debtkit

Debt sustainability analysis in R

Charles Coverdale

London, United Kingdom

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The question

How should we run the standard IMF and EC debt sustainability analysis workflow in a single reproducible R interface?

Twelve functions, one uniform schema, deterministic to stochastic in five lines.

Why it matters

- **Finance ministries** run annual debt sustainability analysis under IMF and EC templates
- **Central banks** assess fiscal risk in their financial stability reports
- **IMF Article IV missions** apply the Sovereign Risk and DSA Framework to every member
- **Sovereign-credit analysts** price default risk off debt-to-GDP trajectories

What is already out there

- **`vars`, `quantmod`**: time-series building blocks, no DSA templates[1]
- **IMF and EC DSA spreadsheets**: authoritative but closed, manual, hard to version
- **Bespoke ministry code**: reinvented on every project, inconsistent methodology
- **No R package implements the standard toolkit**

The gap: **no open-source package covers the full DSA workflow end to end**.

[1] Pfaff (2008), *Analysis of Integrated and Cointegrated Time Series with R*, Springer; Ryan & Ulrich (2024), *quantmod*, R package.

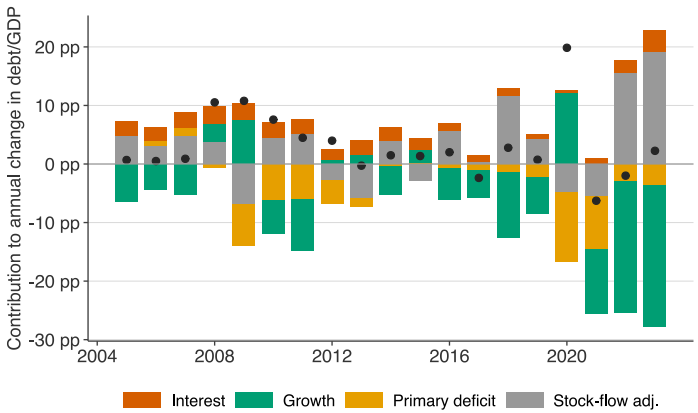
What debtkit offers

1. **Coverage**: 12 functions spanning projections, decomposition, Bohn tests, fan charts, IMF stress tests, heat maps, GFN, EC S1/S2 gaps
2. **Interface**: uniform `dk_` prefix, data-frame-in, S3-object-out, with `print()` and `plot()` methods
3. **Provenance**: pure computation, no data-vendor dependency, over 130 unit tests, on CRAN

Methods follow Blanchard (1990), Bohn (1998), Celasun-Debrun-Ostry (2006), IMF (2022), and EC (2024)[2].

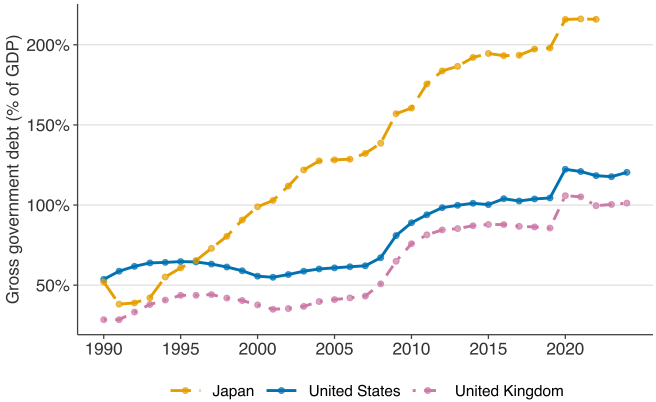
[2] Bohn (1998), *The Behaviour of US Public Debt and Deficits*, QJE 113(3); IMF (2022), *Staff Guidance Note on the Sovereign Risk and DSA Framework*; EC (2024), *Fiscal Sustainability Report 2024*.

Debt decomposition: what drove the ratio



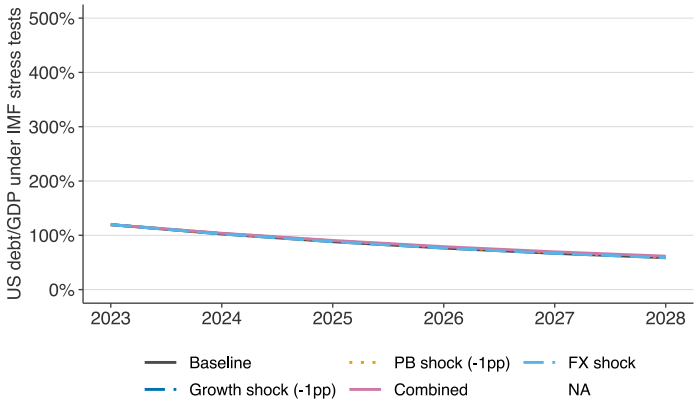
Historical decomposition of the US federal debt ratio, 2004 to 2023, into primary balance, $r - g$, and stock-flow contributions. Exports: `dk_decompose()`, `dk_rg()`.

Cross-country debt paths



Debt-to-GDP trajectories for the US, UK, and Japan; Japan sits as the 240 per cent outlier. Exports: `dk_project()`, `dk_compare()`.

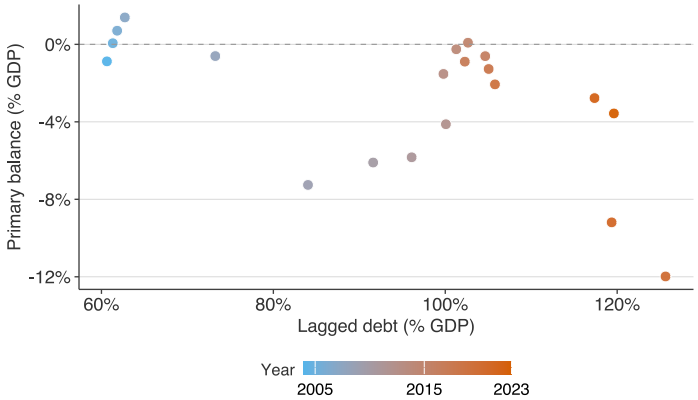
Stress testing: six standardised shocks



IMF SRDSF stress grid: six standardised shocks on the US baseline; the interest-rate shock has the widest tail.

Exports: `dk_stress_test()`, `dk_heat_map()`.

Bohn regression: does the primary balance respond to debt?



Bohn (1998) fiscal reaction function for the US, 2004 to 2023; positive slope is a sufficient condition for solvency.

Exports: `dk_bohn_test()`, `dk_sustainability_gap()`.

Central formulas

Debt dynamics equation (Blanchard 1990):

$$d_{t+1} = \frac{1 + r_{t+1}}{1 + g_{t+1}} d_t - pb_{t+1} + sfa_{t+1} \tag{1}$$

Debt-stabilising primary balance:

$$pb^* = \frac{r - g}{1 + g} d \tag{2}$$

Bohn (1998) fiscal reaction test (sufficient condition: $\beta > 0$):

$$pb_t = \alpha + \beta\, d_{t-1} + \gamma' X_t + \varepsilon_t \tag{3}$$

Package at a glance

Function families:

- **Projection**: `dk_project()`, `dk_rg()`, `dk_compare()`
- **Decomposition**: `dk_decompose()`
- **Reaction function**: `dk_bohn_test()`
- **Stochastic**: `dk_estimate_shocks()`, `dk_fan_chart()`
- **Stress tests**: `dk_stress_test()`
- **Diagnostics**: `dk_heat_map()`, `dk_gfn()`, `dk_sustainability_gap()`
- **Helpers**: `dk_sample_data()`

Deps: `cli`, `grDevices`, `graphics`, `stats`. R $\geq$ 4.1.0.

Uniform interface

Every function accepts:
`debt`, `interest_rate`, `gdp_growth`, `primary_balance`
and returns an S3 object with `print()` and `plot()` methods.

Minimal working example

```r
library(debtkit)

# Five-line canonical DSA workflow
d      <- dk_sample_data()
decomp <- dk_decompose(d$debt, d$interest_rate, d$gdp_growth,
                       d$primary_balance, years = d$years)
shocks <- dk_estimate_shocks(d$gdp_growth, d$interest_rate,
                             d$primary_balance)
fan    <- dk_fan_chart(tail(d$debt, 1), 0.04, 0.03, -0.01,
                       shocks = shocks, n_sim = 2000, horizon = 10)
stress <- dk_stress_test(tail(d$debt, 1), 0.04, 0.03, -0.01)
```

Five lines take an analyst from raw fiscal series to the full IMF DSA template: decomposition, stochastic fan, and the six standardised stress tests.

US federal debt dynamics after the pandemic

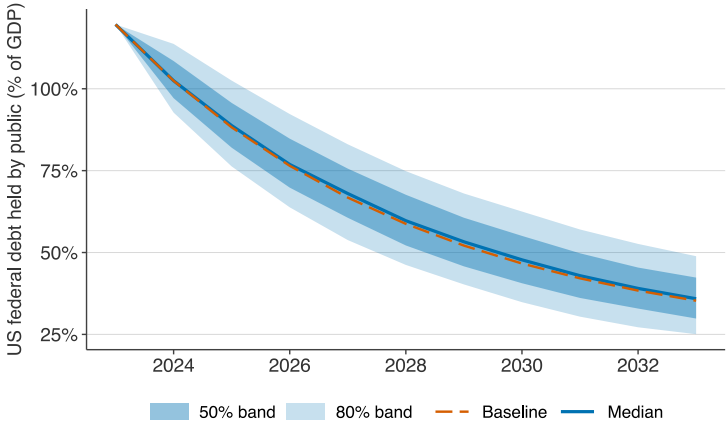
Data. FRED `GFDEGDQ188S` (US federal debt held by the public), `FYFSGDA188S` (federal balance), `IRLTLT01USM156N` (10-year yield), `A091RC1Q027SBEA` (GDP). Annual panel 2004 to 2023.

Question. *Is the US debt ratio, at 100 per cent of GDP, on a sustainable trajectory through 2033?*

Why this case. The most-watched fiscal question in US policy since 2020[3]. Debt jumped from 79 per cent in 2019 to 100 per cent in 2021. Reproducible with the debtkit pipeline in under 20 lines.

[3] Blanchard (2022), *Fiscal Policy under Low Interest Rates*, MIT Press; Furman & Summers (2023), *A Reconsideration of Fiscal Policy in the Era of Low Interest Rates*, Brookings.

US debt fan chart, 2023 to 2033



Ten-year stochastic fan chart for US federal debt held by the public, 2000 Monte Carlo draws; 50 and 80 per cent intervals. Source: FRED.

What debtkit does not yet do

- **Annual frequency only**: IMF and EC templates are annual; quarterly DSA is possible but not standardised
- **First-order VAR or bootstrap shocks**: no regime-switching, time-varying-parameter, or stochastic-volatility models
- **No ageing-cost series bundled**: users source EC Ageing Report or OECD long-term projections for S2
- **Single contingent-liability shock**: no granular guarantee-call or SOE exposure modelling

v0.2.0 roadmap: quarterly-frequency support, Markov-switching shock models, bundled OECD ageing-cost series, and foreign-currency pass-through.

Contact, code, paper

Charles Coverdale

charles.f.coverdale@gmail.com
github.com/charlescoverdale/debtkit
charlescoverdale.github.io/publications

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