



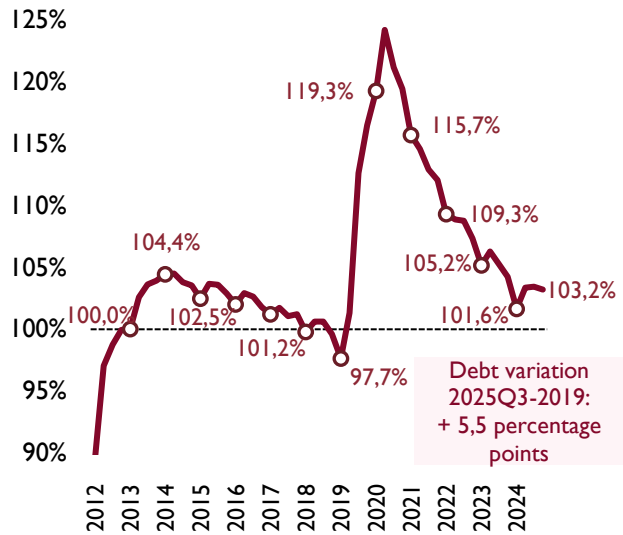
- The public debt ratio was 103.2% of GDP in the third quarter of 2025, a year-on-year reduction of 1 percentage point, although it remains 5.5 percentage points above the pre-pandemic level.
- Since the peak reached in 2021 (124.2% of GDP), debt has fallen by 21 percentage points.
- According to the Bank of Spain's monthly GDP estimate, the debt ratio would have fallen to 101.7% of GDP in October.
- In nominal terms, public debt reached €1.693 trillion, with year-on-year growth of 4%.
- Since the pandemic, most of the most heavily indebted EU countries have begun debt correction processes. Greece and Portugal have achieved the largest reductions in their debt-to-GDP ratios, supported by sharp falls in the deficit and even surpluses.
- Spain and Italy have also seen significant falls, albeit smaller ones, while France has performed less favourably, with a virtually stagnant ratio and a slight recent uptick, making it the third most indebted country in the EU after Greece and Italy.
- Inflation in the euro area has moderated significantly since its 2022 peak, reaching the 2% target in May and 2.2% in November; however, significant variation persists between countries.
- As inflation has moderated, the major central banks (with the exception of Japan) have entered a phase of monetary easing since 2024, albeit with a cautious, data-dependent approach, attentive to underlying inflation, wage developments, and the strength of domestic demand.
- This has led to interest rate cuts proceeding at different paces among the major advanced economies.
- In the euro area, the ECB has cut rates four times in 2025; however, in its four most recent monetary policy decisions, it has opted to hold rates unchanged. The high probability of rate stability reflects the ECB's "wait-and-see" strategy, aimed at balancing offsetting risks.
- In the United States, the Federal Reserve has cut interest rates three times in 2025 while balancing its two mandates—price stability and maximum employment—amid still elevated inflationary pressures and a gradual deterioration in the labour market.
- Rate cuts have been accompanied by quantitative tightening through passive balance sheet reduction, aimed at normalising monetary conditions after years of expansionary policies; as a result, the balance sheets of the major central banks continue on a downward trend.

- In 2025, financial markets have experienced high volatility driven by political, geopolitical, and fiscal factors, reflected in the spike in the “fear index” (VIX) in April, although uncertainty has moderated in subsequent months.
- European stock markets are showing mixed performance, with widespread gains but significant differences between countries, reflecting varying levels of uncertainty, particularly in France.
- These divergences are also reflected in sovereign debt markets, where risk perception varies between countries.
- In a context of monetary easing, one-year debt yields have fallen in the main economies, with a drop of around 17 basis points in Spain.
- At the long end of the curve, yield movements reflect national differences: the risk premium has fallen in Italy and Spain (by around 50 and 25 basis points, respectively), while in France political uncertainty and the need for fiscal adjustment have pushed up the yield on 10-year bonds, keeping its risk premium stable but with an upward bias.
- The average cost of new Treasury issues was 2.7% in 2025, down 74 basis points from the 2023 peak, while the average cost of outstanding debt remains contained at 2.31%, thanks to the high average life of the portfolio, which reinforces resilience to tightening financial conditions.
- As for the 2026 financing programme, the Treasury is maintaining a similar strategy to the previous year, with net issuance of €55 billion despite the increase in defence spending. Gross issuance will reach €285.677 billion (+4%) due to the higher volume of maturities.
- Sovereign debt presents low risk, with well-distributed maturities and no significant concentrations; one-year refinancing risk is around 13%.
- The debt ratio is expected to fall over the medium term, with broad consensus across both stress scenarios and international forecasts, although the pace and magnitude of the adjustment depend on macro-fiscal assumptions and financial conditions.
- In AIReF's central scenario, debt follows a downward path, reaching around 95.2% of GDP in 2030, supported by nominal growth and an improving primary balance.
- Adverse scenarios show that lower growth (−0.5 p.p.) would raise debt to around 97.7% of GDP, and that higher interest rates (+50 b.p. on new issues from 2025) would slow the adjustment to around 95.9%, without reversing the downward trend.
- International forecasts are somewhat more favourable: the IMF puts debt at around 92.6% of GDP in 2030, and the European Commission and the OECD project a ratio for 2027 almost one point lower than AIReF's estimate.
- Based on the probability distribution of stochastic projections obtained using the updated European Commission methodology, the probability of debt falling by the end of the projection period in 2030 is estimated at around 71%.
- There is also a 59% probability that debt projected in the baseline scenario will exceed the 2030 estimate under the adjusted path of the Structural-Fiscal Plan, although the latter does not constitute a target or commitment under the new European fiscal rules framework.

- *AIReF's projections estimate that a primary balance of zero would stabilise the debt ratio at around 100% of GDP, while reducing and maintaining it at around 95% or 90% would require primary surpluses of 0.3% and 0.6% of GDP, respectively.*
- *According to the baseline projection, from 2030 onwards debt dynamics deviate from the stabilisation paths and begin to show an upward trend.*
- *To maintain the debt ratio over the long term—let alone reduce it—would require additional fiscal efforts, mainly through higher primary balances. This poses a significant challenge given that, from a historical perspective, achieving sustained primary surpluses has not been the norm.*

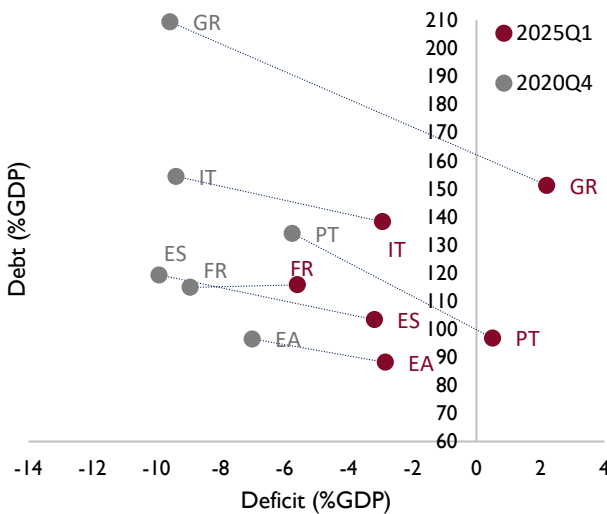
Spain's debt-to-GDP ratio was 103.2% in the third quarter of 2025, a reduction of 1 percentage point compared to the same quarter of the previous year but an increase of 5.5 percentage points compared to the pre-pandemic level. Compared to the last quarter of 2024, the ratio rose by 1.6 points, driven by the increase during the first quarter of the year, a period typically marked by positive seasonality. Since the peak reached in the first quarter of 2021 (124.2%), the ratio has fallen by 21 points. In monetary terms, public debt grew by 4% year-on-year in 2025, reaching €1.693 trillion in October. According to the Bank of Spain's monthly GDP estimate, public debt was 101.7% in October, down 1.5 points from September.

Debt (GDP), quarterly trend



Source: Bank of Spain and INE

Comparison of EU debt, most indebted countries: Debt/deficit 2025Q2 vs 2020Q4



Source: Eurostat and AIReF

Since the pandemic, debt ratios in the most indebted EU countries show a correction process in most cases, following the sharp increase during the health crisis. Greece and Portugal have achieved the most significant reductions in their debt-to-GDP ratios, supported by fiscal consolidation and post-pandemic economic growth, which has significantly reduced public deficits—with both countries even recording surpluses. Spain and Italy have also seen significant falls, albeit smaller ones. In contrast, French public debt remains at levels similar to those observed after the pandemic, with a slight recent increase, making France the third most indebted country by debt-to-GDP ratio, behind Greece and Italy.

The inflation rate in the euro area has moderated since the peak reached in 2022, achieving the 2% target in May. In November, the inflation rate was 2.2%, close to the target. However, despite aggregate convergence, significant variation persists between countries. Below the 2% target are France (0.8%), Cyprus (0.2%), Italy (1.1%), and Finland (1.4%). Portugal (2.1%) is approximately at the 2% target. Above the inflation target are Germany (2.6%), Belgium (2.6%), Greece (2.9%), and Spain (3.1%); the Baltic-Central European group also has higher inflation rates, reaching 4.7% in Estonia.

Harmonised inflation in the euro area (EA20). Year-on-year rate. Latest data: November 2025

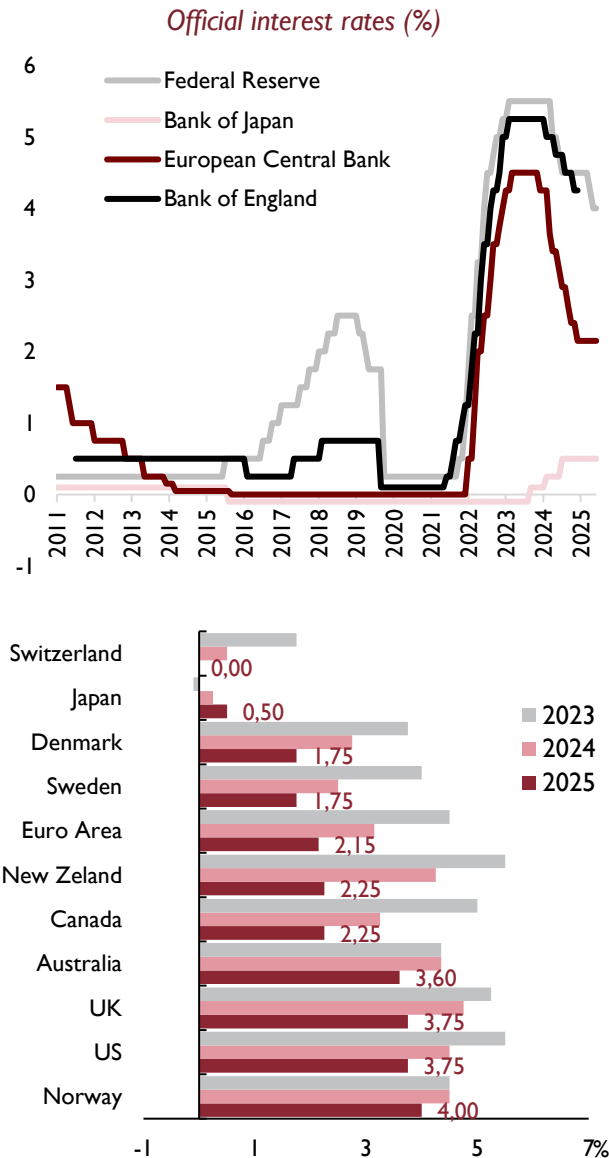


Source: Eurostat. Each of the abbreviations in this chart corresponds to the following countries: AT (Austria), BE (Belgium), CY (Cyprus), EE (Estonia), FI (Finland), FR (France), DE (Germany), GR (Greece), IE (Ireland), IT (Italy), LV (Latvia), LT (Lithuania), LU (Luxembourg), MT (Malta), NL (Netherlands), PT (Portugal), SK (Slovakia), SI (Slovenia), HR (Croatia), ES (Spain).

As inflation has moderated, the main central banks have entered a phase of monetary easing since 2024, with the exception of Japan. Headline inflation has gradually declined in advanced economies and is approaching price stability targets. However, the monetary stance remains cautious and gradual: each decision is taken on the basis of available data, with particular attention paid to core inflation developments, wage behaviour, and the strength of domestic demand.

This has led to interest rate cuts proceeding at different paces among the major developed economies. In the euro area, the ECB has cut interest rates four times in 2025. However, in its last four monetary policy decisions, the latest on 18 December, it has left interest rates unchanged. Since 11 June, the interest rate for main refinancing operations has been 2.15%; the deposit facility rate 2%; and the marginal lending facility rate 2.4%.

According to the ECB press conference, the decision to maintain rates is based on the resilience of the euro area economy, with moderate growth supported by domestic demand, stable financial conditions, and a still-solid labour market, in an environment of high geopolitical uncertainty. The ECB has therefore reiterated a cautious, data-dependent approach to its monetary policy decisions.

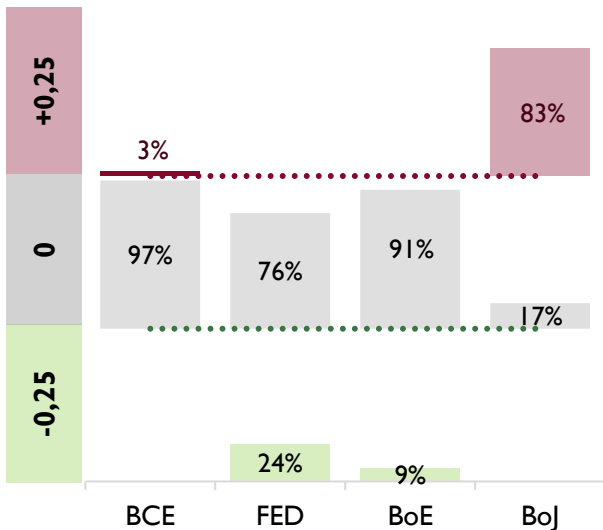


Source: Refinitiv

As for the US, the Federal Reserve has cut interest rates by 25 basis points on three occasions in 2025: on 17 September, 29 October, and 10 December, bringing them to the 3.5%–3.75% range. These decisions seek to balance the Fed's two mandates—maximum employment and price stability—in a particularly complex context characterised by inflationary pressures still above target and a gradual deterioration in the labour market. The latest rate cut reflects the assessment that downside risks to employment have increased in recent months, while inflation is deemed to be partly driven by temporary factors, mainly the impact of tariffs on goods prices. The Federal Reserve expects that, once this effect has been absorbed, inflation will resume its path towards the 2% target, while a monetary stance closer to neutrality will help stabilise the labour market.

Looking ahead to upcoming monetary policy decisions, markets anticipate significant divergence among major central banks. In the euro area, the ECB is expected to hold interest rates unchanged at its 5 February meeting, with the deposit rate at 2.00%. In the United Kingdom, following the 25 basis point cut on 18 December—already anticipated by markets—rates are expected to remain unchanged at the next meeting in February. In the United States, ahead of the January meeting, the Federal Reserve is widely expected to hold rates unchanged after the cumulative cuts throughout 2025, although with a higher probability of a rate cut than for the other two central banks. Finally, in Japan, markets assign a probability of more than 80% to an interest rate hike at the 19 December meeting.

Probability of interest rate change



Source: Refinitiv

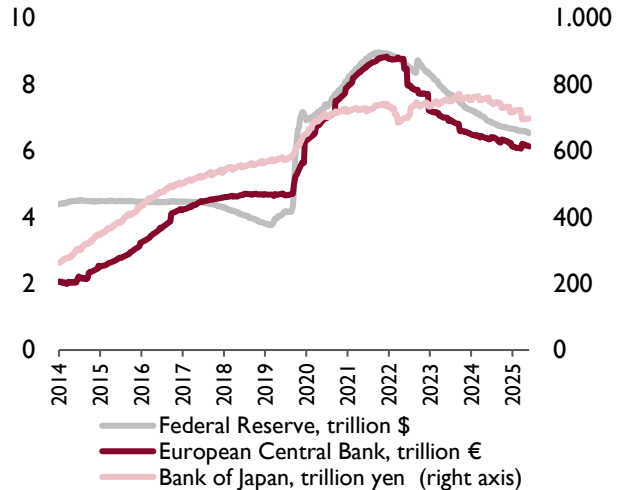
In the euro area, the high probability of rate stability reflects the ECB's “wait-and-see” strategy, aimed at balancing offsetting risks. Factors that could justify monetary easing persist, such as the global economic slowdown, the appreciation of the euro, and the structural weakness of the industrial sector. At the same time, inflation remains slightly above the 2% target, with possible upward pressures from services and food inflation, increased defence spending, and fiscal stimulus in Germany. This environment, together with recent messages from some members of the Governing Council, has led financial markets to scale back their expectations of rate cuts for 2026.

In the United States, Powell's message following the latest rate cut seems to indicate a pause in 2026, having pointed out that after the adjustments made since September (75 basis points), interest rates are now within a wide range of estimates of their neutral level. This allows the Fed to adopt a wait-and-see approach and cautiously assess incoming information and the macroeconomic outlook before deciding on further adjustments.

Interest rate cuts have been accompanied by a reduction in balance sheets that grew exponentially in recent years, in a process known as quantitative tightening, aimed at normalising monetary conditions after years of expansionary policies. Balance sheet reduction has followed a passive strategy, allowing assets to mature without reinvestment. The balance sheets of both central banks thus continue on a downward trend.

However, the Federal Reserve announced it would begin purchasing short-term government debt for operational purposes, aimed at maintaining an adequate level of reserves in the system and ensuring effective control of money market conditions. According to the Federal Reserve, although quantitative tightening has continued without generating tensions, the decline in use of the reverse repo facility and approaching seasonal liquidity drains—such as Tax Day in April—justify these technical measures. The aim is to ensure that reserves remain comfortably adequate even during temporary liquidity shortfalls, and to prevent a consequent rise in repo rates.

Central Bank Balance Sheets

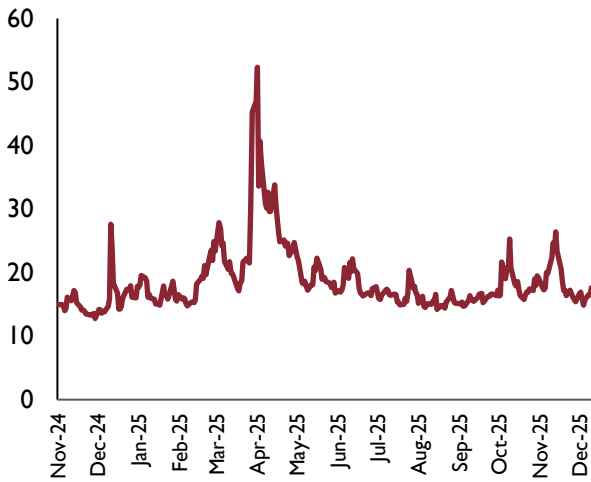


Source: Refinitiv

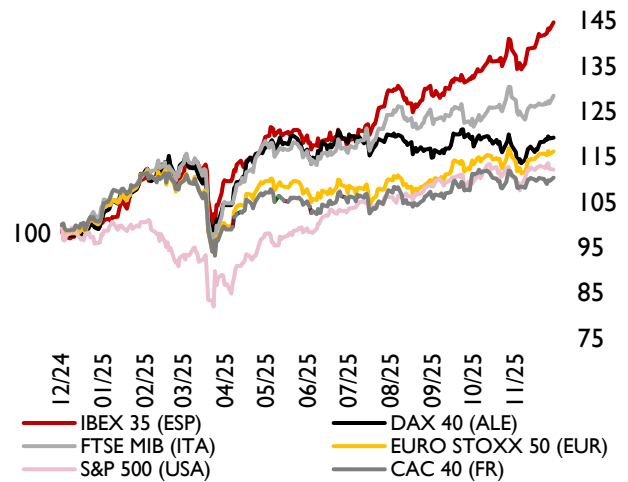
The Federal Reserve has therefore decided to carry out reserve management purchases amounting to \$40 billion in the first month, a volume that will remain elevated in the following months to ensure an orderly transition during this seasonally demanding period for liquidity.

As for financial markets, 2025 has been marked by high volatility, fuelled by the Trump administration's tariff and fiscal policies, geopolitical tensions, and strains arising from growing spending needs in Europe. This instability has been reflected in the VIX index, or "fear index," which measures expected stock market volatility; in April it exceeded 50 points, coinciding with the announcement of "Liberation Day". This initial uncertainty seems to have subsided; since the peak reached in April, the index has fallen back to 16.5 points.

VIX volatility index



Year-on-year change in the main stock market indices

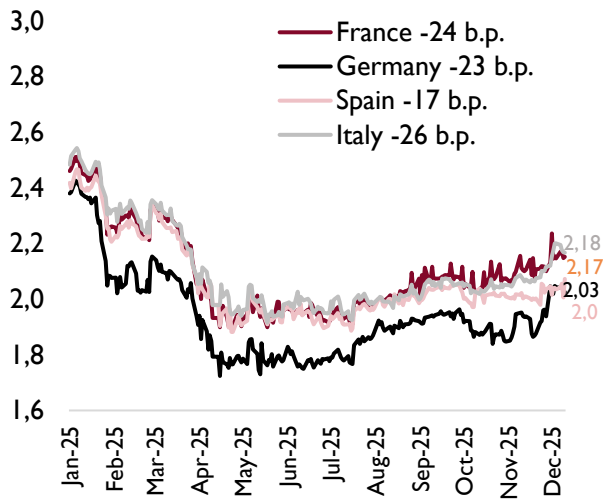


Source: EDF and AIReF

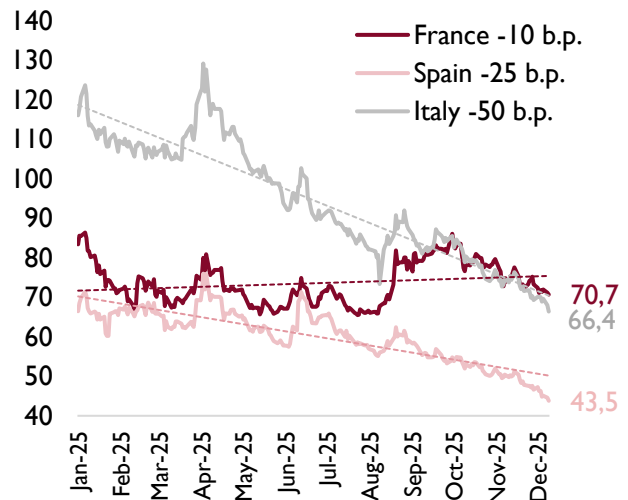
Source: Refinitiv and AIReF. Base 100 = 01/12/2024

A cross-country comparison reveals notable disparity in the performance of the various stock markets, reflecting the different levels of uncertainty affecting each economy. Among European stock markets, although the main indices have posted gains over the last year and the EURO STOXX 50 has performed strongly (+17.6% year-on-year), there are significant differences between national markets, such as the IBEX 35 (+40.4%) and the French CAC 40 (+11.8%).

Sovereign debt yield, 1-year bond



Sovereign debt yield, 10-year bond



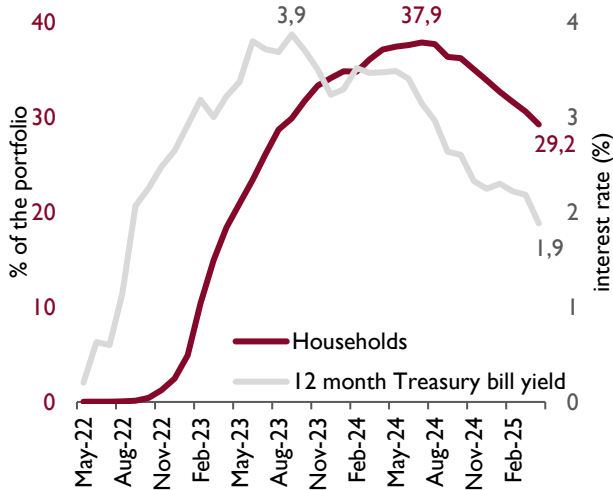
Source: Refinitiv

These divergences, linked in part to greater uncertainty in France, are also reflected in the yields demanded by markets on different countries' sovereign debt, highlighting differing risk perceptions among investors. Throughout 2024 and early 2025, one-year debt yields have followed a downward trajectory in the main European economies as a result of monetary policy easing. In Spain, the yield on one-year bonds has fallen by around 17 basis points.

However, this trend contrasts with that observed at the longer end of the curve. The yield on 10-year bonds reflects to a greater extent the particularities affecting each country, which feed through to risk premium movements relative to German bonds. Over the last year, the risk premium has fallen significantly in Italy and Spain, by around 50 and 25 basis points, respectively. In contrast, in France, the combination of political uncertainty and the need for a credible fiscal adjustment has pushed up the yield on 10-year bonds, which since October 2024 has been trading persistently above Spanish yields and, since last month, above Italian yields. As a result, the French risk premium has not followed a downward path like that of Spain and Italy, and remains virtually stable with a slight upward

bias. This pattern reflects growing market pressure on the sustainability of French debt compared to that of other euro area partners.

Yield on 1-year Treasury bills and % held by households

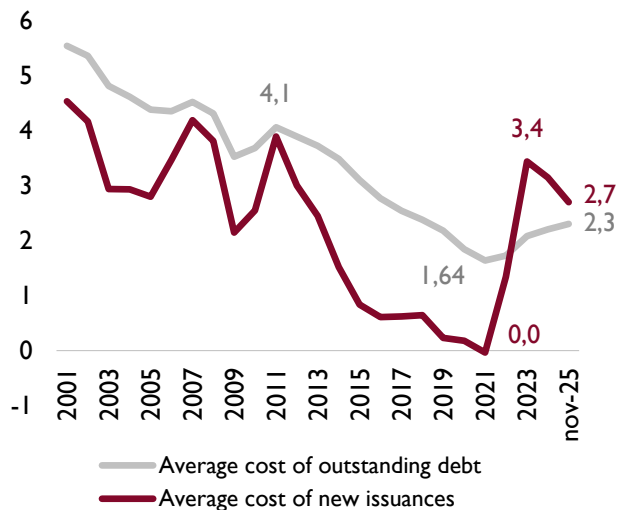


Source: Banco de España and Refinitiv

The average cost of new Treasury issues was 2.7% in November 2025, in line with the downward trend that began in 2023. Since the peak in 2023 (3.44%), the average cost of new debt has fallen by 74 basis points, and by 46 basis points compared to 2024. Despite the notable increase in official interest rates, the average cost of outstanding debt remains contained, at 2.31% in November 2025. This represents an increase of 67 points from the historic low reached in 2021 (1.64%), in a context where official rates have risen by 250 points. The average cost of outstanding debt has remained moderate thanks to the high average maturity of the public debt portfolio, which reinforces its resilience to changes in financial conditions.

Yield and cost of debt

Average cost of government debt (%)



Source: Treasury

Treasury financing in 2025 and 2026 (€bn)

(billions of euros)	Initial fore. 2025	Execution 2025	Forecast 2026
Net issuance	60,0	54,8	55,0
Gross issuance	278,4	274,0	285,7
Medium and long term			
Gross issuance	176,5	171,3	176,9
Redemptions	121,5	121,5	126,9
Net issuance	55,0	49,8	50,0
Treasury bills			
Gross Issuance	101,9	102,7	108,7
Redemptions	96,9	97,7	103,7
Net Issuance	5,0	5,0	5,0

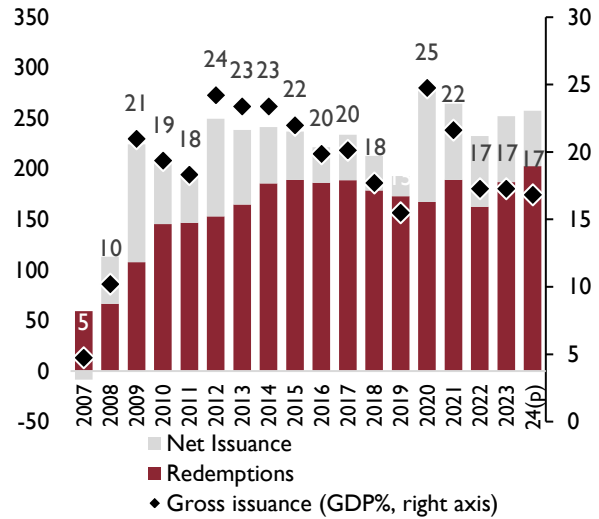
Source: Treasury

For 2026, the Treasury proposes a financing programme in line with the previous year: net issuance will remain at €55 billion, despite increased defence spending. Planned gross issuance will total €285.677 billion, a 4% increase compared to 2025, as a result of the higher volume of maturities in 2026. Medium- and long-term maturities will total €126.935 billion, including a projected ESM repayment of €3.643 billion, while Treasury bill maturities will total €103.742 billion. Gross medium- and long-term issuance is therefore expected to reach €176.935 billion and gross Treasury bill issuance €108.742 billion.

ECB monetary policy decisions have also influenced the yield on Spanish Treasury bills, which has halved since the peak reached in 2023. Demand from small savers remains high, although below the peak levels reached in July 2024, close to 40%. The latest data, from September 2025, point to a 19.8% share of Treasury bills held by households—still very significant given the sharp fall in yields. Compared to September 2024, Bank of Spain holdings have fallen (-4.1 points), while holdings by non-residents and other residents have increased (by 3.6 and 0.5 points, respectively).

In 2026, the Treasury also expects to receive €6.5 billion in European loans under the Next Generation EU programme, in addition to the €15.935 billion received in 2025. These loans are intended to strengthen the financial instruments created in the addendum to the Recovery Plan, which aim to channel financing to Spanish businesses to stimulate private investment and boost long-term growth. 2026 is the last year in which payments may be received under the Recovery and Resilience Facility. However, the Security Action For Europe (SAFE) instrument will also become available, providing loans to finance increased defence spending.

Treasury financing needs (€bn and % of GDP)



Source: Treasury

In 2026, the Treasury will maintain its securities issuance pattern, obtaining the bulk of its financing through regular auctions of Treasury bills and government bonds. It will also continue to reopen the green bond issued in 2021 until it reaches a volume similar to that of the other benchmarks on the Treasury curve, thereby providing liquidity to this instrument.

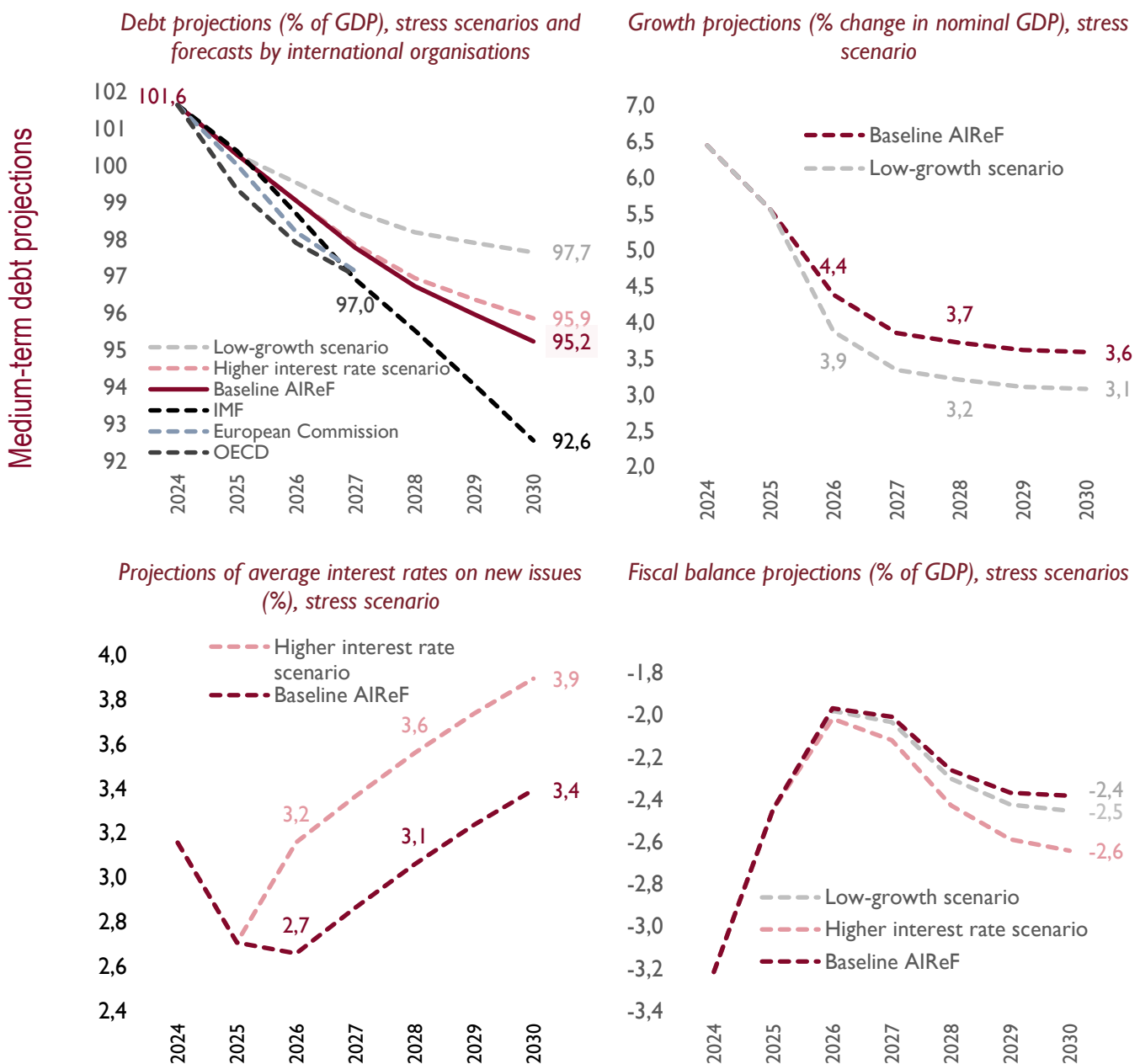
Sovereign debt presents low refinancing risk. The sovereign debt maturity profile shows well-distributed financing needs over the coming years, with moderate short-term maturities and a medium- and long-term distribution without concentration in any given year, so that only a small part of the debt is subject to each year's financial conditions. One-year refinancing risk is around 13%.

Overall, both stress scenarios and international forecasts show **broad consensus on a reduction in debt over the medium term**, although the pace and magnitude of the adjustment depend crucially on macroeconomic assumptions, especially growth and financial conditions.

In AIReF's central scenario, debt follows a downward path, reaching around 95.2% of GDP in 2030, reflecting a gradual reduction supported by nominal growth and an improving primary balance.

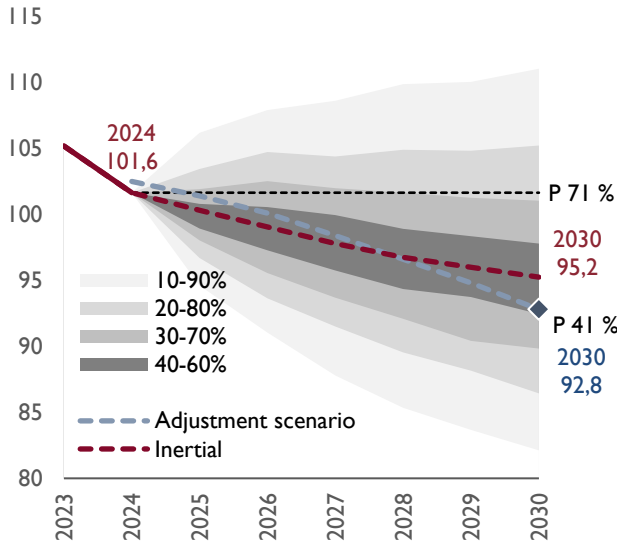
In contrast, the **adverse scenarios** illustrate the main risks: lower economic growth, with a GDP growth rate 0.5 percentage points below the central scenario, would keep debt at higher levels, close to 97.7% of GDP. A scenario of higher interest rates, assuming a 50 basis point increase in rates on new issues from 2025, would slow the adjustment, placing the ratio at around 95.9% in 2030. **Both cases reflect a less favourable trajectory than the central scenario, although without fully reversing the downward trend in debt.**

Other international organisations project a somewhat more favourable outlook than AIReF. The International Monetary Fund anticipates a sharper reduction in debt, to around 92.6% of GDP by 2030. The European Commission and the OECD project a debt ratio for 2027—the last year available in their forecasts—almost one percentage point lower than AIReF's estimate for the same year.



Source: AIReF. IMF. European Commission and OECD

Stochastic projection of debt (%GDP) and associated probabilities



Source: AIReF

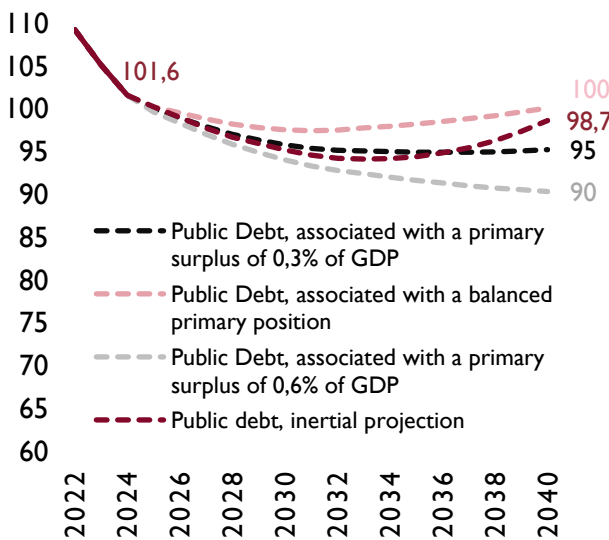
Based on the probability distribution obtained using the European Commission's methodology, **the probability of debt falling by the end of the projection period is estimated at around 71%**. There is also a 41% probability that debt projected in the baseline scenario will be lower than the 2030 estimate under the adjusted path of the Structural-Fiscal Plan, although this path does not constitute a target or commitment under the new fiscal rules framework.

The chart shows AIReF's central forecast for the public debt ratio, together with its stochastic projections, represented by a fan chart that reflects increasing uncertainty over the projection horizon. The different probability bands show the distribution of **possible debt trajectories, which widen progressively over time and display an asymmetric skew towards less favourable scenarios**, in line with the nature of macro-fiscal risks.

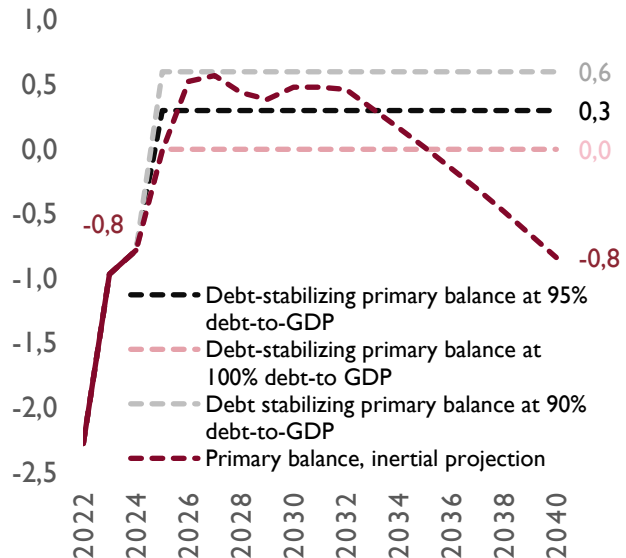
The fan chart bands have been constructed in accordance with the **European Commission's methodology**, following its latest methodological update, which introduces improvements in the generation of shocks and their persistence. The technical details of this approach are described **in the annex**.

AIReF estimates the constant primary balances needed to stabilise the public debt ratio at different levels. A **primary balance of zero (0.0% of GDP)** would stabilise debt at around **100% of GDP**. Stabilising it at around **95%** would require a primary surplus of **0.3% of GDP**, while bringing it to around **90%** would require a primary surplus of **0.6% of GDP**.

Debt projections (% GDP) associated with different primary balances



Baseline primary balances (% GDP) and debt stabilisers at different levels

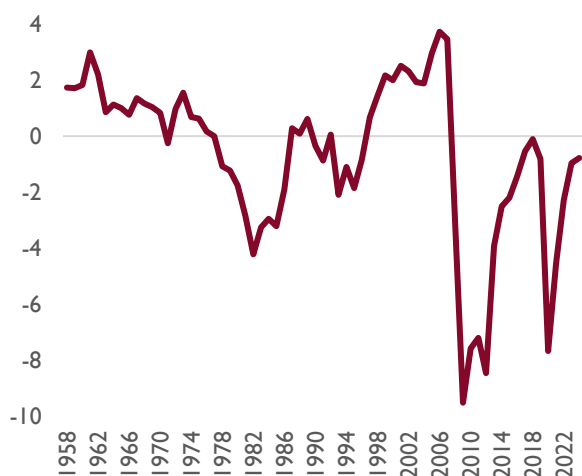


Source: AIReF

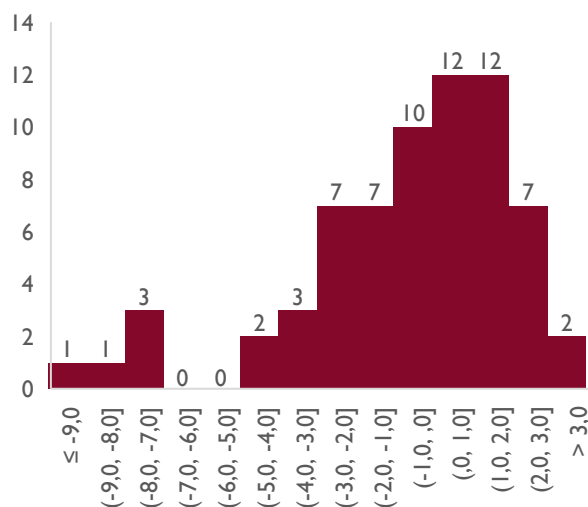
By comparison, **AIReF's baseline projection for the coming years is close to the stabilisation trajectories around 95% of GDP**. However, **from 2030 onwards, debt dynamics deviate from these equilibrium paths and show an upward trend**. This suggests that **maintaining a stable debt ratio over the long term would require additional fiscal efforts**, mainly through **higher primary balances**.

From a historical perspective, maintaining a sustained primary surplus has not been the norm. Of the 67 observations available, the primary balance has been above 0% in 49% of cases, indicating that episodes of surplus have been relatively frequent, although not dominant. However, achieving and maintaining a primary surplus of more than 1% of GDP has been much less common, occurring only 21 times—around 30% of total observations—underscoring the historical difficulty of sustaining more intensive fiscal efforts over time.

Historical series of the primary balance (% GDP)



Histogram of primary balances



Source: Source: AIReF and Ministry of Finance (BDMACRO)

Methodological annex – Stochastic simulations in the European Commission's DSA

Introduction

The European Commission's debt sustainability analysis (DSA) is a central exercise in the new European fiscal framework. The stochastic approach helps understand debt dynamics and is necessary to derive the net primary expenditure path to which Member States commit in their Medium-Term Structural-Fiscal Plans. Since 2012, the European Commission has produced stochastic simulations of public debt using a variance-covariance matrix¹ calibrated for each country. **In 2025, the European Commission refined its methodological approach², changing the way shocks are generated and incorporating shock persistence.** This annex describes the methodology, focusing on Spain and the changes introduced.

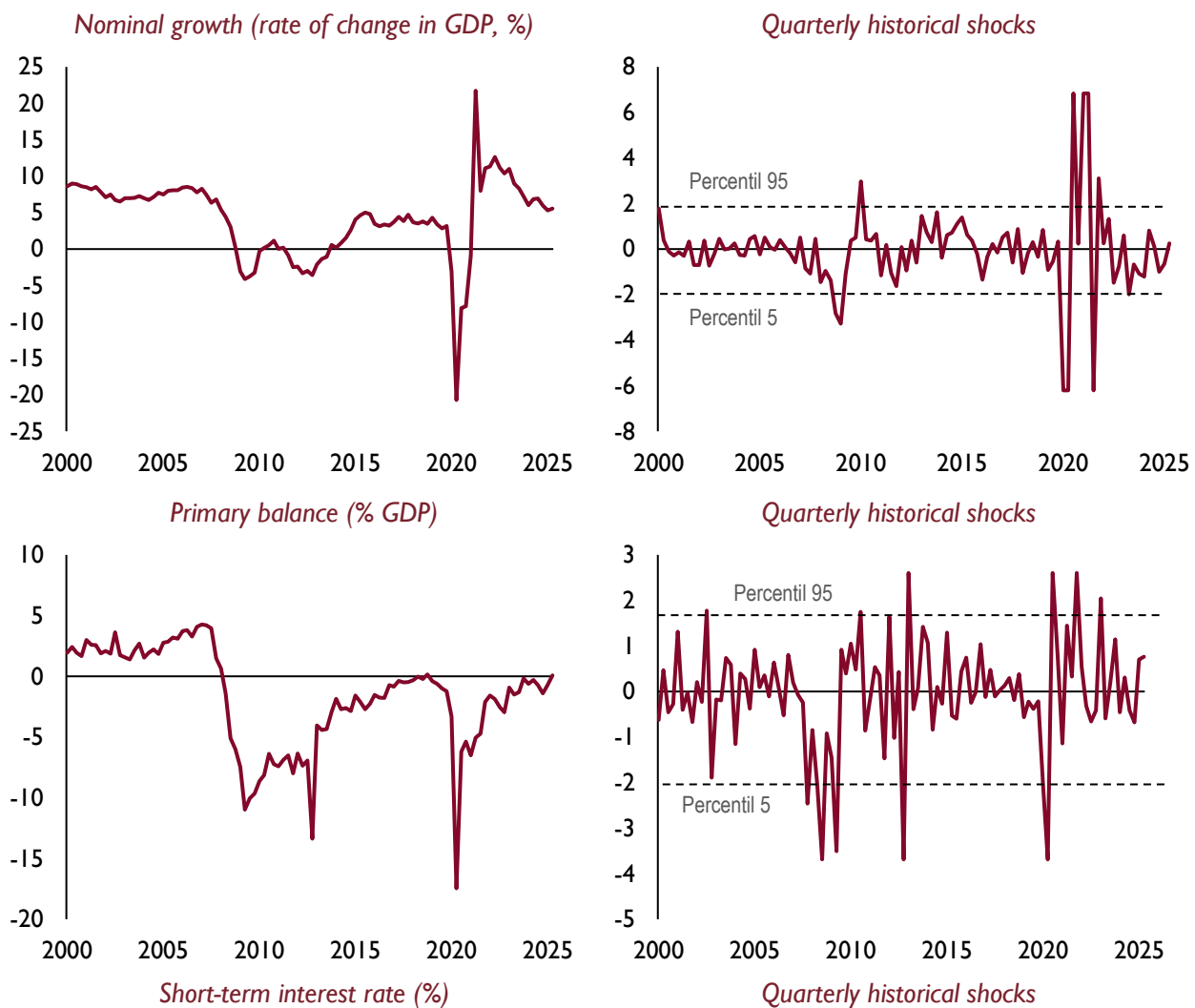
Data

Following European Commission methodology, the quarterly series³ forming part of the public debt dynamics equation are used: **primary deficit as a percentage of GDP** (pb_q Eurostat), **nominal GDP growth** (g_q Eurostat), **short-term nominal interest rate** ($IRST_q$ OECD), and **long-term nominal interest rate** ($IRLT_q$ ECB). The sample runs from 2000:Q1 to 2025:Q2 and is winsorised between the 5th and 95th percentiles, replacing outliers with the closest value.

Each quarterly series (x_q) is transformed into a series of quarterly historical shocks (Δx_q), defined as the first quarterly difference:

$$\Delta x_q = x_q - x_{q-1} \quad (1)$$

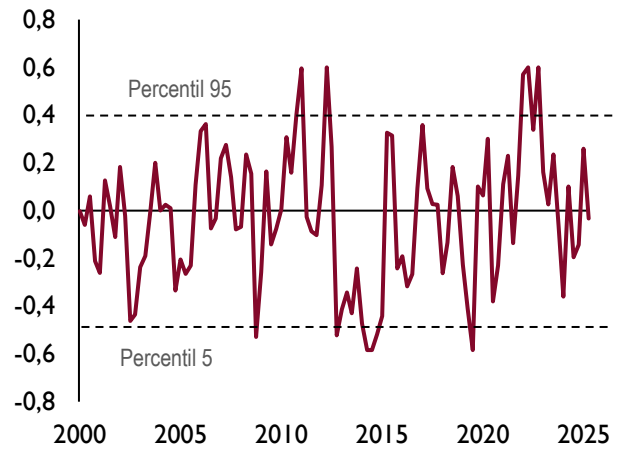
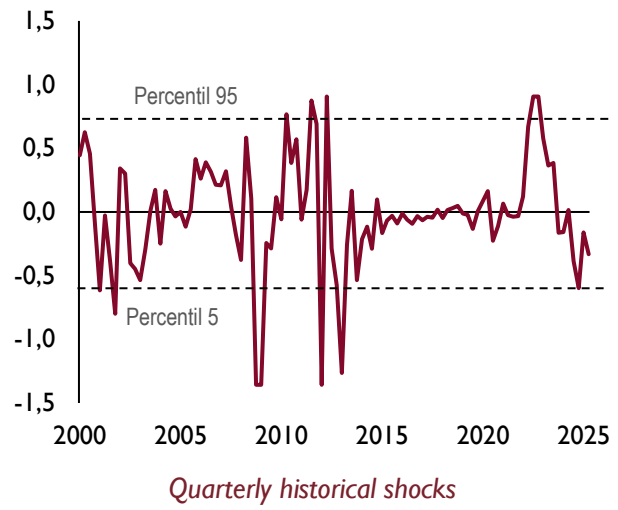
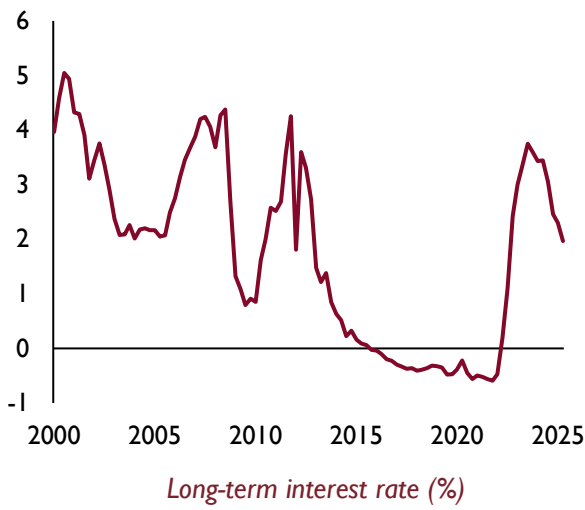
Where $x_q \in \{pb_q, g_q, IRST_q, IRLT_q\}$ in the quarter (q).



¹ *Stochastic public debt projections using the historical variance-covariance matrix approach for EU countries*, Economic Papers 480, April 2013

² *The Stochastic Simulations of the Commission's Debt Sustainability Analysis: A Refined Approach*, European Commission Discussion Paper, No. 226

³ See Annex A4 of the *Debt Sustainability Monitor of 2024*.



Source: . Eurostat, AIReF and Refinitiv

Consideration of the persistence of shocks

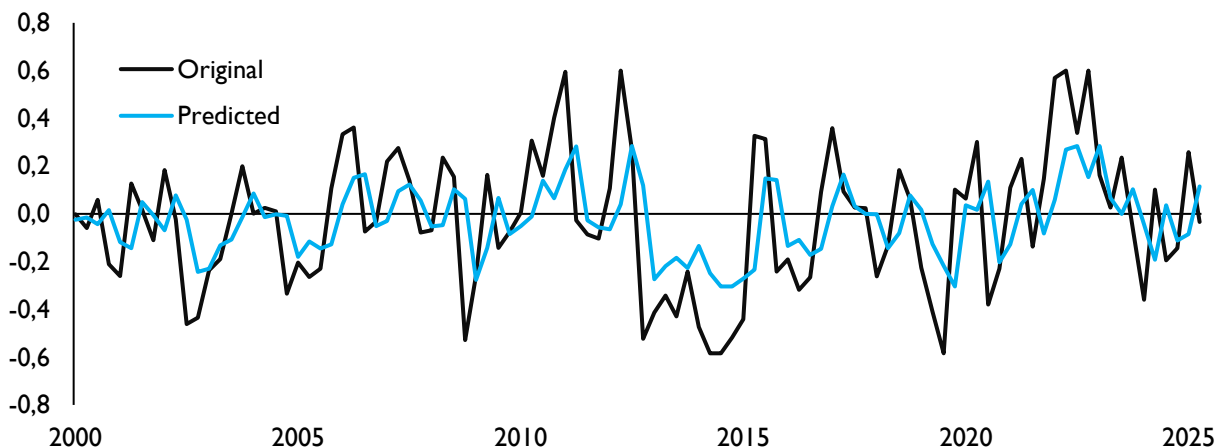
The previous methodology calculated the variance-covariance matrix of shocks. This matrix was introduced into a zero-mean multivariate normal distribution from which random shocks were simulated using Monte Carlo methods. This approach would have two limitations: (1) absence of autocorrelation and (2) dependence on a Gaussian distribution.

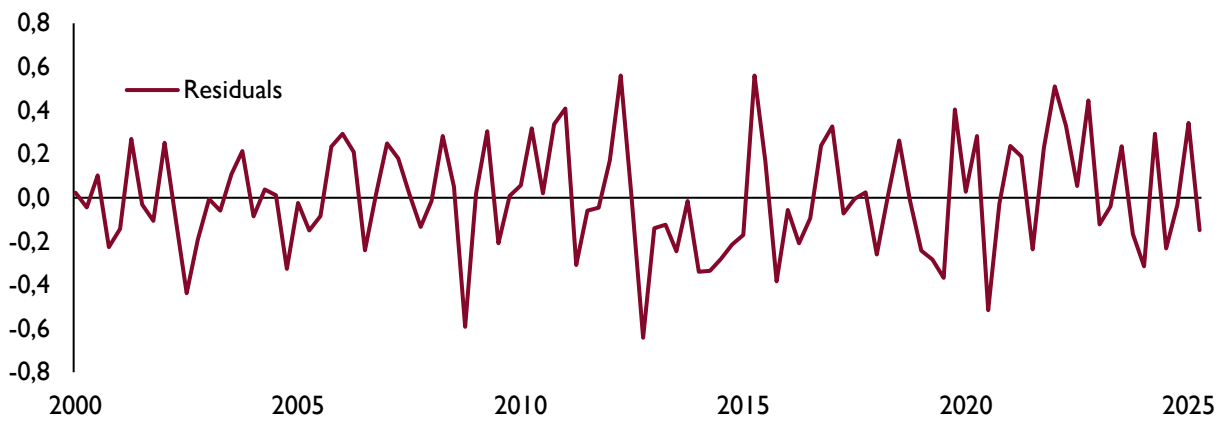
The new approach filters the shocks by using OLS to estimate an autoregressive process $AR(p)$ as described in equation 2. The lag order (p) is chosen according to the Ljung-Box statistical test to achieve stationarity of the residuals. For Spain, the lag order is 1 for all variables except growth, where it is 4.

$$\Delta x_q = \hat{c} + \hat{\rho}_1 \Delta x_{q-1} + \dots + \hat{\rho}_p \Delta x_{q-p} + \hat{\varepsilon}_q^x \quad (2)$$

Once the model has been estimated for each variable, the adjusted residuals ($\hat{\varepsilon}_q^x$) are computed. The chart shows, for IRLT, the historical shock (black), the model fit (blue), and the adjusted residual (red).

AR (1) model for IRLT: original, fit, and residuals





Source: AIReF

Shock generation

The previous methodology derived shocks from a multivariate normal distribution. The new approach performs a bootstrap by extracting shocks from the joint distribution of the adjusted residuals ($\hat{\varepsilon}_q^x$). To maintain the contemporaneous (cross-sectional) correlation, the bootstrap is performed row by row.

$$\begin{bmatrix} \hat{\varepsilon}_1^{irst} & \hat{\varepsilon}_1^{irlt} & \hat{\varepsilon}_1^g & \hat{\varepsilon}_1^{pb} \\ \hat{\varepsilon}_2^{irst} & \hat{\varepsilon}_2^{irlt} & \hat{\varepsilon}_2^g & \hat{\varepsilon}_2^{pb} \\ \vdots & \vdots & \vdots & \vdots \\ \hat{\varepsilon}_T^{irst} & \hat{\varepsilon}_T^{irlt} & \hat{\varepsilon}_T^g & \hat{\varepsilon}_T^{pb} \end{bmatrix}$$

To obtain 5 years of simulated residuals, 20 rows (i.e. 20 quarters) are sampled with replacement. This process is repeated a large number of times—(S) specifically 20,000. In other words, from the adjusted residuals matrix, which runs from 2000:Q1 to 2025:Q2, 20 rows are randomly extracted with replacement, equivalent to 20 quarters or 5 years of projection. This exercise is repeated 20,000 times. This involves extracting the contemporaneous residuals of all variables simultaneously, which allows the empirical co-movements of the variables to be broadly preserved in the simulation, as shown by the historical correlation matrix and its similarity to the correlation matrix of the simulated residuals.

Historical residual correlation					Simulated residual correlation				
	G	STIR	LTIR	PB		G	STIR	LTIR	PB
G	1	0.0	0.0	0.5	G	1	0.2	0.2	0.4
STIR	0.0	1	0.4	-0.1	STIR	0.2	1	0.4	-0.1
LTIR	0.0	0.4	1	-0.1	LTIR	0.2	0.4	1	-0.2
PB	0.5	-0.1	-0.1	1	PB	0.4	-0.1	-0.2	1

Source: AIReF

Reconstruction of the series

By introducing the (S) simulated adjusted residuals ($\hat{\varepsilon}_q^x$) into the model $AR(p)$ (equation 2), the (S) simulated shock trajectories for the following 20 quarters are obtained ($\Delta\tilde{x}_q$) recursively.

Stochastic projection of STIR with 100 simulated paths

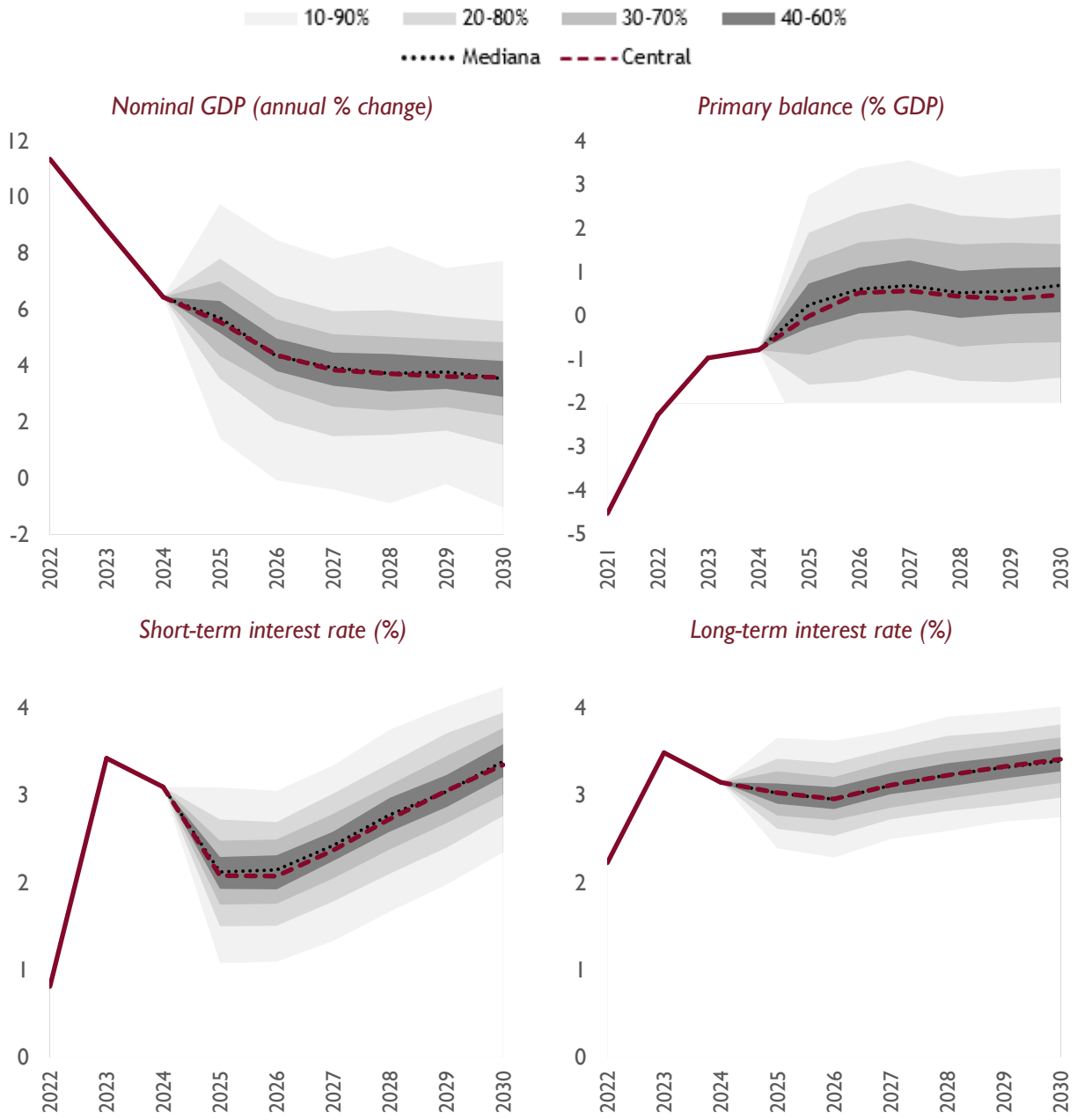


Note: the chart shows the first 100 of the 20,000 simulated trajectories.

Source: AIReF

These series are aggregated to annual frequency by summing. Finally, the path for each variable is simulated by adding the simulated shocks to the baseline or deterministic scenario.

Determinant variables of the debt equation, with their central path and probability bands



Twenty thousand trajectories are projected for each of the variables involved in the dynamics of the debt equation, with the exception of the stock-flow adjustment. These simulations yield 20,000 possible paths for the debt ratio, which can be used to construct its probability cone. This cone has an asymmetric distribution, skewed towards less favourable scenarios, and widens over time, reflecting increasing uncertainty over the projection horizon.

