistently to financing pressures rather than simply to contemporaneous fluctuations.

Columns (4) and (5) examine whether fiscal adjustment becomes stronger when financing conditions worsen. Consistent with the U.S. evidence, the interaction between debt service and the snowball regime—defined as periods in which $r > g$—is positive and significant, whereas the corresponding interaction with debt remains insignificant. Again, the standalone debt-service coefficient loses significance once interacted with the Snowball regime (col. 4), indicating that fiscal adjustment intensifies primarily when financing conditions become unfavorable.

The snowball dummy itself enters negatively and significantly. This is consistent with the idea that periods characterized by $r > g$ combine weaker growth dynamics with greater financing pressures on public budgets, thereby reducing governments' ability to generate primary surpluses absent stronger fiscal correction. Finally, the output gap enters negatively across specifications, indicating that primary surpluses tend to deteriorate during downturns and improve during expansions.

Additional panel evidence Appendix D further examines the robustness of the cross-country results. First, the baseline findings remain stable across alternative panel estimators accounting for serial correlation and cross-sectional dependence. Across specifications, primary surpluses remain positively associated with debt-service costs, whereas debt ratios lose significance once costs are taken into account. Second, we complement the baseline framework with panel cointegration techniques and Mean Group estimators to examine long-run fiscal responsiveness under heterogeneous country dynamics.

In sum, despite substantial heterogeneity across countries and historical periods, our cross-country evidence suggests that the primacy of debt-service pressures over debt stocks is not a uniquely American historical feature, but a broader characteristic of fiscal adjustment dynamics across advanced economies.

Table 3: Fiscal Responses to Debt-Service Pressures: Cross-Country Evidence

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	Primary surplus				
Primary surplus$_{t-1}$	0.796***	0.791***	0.785***	0.780***	0.779***
	(0.017)	(0.017)	(0.017)	(0.020)	(0.020)
Debt	0.071***	-0.052	-0.062	0.021	-0.027
	(0.023)	(0.048)	(0.043)	(0.071)	(0.071)
Service		0.136***		0.067	0.127**
		(0.045)		(0.061)	(0.059)
Service$_{t-1}$			0.149***		
			(0.041)		
Service $\times$ Snowball				0.113**	
				(0.052)	
Debt $\times$ Snowball					0.096
					(0.064)
Snowball				-0.200***	-0.497**
				(0.061)	(0.245)
Output gap$_{t-1}$	-0.071***	-0.071***	-0.069***	-0.076***	-0.078***
	(0.017)	(0.017)	(0.017)	(0.020)	(0.020)
Observations	1 842	1 842	1 842	1 518	1 518
Country FE	X	X	X	X	X
Wars + 2008 crisis	X	X	X	X	X

Notes: Robust standard errors are reported in parentheses. All variables are expressed in logs relative to GDP. The dependent variable is the primary surplus. All specifications include the lagged output gap, as well as dummy variables for World Wars I and II and the Global Financial Crisis. Snowball denotes a dummy equal to one when $r > g$. Columns (4) and (5) interact the Snowball regime with debt-service costs and debt stocks respectively. Appendix tables report alternative specifications including year fixed effects, which leave the qualitative results unchanged. *, **, and *** denote significance at the 10, 5, and 1 percent levels.

5 Concluding remarks

This paper revisits fiscal sustainability through the lens of debt-service burdens. Using two centuries of U.S. data and a panel of advanced economies, we show that primary surpluses are more closely associated with debt-service costs than with debt ratios. Once debt service is taken into account, debt ratios lose much of their explanatory power.

The evidence also suggests that this relationship is state-dependent. Primary surpluses are more strongly associated with debt-service costs when financing conditions deteriorate, especially when the interest-growth differential becomes unfavorable. The nature of fiscal stabilization also changed over time: nineteenth-century adjustment relied primarily on sharp but short-lived postwar consolidations, whereas modern fiscal regimes are characterized by more gradual and persistent forms of adjustment.

Our findings suggest that fiscal sustainability depends less on debt accumulation itself than on governments' ability to absorb the financing burden generated by outstanding public liabilities. Debt stocks determine governments' exposure to future financing pressures, whereas debt-service burdens summarize the effective fiscal pressure associated with that exposure.

From this perspective, standard debt-based fiscal reaction functions may overlook an important dimension of fiscal sustainability by focusing on debt accumulation rather than on the budgetary burden it creates. Ultimately, sovereign debt becomes fiscally constraining not when debt ratios reach a particular threshold, but when financing conditions transform outstanding liabilities into an immediate budgetary burden.

References

Attanasio, O. P., L. Picci, and A. E. Scorcu (2000). Saving, Growth, and Investment: A Macroeconomic Analysis Using a Panel of Countries. *The Review of Economics and Statistics 82*, 182–211.

Bahaj, S. (2020). Sovereign spreads in the euro area: Cross border transmission and macroeconomic implications. *Journal of Monetary Economics 110*, 116–135.

Blanchard, O. (2019). Public debt and low interest rates. *American Economic Review 109*, 1197–1229.

Bohn, H. (1998). The behavior of U.S. public debt and deficits. *The Quarterly Journal of Economics 113*, 949–963.

Bohn, H. (2008). The sustainability of fiscal policy in the United States. In R. Neck and J.-E. Sturm (Eds.), *Sustainability of Public Debt*, Chapter 2. MIT Press.

Bolt, J. and J. L. V. Zanden (2025). Maddison-style estimates of the evolution of the world economy: A new 2023 update. *Journal of Economic Surveys 39*, 631–671.

Checherita-Westphal, C. and P. Rother (2012). The impact of high government debt on economic growth and its channels: An empirical investigation for the euro area. *European Economic Review 56*, 1392–1405.

Checherita-Westphal, C. and V. Zyárek (2017). Fiscal reaction function and fiscal fatigue: evidence for the euro area. *ECB Working Paper No. 2036*.

Collignon, S. (2012). Fiscal policy rules and the sustainability of public debt in Europe. *International Economic Review 53*, 539–567.

Debrun, X. and T. Kinda (2016). That squeezing feeling: The interest burden and public debt stabilization. *International Finance 19*, 147–178.

Debrun, X., J. D. Ostry, T. Willems, and C. Wyplosz (2020). Debt sustainability. In S. A. Abbas, A. Peinkowski, and K. Rogoff (Eds.), *Sovereign Debt*, Chapter 4, pp. 151–191. Oxford University Press.

Eichengreen, B. (1990). *Elusive stability: essays in the history of international finance, 1919-1939*. Cambridge University Press.

Eichengreen, B. J., A. El-Ganainy, R. Esteves, and K. J. Mitchener (2021). *In Defense of Public Debt*. Oxford University Press.

European Comission (2019). Fiscal Sustainability Report 2018. *Institutional Paper 094*.

Favero, C. and A. Missale (2012). Sovereign spreads in the eurozone: which prospects for a Eurobond? *Economic Policy 27*, 231–273.

Federico, G. and A. Tena-Junguito (2016). World trade, 1800-1938: a new data-set. *EHES Working Papers in Economic History*.

Furman, J. and L. Summers (2020). A reconsideration of fiscal policy in the era of low interest rates. *Harvard University and Peterson Institute for International Economics*.

Ghosh, A. R., J. I. Kim, E. G. Mendoza, J. D. Ostry, and M. S. Qureshi (2013). Fiscal fatigue, fiscal space and debt sustainability in advanced economies. *Economic Journal 123*, F4–F30.

Goodhart, C. (1988). *The evolution of central banks*. MIT press.

Guichard, S., M. Kennedy, E. Wurzel, and C. André (2007). What promotes fiscal consolidation: OECD country experiences. *OECD Working Paper No. 553*.

Hall, G. J. and T. J. Sargent (2011). Interest rate risk and other determinants of post-wwii us government debt/gdp dynamics. *American Economic Journal: Macroeconomics 3*(3), 192–214.

IMF (2013). *Staff Guidance Note for Public Debt Sustainability Analysis in Market-Access Countries*. Washington, D.C: International Monetary Fund.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American economic review 95*(1), 161–182.

Jordà, O., M. Schularick, and A. M. Taylor. (2017). Macrofinancial history and the new business cycle facts. *NBER Macroeconomics Annual 31*, 213–263.

Judson, R. A. and A. L. Owen (1999). Estimating dynamic panel data models: A guide for macroeconomists. *65*(1), 9–15.

Li, Q. and J. S. Racine (2007). *Nonparametric econometrics: theory and practice*. Princeton University Press.

Maltritz, D. (2012). Determinants of sovereign yield spreads in the Eurozone: A Bayesian approach. *Journal of International Money and Finance 31*, 657–672.

Mauro, P., R. Romeu, A. Binder, and A. Zaman (2015). A modern history of fiscal prudence and profligacy. *Journal of Monetary Economics 76*, 55–70.

Mauro, P. and J. Zhou (2021). $r - g < 0$: Can we sleep more soundly? *IMF Economic Review 69*, 197–229.

Mehrotra, N. R. and D. Sergeyev (2021). Debt sustainability in a low interest rate world. *Journal of Monetary Economics 124*, S1–S18.

Mendoza, E. G. and J. D. Ostry (2008). International evidence on fiscal solvency: Is fiscal policy “responsible”? *Journal of Monetary Economics 55*, 1081–1093.

Menuet, M., A. Minea, and P. Villieu (2024). The perils of fiscal feedback rules. *Journal of Economic Theory 220*, 105857.

Montiel Olea, J. L. and M. Plagborg-Møller (2021). Local projection inference is simpler and more robust than you think. *Econometrica 89*(4), 1789–1823.

Primiceri, G. E. (2005). Time varying structural vector autoregressions and monetary policy. *The Review of Economic Studies 72*, 821–852.

Reinhart, C. and K. Rogoff (2010). Growth in a Time of Debt. *American Economic Review 100*(2), 573–578.

Reinhart, C. M. and M. B. Sbrancia (2015). The liquidation of government debt. *Economic Policy 30*(82), 291–333.

Rockoff, H. (2015). War and inflation in the united states from the revolution to the first iraq war. Technical report, National Bureau of Economic Research.

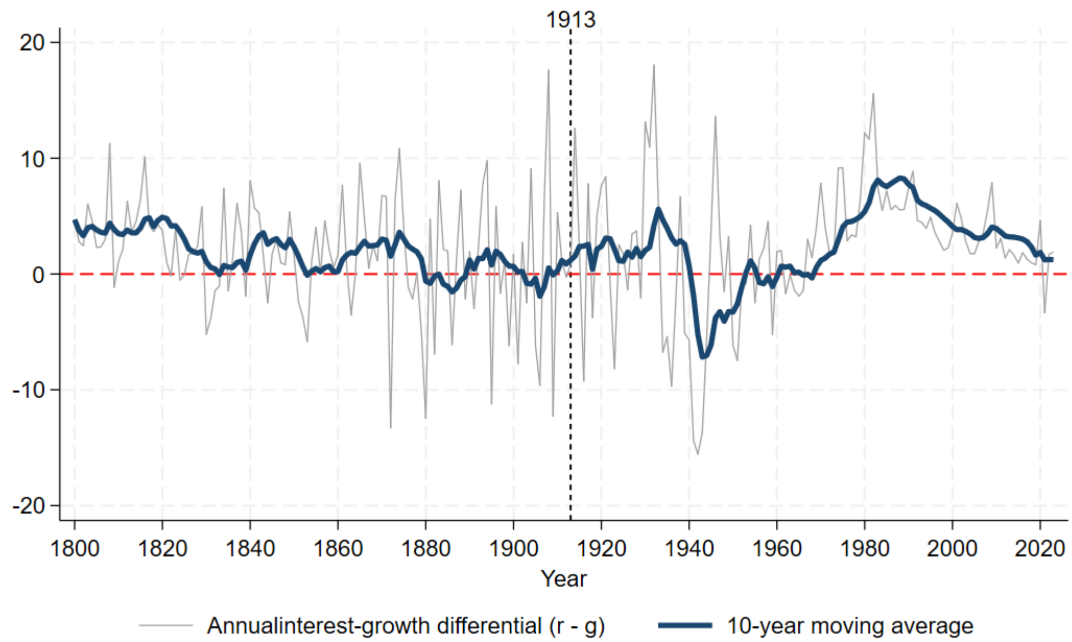
Sylla, R. (1969). Federal policy, banking market structure, and capital mobilization in the united states, 1863–1913. *The Journal of Economic History 29*(4), 657–686.

Sylla, R. (2002). Financial systems and economic modernization. *The Journal of Economic History 62*(2), 277–292.

Wallis, J. J. (2000). American government finance in the long run: 1790 to 1990. *Journal of Economic Perspectives 14*(1), 61–82.

Williamson, S. H. (2026). Sources of interest rates. https://www.measuringworth.com/. MeasuringWorth.

Figure 4: Interest-Growth Differential in the United States, 1800–2023



Note: This figure plots the annual interest-growth differential $(r - g)$ for the United States from 1800 to 2023, where r denotes the long-term interest rate and g the growth rate. The thin gray line represents the annual series, while the thick blue line reports a 10-year moving average. The horizontal red dashed line corresponds to the threshold $r - g = 0$. The vertical dashed line marks the year 1913.

A Data

This appendix presents data sources, variable definitions, and descriptive statistics used throughout the paper. Tables 4 and 5 report summary statistics for the United States and the cross-country panel, while Figure 5 illustrates the long-run evolution of U.S. public debt and financing conditions since 1800.

Table 6 provides detailed definitions and sources for the variables used in the U.S. analysis. For the cross-country panel, fiscal variables are expressed as shares of GDP and annual data are drawn from the IMF's *Public Finances in Modern History* database (`https://www.imf.org/external/datamapper/datasets/FPP`).

Table 4: Summary statistics - United States (1800-2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
Primary surplus (% GDP)	224	-1.06	4.26	-18.39	6.08
Service (% GDP)	224	1.15	1.02	0	3.86
Debt (% GDP)	224	34.09	32.6	0	131.83
GDP growth	224	3.66	4.88	-13.17	19.73
Inflation	224	1.61	5.62	-15.73	25.14
Trade openness	224	0.04	0.06	0.001	0.24
Long-term interest rate	224	5.64	2.03	2.48	14.17
Risk Premium	222	3.40	4.80	-8.22	18.44
Output gap	224	0	2.80	-9.40	9.77
Yield	224	4.47	1.94	0.93	13.98

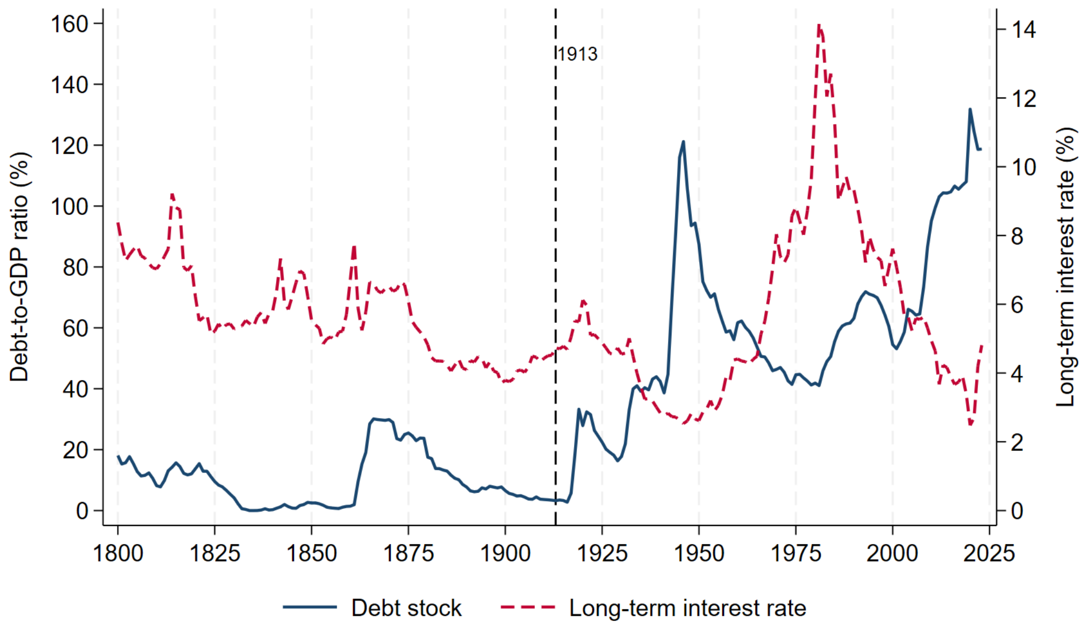
Table 5: Summary statistics - Panel (1800-2023)

Variable	Obs	Mean	Std. Dev.	Min	Max
Primary surplus (% GDP)	1 909	0.51	4.67	-47.67	25.94
Service (% GDP)	1 919	2.28	1.93	0	12.66
Debt (% GDP)	1 932	55.54	41.24	0	269.8
GDP growth	1 984	2.71	5.19	-52.59	68.81
Long-term interest rate	1 575	2.35	5.38	-36.23	26.9
Output gap	1 943	0	3.19	-43.17	28.72

Table 6: Variables and data sources

Variable	Definition	Source
Primary surplus	Government primary balance (% of GDP)	IMF Public Finances in Modern History
Debt	General government debt (% of GDP)	IMF Public Finances in Modern History
Debt service	Interest payments on public debt (% of GDP)	IMF Public Finances in Modern History
Real GDP growth	Real GDP growth rate (%)	IMF Public Finances in Modern History
Long-term interest rate	Long-term government bond yield (%)	Williamson (2026), U.S. Long-Term Rate.
Output gap	HP-filtered real GDP	Authors' calculations using Maddison Project Database (Bolt and Zanden, 2025)
Trade openness	Exports + imports (% of GDP)	World Trade Historical Database (Federico and Tena-Junguito, 2016); World Bank WDI
Inflation	Annual CPI inflation	Federal Reserve Economic Data (FRED)
Risk premium	U.S. equity-bond premium	FINAEON Database
Bond yield	10-year Treasury yield	FINAEON Database
Federal Reserve independence	Dummy equal to one after the 1951 Treasury–Fed Accord	Authors' coding
NBER recession	Dummy equal to one during NBER recessions	NBER Business Cycle Dating Committee

Figure 5: Public debt and long-term interest rates in the United States



Notes: The figure reports the evolution of the U.S. debt-to-GDP ratio (left axis) and the long-term government interest rate (right axis) over the period 1800–2023. The vertical dashed line marks 1913, corresponding to the establishment of the Federal Reserve System. Debt data are from IMF Public Finances in Modern History. Long-term interest rates are from Williamson (2026), U.S. Long-Term Rate: Consistent Series.

Figure 5 illustrates the historical disconnect between debt accumulation and financing costs in the United States. Several episodes combined historically high debt levels with relatively moderate interest rates, particularly in the post-WWII period and during the decade following the 2008 financial crisis. Conversely, periods such as the Volcker disinflation were characterized by elevated interest rates despite substantially lower debt ratios.

B Additional baseline specifications

Alternative dynamic specifications Table 7 reports robustness checks using alternative dynamic specifications. Columns (1) to (3) re-estimate the baseline models using Newey–West heteroskedasticity- and autocorrelation-consistent standard errors to account for potential serial correlation in the residuals. In Column (1), we augment the baseline specification by controlling for the long-term interest rate, thereby accounting for the potential effect of borrowing costs on fiscal outcomes. While the estimated coefficient is positive, it is not statistically significant. The baseline findings remain unchanged: lagged debt-service costs also remain positively associated with primary surpluses (col. 2), suggesting that fiscal responses are not purely contemporaneous; the interaction between debt-service costs and the Snowball regime also remains positive and significant (col. 3). Column (4) estimates the specification within an ARDL framework, allowing for dynamic adjustment and long-run relationships between fiscal surpluses and financing pressures. Lag selection is based on the Bayesian Information Criterion (BIC), leading to the preferred ARDL(1,0,0,0,0,0,2,0,1) specification. The implied long-run coefficients continue to show a positive association between primary surpluses and debt-service costs, while debt ratios remain insignificant. Taken together, these exercises suggest that the baseline results are not driven by serial correlation, omitted dynamics, or a particular time-series specification.

Table 7: Alternative Estimations – Fiscal Responses to Debt-Service Pressures, 1800–2023

	(1)	(1)	(2)	(3)
	Newey–West			ARDL
Primary surplus$_{t-1}$	0.747***	0.777***	0.764***	-0.214***
	(0.071)	(0.072)	(0.070)	(0.041)
Debt	-0.139	-0.084	-0.169	-0.155
	(0.092)	(0.053)	(0.117)	(0.467)
Service	0.192*		0.105	0.044
	(0.106)		(0.159)	(0.667)
Service$_{t-1}$		0.133*		
		(0.078)		
Service $\times$ Snowball			0.168***	0.869**
			(0.057)	(0.451)
Observations	223	223	221	220
Controls	X	X	X	X

Notes: Standard errors in parentheses. The dependent variable is the primary surplus. All variables are expressed in logs relative to GDP. All specifications include output gap, inflation, trade openness, major wars dummies, and a Global Financial Crisis dummy. Service is interacted with a dummy equal to one when $(r - g) > 0$. In column (1), we augment the baseline specification by including the long-term interest rate as an additional control variable, which is not statistically significant. Columns (2) and (3) re-estimate the baseline specifications using Newey–West heteroskedasticity- and autocorrelation-consistent (HAC) standard errors. Column (4) reports estimates from an ARDL(1,0,0,0,0,0,2,0,1) model, with lags selected using the Bayesian Information Criterion. The reported coefficients correspond to the implied long-run relationships. The ARDL specification includes a time trend. *, **, *** denote significance at the 10, 5, and 1 percent levels.

Alternative debt-service measures Table 8 examines whether the baseline results depend on the specific measure used to capture financing pressures. Column (1) replaces realized debt-service costs with sovereign yields, capturing market financing conditions. Column (2) uses an alternative burden measure defined as interest payments relative to lagged debt, isolating the effective financing cost of outstanding liabilities independently from debt accumulation itself. Across specifications, financing measures remain positively and significantly associated with primary surpluses, whereas debt ratios continue to exhibit little explanatory power. These results reinforce the paper's central finding that fiscal surpluses are more closely associated with debt-service costs than with debt ratios themselves.

Table 8: Alternative debt-service measures – Fiscal Responses to Debt-Service Pressures, 1800–2023

	(1) Yield	(2) Burden
Primary surplus$_{t-1}$	0.754***	0.792***
	(0.066)	(0.061)
Debt	0.037	0.046
	(0.041)	(0.039)
Yield	0.135***	
	(0.049)	
Burden		0.718**
		(0.317)
Observations	221	221
Controls	X	X

Notes: Robust standard errors in parentheses. The dependent variable is the primary surplus. All variables are expressed in logs relative to GDP. Yield corresponds to the long-term sovereign interest rate, capturing the contemporaneous market cost of government borrowing. Burden is defined as interest payments relative to lagged public debt, capturing the realized effective financing cost of outstanding liabilities independently from debt accumulation itself. All specifications include output gap, inflation, trade openness, risk premium, major wars dummies, and a Global Financial Crisis dummy. *, **, *** denote significance at the 10, 5, and 1 percent levels.

C Dynamic Responses

This appendix provides additional details on the dynamic specifications used in subsection 3.2. We first present the vector autoregression (VAR) framework used to analyze the dynamic responses of fiscal surplus to debt-service and debt shocks, along with stationarity diagnostics and Granger-causality tests. We then describe the state-dependent local projection specifications used to assess whether fiscal responses vary across financing and macroeconomic conditions.

C.1 VAR specification

As an additional robustness exercise, we extend the baseline VAR specification presented above by allowing coefficients and impulse responses to evolve over time following Primiceri (2005). The objective is not to provide a separate identification strategy, but to assess whether the dynamic response of fiscal adjustment to debt-service shocks varies across historical regimes.

Formally, we estimate:

$$Y_t = \sum_{p=1}^{4} A_p Y_{t-p} + \delta t + u_t, \tag{9}$$

where Y_t is a 4×1 vector containing the output gap, risk premium, debt service, and primary surplus; t denotes a deterministic linear time trend; A_p are 4×4 coefficient matrices; and u_t is a vector of reduced-form innovations. Given the objective of adequately capturing long-run macro-financial dynamics, we retain a VAR(4) specification as the baseline model. This choice balances dynamic richness against over-parameterization and is consistent with standard practice in macroeconomic VAR analysis.

Figure 9 reports the resulting time-varying impulse responses of the primary surplus to debt-service shocks. The response remains positive throughout the historical sample, but varies substantially in magnitude and persistence. Fiscal responses appear strongest around the post-WWII period and more muted in the recent decades, consistent with the broader historical evolution of U.S. fiscal regimes discussed in the main text

Unit Root and Persistence properties We assess the time-series properties of the variables using Phillips-Perron (PP), Augmented Dickey-Fuller (ADF), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The results, reported in Table 9, support the absence of a unit root of the variables used in the VAR specifications. The VARs are therefore estimated in levels.[10] Lag selection criteria suggested between one and four lags. We retain a VAR(4), balancing fit and parsimony. Stability conditions are satisfied. Residual autocorrelation remains limited but persistent at some horizons, a common feature in long-run historical macroeconomic datasets. Results are robust to alternative lag specifications.

[10] The ADF and PP tests examine the null of a unit root against stationarity, whereas KPSS tests the null of stationarity. The results consistently reject the presence of a unit root in all series.

Table 9: Unit Root Tests

Variable	**PP(10)**	**ADF(4)**	**KPSS(10)**	**Conclusion**
Primary surplus	-4.491***	-3.639**	0.080	Stationary
Service	-2.993	-3.322*	0.114	No rejection
Debt	-3.246*	-3.421*	0.086	Stationary
Inflation	-8.444***	-5.100***	0.041	Stationary
Risk Premium	-10.315***	-3.531**	0.146	No rejection
Critical values				
5%	-3.434	-3.434	0.146	
1%	-3.999	-4.000	0.216	

Notes: *, ** and *** denote significance at 10%, 5% and 1% levels. All results are reported for an AR(4) in ADF and for 10 lags in PP and in KPSS to account for short-run dependencies.

Granger-causality tests. We also report Granger-causality tests in Tables 10 and 11. These tests indicate that debt-service costs contain predictive information for future primary surpluses, whereas debt stocks do not.

Table 10: Granger causality test with debt service

Equation	**Excluded**	**Chi2**	**df**	**P >Chi2**
Output gap	Risk premium	30.864	4	0.000***
	Service	2.716	4	0.606
	Primary surplus	7.978	4	0.092*
	All	44.075	12	0.000***
Risk premium	Output gap	21.486	4	0.000***
	Service	2.496	4	0.645
	Primary surplus	7.416	4	0.115
	All	29.435	12	0.003***
Service	Output gap	3.804	4	0.433
	Risk premium	0.852	4	0.931
	Primary surplus	12.118	4	0.016**
	All	17.958	12	0.117
Primary surplus	Output gap	6.377	4	0.173
	Risk premium	4.381	4	0.357
	Service	13.155	4	0.011**
	All	23.394	12	0.025**

Notes: Debt service causes primary surplus. Primary surplus causes debt service

Table 11: Granger causality test with debt

Equation	Excluded	Chi2	df	P >Chi2
Output gap	Risk premium	32.075	4	0.000***
	Debt	1.021	4	0.907
	Primary surplus	10.253	4	0.036**
	All	42.062	12	0.000***
Risk premium	Output gap	20.048	4	0.000***
	Debt	0.359	4	0.986
	Primary surplus	6.557	4	0.161
	All	27.036	12	0.008***
Debt	Output gap	0.729	4	0.948
	Risk premium	0.716	4	0.949
	Primary surplus	4.516	4	0.341
	All	5.209	12	0.951
Primary surplus	Output gap	5.813	4	0.214
	Risk premium	3.450	4	0.486
	Debt	7.666	4	0.105
	All	17.662	12	0.126

Notes: There is no evidence of a causal relationship between variables of interest.

C.2 State-Dependent Local Projections

To assess whether fiscal responses to debt-service shocks vary with financing conditions we estimate state-dependent local projections following Jordà (2005). For each horizon h, we estimate:

$$\log PS_{t+h} = \alpha_h + \xi_h \log PS_{t-1} + \gamma_h \log Service_t + X'_{t-1}\nu_h + \varepsilon_{t+h}, \tag{10}$$

where PS_t denotes the primary surplus and $Service_t$ the debt-service ratio. The control vector X_{t-1} includes the debt ratio, the inflation, the output gap, a dummy for Fed independence. The coefficient γ_h traces the response of the primary surplus at horizon h to a debt-service shock.

We first examine whether fiscal responses differ across Snowball regimes:

$$\begin{aligned}\log PS_{t+h} =& \alpha_h + \xi_h \log PS_{t-1} + \gamma_+^h \left[\mathbf{1}\{(r-g)_t > Q_{25}(r-g)\} \times \log Service_t\right] \\ &+ \gamma_-^h \left[\mathbf{1}\{(r-g)_t \leq Q_{25}(r-g)\} \times \log Service_t\right] + X'_{t-1}\nu_h + \varepsilon_{t+h}, \end{aligned} \tag{11}$$

where positive (negative) Snowball regimes correspond to years in which $(r-g)$ is above (below) its 25th percentile.

We next estimate responses conditional on sovereign risk premia:

$$\begin{aligned}\log PS_{t+h} =& \alpha_h + \xi_h \log PS_{t-1} + \gamma_H^h \left[\mathbf{1}\{RiskPrem_t > Q_{75}(RiskPrem)\} \times \log Service_t\right] \\ &+ \gamma_L^h \left[\mathbf{1}\{RiskPrem_t \leq Q_{75}(RiskPrem)\} \times \log Service_t\right] + X'_{t-1}\nu_h + \varepsilon_{t+h}, \end{aligned} \tag{12}$$

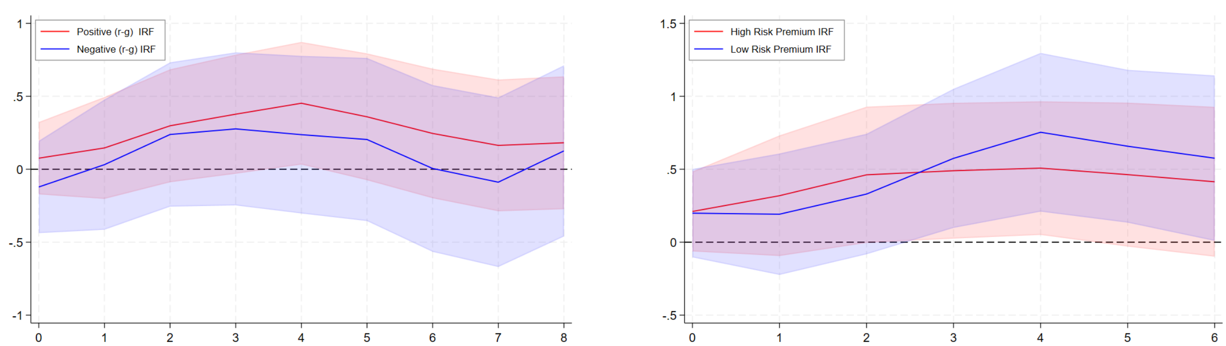
where high (low) financial-stress regimes are defined as years in which the sovereign risk premium is above (below) its 75th percentile.

The corresponding impulse responses are reported in Figure 3 using 90% confidence intervals. Figure 6 reproduces estimates using 95% confidence intervals as a robustness check. The response remains statistically significant around horizon four when $(r-g) > 0$. Consistent with the baseline results, fiscal adjustment remains more gradual under favorable financing conditions than when financing conditions are tighter.

Figure 6: State-dependent fiscal responses to debt-service shocks (95% confidence intervals)

(a) Snowball regimes

(b) Risk-premium regimes



Notes: The figure reports state-dependent local projection impulse responses of the primary surplus to a debt-service shock (Jordà, 2005). Panel (a) splits the sample according to the interest-growth differential, with high-$(r-g)$ periods defined as years above the 25th percentile of the distribution. Panel (b) distinguishes periods of low and high sovereign risk premia, where high-risk periods correspond to observations above the 75th percentile. Shaded areas represent 95% confidence intervals. This figure corresponds to Figure 3 in the main text, which reports 90% confidence intervals.

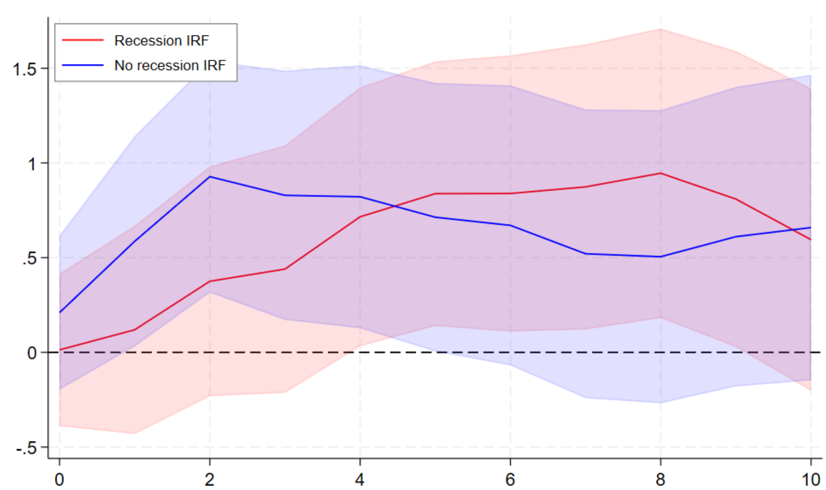
Business-cycle regimes As an additional robustness exercise, we estimate local projections separately across recession and non-recession years over the period 1928–2023, for which NBER recession data are available:

$$\begin{aligned} \log PS_{t+h} =& \alpha_h + \xi_h \log PS_{t-1} + \gamma_R^h \left[\mathbf{1}\{Rec_t = 1\} \times \log Service_t\right] \\ &+ \gamma_N^h \left[\mathbf{1}\{Rec_t = 0\} \times \log Service_t\right] + X_{t-1}' \nu_h + \varepsilon_{t+h}, \end{aligned} \tag{13}$$

where Rec_t is an indicator variable equal to one during NBER recession years and zero otherwise. NBER recessions correspond to official U.S. business-cycle turning points identified by the NBER based on a broad set of macroeconomic indicators, including output, employment, income, and industrial production.

Figure 7 suggests that fiscal adjustment following debt-service shocks is delayed during recessions relative to non-recession periods. Outside recessions, the primary surplus reacts more rapidly, with the response becoming significant after roughly two years. By contrast, during NBER recession periods, the adjustment materializes more gradually and peaks at longer horizons. This pattern is consistent with the countercyclical role of fiscal policy: during downturns, governments may postpone fiscal consolidation in order to stabilize economic activity, whereas adjustment becomes easier to implement once macroeconomic conditions improve.

Figure 7: State-dependent fiscal responses during recessions and expansions



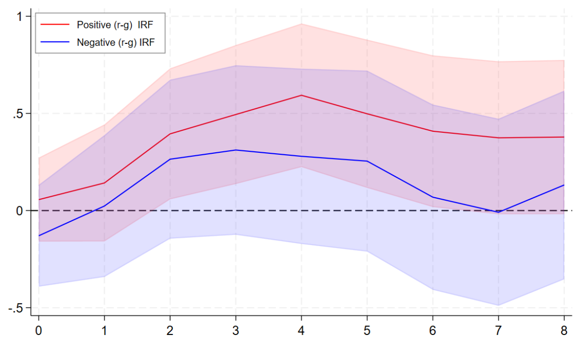
Notes: The figure reports state-dependent local projection impulse responses of the primary surplus to a debt-service shock over the period 1928–2023. The recession indicator equals one during NBER recession years and zero otherwise. Controls include lagged debt, inflation, and the output gap. Shaded areas represent 95% confidence intervals.

Robustness to an Augmented Lag Specification We re-estimate the state-dependent local projections using a more flexible dynamic specification that augments the baseline model with a second lag of the dependent variable and all control variables. Whereas the baseline specification includes one lag of these variables, the augmented specification additionally controls for their second lag. This robustness exercise follows the recommendations of Montiel Olea and Plagborg-Møller (2021), who emphasize the importance of adequately controlling for lag dynamics in local projection models to improve finite-sample inference.

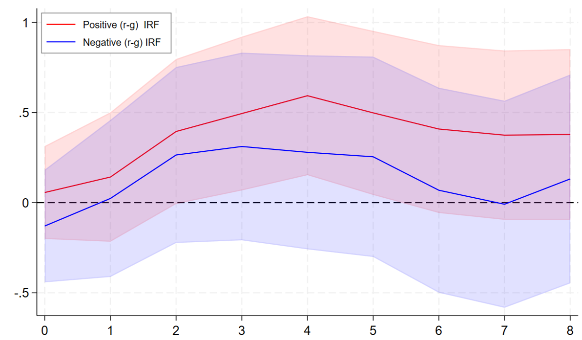
Figure 8 shows that the impulse responses remain qualitatively unchanged. The magnitude and timing of the responses closely match the baseline estimates across all state-dependent specifications, including Snowball and risk-premium regimes (Figures 3-6) as well as recession regimes (Figure 7), with only a slight loss of precision reflecting the inclusion of additional lagged regressors. Overall, the results indicate that our findings are not driven by the particular lag specification adopted in the baseline model.

Figure 8: Lag-augmented State-dependent fiscal responses to debt service shocks

Snowball regimes

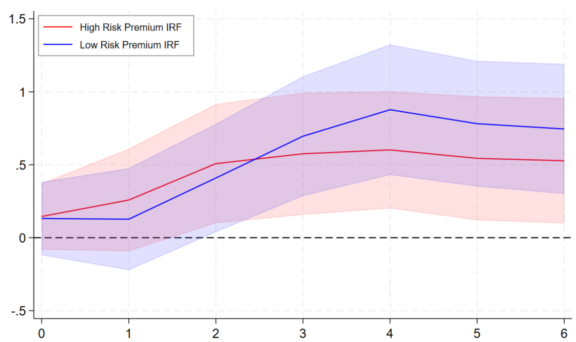


(a) 90% confidence intervals

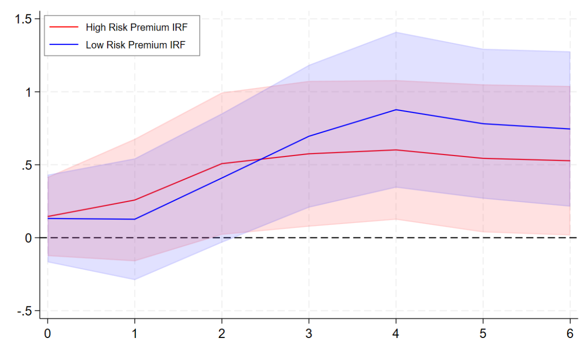


(b) 95% confidence intervals

Risk premium regimes

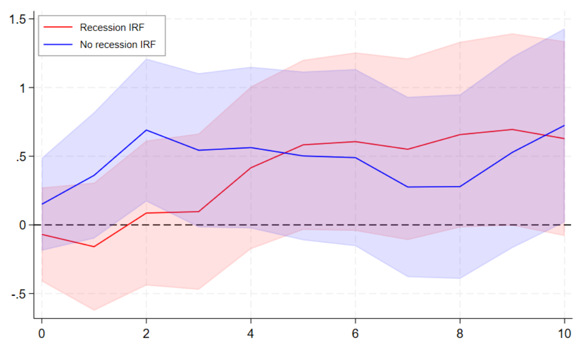


(c) 90% confidence intervals

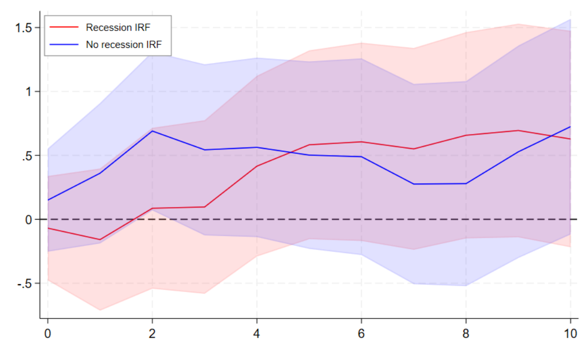


(d) 95% confidence intervals

Recessions



(e) 90% confidence intervals



(f) 95% confidence intervals

Notes: The figure reports lag augmented state-dependent local projection impulse responses of the primary surplus to a debt-service shock. Panels (a) and (b) split the sample according to the interest-growth differential, with high-$(r-g)$ periods defined as years above the 25th percentile of the distribution. Panels (c) and (d) distinguish periods of low and high sovereign risk premia, where high-risk periods correspond to observations above the 75th percentile. Panels (e) and (f), the recession indicator equals one during NBER recession years and zero otherwise over the period 1928–2023. Shaded areas represent confidence intervals. In these specifications, the lagged primary surplus and all control variables (debt, inflation, and the output gap) include an additional lag relative to the specifications reported in Figures 3-6-7.

C.3 Time-Varying Responses

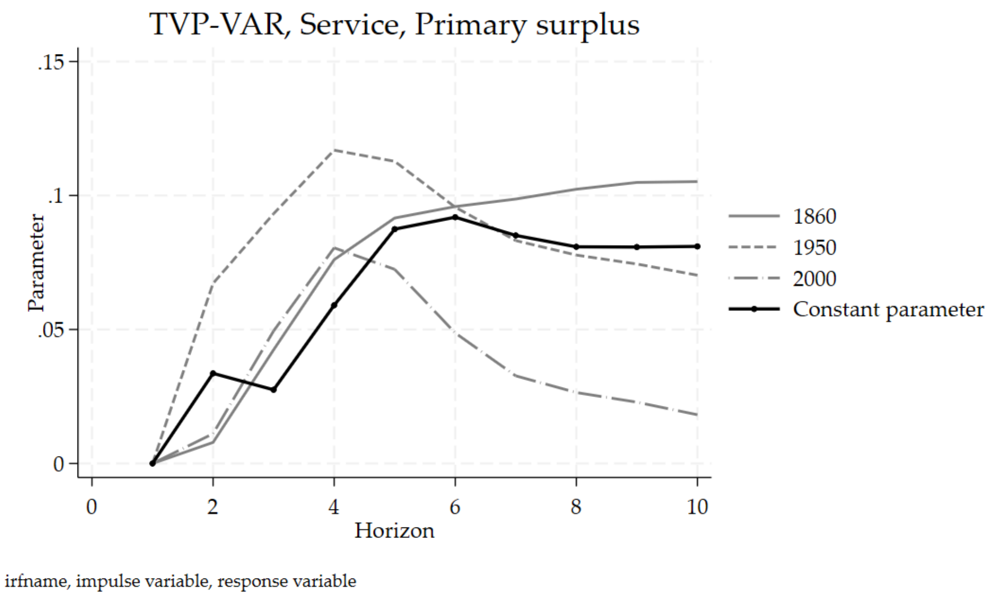
As an additional robustness exercise, we estimate a time-varying parameter VAR following Primiceri (2005). The objective is not to provide a separate identification strategy, but to assess whether the dynamic response of the primary surplus to debt-service shocks varies over the long historical sample.

The specification allows the autoregressive coefficients to evolve over time:

$$Y_t = \sum_{p=1}^{2} A_{p,t} Y_{t-p} + u_t, \tag{14}$$

where Y_t includes the primary surplus, the debt-service ratio, and the output gap.

Figure 9: Time-varying fiscal response to debt-service shocks



Notes: The figure reports time-varying impulse responses of the primary surplus to a debt-service shock estimated from a TVP-VAR following Primiceri (2005).

Figure 9 shows that the response of the primary surplus to debt-service shocks is consistently positive but varies in persistence and magnitude over time. Relative to the constant-parameter specification, fiscal responses are stronger and more persistent around the post-war period, particularly for the 1950 specification, where the response peaks between four and six years after the shock. By contrast, the response becomes substantially weaker in the more recent period represented by the 2000 specification, where the adjustment declines more rapidly after the initial response. The earlier historical regime (1860) instead displays a more gradual but persistent adjustment profile. These patterns suggest that fiscal responses to debt-service pressures evolved with long-run changes in U.S. fiscal institutions and financing conditions.

D Cross-country evidence

This appendix reports additional robustness checks and long-run panel evidence for the cross-country analysis. We first examine the stability of the baseline results across alternative panel estimators accounting for serial correlation and cross-sectional dependence. We then complement the baseline fiscal reaction framework with Mean Group estimators and cointegration analysis to study long-run fiscal responsiveness to debt-service pressures under heterogeneous country dynamics.

D.1 Alternative estimators

We examine the robustness of the panel results to alternative estimation strategies accounting for heteroskedasticity, serial correlation, and cross-sectional dependence. Tables 12 and 13 report fixed-effects panel-corrected estimates and AR(1)-corrected panel specifications respectively.

Across estimators, the main result remains unchanged. Once debt-service costs are introduced, the coefficient on debt becomes insignificant, whereas the coefficient on debt-service is positive and significant (col. 2, 1', 2'). Quantitatively, the estimated elasticity of the primary surplus with respect to debt service ranges from 0.14 to 0.24 across specifications.

The interaction specifications also confirm that fiscal adjustment strengthens when financing conditions deteriorate. In both FE panel-corrected and AR(1)-corrected specifications, the interaction between debt service and the Snowball regime ($r > g$) remains positive and statistically significant, whereas debt stocks themselves remain insignificant once financing pressures are taken into account (col. 3, 4'). These results reinforce the interpretation that fiscal adjustment responds primarily to realized financing pressures rather than to debt accumulation itself.

Table 12: Robustness – FE Panel-corrected estimates of primary surplus

	(1)	(2)	(3)
Dependent variable:	Primary surplus		
Primary surplus$_{t-1}$	0.808***	0.798***	0.780***
	(0.015)	(0.015)	(0.017)
Debt	0.116***	-0.096	0.002
	(0.028)	(0.059)	(0.082)
Service		0.236***	0.123
		(0.058)	(0.078)
Service $\times$ Snowball			0.090*
			(0.051)
Snowball			-0.043
			(0.064)
Output gap$_{t-1}$	-0.009	-0.009	-0.004
	(0.017)	(0.017)	(0.021)
Observations	1 842	1 842	1 518
Country FE	X	X	X
Year FE	X	X	X

Notes: Numbers in parentheses are standard errors. All variables are in log. FE estimation corrects for heteroskedasticity and cross-sectional dependence. *, ** and *** denote significance at 10, 5 and 1 percent levels.

Table 13: Robustness – AR(1) Panel-corrected estimates of primary surplus

	(1')	(2')	(3')	(4')
Dependent variable:	Primary surplus			
Primary surplus$_{t-1}$	0.804***	0.787***	0.781***	0.770***
	(0.015)	(0.016)	(0.017)	(0.022)
Debt	-0.094	-0.054	-0.065	0.019
	(0.059)	(0.061)	(0.057)	(0.109)
Service	0.233***	0.137**		0.071
	(0.058)	(0.061)		(0.098)
Service$_{t-1}$			0.152***	
			(0.057)	
Service $\times$ Snowball				0.114*
				(0.063)
Snowball				-0.202**
				(0.084)
Output gap$_{t-1}$	-0.009	-0.006	-0.069***	-0.006
	(0.017)	(0.016)	(0.019)	(0.016)
Observations	1 842	1 842	1 842	1 518
Country FE	X	X	X	X
Year FE	X			
AR rho	-0.017	0.011	0.013	0.029

Notes: Numbers in parentheses are standard errors. All variables are in log. AR(1) refers to fixed-effects estimations with an AR(1) error structure. Specifications without year fixed effects control for major wars and the 2008 financial crisis using dummy variables. *, ** and *** denote significance at 10, 5 and 1 percent levels.

D.2 Long-run fiscal responsiveness: Mean Group evidence

The baseline panel specifications impose a common short-run fiscal response across countries. To account for potential heterogeneity in long-run fiscal behavior, we complement the analysis using Mean Group (MG) estimators, which allow long-run elasticities to differ across countries and historical periods.

We estimate an error-correction specification relating the primary surplus to debt-service costs and macroeconomic conditions:

$$\Delta \log PS_{i,t} = \phi_i \Big(\log PS_{i,t-1} - \theta_0 - \theta_{1i} \log Debt_{i,t-1} - \theta_{2i} \log Service_{i,t-1} - \theta_{3i} \log OutputGap_{i,t-1} \Big) - \delta_{1i} \Delta \log Debt_{i,t} - \delta_{2i} \Delta \log Service_{i,t} - \delta_{3i} \Delta \log OutputGap_{i,t} + \varepsilon_{i,t}, \tag{15}$$

where ϕ_i captures the speed of adjustment toward the long-run equilibrium relationship.

Before estimating the MG specifications, it is necessary to verify the existence of a cointegrating relationship among the variables considered. We test for the existence of a stable long-run relationship between the variables. Table 14 reports panel cointegration tests proposed by Pedroni, Kao, and Westerlund. Across all tests, the null hypothesis of no cointegration is strongly rejected, providing evidence of a stable long-run relationship among the variables included in the model. This finding is further confirmed by the subsequent Mean Group estimations, in which the error-correction term is negative, statistically significant, and bounded between 0 and -1. Such a coefficient indicates the existence of a long-run relationship.

Table 14: Panel Cointegration Tests

Test	**Statistic**	**p-value**	**Null rejected**
Kao test			
Modified Dickey–Fuller t	-18.921	0.000	Yes
Dickey–Fuller t	-9.465	0.000	Yes
Augmented Dickey–Fuller t	-9.024	0.000	Yes
Pedroni test			
Modified Phillips–Perron t	-14.553	0.000	Yes
Phillips–Perron t	-7.799	0.000	Yes
Augmented Dickey–Fuller t	-7.544	0.000	Yes
Westerlund test			
Variance ratio	-3.342	0.000	Yes

Notes: The table reports panel cointegration tests for the primary surplus, debt-service costs, debt, and the output gap. The null hypothesis is the absence of cointegration. Pedroni and Westerlund tests allow for heterogeneous cointegrating relationships across countries, whereas the Kao test assumes a common cointegrating vector. Lag selection is based on the Bayesian Information Criterion (BIC). Bartlett kernels and Newey–West bandwidth corrections are applied where appropriate.

Table 15 reports country-specific long-run elasticities of the primary surplus with respect to debt-service costs over the periods 1800–2023 and 1913–2023. The results reveal substantial heterogeneity across countries and historical periods. Some countries—notably Canada, Spain, and, in the modern period, the United Kingdom—display long-run elasticities above unity, consistent with sufficiently strong fiscal responsiveness to stabilize debt-service pressures over time. Other countries exhibit positive but weaker fiscal responses.

More broadly, the MG estimates reinforce the paper's central mechanism. Even when allowing for substantial cross-country heterogeneity in long-run fiscal dynamics, fiscal adjustment remains associated with debt-service pressures rather than with debt stocks themselves.

Table 15: Long run elasticity estimates of debt service on primary surplus

	(1)	(2)	(3)	(4)
Dependent variable : Primary surplus				
	1800-2023		1913-2023	
Country	Elasticity	Std. Errors	Elasticity	Std. Errors
Canada	1.074***	0.412	1.115***	0.322
Denmark	0.561*	0.317	0.432	0.377
France	1.072	1.282	0.998	1.107
Germany	0.683**	0.345	0.571*	0.306
Italy	1.758	1.735	1.350	1.450
Netherlands	0.870***	0.254	0.808***	0.258
Norway	0.725	0.684	0.455	0.774
Portugal	0.448	0.470	0.526	0.412
Spain	1.241*	0.055	1.758**	0.709
Sweden	-0.068	0.318	0.064	0.372
United Kingdom	1.176	0.819	3.103***	0.885
United States	0.842	0.238	0.882	1.193

Notes: The reported coefficients and standard errors are associated with the debt service. The set of explanatory variables include the dependent variable, debt, debt service and the output gap. All variables are in log and lagged by one year. *, ** and *** denote significance at 10, 5 and 1 percent levels.

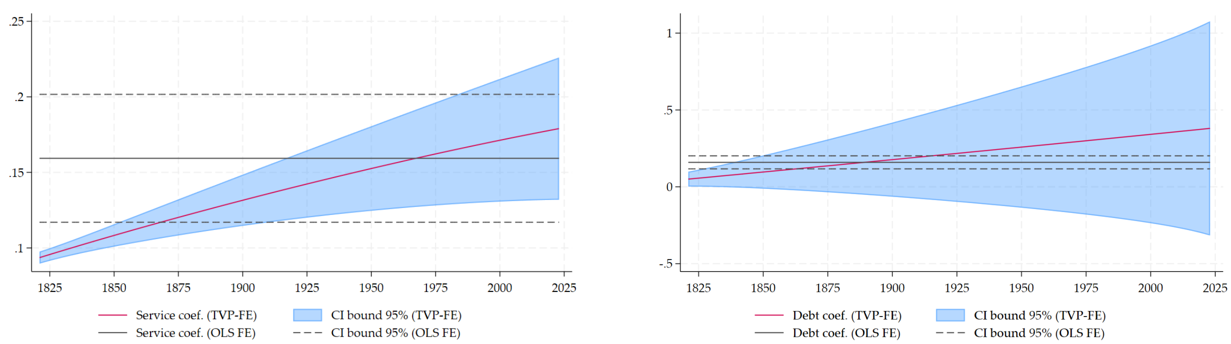
D.3 Time-varying fiscal responsiveness

To examine how fiscal responsiveness evolves over time, we estimate nonparametric time-varying coefficient models with fixed effects. This approach avoids imposing restrictive functional-form assumptions and therefore reduces the risk of inconsistent estimates arising from model misspecification in parametric panel settings (Li and Racine, 2007).

Figure 10.a shows that the estimated coefficients associated with debt servicing increase over time. The magnitude of the response doubles on average over the period, while the confidence interval bounds widen most dramatically after 1900. This is consistent with the heterogeneous dynamics of long-term elasticity between countries across to the two estimation periods observed in Table 15. In contrast, when we examine the evolution of the effect of debt on the primary surplus over time, it proves to be insignificant over the period (Figure 10.b.)

These results are consistent with the broader historical transformation emphasized in the paper. As sovereign financing systems deepened and debt markets expanded, governments were increasingly able to sustain large debt stocks under favorable financing conditions. Fiscal adjustment consequently became more closely tied to financing pressures than to debt accumulation itself.

Figure 10: Time-varying marginal effects on the primary surplus



(a) Debt-service

(b) Debt

Notes: TVP-FE refers to nonparametric time-varying coefficients with fixed effects estimated using a local linear dummy variable approach. OLS-FE corresponds to standard fixed-effects estimates with country and year fixed effects. In panel (a), the set of regressors includes lagged primary surplus, debt-service, and the output gap. In panel (b), debt-service is replaced by debt. All estimates are based on 50 bootstrap replications.