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Abstract

Servicing the Japanese government debt will cost more than 31 trillion yen in Fiscal Year 2026. This comprises 26% of government expenditures. The interest rate on Japanese government bonds (JGB) is thus important. Finance theory teaches that assets' required returns depend on their risk characteristics. Assets whose returns covary positively with stocks are riskier and must offer higher expected returns. From 2007 to 2021 JGB returns covaried negatively with Japanese stock returns. As the Russia-Ukraine war and the U.S. Iran war stoked inflation, however, Japanese bond-stock comovements turned positive. The Eurozone and the U.S. exhibited similar bond-stock covariances as Japan did. This indicates that global supply shocks that raised energy prices and stoked inflation increased the riskiness of sovereign bonds throughout the developed world. Japan will not be able to prevent global supply shocks that raise oil prices and inflation. It should instead encourage businesses to reduce their exposure to fossil fuels and to choose environmentally friendly production methods. It should also invest in technologies to improve wind, solar, and hydro power and reduce Japan's exposure to increases in the prices of food, fertilizers, and commodities.

Keywords: Bond-Stock Comovements, Bank of Japan, Inflation

JEL classification: G1, G12

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1. Introduction

Japanese government debt is forecasted to reach 1,344 trillion yen by the end of fiscal year 2026 (FY2026).[1] The government will also have to issue more than 30 trillion yen of new bonds in FY2026. This will cover 24% of government revenues.

The budget shortfall may grow in the future. Under the *Honebuto no Hoshin*, Prime Minister Takaichi plans to increase spending to stimulate productivity growth. She may also lower the consumption tax on food and beverages and provide assistance to consumers struggling with higher food costs.

Servicing the debt is forecasted to cost more than 31 trillion yen in FY 2026 (Ministry of Finance, 2026). This comprises 26% of government expenditures. Given massive debt and the possibility that it might grow, the costs of servicing the debt are of particular moment.

The Bank of Japan (BoJ) has pursued low interest rates and reflation. Between 2013 and 2023 it increased the monetary base four time. In 2016 it fixed the overnight interest rate at -0.1% and kept the ten-year Japanese government bond (JGB) rate close to zero. As the Russia-Ukraine war that began in February 2022 stoked inflation, the BoJ began normalizing interest rates. In 2024 it raised its target for the overnight call rate. From below zero, the overnight call rate has increased to 1.25% in 2026. The BoJ also allowed the 10-year JGB rate to increase. As Figure 1 shows, by August 2026 it has approached 3%.

In a normal environment, bond interest rates are determined by their risk characteristics. As bonds become riskier, the returns that investors require to hold them will increase. Macroeconomic drivers of risk include factors such as inflation, monetary policy, and debt levels. The modern theory of finance highlights that an asset's riskiness depends on its

[1] This paragraph draws on Ministry of Finance (2026).

covariance with the stochastic discount factor (SDF) (see e.g., Campbell, 2014). As discussed in the next section, when the SDF is high investors will value consumption more. Assets that pay off more at these times are less risky and can offer lower expected returns.

Stocks offer high expected returns. For this reason they are assumed to covary negatively with the SDF (see Campbell et al., 2026). By examining how bonds covary with stocks, it is possible to learn about their risk characteristics. Until 2022, JGBs were negatively correlated with stocks. Then as inflation rose and the BoJ implemented contractionary monetary policy, JGBs were positively correlated with stocks in 2022 and 2023. The covariance then turned negative. In 2026 sought to fight inflation by raising its policy rate to the highest level since 1995. This may have contributed to JGBs comoving positively with bonds in 2026Q2.[2]

To investigate whether the changing risk characteristics reflected Japan-specific factors or global factors, bond-stock comovements are also examined for the U.S. and the Eurozone. The patterns is the U.S. and the Eurozone mirror those in Japan. Bond-stock comovements were negative until 2022 and then turned positive. They became negative again and then became positive in 2026Q2. This indicates that worldwide factors are influencing the riskiness of JGBs. Prime among these are supply shocks from the Russia-Ukraine and the U.S.-Iran wars that raise inflation and generate anti-inflationary monetary policy. Japan cannot prevent global shocks that raise oil prices. It should instead encourage businesses to reduce their exposure to fossil fuels and to choose environmentally friendly production methods. This can help reduce the inflationary impact of higher energy prices.

[2] Capital flight could also cause bonds and stocks to move together. This is seen in the UK and other countries.

The next section examines the relationship between bond-stock comovements and the stochastic discount factor. Section 3 presents the data, methodology, and results. Section 4 concludes.

2. Bond-Stock Comovements and the Stochastic Discount Factor

Consider an asset that pays out X(s) in state *s* where *s* extends from 1 to S.[3] Campbell (2014) demonstrated that the absence of arbitrage implies that the asset's price P(x) is given by:

$$P(X) = \sum_{s=1}^{S} q(s)X(s), \quad (1)$$

where q(s) is the price of a contingent claim that pays 1 in state s and zero otherwise. Multiplying and dividing equation (1) by the probability of state *s* occurring (π(s)) yields:

$$P(X) = \sum_{s=1}^{S} \pi(s)X(s)q(s)/\pi(s) = \sum_{s=1}^{S} \pi(s)X(s)M(s) = E(MX), \quad (2)$$

where M(s) = q(s)/π(s) is the stochastic discount factor (SDF). As Campbell (2014) showed, for a riskless asset whose payoff X(s) equals 1 in every state, equation 2 implies:

$$P_f = \sum_{s=1}^{S} q(s) = E(M), \quad (3)$$

The riskless interest rate, r_f, is then given by:

$$1 + r_f = \frac{1}{P_f} = \frac{1}{E(M)} \quad (4)$$

[3] This section draws on Campbell (2014) and Campbell, Pflueger, and Viceira (2026).

Campbell (2014) presented a two-period model where consumers have rational expectations and choose consumption in the initial period C_0 and in every state of the second period C(s). Consumers are assumed to maximize a time-separable utility function:

$$u(C_0) + \sum_{s=1}^{S} \beta\pi(s)\, u\big(C(s)\big) \quad , \qquad (5)$$

subject to:

$$C_0 + \sum_{s=1}^{S} q(s)\,\big(C(s)\big) = W_0 \quad , \qquad (6)$$

where W_0 is initial wealth. Campbell showed that the first order condition implies:

$$M(s) = \frac{q(s)}{\pi(s)} \;=\; \frac{\beta u'(c(s))}{u'(c_o)} \quad . \qquad (7)$$

Equation (7) indicates that the SDF M(s) increases as the marginal utility in state *s* (u'(c(s))) rises. Marginal utility is higher when consumption is lower. Thus the SDF is higher in states when consumption is lower. An asset whose return covaries positively with the SDF pays off more when consumption is lower and thus yields more utility. Intuitively such an asset is less risky.

Assuming that assets are priced in period t and pay out in period t+1, equation (2) can be rewritten:

$$P_{i,t} = E_t\big(M_{t+1}X_{i,t+1}\big) = E_t\,(M_{t+1})E_t(\,X_{t+1}) + cov_t(M_{t+1}X_{t+1}) \quad . \qquad (8)$$

Dividing through by $P_{i,t}$ (assuming $P_{i,t}$ is positive), replacing $X_{i,t+1}/P_t$ by $1+R_{i,t+1}$, and $E(M_{t+1})$ by $1/(\,1+R_{f,t+1})$, Campbell (2014) showed that equation (8) can be rewritten as:

$$E_t\big(R_{i,t+1} - R_{f,t+1}\big) = -\big(1 + R_{f,t+1}\big)cov_t\big(M_{t+1}, R_{i,t+1} - R_{f,t+1}\big), \qquad (9)$$

where $R_{i,t+1}$ is the realized return on asset *i* in period t+1. Equation (9) says that the excess expected return on an asset over the risk-free rate declines as the asset's excess return in more

positively correlated with the SDF. Such an asset can offer a lower expected return since it is less risky.

From equation (9) it is straightforward to derive an asset's Sharpe ratio (the ratio of its excess expected return over the risk-free rate divided by the standard deviation of its excess return over the risk-free rate:

$$\frac{E_t(R_{i,t+1} - R_{f,t+1})}{\sigma_t(R_{i,t+1} - R_{f,t+1})} = -Corr_t\left(M_{t+1}, R_{i,t+1} - R_{f,t+1}\right)\frac{\sigma_t(M_{t+1})}{E_t M_{t+1}} \ , \qquad (10)$$

where σ_t represents the standard deviation and $Corr_t$ represents the Pearson correlation coefficient. Since stocks have high Sharpe ratios, they tend to be negatively correlated with the SDF. Campbell et al. (2026) thus treated the correlation of other assets with stocks as a proxy for their correlation with the SDF. In particular, if bond prices comove positively with stock prices, they are riskier and thus have a higher Sharpe ratio.

Campbell et al. (2026) showed that the covariance between the log of the SDF (m_{t+1}) and the log of the real return on a two-period nominal bond between *t* and *t+1* ($r_{nom,2,t+1}$) depends on the covariance between m_{t+1} and the sum of the log of the real return on a one-period real bond between *t+1* and *t+2* ($r_{,1,t+2}$), the log of the inflation rate between *t* and *t+1* ($infl_{t+1}$) and the conditional expectation at time *t+1* of the inflation rate between *t+1* and *t+2* ($E_{t+1}infl_{t+2}$):

$$cov_t(m_{t+1}, r_{nom,2,t+1}) = -cov_t(m_{t+1}, r_{1,t+2} + infl_{t+1} + E_{t+1}infl_{t+2}) \ . \quad (11)$$

Equation (11) indicates that, when current and expected inflation are negatively correlated with the SDF, the real return on a two-period bond is positively correlated with the SDF. In this case bonds pay off more when the payoffs are most valued by investors. Because of this they can offer a lower risk premium and a lower expected return. The behavior of bond returns in this case is the opposite of the behavior of stock returns and bond-stock comovements

will be negative. On the other hand, if inflation is positively correlated with the SDF, bonds will be risky as stocks are and will require a higher expected return. The behavior of bond returns in this case mirrors stock returns and bond-stock comovements will be positive.

In consumption-based asset pricing models, innovations in the SDF are related to innovations in current and future consumption. With Epstein-Zin (1989) preferences and assumptions about the coefficient of relative risk aversion, the intertemporal elas-ticity substitution, and the time discount factor, Campbell et al. (2026) showed that innovations in the SDF are negatively related to innovations in current and future consumption. Interpreting stocks as a claim on consumption, stocks under plausible assumptions will have a strong negative correlation with the SDF. Campbell et al. then demonstrated that nominal bonds will covary positively with stocks when innovations in current and expected inflation are negatively correlated with innovations in current and expected consumption growth. In other words, stock and bond prices move together when inflation is countercyclical.

Pflueger (2025) endogenized consumption and production decisions within a three-equation New Keynesian model. She employed a consumption Euler equation, a Phillips Curve, and a monetary policy rule equation. She solved for the dynamics of the output gap, wage inflation, and the nominal risk-free rate as functions of shocks to the three equations. Price inflation then depends on wage inflation and productivity.

Pflueger (2025) calibrated her model over two periods, one centered around the 1980s and the other after 2000. In the first period, supply shocks were volatile and the monetary policy rule assigned a high weight to inflation. In the second period, demand shocks dominated, supply shock volatility was lower, and monetary policy assigned less weight to fighting inflation.

Consistent with historical experience, the bond-stock comovements generated during the first period are positive and the bond-stock comovements during the second period are negative.

Pflueger (2025) then ran a counterfactual scenario to try to obtain positive bond-stock comovements using the calibration from the 2000s. She reported that sup-ply shock volatility is necessary but not sufficient to generate the large positive bond-stock betas observed in the 1980s. Monetary policy also has to assign a high weight to inflation. Intuitively, if monetary policy allows the real rate to decrease following a negative supply shock, the economy will avoid a recession. Thus, while bond prices fall due to inflation, stock prices do not fall because monetary policy cushions the output decline. On the other hand, if monetary policy is hawkish, the higher inflation due to the supply shock will be accompanied by a decrease in output. The higher inflation reduces bond returns and the decline in output reduces stock returns. Thus stock and bond prices will move together.

3. Data, Methodology, and Results

Bond returns are calculated from 10-year zero coupon government bond yields. Zero-coupon yields are model-based estimates (see Gürkaynak et al., 2007, and Kikuchi and Shintani, 2011). Data for Japan come from LSEG Datastream. Data for the Eurozone come from the ECB data portal. Data for the U.S. come from the online appendix to Gürkaynak et al. (2007).[4]

Bond returns are regressed on stock returns. For Japan, returns on the aggregate stock market are used. For Europe, returns on the STOXX Europe 600 are used. For the U.S., returns on the Standard and Poors' 500 are used. All the data are obtained from Datastream.

[4] The website for LSEG Datastream is https://www.lseg.com/en/data-analytics/products/datastream-macroeconomic-analysis . The website for the ECB data portal is: https://data.ecb.europa.eu . The website for the Gürkaynak et al (2007) data is https://www.federalreserve.gov/econres/feds/2006.htm .

Japanese zero-coupon data are available from the end of 2006. The model is thus estimated over the 1 January 2007 to 30 June 2026 period. Regressions are performed using daily data for each quarter between 2007Q1 and 2026Q2. The estimated equations take the form:

$$R_{10,t,i} = \beta_0 + \beta_1 S_{t,i} \ , \qquad (1)$$

where $R_{10,t,i}$ is the return on a 10-year zero coupon bond in region *i* (either Japan, the Eurozone, of the U.S.) at time *t* and $S_{t,i}$ is the return on the aggregate stock market in region *i* at time *t*.

Figure 2 plots all of the quarters between 2007Q1 and 2026Q2 when the coefficient β_1 for Japan is significant at at least the 10% level. In 44 of the 60 quarters between 2007Q1 and 2021Q4 the betas are negative and statistically significant at at least the 10% level. They are never positive and statistically significant during this period. This indicates that investors priced JGBs as safe assets during this period.

In 2022Q4 bond-stock betas turned positive for the first time. The following quarter the beta becomes negative again and takes on the largest negative value over the sample period. In 2023Q3 and 2023Q4 they became positive again. They reverted to being negative in six quarters between 2024Q3 and 2025Q4. Then in 2026Q2 they became positive again.

Figure 3 plots all of the quarters between 2007Q1 and 2026Q2 when the coefficient β_1 for the Eurozone is significant at at least the 10% level. In 36 of the 61 quarters between 2007Q1 and 2022Q1 the betas are negative and statistically significant at at least the 10% level. They are never positive and statistically significant during this period. This indicates that investors priced Eurozone government bonds as safe assets during this period.

In 2022Q3 Eurozone bond-stock betas turned positive for the first time. In nine of the 16 quarters between 2022Q3 and 2026Q2, they are positive. In only three of the quarters are the betas negative. Investors thus priced Eurozone bonds as risky assets after 2022Q2.

Figure 4 plots all of the quarters between 2007Q1 and 2026Q2 when the coefficient β_1 for the U.S. is significant at at least the 10% level. In 46 of the 60 quarters between 2007Q1 and 2021Q4 the betas are negative and statistically significant at at least the 10% level. They are never positive and statistically significant during this period. This indicates that investors priced U.S. government bonds as safe assets during this period.

In 2022Q3 bond-stock betas turned positive for the first time. In six of the 16 quarters between 2022Q3 and 2026Q2, U.S. bond-stock betas are positive. In only two of the quarters are the betas negative. Investors thus priced U.S. bonds as being riskier assets after 2022Q2.

Figure 5 examines whether global factors contributed to Japanese betas becoming positive in 2022-2023 and 2026. The figure plots bond-stock betas for Japan, the Eurozone, and the U.S. together. For all three regions the betas are negative or insignificant up to the end of 2021. Then in 2022 and 2023 positive betas appear in all three regions. In Japan the betas turned negative again in 2024. In the U.S. and especially in Europe there were many positive betas beginning in 2022. In 2026Q2 betas were positive for all three regions.

Figure 6 sheds light on why there were more positive betas in the U.S. and Europe after the pandemic as compared to Japan. The figure plots the consumer price index inflation rate. Inflation peaked at over 10% in the Eurozone, at almost 9% in the U.S., but at only 4.3% in Japan. Higher inflation in both the Eurozone and the U.S. increased the riskiness of their bonds relative to Japanese bonds.

Anti-inflationary monetary policy was also more aggressive in the Eurozone and the U.S. relative to Japan. Between July 2022 and September 2023, the European Central Bank raised the Deposit Facility Rate from -0.5% to 4.0%, the Main Refinancing Operations rate from 0% to 4.5%, and the Marginal Lending Facility Rate from 0.25 to 4.75. The Federal Reserve raised the

federal funds rate target from close to zero in March 2022 to almost 5.5% in August 2023. By contrast the BoJ did not raise the overnight call rate above zero until March 2024. It did, though, allow ten-year JGB yields to increase from close to zero at the beginning of 2022 to 1% by November 2023 and to close to 3% by August 2026. The combination of higher inflation and more contractionary monetary policy in the Eurozone and the U.S. compared to Japan explains why government bonds in the Eurozone and the U.S. exhibited more positive bond-stock comovements than Japan did beginning in 2022.

The finding that bond-stock comovements in the Eurozone, Japan, and the U.S. all turned positive beginning in 2022 indicates that common factors are making government bonds throughout the developed world more risky. Prime among these are inflation initiating from global supply shocks and disinflationary monetary policy.

4. Conclusion

General JGBs outstanding are projected to reach 1,145 trillion yen by the end of FY 2026 (Ministry of Finance, 2026). Interest payments on the debt in FY 2026 will comprise 26% of government expenditures. With the advent of Prime Minister Takaichi's *Honebuto no Hoshin*, Japanese government deficits and debt may increase. The cost of servicing the debt is thus crucial.

Interest rates on government bonds depend on their risk characteristics. Finance theory holds that an asset's riskiness depends on its correlation with the SDF. Stocks must offer a higher expected return to be willingly held. This provides *prima facie* evidence that stocks covary negatively with the SDF and are thus risky. If bonds comove negatively with stocks, they are less risky assets and will be held at a lower expected return. If bonds comove positively with stocks, they are riskier and must offer investors a higher expected return.

In 44 of the 60 quarters between 2007Q1 and 2021Q4, Japanese bond-stock betas are negative and statistically significant at at least the 10% level. They are never positive and statistically significant during this period. This indicates that investors priced JGBs as safe assets during this period. Then in 2022Q4 bond-stock betas turned positive for the first time. In 2023Q3 and 2023Q4 they became positive again. They were negative and statistically significant in seven quarters between 2023Q1 and 2025Q4. In 2026Q2 bond-stock comovements became positive again.

A similar pattern emerged in the Eurozone and the U.S. Bond-stock betas were frequently negative and statistically significant between 2007 and 2021 and never positive and significant. They then turned positive in 2022Q3 as inflation rose and the ECB and Fed implemented contractionary monetary policy. Between 2023Q3 and 2026Q2 bond-stock betas in the Eurozone were positive and significant in nine quarters and negative and significant in three. In the U.S. over this period betas were positive in six quarters and negative in two. The greater riskiness of Eurozone and U.S. bonds compared to Japanese bonds since 2022 reflects the fact that inflation rose twice as high in the Eurozone and the U.S. compared to Japan. It also reflects the fact that central banks fought inflation more aggressively in the Eurozone and the U.S. than in Japan.

The similar bond-stock comovements in the Eurozone, Japan, and the U.S. beginning in 2022 when the Russia-Ukraine war stoked inflation and in 2026 when the U.S.-Iran war stocked inflation indicates that global factors roiled bond markets across the developed world. Japan will not be able to stop global supply shocks that raise oil prices and inflation. It should instead encourage businesses to reduce their exposure to fossil fuels and to choose environmentally friendly production methods. It should also invest in technologies to improve wind, solar, and hydro power. Finally it should seek to reduce Japan's exposure to increases in the prices of food,

fertilizers, and other commodities, These steps will reduce the inflationary impact of adverse supply shocks.[5]

[5] Supply shocks may be driven by more than oil prices. For instance, after the Russia-Ukraine War started the prices not only of oil but also of fertilizers and food increased. However, Beattie (2026) has shown that the shock from the U.S.-Iran War is mainly due to oil price increases rather than increases in fertilizer and food prices.



Figure 1. Yield on Ten-Year Zero-Coupon Japanese Government Bonds.
Source: CEIC Database.

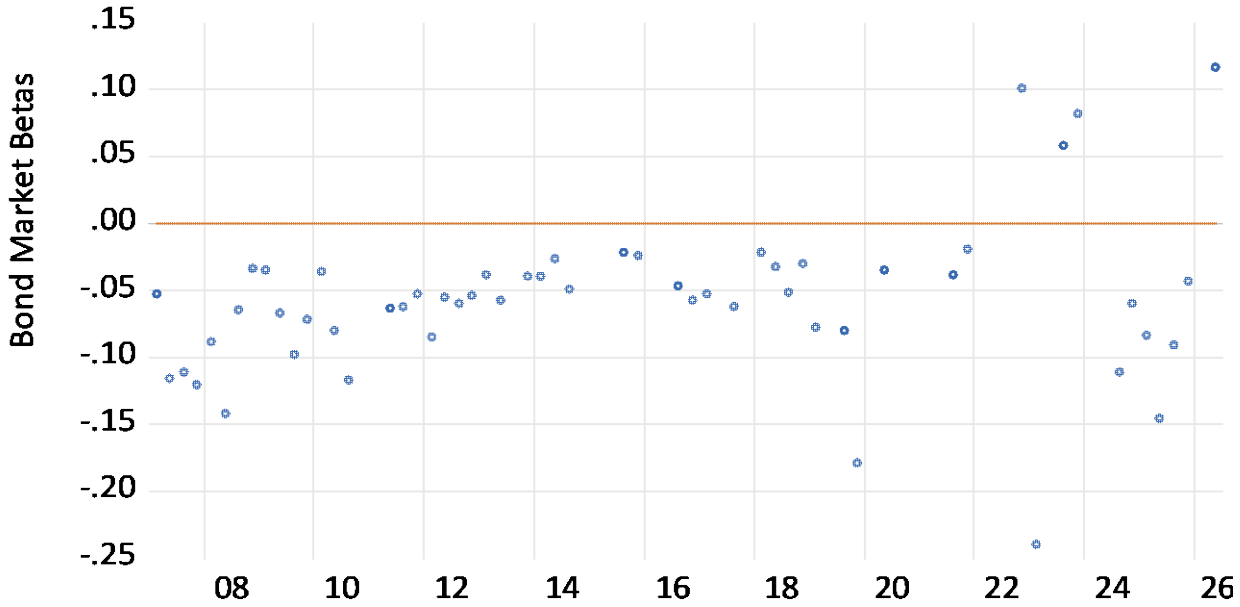


Figure 2. Beta Coefficients for Returns on Ten-Year Zero-Coupon Japanese Government Bonds.

Notes: The figure presents regression coefficients from regressing daily returns on 10-year zero-coupon Japanese nominal government bonds on daily returns on the Japanese aggregate stock market. The regressions are performed quarterly between 2007Q1 and 2026Q2. The figure reports all of the regression coefficients that are significant at at least the 10% level using heteroskedasticity and autocorrelation consistent standard errors.

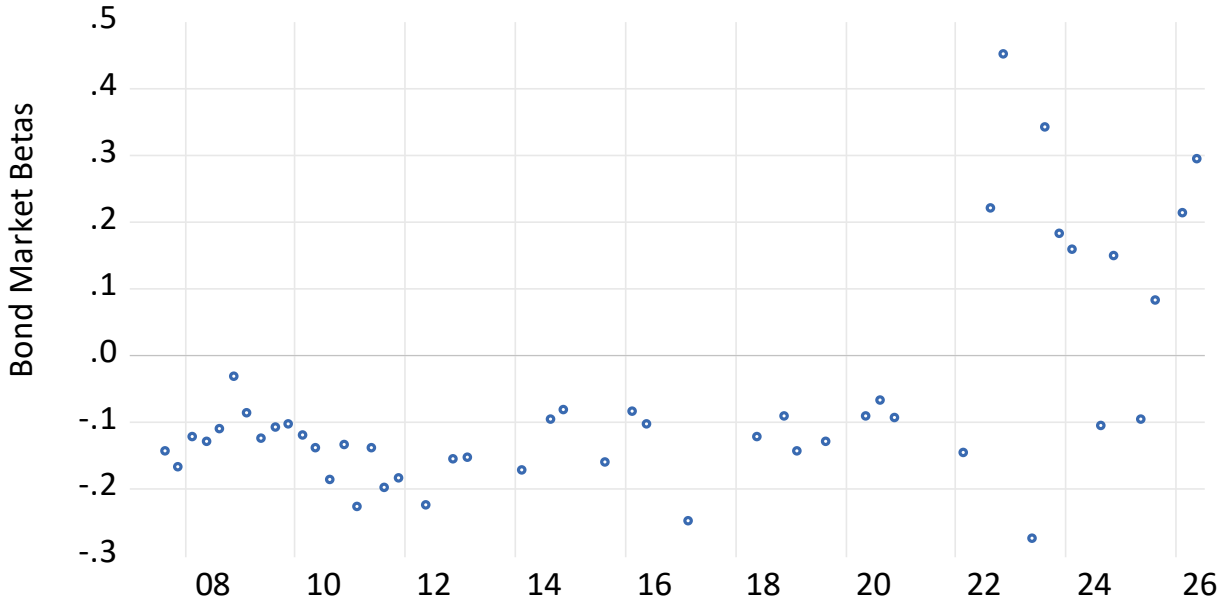


Figure 3. Beta Coefficients for Returns on Ten-Year Zero-Coupon Eurozone Government Bonds.

Notes: The figure presents regression coefficients from regressing daily returns on 10-year zero-coupon Eurozone nominal government bonds on daily returns on the STOXX Europe 600 stock market. The regressions are performed quarterly between 2007Q1 and 2026Q2. The figure reports all of the regression coefficients that are significant at at least the 10% level using heteroskedasticity and autocorrelation consistent standard errors.

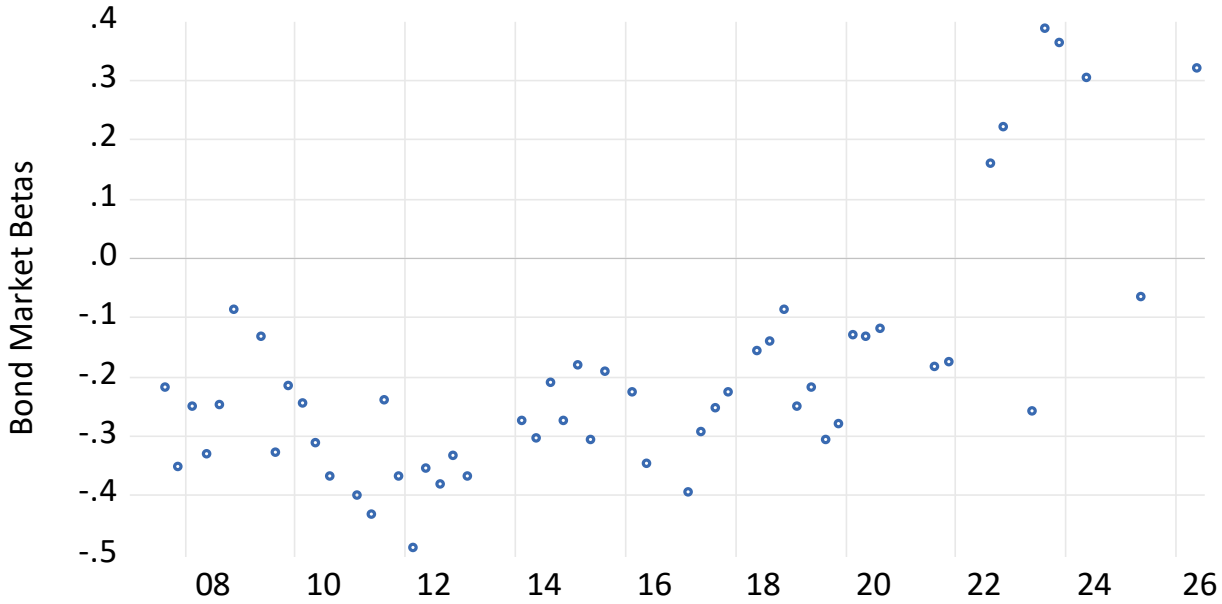


Figure 4. Beta Coefficients for Returns on Ten-Year Zero-Coupon U.S. Government Bonds.

Notes: The figure presents regression coefficients from regressing daily returns on 10-year zero-coupon Treasury bonds on daily returns on the S&P 500 Index. The regressions are performed quarterly between 2007Q1 and 2026Q2. The figure reports all of the regression coefficients that are significant at at least the 10% level using heteroskedasticity and autocorrelation consistent standard errors.

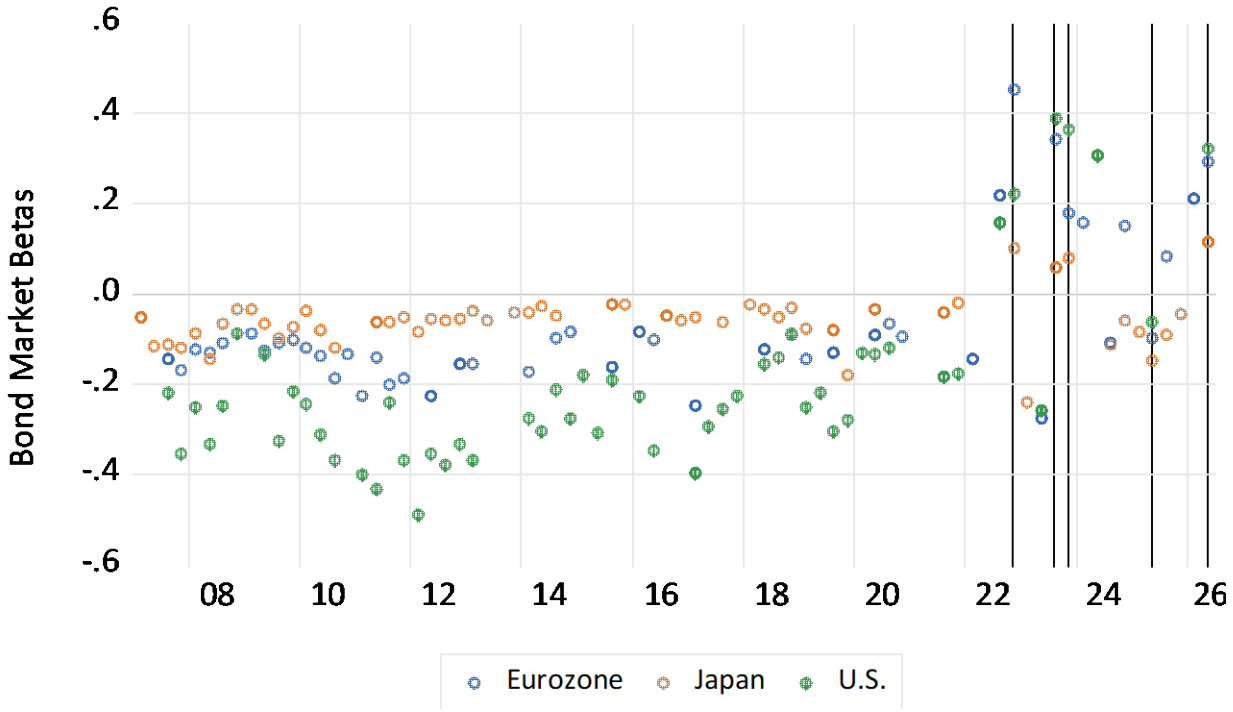


Figure 5. Beta Coefficients for Returns on Ten-Year Zero-Coupon Eurozone, Japan, and U.S. Government Bonds.
Notes: The figure presents regression coefficients from regressing daily returns on 10-year zero-coupon nominal government bonds for the Eurozone, Japan or the U.S. on daily returns on either Eurozone, Japan, or U.S. aggregate stock markets. The regressions are performed quarterly between 2007Q1 and 2026Q2. The figure reports all of the regression coefficients that are significant at at least the 10% level using heteroskedasticity and autocorrelation consistent standard errors. The vertical lines represent quarters beginning in 2022Q4 when betas for all three regions were of the same signs and statistically significant.

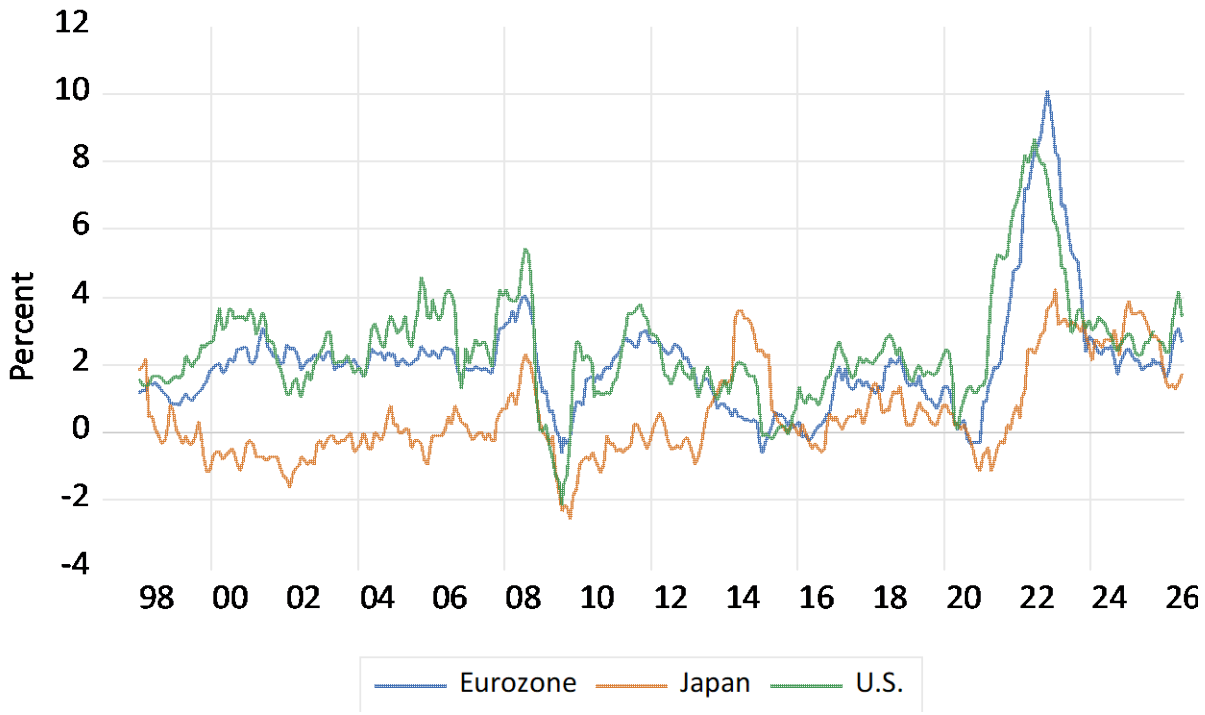


Figure 6. Consumer Price Inflation Rates for the Eurozone, Japan, and the U.S.
Notes: The figure presents the difference in the log of the consumer price index and the log of the consumer price index lagged 12 months.
Source: Federal Reserve Bank of St. Louis FRED database and the CEIC database.

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