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Europe's Debt (Un)Sustainability: Looking Through Bohn's Magnifying Glass

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ABSTRACT: No large European countries and only few small ones have met the so-called Bohn rule during the past 40 years or so. The Bohn rule specifies that past increases of public debt need to be systematically compensated with current and future fiscal surpluses to stabilize debt at some steady-state level. We find that post-1980 European fiscal primary balances have been driven by spending growth and consumption smoothing. The results change little between periods before and after the global financial crisis.

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I. Introduction

We find no evidence of a debt-stabilizing mechanism in large European countries, and only in a few small ones. Even in the countries with stabilizing mechanisms, the estimated speed of adjustment toward sustainable public debt is very slow. It would take up to 20 years of primary balance surpluses to offset the debt shocks observed during the global financial crisis or the COVID pandemic. The fiscal balances in our sample countries are typically driven by cyclical spending growth and cyclical-smoothing objectives. We fail to find any statistically significant corrective mechanism of the risk premiums—countries whose government paper yields were much higher than those of Germany behaved the same way as countries with little or no premium. The shock of the global financial crisis does not seem to have affected the fiscal behavior of European countries either—the results change very little between the pre- and post-global financial crisis samples, or for countries with and without the euro. Finally, the introduction of the so-called fiscal Maastricht criteria or euro adoption/non-adoption did not seem to have any measurable effect on primary balances.

Thoroughly assessing all angles of fiscal sustainability is a complex exercise (International Monetary Fund 2021, Blanchard 2022). In contrast, the so-called Bohn rule is a simple, well-recognized relationship that ensures that public debt does not grow out of control. The rule specifies that past increases in public debt need to be compensated with future fiscal surpluses to stabilize debt at some steady-state level, in turn implying a mean-reverting behavior—stationarity—of public debt. Indeed, past efforts to stabilize debt through primary balance adjustments are a useful signal that governments may execute such policies in the future. Needless to say, stationarity of public debt is not the same as debt sustainability, with the latter being more appropriately assessed using the IMF framework that zeros in on the risk of sovereign stress by employing methodologies that enhance predictive power and provide a clearer understanding of sovereign debt risks.

The law of motion for debt dynamics is well known and the Bohn rule exploits its key relationship. The debt-to-GDP ratio moves autonomously given the interest rate-output growth rate differential—if the response of the primary balance to rising/declining debt is stronger than the differential, then the primary balance adjustment offsets the autonomous dynamics and the debt ratio converges to a finite, desired value. Such a relationship is testable as the required series are either readily available in most databases or can be easily calculated. Overall, however, the empirical evidence from the existing literature has been inconclusive. The empirical results differ country by country and by estimation technique, while choice of panel setup versus single-country estimation seems to play a role as well. In addition, issues exist with the estimation of nonstationary series that some past studies overlooked.

Past research followed Bohn (1998 and 2008) in regressing the cyclically-adjusted primary balance on the level of public debt, implicitly assuming that both variables are stationary, or I(0), variables.[1] Both assumptions would have to be satisfied in the *long term* as either financial markets or political processes would eventually ensure stationarity. Regarding the stationarity of primary balances, forever increasing primary deficits would run into financing constraints, while forever increasing primary surpluses would squeeze public-good provision. Regarding the stationarity of debt, forever increasing debt would violate the "no-Ponzi game condition", while permanently increasing negative debt would be politically inferior to cutting taxes. Unfortunately, neither

[1] Bohn (2008) advanced an argument that even if debt is nonstationary the regressions can be estimated in levels, as if stationary. All that is needed is that there is some finite degree of differencing at which the time series of the debt-to-GDP ratio becomes stationary, a condition that is always satisfied in the data.

stationarity assumption is automatically satisfied in the time horizon of a typical empirical study: most papers used post-WWII data and consistent multi-country databases with debt and fiscal series (Organisation for Economic Co-operation and Development [OECD] or IMF) often start only in 1980s or later. As we document in the paper, during the four decades from 1980 to 2022, debt is nonstationary, or I(1), in almost all countries and primary balance is nonstationary in one-half of them

Mixing of stationary and nonstationary variables results in a well-known triage of empirical problems: spurious regressions, inconsistent estimates, and incorrect inference.[2] In our view, it is of little use to rely on long-term stationarity properties if we know the observed series do not possess such properties. We thus follow a more appropriate approach of testing for stationarity, cointegration, and then estimating the Bohn rule in an error-correction framework, or estimating in first differences, if no cointegration vectors can be found.

Our results can be summarized as a rejection of the Bohn rule for most countries in our sample of European countries. Only in a handful of small countries do we find discretionary fiscal policy reacting to debt movements. The dominant drivers of fiscal balances were cyclical spending growth and smoothing of the business cycle. In addition, we fail to find any impact of (1) the risk premiums as countries facing high sovereign yields behaved broadly the same way as countries with low yields, (2) the introduction of the euro, or (3) the shock of the global financial crisis.

The paper is organized as follows. First, we introduce the Bohn rule and selectively survey the literature. Second, we present our 1980–2022 data sample and series' transformation for 26 European countries (and the United States) and analyze the stationarity properties of the series. Third, we outline our estimation strategy and summarize our results, including robustness checks. The final section concludes.

[2] Omnipresent residual autocorrelation—a sign that that the regression variables have unit root—was in Bohn-type regressions typically addressed either through the Cochran-Orcutt procedure or AR(1) estimation.

II. The Analytical Framework and Survey of the Literature

Assessing fiscal sustainability can be tedious, both quantitatively and judgmentally. The International Monetary Fund has divided the assessments into one focused on low-income countries and the other on countries with market access, each with different tools, benchmarks, fan charts, rule for informed judgment, and so on. To get the sense of the complexity of the task, the July 2022 guidance note for the market access countries runs 135 pages. All these analyses leave the reader wondering if there is a simpler way to approach the task initially. In our view, the Bohn rule can play this role.

A. Debt Dynamics

We start by restating the standard debt dynamics equation, which will help us to understand whether debt-to-GDP developments were due to discretionary fiscal actions, that is, cyclically-adjusted primary balances, or autonomous, non-discretionary factors, that is, the real interest rate to real growth differential, or stock-flow adjustments and contingent liability developments.

The standard debt dynamics equation expresses all variables in percent of GDP, except the interest rate, r, and the real rate of growth, g. The stock of debt today, b_t, is a composite result of three set of factors. First, the difference between government revenues and non-interest expenditure or the *primary balance*, s_t, adjusted for the business cycle. The primary balance is the only factor in the equation under control of the authorities, who make decisions about taxation and spending, subject to domestic policy considerations.

$$\Delta b_t = -s_t + \frac{(r-g)}{(1+g)} * b_{t-1} + z_t$$

Second, the debtor will pay *interest*, r, on debt accumulated in previous periods, $t-1$. Debt expressed in percent of GDP shrinks as the denominator grows at the rate of g. A negative $r-g$ differential ($r<g$), implies that the economy is growing faster than the interest accruing on the debt, which, everything else being equal, leads to a reduction in the debt-to-GDP ratio. Vice versa, for $r>g$, the current-period debt in percent of GDP will autonomously increase. In addition, if debt was contracted in foreign currency, depreciation of the exchange rate increases the stock of debt in domestic currency, and vice versa with appreciation of the domestic currency. These "autonomous" factors are not under control of the authorities.[3] Finally, *stock-flow adjustments*, that is changes in debt due privatization receipts, valuation changes, or accumulation of financial assets, and *contingent liabilities*, that is realization of government guarantees or bailouts of failing companies or banks, can increase debt without any corresponding change in the primary balance (International Monetary Fund, 2024). Again, these factors, z_t, are typically not under control of the fiscal authority.

[3] At least not perfectly. The authorities can at least temporarily lower their interest payments through various financial repression measures, keep the exchange rate overvalued, repudiate some debts, and so on (Reinhart, Kirkegaard, and Sbrancia 2011). Alternatively, the fiscal authority can time recording of some of the out-of-the budget items, a tool much used in the runup to the euro adoption (Koen van den Noord 2005.

B. The Bohn Rule

The Bohn rule follows from the distinction between discretionary and autonomous factors in the debt dynamics equation. Henning Bohn (1998) argued that in the long term today's increases in the debt-to-GDP ratio need to be offset by future *discretionary* fiscal consolidations to ensure that fiscal policy and public debt are viewed by the bond market as sustainable. The subsequent literature confirmed that a reasonably large response of the fiscal balance to past debt increases is indeed sufficient, if a "weak" condition for debt sustainability. The offset need not be contemporaneous or complete, as a full contemporaneous offset would presumably destabilize today's fiscal position even more (Blanchard 2022). What is needed to convince the bond market about fiscal sustainability is some evidence that the fiscal authorities have been, and thus will be, capable of extinguishing, either quickly or slowly, past debt increases. Indeed, successful past periods of fiscal consolidation often lasted decades (Balasundharam and others 2023).

The rule has been tested by regressing the cyclically-adjusted primary balance, s_t, on lagged public debt, b_{t-1}, with both variables expressed as the ratios to GDP. A positive and statistically significant relationship implies sustainable fiscal policy that ensures that debt does not explode but converges to some targeted, "steady-state" value. The estimated relationship has also typically included control variables that capture (1) the impact of the business cycle on the discretionary fiscal variable, measured by the output gap, x_t, and (2) the impact of transitory fiscal spending, measured by the deviations of real government spending from its trend, g_t:[4]

$$s_t = f(b_{t-1}, x_t, g_t) \quad (1)$$

Non-rejection of the null hypothesis of a statistically significant point estimate of the coefficient of the primary balance with respect to lagged debt implies that the Bohn rule holds. Either a negative or insignificant point estimate implies that the rule does not hold. The output gap and the growth of real expenditure are conditioning variables and have expected positive and expected negative signs, respectively.

It has been recognized that full assessment of fiscal sustainability is a more involved exercise than estimating a regression coefficient.[5] There is extensive literature based on different models (see Blanchard 2022 for a review). The current practice of debt sustainability assessment by the International Monetary Fund and the World Bank (Chalk and Hemming 2000, International Monetary Fund 2002, International Monetary Fund 2021) draws on a much richer set of assessments and cross-country comparisons. That said, the Bohn rule offers a simple-to-calculate and easy-to-compare measure of whether past discretionary fiscal actions stabilized debt or not.

C. A Selective Review of the Literature

The empirical literature testing equation (1) is vast, with most contributions covering either the U.S. or European Union countries. And it is surprisingly inconclusive, with the results varying with the sample periods,

[4] The Bohn rule and its components represent a typical fiscal policy reaction function (Plödt and Reicher 2015).

[5] Ghosh and others (2013) argued that a positive coefficient on the lagged debt cannot be viewed as *sufficient* to achieve fiscal sustainability if there is a political-economy limit for positive values of primary balances. Such limits can come about at very high debt levels or during financial market turmoil when the increase in the primary balance is not large enough to account for the exploding interest rate-growth differential.

sample countries, and empirical approaches to testing the rule. Our literature review is highly selective on purpose, and we suggest Table A.1 in Checherita-Westphal and Žďárek (2017) for a comprehensive review.

In our reading of the dozens of empirical papers, we split the literature findings along three dimensions. First, the sample period: papers that employed debt series up to or beyond the global financial crisis tend to find either a positive, but insignificant, or negative parameter on lagged debt. Second, panel regressions were employed more frequently than single-country regressions. The stability of the debt parameter estimates in the panel was questionable, however, with only a handful of papers attempting to cross-check panel results against single-country results. Third, the choice of the estimation technique does not seem to sway the results toward rejection or non-rejection of the rule. The techniques ranged from ordinary least squares regressions, including those with error-correction models and autoregressive distributed lags, to Bayesian time-varying coefficients, time-varying coefficients using the Kalman filter, and regime switching regressions.

The early contributions to the literature typically found U.S. debt sustainable from 1916 or even 1792 to 2000 (Bohn 1998, 2008). Subsequent papers, which included post-2000 data, generally failed to replicate Bohn's results (see for example Cassou, Shadmani, and Vázquez 2017 or Aldama and Creel 2019). Aldama and Creel addressed the statistical insignificance of the coefficient on lagged debt by estimating a Markov-switching rule, finding a few short "sustainable-regime" periods and a few longer "unsustainable-regime" periods. Similar papers exploring developments in Europe's high-debt countries are less sanguine about Bohn-type sustainability from the onset of the literature (Papadopoulos and Sidiropoulos 1999). Paniagua, Sapena, and Tamarit (2017) found similar parameter instability and regime-switching properties in a panel of 11 EU member countries. Collignon (2012) found that fiscal discipline was higher within euro-area countries than outside; however, the euro area governments responded to the deficit target rather than to debt developments. The impact of the so-called Maastricht criterion of a 60-percent debt ceiling (Buti and Gaspar 2021) was found to be statistically insignificant in virtually all papers that tested its impact.

Empirical estimates of emerging and low-income countries are far fewer, given data limitations. Some of the largest samples were constructed by IMF economists, however. Mendoza and Ostry (2008) tested the Bohn rule for 22 industrial and 34 emerging economies for 1990–2005, finding that emerging economies showed a stronger response of primary surplus to debt than did industrial economies. Overall, they did not find evidence supporting a positive response of primary balance to public debt increases beyond certain thresholds for industrial economies. An earlier World Economic Outlook chapter (International Monetary Fund 2003) had findings broadly similar to those of Mendoza and Ostry. Mauro and others (2013) compiled in a large data set covering up to two centuries of data and 55 countries, finding that the relationship between the primary balance and lagged public debt varies significantly over time within individual countries. One of their key conclusions is that countries grew less fiscally prudent in recent decades as compared to the previous periods.

III. Data and Stationarity Tests

A. Data Sources

In this section we introduce our dataset and explore the basic bi-variate relationships. In particular, we are interested in debt clusters, and any visible links between debt and the $r - g$ differential or between debt and the country-specific risk premiums vis-à-vis German sovereign yields.

Our sample is an unbalanced dataset of 26 European countries that are all OECD members, thus ensuring consistency of general government data coverage (see Table 1 and Annex I for country-specific time series). In addition, we include the United States in our analysis as the most tested country in the literature. Our primary source is the 1980–2022 annual dataset from the IMF World Economic Outlook (WEO), April 2024 vintage for fiscal balances, government spending, and real GDP for all European countries; for the United States (US), we use the Bureau of Economic Analysis for government expenditure and receipts to calculate the primary balance. The public debt ratios are sourced from the IMF Global Debt Database, April 2024 vintage.[6] While the WEO data are generally available from 1980, for the former transition economies, which joined the European Union during the 2000s as the so-called new EU member states, the series started only in the mid-1990s.[7]

The sample is predictably diverse, reflecting different political environments, fiscal policies, and initial debt conditions. While most sample countries ran negative cyclically-adjusted primary balances during the COVID period and immediately prior to it (2018–2022), these discretionary deficits were very large in the Baltics and in Slovenia and Slovakia. In contrast, the Nordic countries (Denmark, Norway, and Sweden) and Germany, Netherlands, and Luxemburg recently recorded either balanced primary budgets or even small surpluses. Moreover, the size of the government has been steadily increasing—all sample countries posted positive average growth of real fiscal spending.

The national gross debt levels differed dramatically, hidden behind the sample average of about 65 percent for 2018–2022 (Figure 1). On the low end, the Baltic and Nordic countries and Switzerland averaged debt at or below 40 percent of GDP. Of the new member states, only Slovenia and Hungary have recorded debt marginally above the sample average. On the high end, countries like Portugal, Italy, and Greece averaged debt at double or triple the European average. The averages as well as regression results changed only marginally when we shortened the sample to pre-COVID years, up to 2019. This is not entirely surprising—the COVID-related debt increases in 2020-2021 were partly offset by unexpected inflation in 2021-2022 that increased the denominator in the debt-to-GDP ratio (see country-specific series in Figure A1.4).

[6] See https://www.imf.org/external/datamapper/datasets/GDD.

[7] For information on EU enlargement see https://neighbourhood-enlargement.ec.europa.eu/enlargement-policy/6-27-members_en.

Table 1. Sample Countries and Their Characteristics

Country	ISO code	Sample period	Average Real GDP per Capita, 2018–2022[1]	Average Cyclically-Adjusted Primary Balance, 2018–2022[2] (- indicates a deficit)	Average Gross Debt-to-GDP Ratio, 2018–2022[3]
Austria	AUT	1988 – 2022	54,932	-2.31	77.5
Belgium	BEL	1980 – 2022	51,862	-2.47	104.8
Czechia	CZE	1995 – 2022	40,264	-1.94	36.8
Denmark	DNK	1980 – 2022	57,720	2.25	35.2
Estonia	EST	1995 – 2022	36,722	-1.98	14.0
Finland	FIN	1980 – 2022	48,403	-2.11	70.4
France	FRA	1980 – 2022	55,647	-3.61	107.0
Germany	DEU	1991 – 2022	53,595	-0.78	64.7
Greece	GRC	1988 – 2022	29,292	-0.97	193.3
Hungary	HUN	1995 – 2022	33,132	-2.79	71.8
Iceland	ISL	1980 – 2022	56,236	-1.90	70.4
Ireland	IRL	1980 – 2022	95,996	0.25	55.8
Italy	ITA	1988 – 2022	42,375	-2.55	143.6
Latvia	LVA	1998 – 2022	30,886	-2.02	40.4
Lithuania	LTU	1995 – 2022	37,937	-0.85	39.9
Luxembourg	LUX	1995 – 2022	117,205	0.19	23.3
Netherlands	NLD	1995 – 2022	57,217	0.00	51.3
Norway	NOR	1980 – 2022	64,078	7.84	41.7
Poland	POL	1995 – 2022	33,931	-1.29	51.0
Portugal	PRT	1980 – 2022	34,244	0.83	122.9
Slovakia	SVK	1995 – 2022	32,865	-2.08	55.5
Slovenia	SVN	1995 – 2022	39,335	-1.35	71.9
Spain	ESP	1980 – 2022	39,236	-3.22	109.9
Sweden	SWE	1980 – 2022	53,784	-0.05	36.4
Switzerland	CHE	1980 – 2022	70,875	0.23	40.7
United Kingdom	GBR	1980 – 2022	45,699	-3.98	96.9
United States	USA	1980 – 2022	63,132	-5.31	119.5

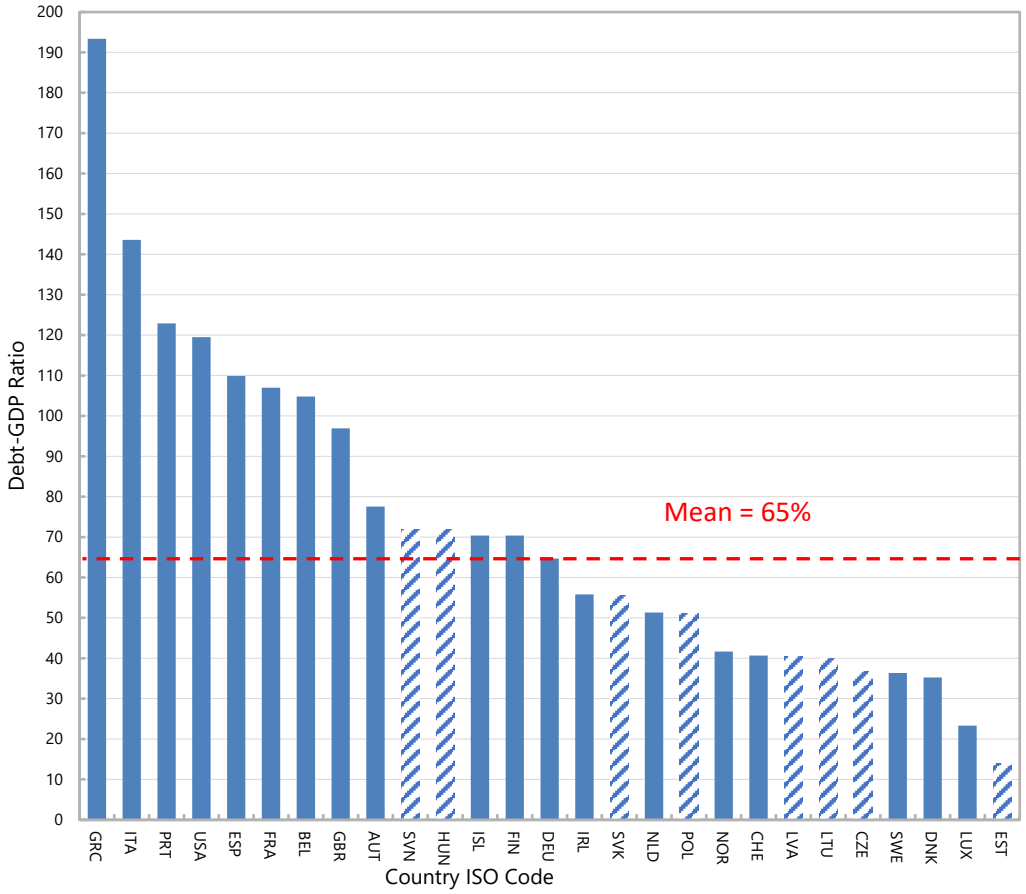
Source: IMF, World Economic Outlook Database, April 2024.

[1] GDP per capita is measured in purchasing power parity, 2017 international US dollars.

[2] Headline primary balance of the general government *minus* automatic stabilizers. In percent of potential GDP.

[3] In percent of GDP.

Figure 1. Public Debt, 2018 – 2022
(Percent of GDP)



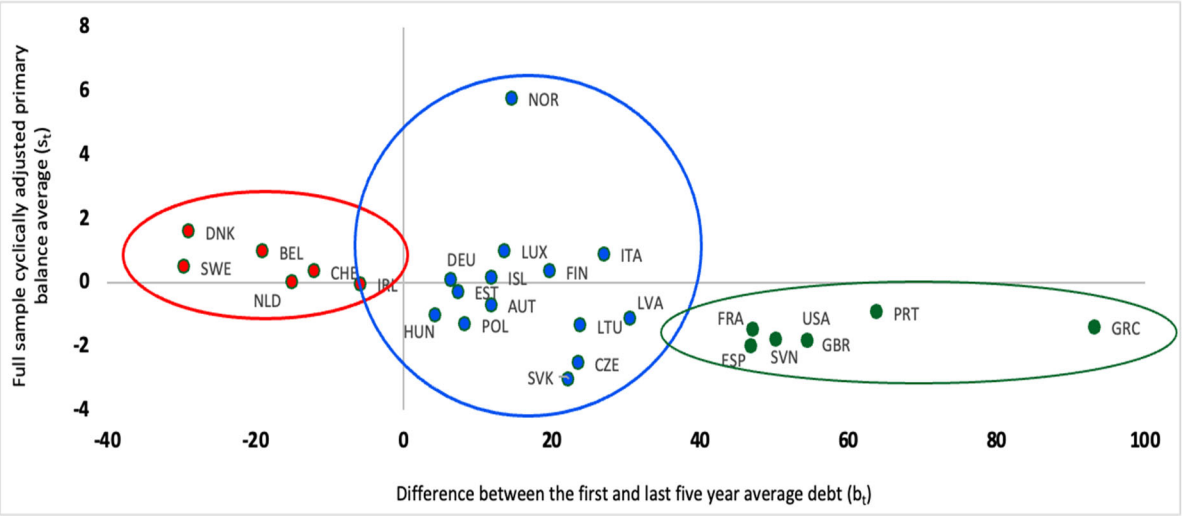
Source: IMF Global Debt Database, April 2024.
Notes: The mean of the 2018–2022 debt-to-GDP ratios. The patterned columns represent the new EU member states, that joined EU in 2007 and later.

The sample neatly breaks down into three clusters in the debt-to-primary-balance space (Figure 2). The first cluster (in red) contains countries that lowered their debt-to-GDP ratios between 2018–2022 and the average of 1995–1999, on average by 20 percentage points. These are Nordic countries, Belgium, Ireland, and Netherlands and they ran either surpluses or balanced budgets on average, so these were discretionary debt stabilizations toward some latent steady-state level of public debt, from Figure A1.4 presumably around 40-to-50 percent of GDP (except Belgium). We will explore later whether these countries satisfied the properties of the Bohn rule.

The largest cluster (in blue) contains countries where the debt level increased modestly, on average by about 15 percent. This group is evenly split between countries that ran primary surpluses, for example, Italy, and those with primary deficits, for example, Slovakia. Norway, the only commodity exporter in the sample, is an outlier, as the increase in gross debt was offset by accumulation of public assets. The final cluster—where the debt levels increased on average by about 60 percent—contains France, Greece, Slovenia, Spain, Portugal, but also the United Kingdom (UK) and the US. All six countries ran on average primary deficits on average

during the 20-year period from 2000, so this was again a discretionary policy choice. Averages often hide major policy shifts, however. For example, Portugal ran cyclically-adjusted primary surpluses since 2012, decreasing its debt-to-GDP ratio by some 15 percentage points during this period, albeit still having debt twice its 1990s level.

Figure 2. Discretionary Fiscal Policy and Public Debt



Source: Authors' calculations; World Economic Outlook Database April 2024 and Global Debt Database April 2024.
Notes: The chart shows (1) the sample average of cyclically-adjusted primary balances for each country on the vertical axis as a measure of discretionary fiscal policy and (2) the change in the public debt-to-GDP ratio between the average of the last five years (2018–2022) and the average of 1995 - 1999. The red, blue, and green ovals denote groupings identified by cluster analysis.

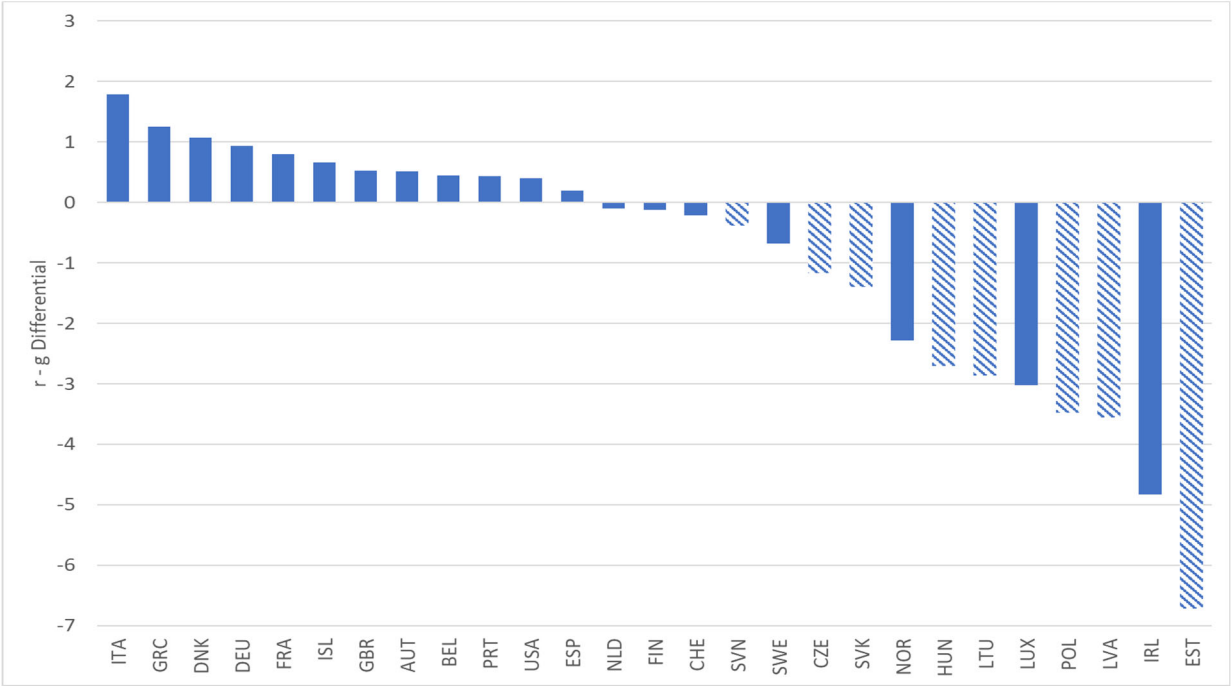
If the real interest rates are low (or real growth is high), the $r < g$ differential will ensure an autonomous decline in debt. Some economists have argued that sustained low interest rates make debt accumulation practically a free lunch, as negative $r - g$ differentials allow more expansionary fiscal policies without debt service repercussions (Blanchard 2022). However, we find limited evidence of a free-lunch scenario for most countries in our sample (Figure 3). We measure the nominal rates as "effective" yields by dividing the general government interest payments in domestic currency by the previous-year stock of debt in domestic currency times 100. This is a superior measure than the short-term policy interest rates or primary-market sovereign yields: what interest governments effectively pay on their past borrowings is often very different from the current-period yields, especially when most debt is in long bonds or accumulated on concessional terms.

All new EU member states (the former transition economies), and several other, mostly small countries, recorded very large negative $r - g$ differentials, some of them to the tune of 2 to 4 percentage points. The low r's in these countries reflected, among other things, sizable concessional borrowing from European lenders in the 1990s and early 2000s, before their EU accession.[8] Countries like Greece or Portugal benefitted from their

[8] For example, the effective *real* interest rate during 1996–2005 was 1.9 percent in Czechia and 3.0 percent in Slovenia, both then classified as transition countries, despite having comparatively high expected inflation and presumably higher sovereign risk than countries already in the EU. In contrast, during the same period, France paid a 4.2 percent effective real rate, Belgium paid 4.3 percent, and Germany paid 4.6 percent!

post-global-financial-crisis bailouts. In contrast, the differentials were positive and larger than one percentage point for Italy, Denmark, Belgium, the US, Finland, France, and UK. The differential was positive, if small, even in Germany, considered as the most fiscally conservative country in Europe. In summary, no free lunch in large, advanced countries: none of them, except perhaps Netherlands and Spain, benefitted from an autonomous decline in debt driven by a negative $r - g$ differential.

Figure 3. The "*r - g*" Differential
(Percent)

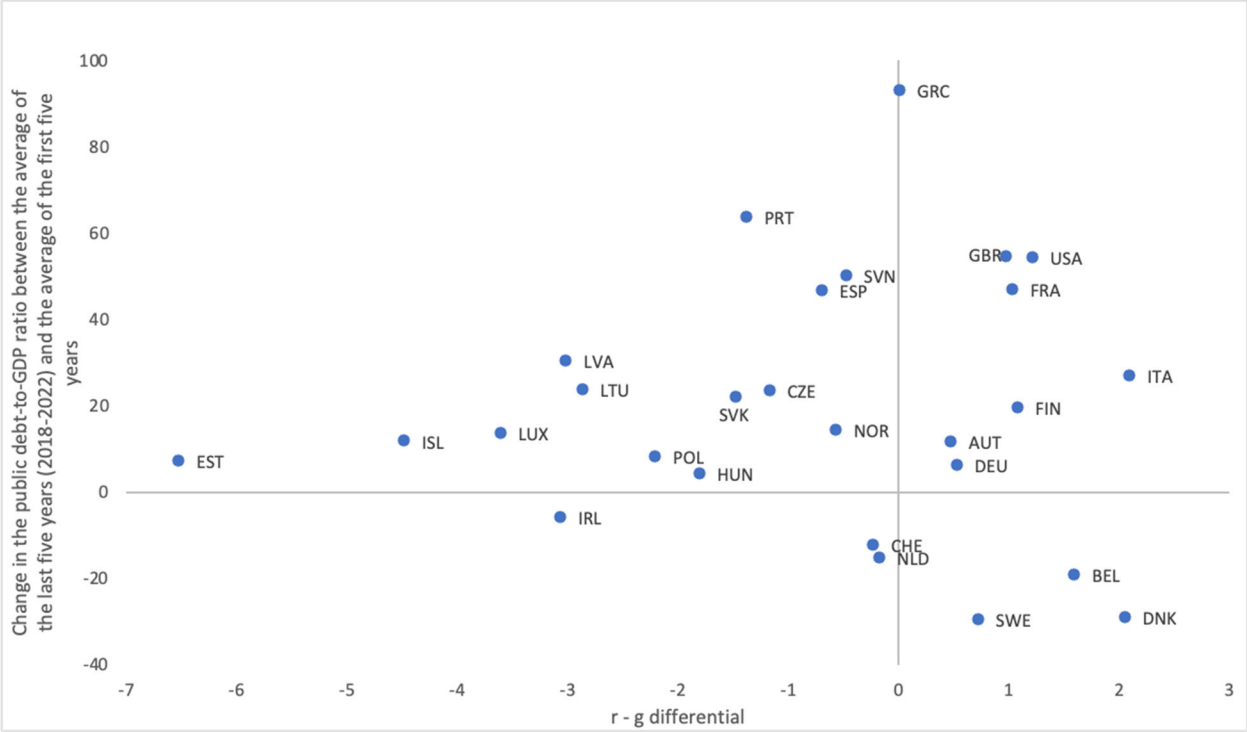


Source: World Economic Outlook Database April 2024 and Global Debt Database April 2024; own calculations.

Notes: The chart shows the difference between the average effective interest rate that a government paid on its debt (r) in percent and the growth rate of the economy (g) in percent. The interest rate on public debt is calculated as an "effective" rate: we divide the general government interest payments in domestic currency by the previous-year stock of debt *times* 100. Unbalanced sample, with series starting whenever available and ending in 2022.

The free-lunch argument implies that countries with negative $r - g$ differentials would be better off with more public spending (or lower taxes) and larger debts, while countries with positive $r - g$ differentials should curtail their spending and lower their debt-to-GDP ratios. We do not find such an inverse relationship between the differential and change in debt in our sample (Figure 4). On the one hand, most countries with $r - g < -1$ (Estonia to Czechia) increased their debt only marginally, on average by about 10 percentage points. On the other hand, many countries with positive $r - g$ differentials borrowed more, some doubling (U.K.) or even quadrupling (France) their debt-to-GDP ratios. Only in Belgium, Denmark, and Sweden the long-run positive differential was associated with lower debt.

Figure 4: Change in Debt and the "*r - g*" Differential



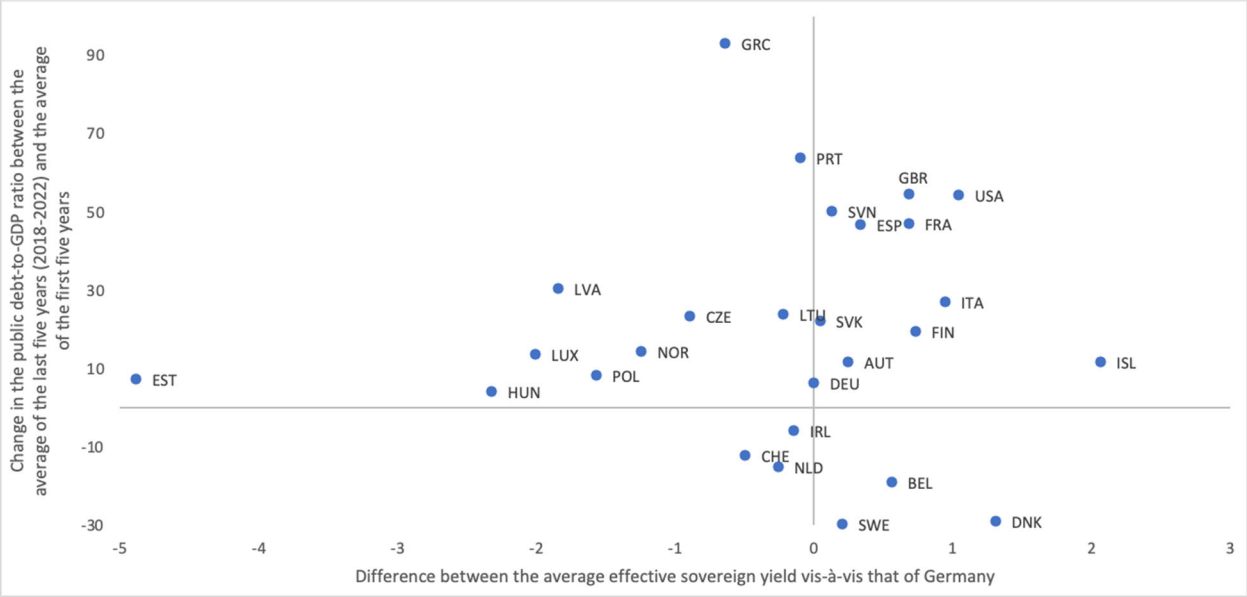
Source: World Economic Outlook Database and Global Debt Database; own calculations.

Notes: The chart plots the change in the public debt-to-GDP ratio between the average of the last five years (2018–2022) and the average of the first five years (country-specific years) on the vertical axis against the full-sample $r - g$ differential on the horizontal axis.

Finally, we do not see much evidence that bond market pressure disciplined fiscal behavior and debt accumulation. To this end we compute the difference between the average effective interest paid on public debt vis-à-vis that of Germany and plot such estimates against our sample period debt change (Figure 5). The correlation coefficient is close to zero—nobody seemed to be permanently intimidated by the bond market, except for Belgium, Denmark, and Sweden, countries in the bottom right corner of Figure 5.[9] The results are similar when plotting the risk premium against the country primary balances, again yielding zero correlation. We find the difference in effective interest paid on public debt more informative than the instantaneous spread in sovereign yields that is frequently used as a risk-premium indicator. Intuitively, only a small fraction of public debt is rolled over every month and on market terms and short-lived spikes in spreads need not have lasting impact on sovereign's behavior.

[9] Bill Clinton political adviser James Carville famously quipped: "I used to think that if there was reincarnation, I wanted to come back as the president or the pope or as a .400 baseball hitter. *But now I would like to come back as the bond market. You can intimidate everybody*."

Figure 5. Change in Debt and the Interest Rate Differential vis-à-vis Germany



Source: World Economic Outlook Database and Global Debt Database; own calculations.

Notes: The chart plots the change in the public debt-to-GDP ratio between the average of the last five years (2018–2022) and the average of the first five years (country-specific years) on the vertical axis against the difference between the average effective interest rate vis-à-vis that of Germany on the horizontal axis.

In summary, the bivariate relationships outlined above do not point to any easy-to-spot explanations of why the debt-to-GDP ratios have been increasing in the majority of our sample countries. We will next explore these links in multivariate regressions in Section IV.

B. Data Transformations

Our dataset contains four variables typically included in the testing of the Bohn rule: the cyclically-adjusted primary fiscal balance (s_t), public debt (b_t), cyclical primary government spending (g_t), and a measure of the cyclical position of the economy (x_t). We will discuss the relevant transformations in turn. All data are in annual frequency, with all but two countries reporting on the calendar year basis. The UK and US data are reported on the fiscal year basis, however, and we recreate the calendar year figures by computing a weighted average of the two fiscal years.[10]

First, we start by describing the calculation of the cyclical position, which is used both as an explanatory variable itself and used in the calculation of the cyclically-adjusted primary fiscal balance. The cyclical position is measured by the *output gap,* x_t, expressed in percent of potential real gross domestic product, Y_t^*, calculated as the difference between the actual GDP, Y_t, and the potential real GDP, Y_t^*:

[10] If a fiscal year runs from May 1 of calendar year 1 to April 30 of calendar year 2, then the calendar year estimate would be calculated as the fiscal year of year 1 times 8/12 plus the fiscal year of year 2 times 4/12.

$$x_t = \left[\frac{(Y - Y^*)}{Y^*}\right] * 100, \quad (2)$$

where potential GDP is calculated using the Hodrick-Prescott filter with λ = 100. Comparing our estimates of the output gap with those published in the IMF April 2024 *World Economic Outlook*, we find that these closely resemble the published series for most of the countries since the late 1990s (Annex 1). For a handful of countries, the IMF teams occasionally estimated slightly different values for output gaps, however, the turning points in the business cycle were identical.

Second, the discretionary fiscal balance of the general government employed is the *cyclically-adjusted primary fiscal balance*. We proceed as follows: (1) convert the primary revenue and primary expenditure series (excluding any interest receipts and payments) into logs; (2) calculate the cyclically-adjusted primary revenues and expenditures; and (3) subtract cyclically-adjusted expenditures from adjusted revenues to obtain the cyclically-adjusted primary balance. Such a balance measures the discretionary fiscal position of the general government as the remainder in the headline primary balance are the automatic stabilizers.

The cyclical adjustment follows the so-called OECD approach:

$$\tilde{\tau} = \tau + (y^* - y)\varepsilon_{\tau,y} \text{ and } \tilde{g} = g + (y^* - y)\varepsilon_{g,y}\ , \quad (3)$$

where tilde denotes a cyclically-adjusted variable; τ and g stand for the logs of revenue and expenditure, respectively; $y^* - y$ denotes the log ratio of potential output to actual output; and $\varepsilon_{\tau,y}$ and $\varepsilon_{g,y}$ are the estimated elasticities of current primary revenue and government expenditures with respect to the output gap, respectively. Both country-specific elasticities are taken from Table 8 in Price, Dang, and Botev (2015).[11] Hence, $\tilde{\tau}$ measures the discretionary component of the fiscal balance and $\tau - \tilde{\tau}$ measures the automatic-stabilizer component of the fiscal balance.

Third, *general government debt* data are expressed as a percentage of GDP (Figure 2). Finally, $\tilde{g}_t$, the *cyclical real public spending*, is defined as the cyclical component of public spending. We calculate the series both using the OECD approach above ($(y^* - y)\varepsilon_{g,y}$) and as a "gap" using the Hodrick-Prescott filter, that is, subtracting the HP-filtered trend from the real spending series. Although the magnitude of these two series is different, they co-move.

C. Stationarity Tests

The stylized facts from the previous section and observing the individual country charts in Annex 1—increasing public debt and long periods of discretionary fiscal deficits—beg the question whether regressing the *level* of the primary deficit on the *level* of debt is appropriate. Bohn (1998) acknowledged that the debt time series may have unit roots but argued that as long as debt can be made stationary by differencing, the level regressions are appropriate. We beg to differ.

We ran extensive stationarity tests on all series in our sample (Table 2): the output gap (x_t), cyclically-adjusted government spending (g_t), cyclically-adjusted primary balance (s_t), and the public debt (b_t). For robustness, we

[11] Note that the said table does not provide elasticities for Lithuania. Thus, we estimate them as the average of elasticities of Latvia and Estonia, its closest geographical neighbors.

ran both the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, the major difference between the two being the definition of the null hypothesis. The ADF test defines the null as presence of the unit-root, that is, the series to be nonstationary. The null for KPSS test stands for presence of stationarity. We test the series using two specifications: with only a constant term and with a constant and a trend term. The setup allows us to classify our series as (1) stationary (S), (2) nonstationary (NS), (3) trend stationary (TS), and (4) difference stationary (DS). The definitions are provided in Table 2, which shows results for stationarity in levels, and in Table 3, which shows results for series in first differences.

We find strong evidence that all sample debt series are nonstationary. Only two sample countries—Norway and Poland—have strictly stationary debt in levels (irrespective of the test specification). For more than two-thirds of the sample, debt was found to be strictly nonstationary, with five of the remaining being estimated as trend-stationary. The evidence for the primary balance is mixed: while in two-fifths of the sample we cannot reject the unit root presence, the series appear to be stationary for the rest of the countries. The nonstationary series were found to be integrated of order 1, I(1), as first-differencing the series removes the unit root (Table 3). Finally, the output gap and cyclical component of real spending are stationary in levels by definition, which is also corroborated by the test results.

D. Cointegration

Nonstationary data, characterized by varying mean and variance over time, pose significant challenges for time series analysis, particularly when some series have unit roots and others do not. In such a case, trends tend to give an impression of an illusory relationship. Cointegration offers a powerful solution to this problem: when two or more nonstationary series are cointegrated, it hints at a long-run equilibrium relationship, outside the fact that both share some trends. The shared equilibrium ensures that any deviation from this long-term path is temporary.

We test for the presence of long-run relationship between debt-to-GDP and cyclically-adjusted primary balance using the Johansen procedure, with the null hypothesis of no cointegrating equation (Table 4). The tests indicate that 17 countries exhibit some long-run relationships between the two nonstationary variables, s_t and b_t. Most are not statistically significant and almost ½ come with a negative sign, that is, an opposite to what is implied by debt sustainability. Table 4 shows the results for the cointegration regressions without deterministic terms; however, inclusion of a constant did not change the results materially.

Table 2. Country-Specific Stationarity Tests: Levels

Country	Cyclically-Adjusted Primary Balance (s_t)		Output Gap (x_t)		Cyclical Real Spending (g_t)		Debt to GDP (b_t)	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend
Austria	S	S	S	S	S	S	NS	TS
Belgium	TS	TS	S	S	S	S	TS	S
Czechia	S	S	S	S	S	S	NS	TS
Denmark	TS	TS	S	TS	S	TS	NS	S
Estonia	S	S	S	S	S	TS	NS	TS
Finland	S	TS	S	S	S	S	NS	TS
France	TS	S	S	S	S	TS	NS	TS
Germany	S	S	S	S	S	S	NS	TS
Greece	S	TS	TS	TS	S	TS	NS	TS
Hungary	TS	TS	TS	TS	S	TS	TS	TS
Iceland	S	S	S	S	S	S	NS	TS
Ireland	TS	TS	TS	TS	S	S	TS	TS
Italy	TS	TS	S	S	S	S	NS	TS
Latvia	S	S	S	TS	S	S	NS	TS
Lithuania	S	S	S	S	TS	TS	NS	TS
Luxembourg	S	S	S	S	S	S	NS	TS
Netherlands	S	S	S	S	S	S	TS	TS
Norway	TS	TS	S	S	S	S	S	TS
Poland	DS	S	S	S	S	TS	S	TS
Portugal	S	TS	S	S	S	S	NS	TS
Slovakia	S	TS	S	TS	S	S	NS	TS
Slovenia	S	S	S	TS	S	S	NS	TS
Spain	TS	TS	S	TS	S	S	NS	S
Sweden	S	S	S	TS	S	S	TS	TS
Switzerland	TS	TS	S	S	S	S	TS	TS
United Kingdom	TS	TS	S	S	S	TS	NS	TS
United States	S	S	S	S	S	S	NS	TS

Source: Authors' calculations.

Notes: The stationarity/nonstationarity assessment is based on the Augmented Dickey-Fuller (ADF) test and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) tests. Each test is run first with a regression that includes a constant and then replicated for a regression with a constant and a trend. Both tests are assessed at the 5 percent significance level. The following are the possible outcomes of applying the tests:
Case 1: Both tests indicate that the series is stationary → Stationarity (S)
Case 2: Both tests indicate that the given series is nonstationary → Nonstationarity (NS)
Case 3: ADF indicates nonstationarity and KPSS indicates stationarity → Trend stationarity (TS)
Case 4: ADF indicates stationarity and KPSS indicates nonstationarity → Difference stationarity (DS)

Table 3. Country-Specific Stationarity Tests: First Differences

Country	Cyclically-Adjusted Primary Balance (s_t)		Cyclical Real spending (g_t)		Debt to GDP (b_t)	
	Constant	Constant and trend	Constant	Constant and trend	Constant	Constant and trend
Austria	S	S	S	S	S	S
Belgium	S	S	S	S	S	S
Czechia	S	S	S	S	S	S
Denmark	S	S	S	S	S	S
Estonia	S	S	S	S	S	S
Finland	S	S	S	S	S	TS
France	S	S	S	S	S	S
Germany	DS	DS	S	S	S	S
Greece	S	S	S	S	S	S
Hungary	S	S	S	S	S	S
Iceland	S	S	S	S	S	S
Ireland	S	S	S	S	TS	TS
Italy	S	S	S	TS	S	S
Latvia	S	S	S	S	S	S
Lithuania	S	S	S	S	S	S
Luxembourg	S	S	S	S	S	S
Netherlands	S	S	S	S	S	S
Norway	S	S	S	S	S	S
Poland	DS	DS	S	S	S	S
Portugal	S	S	S	S	S	S
Slovakia	DS	DS	S	S	S	S
Slovenia	S	S	S	S	S	TS
Spain	S	S	S	S	S	S
Sweden	S	S	S	S	S	S
Switzerland	S	S	S	S	S	S
United Kingdom	S	S	S	S	S	S
United States	S	S	S	S	S	S

Source: Authors' calculations.

Notes: The stationarity/nonstationarity assessment is based on the Augmented Dickey-Fuller (ADF) test and Kwiatkowski-Phillips-Schmidt-Shin test (KPSS) tests. Each test is run first with a regression that includes a constant and then replicated for a regression with a constant and a trend. Both tests are assessed at the 5 percent significance level. The following are the possible outcomes of applying the tests:
Case 1: Both tests indicate that the series is stationary → Stationarity (S)
Case 2: Both tests indicate that the given series is nonstationary → Nonstationarity (NS)
Case 3: ADF indicates nonstationarity and KPSS indicates stationarity → Trend stationarity (TS)
Case 4: ADF indicates stationarity and KPSS indicates nonstationarity → Difference stationarity (DS)

Table 4. Johansen Cointegration Test: Number of Cointegrating Vectors (No deterministic terms)

Countries	Trace	Max-Eigenvalue	Normalized coefficient on b_t; Standard errors in parentheses
Austria	1	0	0.00 (0.01)
Belgium	0	0	
Czechia	0	0	
Denmark	1	1	-0.03 (0.01)
Estonia	1	1	0.05 (0.05)
Finland	0	0	
France	2	2	-0.01 (0.00)
Germany	1	1	-0.01 (0.00)
Greece	2	2	-0.02 (0.01)
Hungary	0	0	
Iceland	1	1	-0.01 (0.01)
Ireland	1	1	0.00 (0.01)
Italy	0	0	
Latvia	0	0	
Lithuania	0	0	
Luxembourg	1	1	-0.04 (0.03)
Netherlands	1	1	0.00 (0.00)
Norway	0	0	
Poland	0	0	
Portugal	1	1	0.00 (0.01)
Slovakia	0	0	
Slovenia	1	1	0.01 (0.01)
Spain	1	1	0.00 (0.01)
Sweden	1	1	-0.01 (0.01)
Switzerland	1	1	-0.01 (0.00)
United Kingdom	1	1	0.02 (0.01)
United States	1	1	0.00 (0.00)

Source: Authors' calculations.

Note: Both tests are assessed at the 5 percent significance level.

Based on the results of stationarity and cointegration tests, the sample of countries can be divided into three groups, and we can assign appropriate regression models that respect the properties of the series (Table 5).

Table 5. Country Groupings Based on Stationarity and Cointegration Tests of s_t and b_{t-1}

Group 1	Group 2	Group 3
Debt is I(1) and the primary balance is I(0). We thus regress s_t on Δb_{t-1}	Both variables are I(1) and cointegrated. We thus estimate an ECM: Δs_t on $\gamma(s_{t-1} - \alpha\Delta b_{t-2})$ and short-term dynamics	Both variables are I(1) and not cointegrated. We thus regress Δs_t on Δb_{t-1}
Austria Czechia Estonia Finland Germany Greece Iceland Latvia Lithuania Luxembourg Netherlands Poland Portugal Slovakia Slovenia Sweden United States	Denmark France Ireland Italy Spain Switzerland United Kingdom	Belgium Hungary Norway

Source: Authors' calculations.

IV. The Estimates of the Bohn Rule

A. Regression models

Our country-specific models are decided on the standard integration and cointegration criteria described above. The baseline specification is then estimated for the full sample period and as a robustness check we test for the presence of structural breaks for the parameter on the b_{t-1} variable. As it happens, the global financial crisis of 2008 (1) neatly splits the sample into two roughly equal halves and (2) separates the low-volatility period ("Great Moderation") from a much more volatile post-global-financial-crisis period.[12] Furthermore, it separates two distinctly different periods of ECB monetary policy. During 1999-2008 the end-of-period policy rate, that is, the deposit facility rate, averaged about 2 percent, declining to or near the zero lower bound for most of 2009-2022.[13] The regression models are as follows.

If debt is nonstationary and the primary balance is stationary, then we regress s_t on Δb_{t-1}. Thus, the baseline specification for Group 1 countries is: $s_t = \beta + \alpha_1 x_t + \alpha_2 g_t + \alpha_3 \Delta b_{t-1} + u_t$.

And with the time dummy variables:

$$s_t = \beta + \alpha_1 x_t + \alpha_2 g_t + \alpha_3\, d_1 * \Delta b_{t-1} \; + \; \alpha_4 d_2 * \Delta b_{t-1} \; + \; u_t,$$

where d_1 is 1 until 2008 and 0 afterward, d_2 is 0 until 2008 and 1 afterward.

If both variables are nonstationary and cointegrated, we then estimate an error-correction model (ECM) and regress Δs_t on $\gamma(s_{t-1} - \alpha \Delta b_{t-2})$, with two lags of I(0) variables to control for short-term dynamics. Thus, the baseline specification for Group 2 countries is:

$$\Delta s_t = \alpha_1 g_t + \alpha_2 g_{t-1} \; + \; \alpha_3 x_t \; + \alpha_4 x_{t-1} + \alpha_5 \Delta b_{t-1} + \alpha_6 \Delta b_{t-2} + \alpha_7 \Delta s_{t-1} + \alpha_8 [s_{t-1} - \alpha_9 (b_{t-2}) - \beta],$$

and the specification with time dummy variables:

$$\begin{aligned} \Delta s_t = {} & \alpha_1 g_t + \alpha_2 g_{t-1} \; + \; \alpha_3 x_t + \alpha_4 x_{t-1} + \alpha_5 \Delta b_{t-1} + \alpha_6 \Delta b_{t-2} + \alpha_7 \Delta s_{t-1} \\ & + \alpha_8 [s_{t-1} - \alpha_9 d_1 * (b_{t-2}) - \; \alpha_{10} d_2 * (b_{t-2}) \; - \beta] \end{aligned}$$

If both variables are nonstationary and are <u>not</u> cointegrated, then we simply regress Δs_t on Δb_{t-1}. Thus, the baseline specification for Group 3 countries is:

$$\Delta s_t = \beta + \alpha_1 x_t + \alpha_2 g_t + \alpha_3 \Delta b_{t-1} \; + \; u_t,$$

and the specification with dummy variables:

$$\Delta s_t = \beta + \alpha_1 x_t + \alpha_2 g_t + \alpha_3 d_1 * \Delta b_{t-1} \; + \; \alpha_4 d_2 * \Delta b_{t-1} \; + \; u_t.$$

[12] Like all event-based splits, dating of the global financial crisis is somewhat arbitrary. For example, in the European periphery the time frame for the crisis was delayed to around 2010.

[13] The unweighted average of the post-GFC policy rate was -0.14 percent.

B. Regression Results for the Baseline Specification

We report three main findings from the full-sample baseline regression specification. First, for the vast majority of countries, we fail to find the expected adjustment of the primary balance to debt developments (see Table 5, column labelled "Full sample period" and Figure 6). For 24 out of 27 sample countries we reject the null hypothesis that changes in debt have been followed by changes in the country primary balances (detailed regression results are presented in Annex 2, Tables A.2.1 to A.2.3). The point estimates of α_3 are either positive but statistically insignificant at the 5 percent significance level, or negative (and sometimes negative and statistically significant). Only for Belgium (Group 3 type of regression), Denmark (Group 2), and Slovenia (Group 1) we find a positive and statistically significant point estimate.

Second, we tested the stability of our regressions as there was at least one major structural break during 1980 to 2022, namely the global financial crisis. It is reasonable to assume that fiscal behavior may have changed after the crisis. To this end, we estimate separately the elasticities of primary fiscal balance with respect to lagged debt for the pre-global-financial-crisis and post-global-financial-crisis periods using interactive dummies as outlined in the previous section (for the point estimates see Annex 2, Table A.2.4). The estimates do not support the hypothesis of a change in fiscal behavior after the global financial crisis but indicated that the coefficients are stable.[14] We find a positive and statistically significant parameter for the pre-global-financial-crisis period in Hungary and Spain and for the post-global-financial-crisis period in Belgium and Slovenia (see Table 5, the last two columns and Figure 6).

Finally, the estimated adjustments (the parameters on b_{t-1}) are very small, less than 0.1, for Denmark, Slovenia, and Spain. For example, the point estimate of Slovenia's primary balance adjustment of 0.05 implies that it would take, all else equal, about 20 years to offset an unexpected increase in the debt-to-GDP ratio. Only for Belgium and for Hungary (pre-global financial crisis) we find the point estimates to be meaningfully large and of the magnitude reported by Bohn and other early papers.

[14] The detailed regression estimates are available on demand.

Table 5. Regression results summary

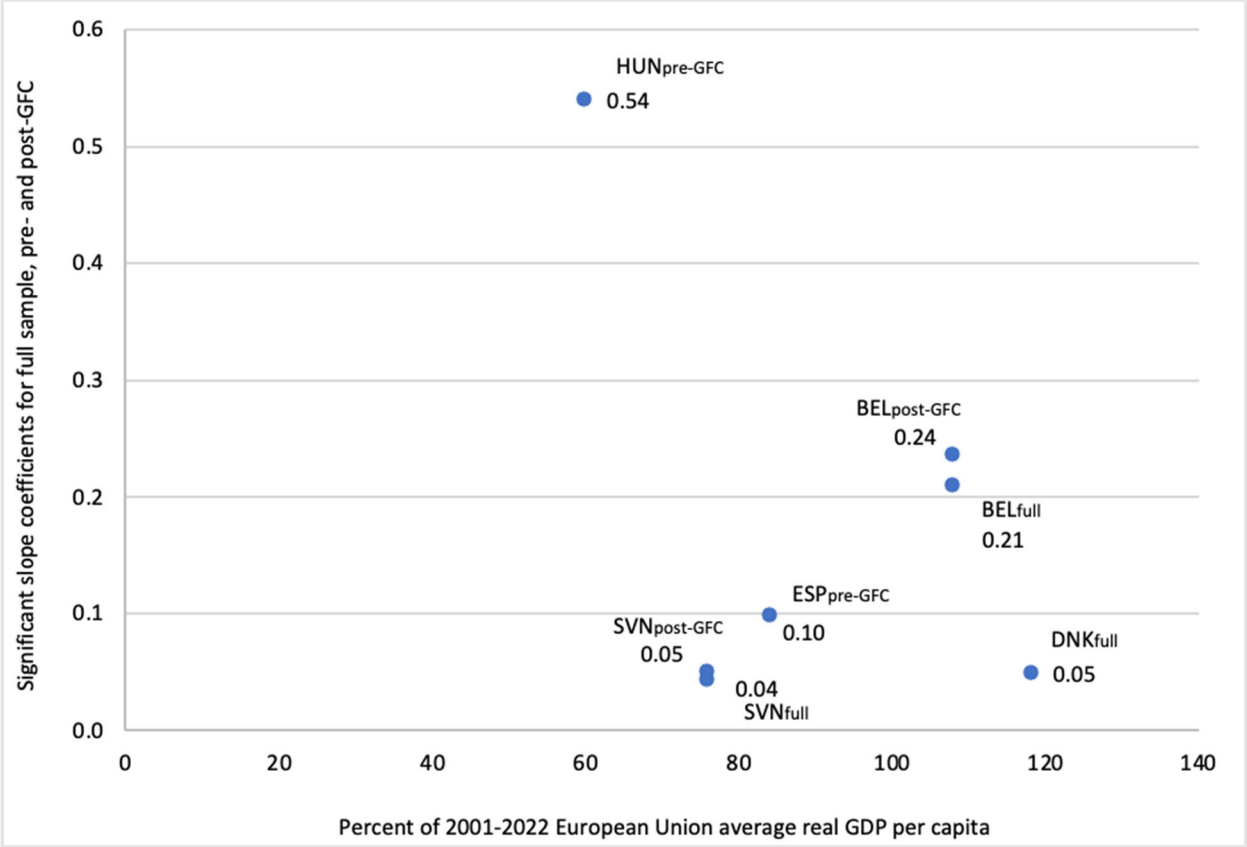
Countries	(1) Full Sample Period[1]	(2) Slope pre GFC[2]	(3) Slope post GFC[3]
Austria	R	R	R
Belgium	NR	R	NR
Czechia	R	R	R
Denmark	NR	R	R
Estonia	R	R	R
Finland	R	R	R
France	R	R	R
Germany	R	R	R
Greece	R	R	R
Hungary	R	NR	R
Iceland	R	R	R
Ireland	R	R	R
Italy	R	R	R
Latvia	R	R	R
Lithuania	R	R	R
Luxembourg	R	R	R
Netherlands	R	R	R
Norway	R	R	R
Poland	R	R	R
Portugal	R	R	R
Slovakia	R	R	R
Slovenia	NR	R	NR
Spain	R	NR	R
Sweden	R	R	R
Switzerland	R	R	R
United Kingdom	R	R	R
United States	R	R	R

Source: Authors' calculations.

Notes: The null hypothesis (H_0) is that the parameter on b_{t-1} is positive and statistically significant, hence, the Bohn rule holds, and the result is labelled as NR. If the coefficient on lagged debt is either positive and statistically insignificant or negative, then we reject the null and assign R. Significance of coefficients is determined at the 5 percent significance level.

[1] This includes the entire sample period of the regression analysis.
[2] Rejection or acceptance of the null hypothesis based on the slope coefficient on lagged debt during 1980–2008 (pre-global financial crisis) or β_2.
[3] Rejection or acceptance of the null hypothesis based on the slope coefficient on lagged debt during 2009–2022 (post-global financial crisis) or β_3.

Figure 6. Discretionary Fiscal Policy and Public Debt



Source: Authors' calculations.

Notes: GFC = global financial crisis, BEL = Belgium, DNK = Denmark, ESP = Spain, HUN = Hungary, SVN = Slovenia. The chart plots only the statistically significant parameters on b_{t-1} against the average per capita GDP expressed as a percentage of EU-wide GDP per capita.

C. Robustness Checks

The existing literature on the Bohn rule proposed multiple robustness check and variable additions. In this section we report two sets of robustness checks: (1) splitting the individual-country sample period before and after the euro adoption (for the countries that did adopt the euro), (2) adding the effective interest rate differential vis-à-vis Germany to the regressions, and (3) re-estimating regressions with WEO estimates of the output gap (as opposed the Hodrick-Prescott-filtered gaps). It turns out that none of these modifications change our baseline findings. Detailed regression results are available on demand.

Euro Adoption

Countries wishing to adopt the euro had to satisfy (or demonstrate progress toward) the so-called Maastricht criteria, which had both "monetary convergence" criteria and "fiscal convergence" criteria (Buti and Gaspar 2021). To this end, the interested countries would participate in the European Exchange Rate Mechanism (ERM I until 1999 and ERM II from 2000 onward). The impact of the ERM participation on monetary stance and inflation is well established: the participating countries tightened monetary policy and inflation declined in the runup to the euro (Bulíř and Hurník 2009). One would expect a similar effect from the fiscal criteria that

stipulated that (1) the annual general government deficit relative to GDP should not exceed 3 percent and (2) the ratio of gross general government debt relative to GDP should not exceed 60 percent.

A total of 17 countries in our 27-country sample adopted the euro at various dates, most in 1999 (11 countries), and then six more in 2022, 2007, 2009, 2011, 2014, and 2015. To test the impact of the adoption of euro, if any, we introduced two dummy variables, one for the ERM and pre-euro period and the other for the post-adoption period. These dummies are then interacted with the lagged debt variable to test whether discretionary fiscal policy changed after the euro introduction. In other words, we are testing a hypothesis that individual-country fiscal behavior changed during the 3-year period spent in the ERM and afterward relative to the pre-ERM period during which the country was not bound by the above fiscal convergence criteria.

We can reject the hypothesis for all 17 countries that adopted the euro—the regression results are identical to the baseline specification. The only marginal difference is Belgium, where we find both the pre- and post-euro fiscal response positive and statistically significant (the pre-GFC estimate was not statistically significant in the baseline). The point estimate of the fiscal policy response is identical for both periods (0.2), similar to the result reported in Figure 6 and, hence, there is no coefficient size difference between the two periods in Belgium.

Effective Interest Rate Differential vis-à-vis Germany

The global financial crisis reiterated that national sovereign debts are imperfect substitutes and that the differences in substitutability are reflected in sovereign yields. Countries saddled with high debt, or without history of debt-stabilizing primary surpluses, tend to pay more to service their debt than fiscally prudent Germany (Figure 5 and Annex I). One would expect that such differentials may motivate countries to tighten fiscal policy and vice versa, a finding evidenced by Mauro and others (2013). To this end, we added the effective interest rate differential vis-à-vis Germany to our baseline regressions and we tested the inclusion of both contemporaneous and lagged differentials. As we argued above, it is the slow-moving effective interest payment that matters rather than a volatile sovereign spread.

We can reject the hypothesis that the price signal of the differential mattered much during our sample period. First, the coefficient on the risk premium was statistically indistinguishable from zero in almost all countries. Second, the conditioning effect of the price signal did lower the standard deviation of the point estimate of α_3, that is, increased the *t*-value of α_3, in only three countries (Hungary, Lithuania, and Switzerland). Hence, in these additional countries we cannot reject the null of the Bohn rule holding in the full sample. How about the three countries where we did not reject the Bohn rule in the baseline specification, namely Belgium, Denmark, and Slovenia? It turns out that the nonrejection still holds for Belgium, but does not hold for Denmark and Slovenia, where the α_3 is now not statistically different from zero.

What can explain the lack of sensitivity of primary balances to the effective interest rate differential? The price signal was rather muted in most countries (Figure A1.5), except for Greece, Iceland, and some of the new member states. The effective interest differential was stable for most of the countries that adopted the euro. We should not find this surprising, however, as Mario Draghi's famous "whatever it takes" policy aimed at achieving precisely the outcome of narrowing the spreads (Draghi 2012). Furthermore, one should not ingnore the impact of the post-GFC monetary stimulus, even if the passthrough from the short-term policy rate to the effective interest rate was slow: the ECB policy rate stayed at or near the zero lower bound for most of 2009-2022.

V. Policy Implications

Inexorably increasing public debt is of course yesterday's news—IMF estimated that global public debt will approach 100 percent of GDP by 2030, subject to optimism bias in the projections (International Monetary Fund 2024). More troublesome than the debt level itself is the widespread apparent inability (or political unwillingness) to stabilize debt through planned, systematic discretionary fiscal consolidations, that is, through a sequence of cyclically-adjusted primary surpluses. To be sure, the debt-to-GDP ratio can decline with (1) a faster rate of growth of the domestic economy (as during the Great Moderation of the 1990s and early 2000s), (2) surprise inflation (as in 2021–22), and (3) financial repression that keeps sovereign yields negative in real terms (as in the 1950s and 1960s), or a combination of all these factors. We see little evidence of any of these factors—surprise growth acceleration, surprise inflation, or financial repression—playing out in the near future in our sample countries, however.

Debt sustainability exercises—performed annually for IMF member countries—are different from statistical tests of debt stationarity of the Bohn type. In IMF's surveillance role, the exercise helps to identify a member country's vulnerability to sovereign stress to steer the member away from such stress before it materializes (International Monetary Fund 2022). As such, IMF's debt sustainability is an inherently forward-looking exercise that asks whether a country's debt-to-GDP ratio is expected to stabilize, or not, under the best prediction of policies by the end of the projection horizon. Unfortunately, the predictions of future policies and macroeconomic outcomes tend to be overly optimistic (Carrière-Swallow and Marzluf 2023). The Bohn rule looks backward, using past fiscal behavior to determine whether a country's debt-to-GDP ratio is expected to stabilize, or not. Hence, it avoids bias from optimistic predictions.

Public debt is not Bohn-sustainable in our sample of 26 European countries and the US. We find no evidence—with the notable exceptions of Belgium and Denmark—that the post-global-financial-crisis changes in the debt-to-GDP ratio have been subsequently corrected by discretionary primary surpluses to stabilize the debt ratio. To put it differently, Belgium (and to a lesser degree Denmark) are the only countries where the decline in debt was systematic in the Bohn sense. Furthermore, the lack of a statistically significant coefficient on b_{t-1} may not matter much for *four* countries that nevertheless *lowered* or *kept low* their debt-to-GDP ratio: Ireland, Netherlands, Sweden, and Switzerland (the red group in Figure 2). The lack of a statistically significant coefficient may not matter much also for countries with below-average debt, many of them the EU new member states. We note, however, that although still comparatively low, the debt-to-GDP ratio increased from about 10 percent in the 1990s to above 40 percent in Czechia, Latvia, or Lithuania.

Perhaps the most worrisome finding is the lack of discretionary fiscal adjustment among the "large" countries in our sample. Only in Germany did debt remain broadly stable (stationary) during the last 20 years or so. All other large European countries in our sample—France, Italy, Spain, and the UK (and the US)—have been amassing more debt without corresponding discretionary consolidations (see the green-circle countries in Figure 2). This is significant for two reasons. First, the borrowing requirements of the four large European countries are going to vastly exceed their share of the combined sample GDP, thus crowding out private and public investment by the other, smaller countries. Second, any continued lack of Bohn-type fiscal adjustment by the large countries is bound to violate the new EU fiscal rules (Darvas, Welslau, and Zettelmeyer 2024) and create incentives for the other countries to violate these rules as well.

VI. Conclusions

Our estimates of the Bohn rule—a relationship linking cyclically-adjusted primary balances to past debt—on a post-1980 sample of European countries do not support evidence of a debt-stabilizing mechanism based on a systematic debt-to-primary-balance relationship. Only in a handful of small countries do we find discretionary fiscal policy reacting to past debt movements. The dominant drivers of fiscal balances are cyclical spending growth and smoothing of the business cycle. We also fail to find any impact of (1) the effective interest rate differential vis-à-vis Germany, as countries facing high sovereign yields behaved broadly the same way as countries with low yields; (2) introduction of the euro; or (3) the shock of the global financial crisis. It seems that politicians of all stripes have lost interest in fiscal prudence (Cao, Dabla-Norris, and Di Gregorio 2024).

We carefully sort out stationary and nonstationary variables, test for cointegration, and design our regression equations accordingly. Specifically, we find that debt series have a unit root in almost all countries and so do primary balances in almost one-half of our sample. We thus avoid mixing I(1) and I(0) variables—a problem that has plagued much of past research in this area and resulted in spurious regressions, inconsistent estimates, and incorrect inference. Our results are also robust to the introduction of additional variables.

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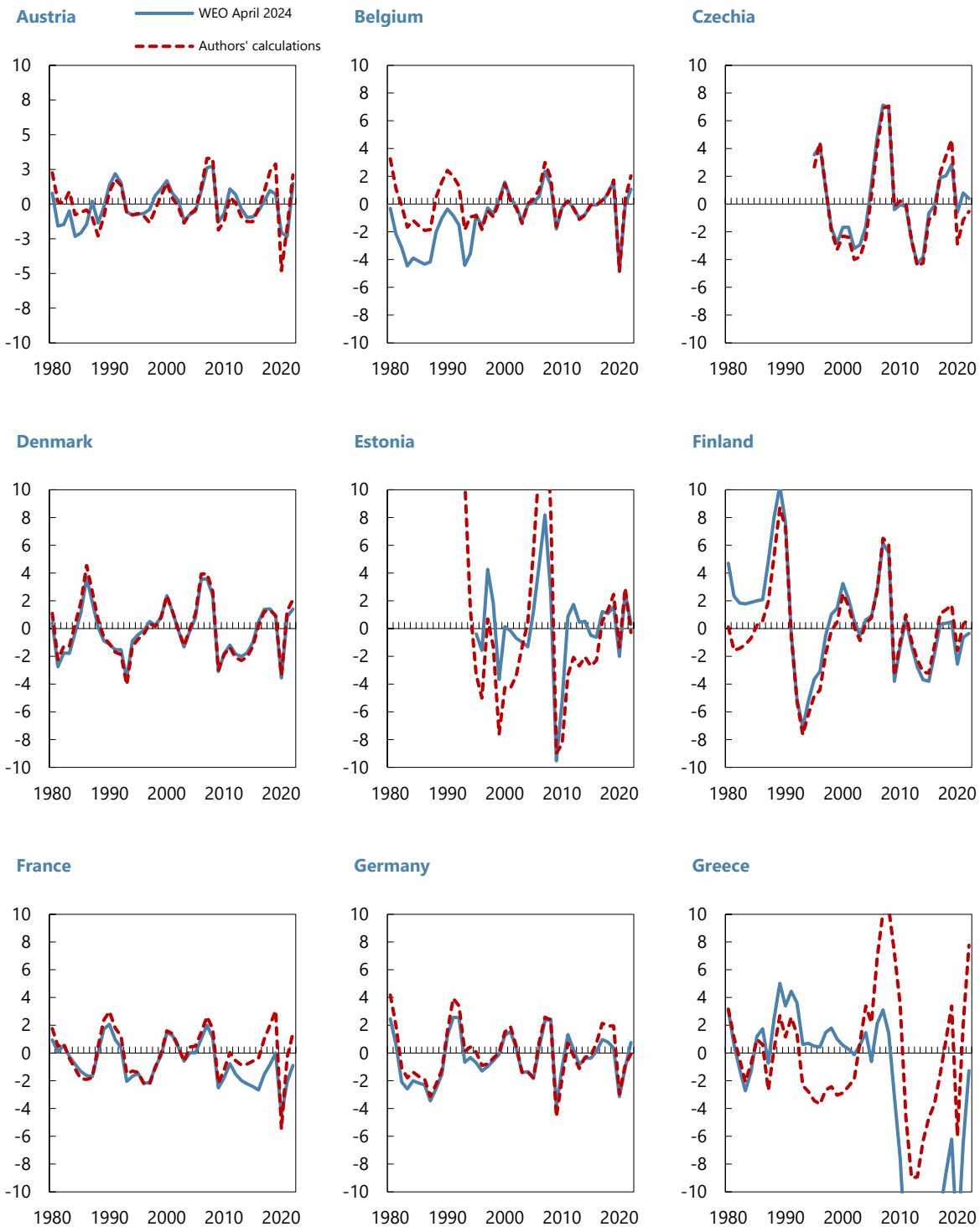
Annex 1. Country Specific Variables

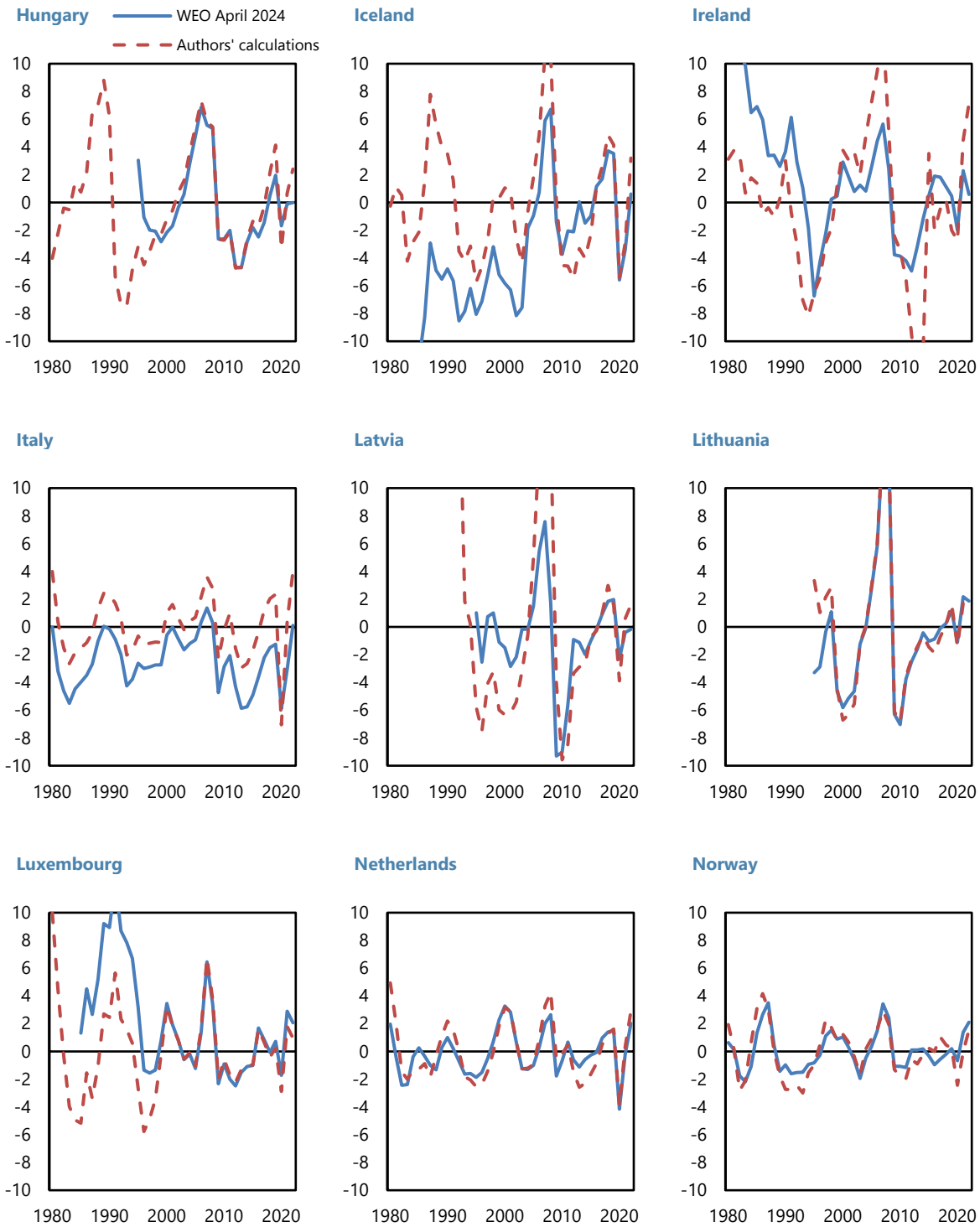
This annex graphically presents the five sets of variables that we use in the paper for all 27 sample countries during 1980–2022 or whenever the series starts: (1) the output gap, (2) cyclical government spending, (3) the cyclically-adjusted primary balance, (4) the debt-to-GDP ratio, and (5) effective interest rate differential vis-à-vis Germany.

Figure A1.1 Output Gap in Percent of Potential GDP (Continued)



Source: Authors' calculations, and IMF World Economic Outlook Database (April 2024). The blue line represents output gap calculated by the authors using the HP filter and the dotted red line reports the output gap from the World Economic Outlook Database (April 2024).

Figure A1.1 Output Gap in Percent of Potential GDP (Continued)

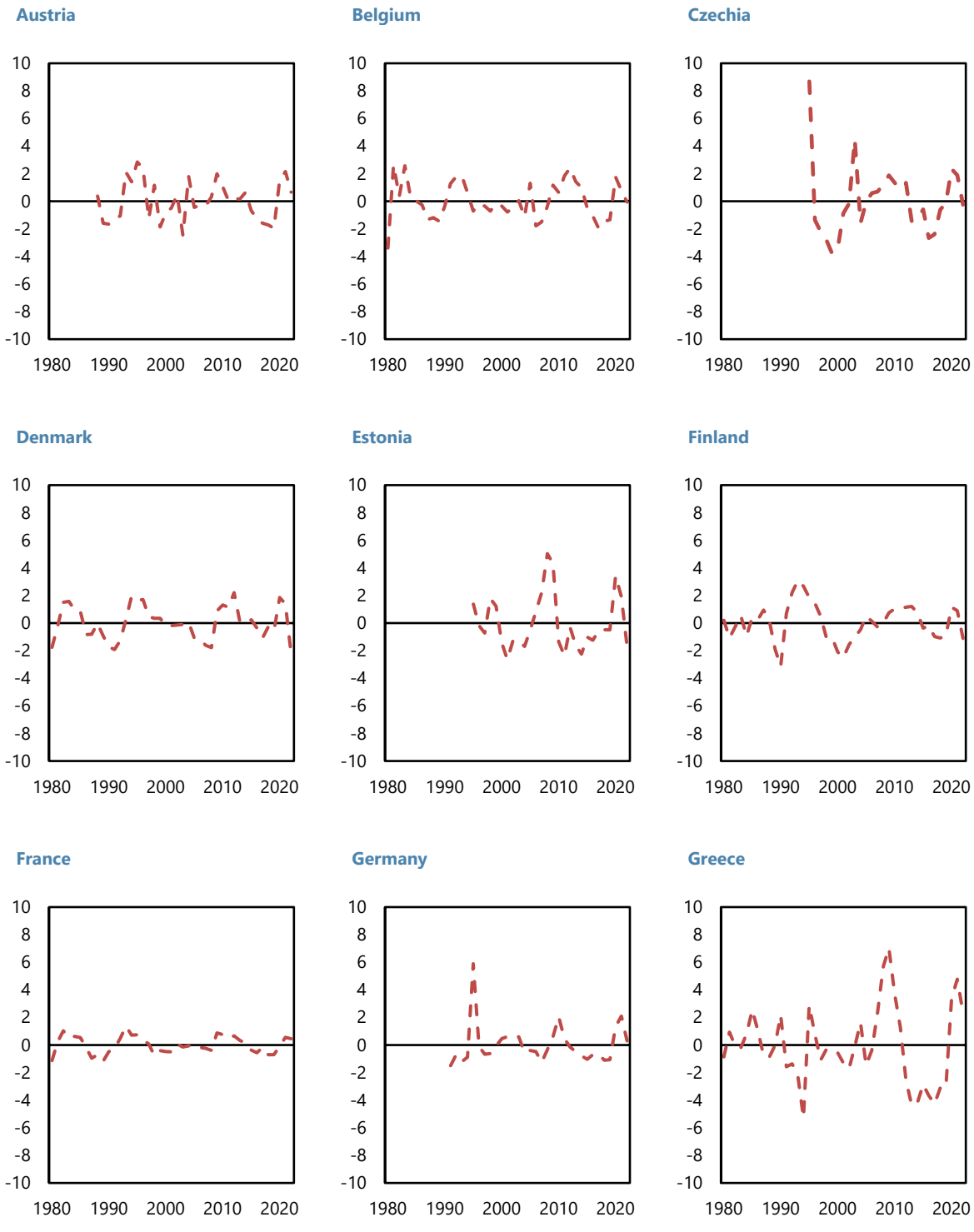


Source: Authors' calculations, and IMF World Economic Outlook Database (April 2024). The blue line represents output gap calculated by the authors using the HP filter and the dotted red line reports the output gap from the World Economic Outlook Database (April 2024).

Figure A1.1 Output Gap in Percent of Potential GDP (Concluded)

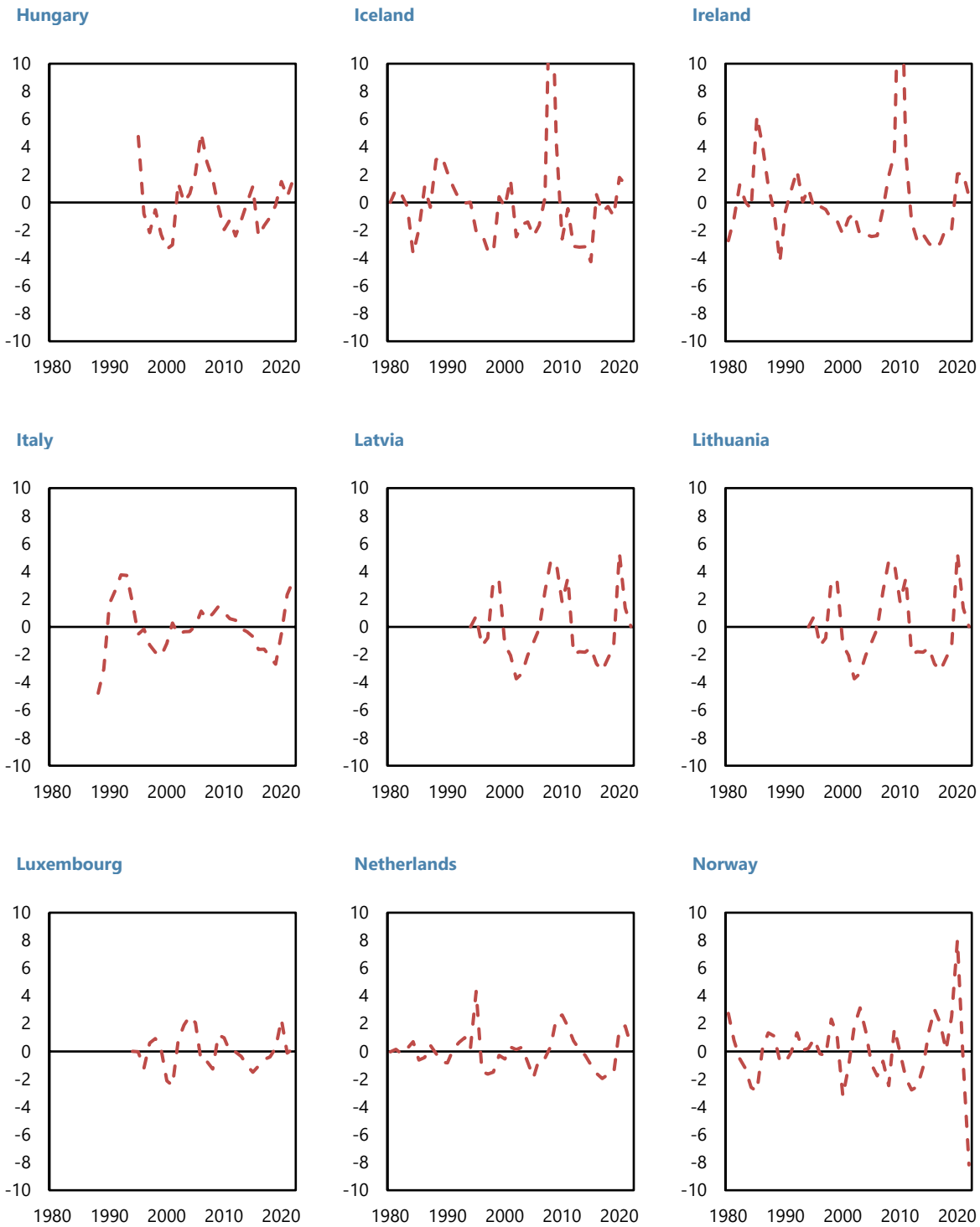
Source: Authors' calculations, and IMF World Economic Outlook Database (April 2024). The blue line represents output gap calculated by the authors using the HP filter and the dotted red line reports the output gap from the World Economic Outlook Database (April 2024).

Figure A1.2 Cyclical Component of Real Government Spending in percent of GDP (Continued)



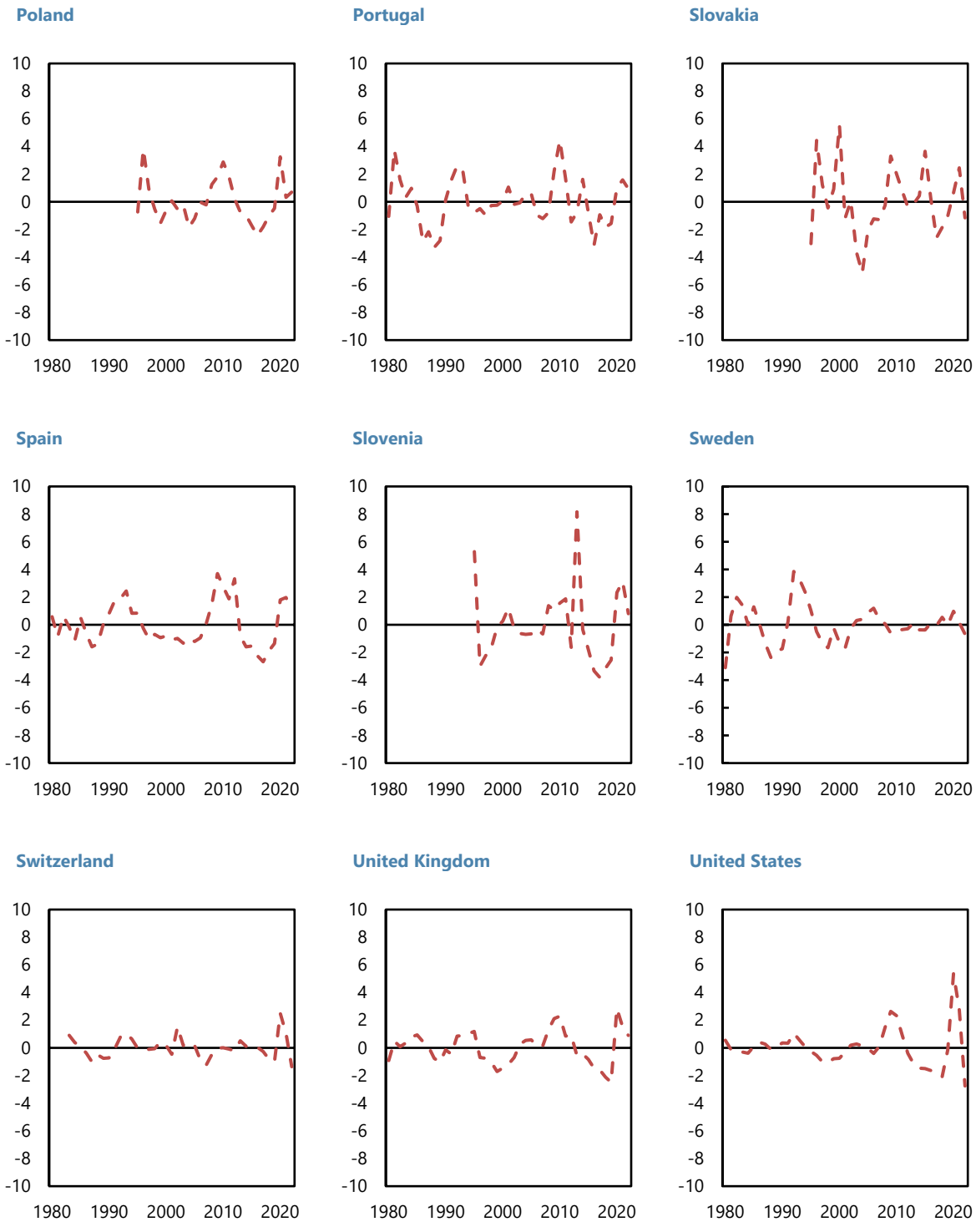
Source: Authors' calculations.

Figure A1.2 Cyclical Component of Real Government Spending in percent of GDP (Continued)



Source: Authors' calculations.

Figure A1.2 Cyclical Component of Real Government Spending in percent of GDP (Concluded)



Source: Authors' calculations.

Figure A1.3 Cyclically-Adjusted Primary Balance in Percent of Potential GDP (Continued)

Source: Authors' calculations, and IMF World Economic Outlook Database (April 2024). The blue line represents estimates based on authors' calculation of the output gap and the dashed red line represents the estimates from the WEO Database (April 2024).

Figure A1.3 Cyclically-Adjusted Primary Balance in Percent of Potential GDP (Continued)

Source: Authors' calculations, and IMF World Economic Outlook Database (April 2024). The blue line represents estimates based on authors' calculation of the output gap and the dashed red line represents the estimates from the WEO Database (April 2024).
* WEO does not publish the cyclically-adjusted primary balance for Norway.

Figure A1.3 Cyclically-Adjusted Primary Balance in Percent of Potential GDP (Concluded)

Source: Authors' calculations, and IMF World Economic Outlook Database (April 2024). The blue line represents estimates based on authors' calculation of the output gap and the dashed red line represents the estimates from the WEO Database (April 2024).

Figure A1.4 Debt-to-GDP Ratio in Percent (Continued)

Source: IMF Global Debt Database (April 2024).

Figure A1.4 Debt-to-GDP Ratio in Percent (Continued)

Source: IMF Global Debt Database (April 2024).

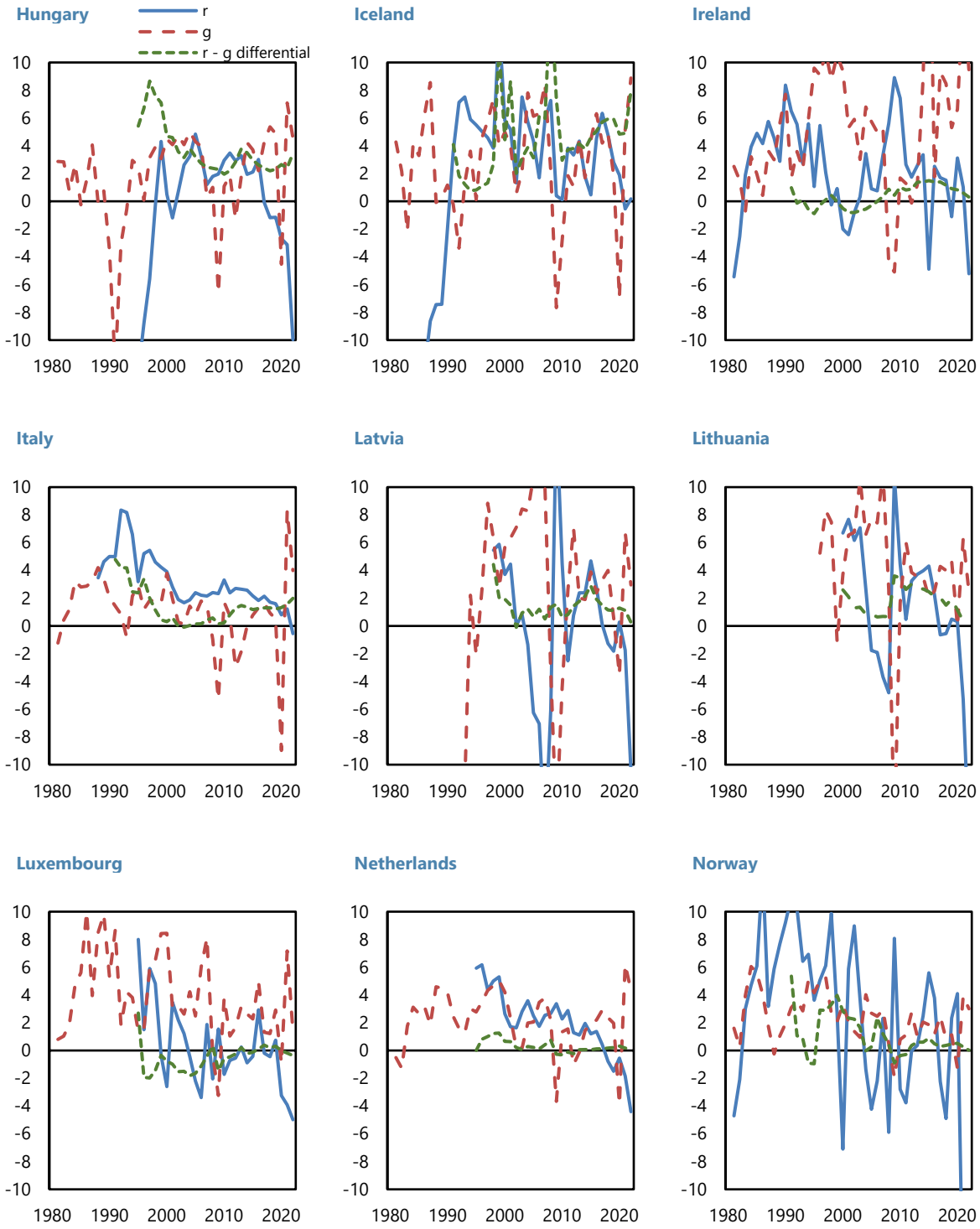
Figure A1.4 Debt-to-GDP Ratio in Percent (Concluded)

Source: IMF Global Debt Database (April 2024).

Figure A1. Effective Interest Rate Differential vis-à-vis Germany In Percent (Continued)

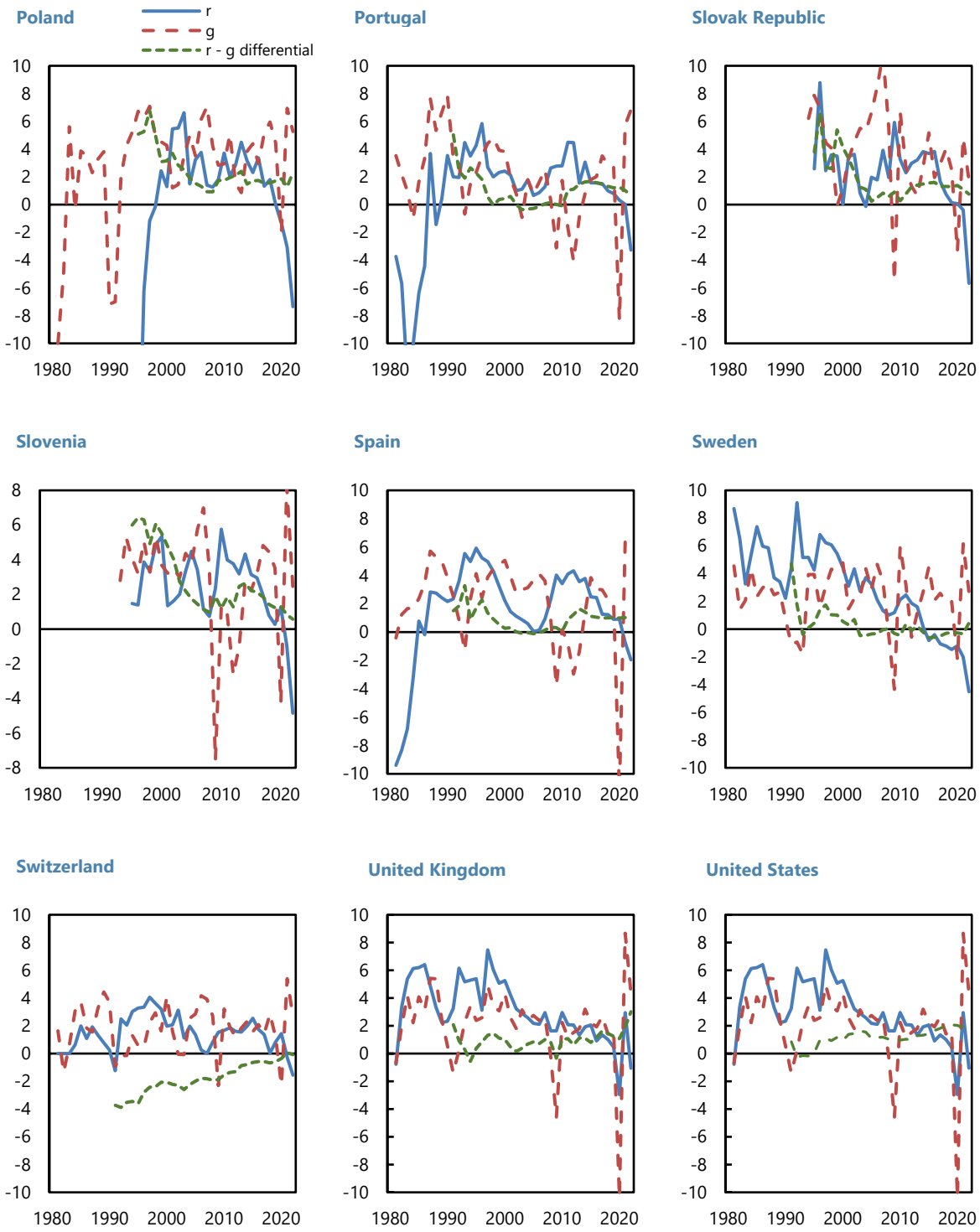
Source: Authors' calculations. The blue line is the ex-post effective real interest rate; the dashed red line is the rate of growth of real GDP; and the green dashed line measures the difference between the domestic effective interest rate and the effective interest rate of Germany.

Figure A1.5 Effective Interest Rate Differential vis-à-vis Germany In Percent (Continued)



Source: Authors' calculations. The blue line is the ex-post effective real interest rate; the dashed red line is the rate of growth of real GDP; and the green dashed line measures the difference between the domestic effective interest rate and the effective interest rate of Germany.

Figure A1.5 Effective Interest Rate Differential vis-à-vis Germany In Percent (Concluded)



Source: Authors' calculations. The blue line is the ex-post effective real interest rate; the dashed red line is the rate of growth of real GDP; and the green dashed line measures the difference between the domestic effective interest rate and the effective interest rate of Germany.

Annex 2. Detailed Regression Results

Baseline specifications as defined in Section 4.A.

Table A2.1: Baseline Results for Group 1

	Group 1 Debt is I(1) and primary balance is I(0), then regress s_t on Δb_{t-1}												
s_t	Δb_{t-1}	xt	gt						Const.	AR(1)	R^2	F-statistic	DW
Austria	0.01 (4.2)	**0.54 (4.6)**	**-0.56 (-4.2)**						-0.99 (-1.5)	**0.71 (4.2)**	0.74	20.65	1.79
Czechia	-0.01 (-0.1)	**0.39 (5.3)**	**-0.66 (-6.3)**						-1.69 (-1.6)	**0.82 (6.8)**	0.88	35.29	1.75
Estonia	0.04 (0.4)	**0.18 (3.4)**	**0.18 (-4.8)**						-0.62 (-1.4)	**0.44 (2.4)**	0.66	9.55	2.41
Finland	0.02 (0.4)	**0.60 (6.4)**	**-0.87 (-3.6)**						-0.22 (-0.2)	**0.81 (7.6)**	0.91	90.40	2.45
Germany[1]	-0.10 (1.4)	0.15 (1.1)	**-1.01 (5.1)**						0.13 (0.6)		0.67	19.38	0.71
Greece[1]	-0.08 (1.7)	-0.07 (0.7)	**-0.74 (4.3)**						**-0.98 (2.2)**		0.48	11.41	0.87
Iceland	-0.12 **(-2.3)**	**0.41 (2.7)**	**-0.95 (-5.9)**						0.12 (0.2)	0.16 (0.9)	0.62	14.19	2.00
Latvia	-0.01 (-0.2)	**0.22 (4.5)**	**-0.78 (-5.5)**						**-1.65 (-2.9)**	**0.64 (4.3)**	0.84	24.62	1.45
Lithuania	-0.01 (-0.1)	**0.25 (3.3)**	**-0.74 (-5.4)**						*-1.13 (-1.8)*	**0.51 (2.6)**	0.73	13.64	1.66
Luxembourg	0.03 (0.3)	**0.34 (3.1)**	**-0.77 (-4.3)**						0.77 (1.2)	**0.69 (4.2)**	0.77	17.92	2.06
Netherlands	-0.02 (-0.7)	0.38 (4.4)	-0.99 (-9.6)						0.04 (0.1)	0.68 (5.4)	0.86	54.89	1.84
Poland	-0.02 (-0.4)	**0.41 (3.3)**	**-0.67 (-4.3)**						**-1.69 (-4.1)**	**0.49 (2.7)**	0.66	10.63	1.82
Portugal	0.03 (1.2)	**0.41 (5.7)**	**-1.09 (-8.8)**						-0.20 (-0.2)	**0.85 (9.4)**	0.85	48.03	1.56
Slovakia	-0.01 (-0.2)	**0.23 (2.7)**	**-0.78 (-8.5)**						**-2.69 (-3.2)**	**0.72 (5.1)**	0.82	24.53	2.38
Slovenia	0.04 **(2.1)**	**0.4 (8.2)**	**-0.97 (-19.8)**						**-1.87 (-2.8)**	**0.81 (5.7)**	0.96	132.05	1.65
Sweden	-0.07 (-1.3)	**0.6 (5.9)**	**-1.24 (-6.0)**						0.74 (1.6)	**0.64 (4.5)**	0.92	98.24	1.72
United States	-0.01 (-0.2)	**0.41 (3.7)**	**-0.94 (-7.5)**						-3.72 (-1.0)	**0.95 (16.2)**	0.94	130.75	1.06

Source: Authors' calculations.

Notes: Point estimates significant at the 5 percent level are indicated in **bold**, estimates significant at the 10 percent level are indicated in *italics*. t-statistics in parentheses. Only positive and statistically significant estimates indicate Bohn-type fiscal sustainability.

[1] The regressions for Germany and Greece do not include an AR(1) term due to multicollinearity.

Table A2.2. Baseline Results for Group 2

	Group 2 (Both debt and primary balance are I(1) & cointegrated, then estimate an ECM: regress Δs_t on $\gamma(s_{t-1} - \alpha\Delta b_{t-2} - \beta)$												
Δs_t	Δb_{t-1}	x_t	g_t	Δb_{t-2}	x_{t-1}	g_{t-1}	EC term	b_{t-2}	Cons.	AR(1)	R^2	F-statistic	DW
Denmark	0.02 (0.4)	**0.75** **(4.9)**	-0.43 (-1.6)	-0.04 (-0.7)	-0.25 (-1.5)	0.31 (1.0)	**-0.57** **(-3.9)**	**0.05** **(2.2)**	-0.62 (-0.5)		0.77	10.94	1.74
France	-0.01 (-0.2)	**0.52** **(8.2)**	**-0.82** **(-2.8)**	0.01 (0.1)	**-0.47** **(-4.7)**	**1.21** **(4.6)**	**-0.23** **(0.1)**	-0.03 (-1.6)	0.30 (0.2)		0.88	25.00	2.36
Ireland	0.02 (0.4)	**0.24** **(2.4)**	**-0.90** **(-9.1)**	-0.01 (-0.2)	-0.13 (-1.3)	**0.73** **(4.8)**	**-0.20** **(-1.9)**	0.19 (1.6)	-12.46 (-1.5)		0.87	21.61	2.19
Italy	-0.05 (-0.6)	**0.45** **(4.1)**	**-0.58** **(-2.6)**	-0.07 (-1.1)	**-0.58** **(-3.4)**	**0.56** **(2.8)**	-0.44 (-2.2)	**-0.10** **(-2.1)**	**13.62** **(2.5)**		0.74	7.76	2.33
Spain	-0.49 (-0.9)	**0.27** **(3.3)**	**-0.79** **(-3.4)**	*-0.15* *(-2.0)*	**-0.49** **(-4.0)**	**0.86** **(3.4)**	**-0.36** **(-2.5)**	0.00 (0.0)	-0.43 (-0.3)		0.77	11.44	1.90
Switzerland	-0.15 **(-2.2)**	0.06 (0.7)	**-0.90** **(-4.9)**	*-0.10* *(-1.9)*	**-0.19** **(-2.1)**	**0.63** **(3.1)**	**-0.51** **(-2.5)**	0.01 (0.2)	0.13 (0.1)		0.86	17.85	2.01
United Kingdom	-0.07 (-1.0)	**0.51** **(6.9)**	**-0.74** **(-4.0)**	0.05 (0.8)	**-0.59** **(-7.5)**	**0.71** **(3.1)**	**-0.16** **(-2.9)**	-0.02 (-0.4)	-1.07 (-0.4)		0.93	44.54	1.44

Source: Authors' calculations.

Notes: Point estimates significant at the 5 percent level are indicated in **bold**, estimates significant at the 10 percent level are indicated in *italics*. t-statistics in parentheses. Only positive and statistically significant estimates indicate Bohn-type fiscal sustainability.

Table A2.3. Baseline Results for Group 3

	Group 3 (Both debt and primary balance are I(1) & *not* cointegrated, then regress Δs_t on Δb_{t-1}												
Δs_t	Δb_{t-1}	x_t	g_t						Cons.	AR(1)	R^2	F-statistic	DW
Belgium	**0.21** **(3.8)**	**0.35** **(2.0)**	**-1.25** **(-5.1)**						-0.01 (0.0)	**0.51** **(3.6)**	0.46	7.54	1.84
Hungary	0.16 (1.6)	*0.34* *(1.8)*	**-0.91** **(-2.9)**						-0.30 (-0.4)	0.20 (0.8)	0.22	1.51	1.65
Norway	0.076 (0.9)	-0.07 (-0.1)	**-1.75** **(-6.7)**						0.35 (0.2)	**0.35** **(2.0)**	0.54	10.15	1.49

Source: Authors' calculations.

Notes: Point estimates significant at the 5 percent level are indicated in **bold**, estimates significant at the 10 percent level are indicated in *italics*. t-statistics in parentheses. Only positive and statistically significant estimates indicate Bohn-type fiscal sustainability.

Table A.2.3. Stability Test: Point Estimates of Lagged Debt Before and After the Global Financial Crisis

Group 1			Group 2			Group 3		
Debt is I(1) and the primary balance is I(0). We thus regress s_t on Δb_{t-1}			Both variables are I(1) and cointegrated. We thus estimate an ECM: Δs_t on $\gamma(s_{t-1} - \alpha \Delta b_{t-2})$			Both variables are I(1) and not cointegrated. We thus regress Δs_t on Δb_{t-1}		
	Pre-GFC	Post-GFC		Pre-GFC	Post-GFC		Pre-GFC	Post-GFC
Austria	-0.00 (-0.1)	0.03 (0.5)	Denmark	0.02 (0.6)	-0.01 (-0.2)	Belgium	0.16 (1.6)	**0.24** **(3.3)**
Czechia	-0.08 (-0.4)	-0.00 (-0.0)	France	0.01 (0.8)	-0.01 (-1.3)	Hungary	**0.54** **(3.9)**	0.03 (0.4)
Estonia	0.80 (1.4)	0.02 (0.2)	Ireland	**0.10** **(2.1)**	0.04 (0.7)	Norway	0.03 (0.3)	0.21 (1.3)
Finland	0.03 (0.4)	0.01 (0.2)	Italy	-0.10 (-1.3)	-0.10 (-1.4)			
Germany	-0.02 (-0.2)	0.00 (0.1)	Spain	**0.13** **(2.9)**	0.04 (2.1)			
Greece	**-0.16** **(-2.3)**	-0.01 (-0.3)	Switzerland	-0.00 (-0.0)	-0.01 (-0.2)			
Iceland	-0.01 (-0.1)	**-0.17** **(-2.9)**	United Kingdom	0.26 (1.3)	0.08 (1.0)			
Latvia	0.04 (0.3)	-0.02 (-0.3)						
Lithuania	-0.40 (-1.6)	0.03 (0.4)						
Luxembourg	-0.13 (-0.8)	0.08 (0.8)						
Netherlands	0.08 (1.0)	-0.06 (-1.3)						
Poland	**-0.27** **(-3.5)**	0.04 (0.7)						
Portugal	0.09 (1.2)	0.02 (0.7)						
Slovakia	0.01 (0.1)	-0.03 (-0.5)						
Slovenia	-0.11 (-1.0)	**0.05** **(2.4)**						
Sweden	-0.06 (-0.8)	-0.08 (-1.0)						
United States	-0.06 (-0.9)	0.00 (0.1)						

Source: Authors' calculations.

Notes: Point estimates of the elasticity of the cyclically-adjusted primary fiscal balance with respect to lagged debt significant at the 5 percent level are indicated in **bold**, estimates significant at the 10 percent level are indicated in *italics*. t-statistics in parentheses. Only positive and statistically significant estimates indicate Bohn-type fiscal sustainability.

PUBLICATIONS

Europe's Debt (Un)Sustainability: Looking Through Bohn's Magnifying Glass

Working Paper No. WP/2025/070