



Study on the Forecasting of Chinese Government Bond Yields Based on Macroeconomic Factors and Principal Component Analysis: A Comparative Analysis of Domestic and Overseas Factors

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Abstract. This paper constructs a government bond yield forecasting model that incorporates both domestic and international macroeconomic factors. Principal component analysis is used to extract the yield curve shape as a control variable. By comparing the regression results of the domestic factor model, the international factor model, and the full model, this study examines the impact of domestic and international factors on government bond yields. The findings reveal that China's policy interest rate is significantly positive, while the year-on-year CPI is significantly negative, making them the core determinants of government bond yield fluctuations. Global liquidity becomes positive and significant after controlling for domestic factors, suggesting a clear international spillover effect. The full model demonstrates superior goodness of fit and overall significance compared to single-factor models.

Keywords: Government bond yields, Principal component analysis, Macroeconomic factors, International spillover effects

1 Introduction

As a fundamental interest rate indicator in financial markets, government bond yields serve not only as a key reference for bond pricing but also as a crucial channel for monetary policy transmission. Accurately forecasting changes in government bond yields is important for investors optimizing portfolios and for policymakers gauging market expectations.

Based on quarterly data from 2006 to 2025, this paper constructs a comprehensive forecasting model that incorporates domestic macroeconomic factors (GDP growth rate, year-on-year CPI, year-on-year M2, and policy interest rates) and overseas macroeconomic factors (average M2 growth rates and average GDP growth rates of the United States, the United Kingdom, Germany, and Japan). We use Principal Component Analysis (PCA) to extract three orthogonal factors—level, slope, and curvature—from the yields of 1-, 3-, 5-, 7-, and 10-year Chinese government bonds. These factors serve as control variables for the shape of the yield curve. On this basis, three

comparison models were established—the domestic factor model, the foreign factor model, and the full model. We estimate the models using Ordinary Least Squares (OLS) with Newey-West HAC robust standard errors.

The empirical results indicate that: First, China's policy interest rate is significantly positive at the 5% level, while the year-on-year CPI is significantly negative at the 5% level; these two factors are the core determinants of changes in government bond yields, whereas GDP growth is marginally significant only at the 10% level; Second, when overseas factors are used in isolation, the model's goodness of fit is low (adjusted $R^2 = -0.01$); however, after controlling for domestic factors, global liquidity (the average M2 growth rate of four countries) is significantly positive at the 5% level, indicating that overseas monetary policy has a clear spillover effect; Third, the goodness of fit ($R^2 = 0.24$) and overall significance (F-test $p = 0.002$) of the full model are both superior to those of the single-factor model.

There are two main determinants government bond yields. The first category comprises domestic macroeconomic fundamentals, including economic growth, inflation, and monetary policy. Ludvigson and Ng (2009) found that macroeconomic factors possess significant predictive power for bond excess returns, and that this predictive power exceeds the information contained in forward rates and term spreads [1]. The second category consists of overseas factors, particularly the policy spillover effects from major developed economies. Wu Hongli et al. (2024) found that Federal Reserve monetary policy shocks significantly affect Chinese government bond yields through risk-taking and asset reallocation channels [2]; Zhuang et al. (2026), based on a network analysis of 40 economies, further demonstrated that European and American economies are the primary sources of risk spillovers in government bond markets, while Asian economies are primarily risk recipients [3]. China Merchants Securities (2025) provides a systematic review of the theoretical literature on international factors, noting that research has shifted toward the spillover effects of monetary policy in developed economies. The Bank for International Settlements has defined the current phase as the 'second stage of global liquidity'[4]. However, existing studies have largely focused on single-category factors, lacking a systematic comparison of domestic and international factors.

At the methodological level, Chen et al. (2025) further found that monetary policy uncertainty remains a significant predictor of bond excess returns even after controlling for yield curve shape, providing a theoretical basis for incorporating both curve shape and macro factors into forecasting models [5]. Diebold and Li (2006) interpreted the three parameters of the yield curve as level, slope, and curvature factors, offering an important framework for characterizing yield curve shape [6]; Du and Hong (2025) conducted an empirical study based on Chinese data that further validated the applicability of principal component analysis in the Chinese government bond market [7]. Wang Ranran (2024) extended the Nelson-Siegel model and applied it to the forecasting of Chinese government bond yields, thereby further enriching the empirical foundation of this framework in the Chinese market [8].

In this paper, we aim to address these gaps by constructing a comprehensive forecasting model that incorporates both domestic and overseas factors, based on quarterly data from 2006 to 2025. The study employs PCA to extract the structural characteristics

of the yield curve and establishes three comparative models: a domestic-factor model, an overseas-factor model, and a full model. Then, we use regression analysis to see how well each model predicts.

This paper makes three main contributions. First, it constructs a comprehensive forecasting framework that incorporates both domestic and foreign macroeconomic factors; second, it incorporates global liquidity indicators into the model, thereby addressing the existing literature's limited focus on financial variables; and third, by comparing the forecasting performance of three models, it systematically evaluates the relative importance of domestic and foreign factors on Chinese government bond yields.

2 Data, Variables and Research Methodology

2.1 Data Sources and Sample Period

Variable definitions and data sources are shown in Table 1.

Table 1. Variable Definitions and Data Sources

Variable	Country/Region	Data Source	Description
Government Bond Yields	China	China Bond Information Network	Extract 1-, 3-, 5-, 7- and 10-year maturities
GDP growth rate	China	National Bureau of Statistics of China	Year-on-year growth rate based on published quarterly GDP figures
Year-on-year CPI	China	Federal Reserve Economic Data(Fred)	
Year-on-year growth in M2	China	Fred	
China's policy interest rate	China	Fred	This paper uses China's benchmark interest rate as defined by the IMF as a proxy for the policy interest rate; this data exhibits good continuity within the sample period
Average M2 of the four countries	US/UK/Germany/Japan	Fred, calculated by the author	UK and Japan data are from their national statistical offices, and are calculated using level values, while the data for the US and Germany are taken directly from Fred.
Average GDP of the four countries	US/UK/Germany/Japan	Fred, calculated by the author	Arithmetic mean of GDP growth rates for the four countries

2.2 Variable Definitions

For the symbols and descriptions of each variable, see Table 2.

Table 2. Variable Symbols and Descriptions

Variable type	Variable name	Symbol	Definition
Dependent variable	The excess return on the 10-year government bond yield	y	Quarterly rate of change in the 10-year government bond yield minus the quarterly rate of change in the 3-month government bond yield (%)
China Domestic factor	GDP growth rate	GDP_g	China's quarterly year-on-year GDP growth rate (%)
	Inflation	CPI_g	China's CPI quarterly year-on-year growth rate (%)
	Money Supply	M2_g	China M2 quarterly year-on-year growth rate (%)
	Monetary policy	R_policy	China's benchmark interest rate under IMF definitions
US, UK, Germany, Japan	Global Growth	GDP_g_4	Arithmetic mean of the four countries' quarterly GDP growth rates (%)
	Global liquidity	M2_g_4	Arithmetic mean of the four countries' quarterly M2 growth rates (%)
Yield curve factor	Level factor	PC1	First principal component of the Chinese yield curve (standardised score)
	Slope factor	PC2	Second principal component of the Chinese yield curve (standardised scores)
	Curvature factor	PC3	Third principal component of the Chinese yield curve (standardised scores)

It should be noted that the dependent variable is the excess return on 10-year government bonds. Following Ludvigson and Ng (2009), we approximate holding-period returns using changes in yields. Specifically, this is constructed as the quarterly rate of change in the 10-year government bond yield minus the quarterly rate of change in the 3-month government bond yield, using year-on-year rates to eliminate the interference of seasonal factors. Although this construction deviates from the strict definition, it reflects the predictive power of relative changes in long-term and short-term interest rates on excess returns whilst controlling for the shape of the yield curve.

2.3 Data Processing

Frequency Conversion.

To ensure data comparability, all variables are aligned at a quarterly frequency. We forecast the dependent variable using its one-period lag, thereby simulating a real-world forecasting scenario. After alignment, the sample comprises 78 valid quarterly observations.

Handling of Missing Values.

For the missing values of China's policy interest rate in Q3 and Q4 2025, we use the Last Observation Carried Forward (LOCF) method. These values are not truly missing;

they reflect the fact that the policy rate remained unchanged in the second half of 2025. Using the LOCF method accurately restores the true state of interest rates remaining constant during this period.

Construction of the Dependent Variable.

The dependent variable is the excess return on China's 10-year government bond yield. Year-on-year growth rates are used to eliminate the interference of seasonal factors, and the three-month risk-free rate is subtracted to strip out funding costs.

Preprocessing for Principal Component Analysis.

Prior to the principal component analysis, the yields on 1-year, 3-year, 5-year, 7-year and 10-year government bonds were standardised to eliminate the impact of dimensional differences among yields of different maturities.

2.4 Research Methodology

Principal Component Analysis.

To characterize the shape of the Chinese government bond yield curve, this paper employs Principal Component Analysis (PCA) to perform dimensionality reduction on the yields of 1-year, 3-year, 5-year, 7-year and 10-year government bonds. Prior to the PCA, the yields for each maturity were standardised (by subtracting the mean and dividing by the standard deviation) to eliminate the impact of differences in the magnitude of yield fluctuations across different maturities.

This study retains the first three principal components (PC1, PC2, PC3). Following the framework of Nelson-Siegel (1987)[9], PC1 is interpreted as the level factor, reflecting the overall shift of the yield curve; PC2 is interpreted as the slope factor, reflecting the long-short spread; and PC3 is interpreted as the curvature factor, reflecting medium-term convexity.

Following Ludvigson and Ng (2009) and Chen et al. (2025)[1][5], this study includes PC1, PC2 and PC3 as control variables in the regression model, based on the following considerations: firstly, we reduce dimensionality by compressing five highly correlated maturity variables into three orthogonal factors, thereby eliminating multicollinearity; secondly, to control for the impact of curve shape on the regression results; and thirdly, to align with international research, facilitating comparison of results.

Ordinary Least Squares (OLS).

This paper uses Ordinary Least Squares (OLS) for regression analysis. To mitigate endogeneity issues, the dependent variable is treated with a one-period lag. Given that the data consist of quarterly time series, which may exhibit heteroscedasticity and autocorrelation, this study employs the HAC robust standard error proposed by Newey and West (1987)[9], with the maximum lag order set at 2. This approach has been widely adopted in time series regression (Lazarus et al., 2018)[10], and is particularly suitable for inferences based on quarterly macroeconomic data.

Multicollinearity Test.

To avoid the issue of multicollinearity, this paper calculates the Variance Inflation Factor (VIF) for each variable before the regression. According to empirical guidelines, a VIF value greater than 10 indicates severe multicollinearity, whilst a value greater than 5 warrants attention. This paper uses these criteria to assess the degree of multicollinearity in the model.

Test for Structural Stability.

To examine whether the reform of the RMB exchange rate formation mechanism on 11 August 2015 (hereinafter referred to as the ‘811 exchange rate reform’) led to changes in the model structure, this paper employs the Chow test (Chow, 1960) using the dummy variable interaction method[11]. A dummy variable D_t , is defined, taking the value 1 for the third quarter of 2015 and thereafter, and 0 for periods prior to that. The following interaction term model is constructed:

$$y_t = \alpha + \beta X_t + \gamma D_t + \delta (D_t * X_t) + \varepsilon_t \quad (1)$$

Where X_t denotes all explanatory variables. If the coefficient of the interaction term δ is jointly significant, this indicates the presence of a structural break. Newey-West HAC robust standard errors (with a two-period lag) are employed to control for potential issues of heteroscedasticity and autocorrelation in the time-series data.

2.5 Models and Equations

This paper specifies three regression models:

Model 1: Domestic Factors Model

$$y = \alpha + \beta_1 \text{GDP} + \beta_2 * \text{CPI} + \beta_3 * \text{PC1} + \beta_4 * \text{PC2} + \beta_5 * \text{PC3} + \beta_6 * \text{PolicyRate} + \beta_7 * \text{M2_China} + \varepsilon \quad (2)$$

Model 2: Overseas factor model

$$y = \alpha + \beta_1 * \text{M2_Four} + \beta_2 * \text{GDP_Four} + \varepsilon \quad (3)$$

Model 3: Full Model

$$y = \alpha + \beta_1 * \text{GDP} + \beta_2 * \text{CPI} + \beta_3 * \text{PC1} + \beta_4 * \text{PC2} + \beta_5 * \text{PC3} + \beta_6 * \text{PolicyRate} + \beta_7 * \text{M2_China} + \beta_8 * \text{M2_Four} + \beta_9 * \text{GDP} \quad (4)$$

Where:

- y = excess return on Chinese 10-year government bonds
- GDP = China’s GDP growth rate
- CPI = Year-on-year change in China’s CPI
- PC1, PC2, PC3 = Principal components of the yield curve
- Policyrate = China’s policy interest rate

- M2_China = Year-on-year growth rate of China's M2
- M2_Four = Average year-on-year growth rate of M2 for the US, UK, Germany and Japan
- GDP_Four = Average GDP growth rate of the US, UK, Germany and Japan
- ε = random error term

3 Empirical Results and Analysis

3.1 Principal Component Analysis Results

Table 3 reports the results of the principal component analysis. The cumulative proportion of variance explained by the first three principal components reaches 99.91%, with PC1 explaining 94.67%, PC2 explaining 4.97%, and PC3 explaining 0.26%. This result indicates that changes in the Chinese government bond yield curve are almost entirely characterised by the first three principal components, which is consistent with the theoretical expectations of the Nelson-Siegel three-factor framework[9].

According to the factor loading matrix, the loadings of PC1 are positive and of similar magnitude across all maturities, reflecting a horizontal shift in the yield curve and thus interpretable as a level factor; the loadings of PC2 have opposite signs in the short and long terms, reflecting changes in the slope of the yield curve and thus interpretable as a slope factor; the loading of PC3 in the medium term is opposite to those at both ends, reflecting changes in the convexity of the yield curve and thus interpretable as a curvature factor.

These results are broadly consistent with the findings of Tang, Ge, Rong and Zhu (2003) and Cheng, Liwei et al. (2014)[12][13], validating the applicability of the Nelson-Siegel three-factor framework to the Chinese market. Incorporating PC1, PC2 and PC3 into the regression model achieves dimensionality reduction whilst capturing the morphological characteristics of the yield curve, thereby laying the groundwork for subsequent analysis.

Table 3. Proportion of variance explained by principal components

Principal Component	Percentage of variance explained (%)	Cumulative proportion of variance explained (%)
PC1	94.67	94.67
PC2	4.97	99.64
PC3	0.26	99.91

3.2 Regression Results

Table 4 reports the regression estimates for the three models. Model 1 includes only domestic factors, Model 2 includes only overseas factors, and Model 3 is the full model incorporating both domestic and overseas factors.

Table 4. Benchmark regression results

Variables	Model 1 (Domestic Factors)	Model 2 (Overseas Factors)	Model 3 (Full Model)
GDP_g	-0.81 (0.66)	-	-1.58* (0.87)
CPI_g	-1.95* (1.13)	-	-2.68** (1.04)
PC1	1.12 (0.90)	-	-2.23*** (0.85)
PC2	-10.16 (6.38)	-	-12.62** (5.29)
PC3	22.21 (25.02)	-	21.87 (21.32)
R_policy	11.81* (6.36)	-	14.25** (6.52)
M2_g	0.26 (0.69)	-	0.52 (0.69)
M2_g_4	-	-0.15 (0.82)	1.90** (0.87)
GDP_g_4	-	0.77 (1.33)	1.20 (1.60)
Constant term	-31.06 (16.06)	-2.21 (3.91)	-45.05** (18.47)
Sample size	78	78	78
R ²	0.19	0.02	0.24
Adjusted R ²	0.11	-0.01	0.14
F-statistic p-value	0.001	0.822	0.002

Note: () indicates robust standard errors; ***, **, * denote significance at the 1%, 5% and 10% levels respectively

The F-statistic for Model 3 (full model) has a p-value of 0.002, indicating that the model is jointly significant.

Domestic Inflation and Monetary Policy Are Significant.

The regression results show that the year-on-year CPI is significantly negative, indicating that when inflationary pressures rise, the market anticipates that monetary policy will become tighter, thereby leading to a decline in current government bond yields; China’s policy interest rate is significantly positive, suggesting that an increase in the policy interest rate directly pushes up government bond yields, and that the transmission mechanism of monetary policy to the bond market is effective. This finding is consistent with the existing literature. Research by Fu, Li and Xie (2025) indicates that the yield on government bonds is negatively correlated with inflation expectations, providing a theoretical explanation for the mechanism by which inflation suppresses yields through the expectations channel[14]. Empirical research by Akram and Pervin (2025), based on an ARDL model, directly verifies the significant trans-

mission effect of China's short-term policy interest rates on long-term government bond yields, confirming the validity of Keynes's theory on policy interest rate transmission in the Chinese market[15].

GDP is Marginally Significant.

China's GDP growth rate is significantly negative only at 10% significance level in the full model, indicating that economic growth has relatively limited explanatory power for government bond yields. Caitong Securities (2025) points out that GDP growth is too low-frequency and ex post; the market often trades in advance based on monthly data, high-frequency data, and policy changes, with interest rates typically reacting ahead of GDP growth[16]. This provides a reasonable explanation for the limited explanatory power of GDP growth found in this paper: market expectations have already been partially reflected in advance in the shape of the yield curve, leading to a decline in the marginal predictive power of GDP growth as a lagging variable for government bond yields.

Global Liquidity is Significant.

The coefficient for the average M2 growth rate across the four countries is 1.90, which is significant at the 5% level, indicating that monetary expansion in developed economies significantly pushes up Chinese government bond yields. It is worth noting that this variable was not significant in Model 2, but became significant after the inclusion of domestic factors. This finding is consistent with the conclusions of Wu Hongli et al. They found that Federal Reserve monetary policy shocks primarily affect Chinese government bond yields through the risk-taking channel and the asset-liability channel, both of which are closely related to global liquidity conditions[2]. Once the interference of real economic factors in developed countries is excluded, the net effect of global liquidity becomes more clearly apparent.

Comparison of Domestic and External Liquidity.

The year-on-year growth rate of China's M2 did not reach a significant level, standing in stark contrast to the significant results for the average M2 growth rate across the four countries. This indicates that the Chinese bond market is more sensitive to external liquidity than to domestic liquidity, reflecting the growing influence of cross-border capital flows on domestic asset prices following the opening of the capital account. This finding is consistent with recent literature: Dong and Yu (2024) found that bond market forces have the most significant impact on capital inflows into China's bond market[17]; McCully (2023) further noted that as the bond market gradually opens up, the importance of global drivers (such as US interest rates and investor risk aversion) has risen significantly[18]. These studies collectively confirm that fluctuations in external liquidity conditions are increasingly becoming a key channel influencing the domestic bond market.

3.3 Results of the Multicollinearity Test

To avoid issues of multicollinearity, this paper calculates the variance inflation factor (VIF) for each variable. As shown in Table 5, the VIF for all variables is less than 5, indicating that the model does not suffer from severe multicollinearity.

Table 5. Variance Inflation Factor (VIF) Test Results

Variable	VIF
China_M2 year-on-year	4.69
PC2	4.65
GDP growth rate	2.49
PC1	2.38
Year-on-year CPI	2.32
Average M2 of the Four Countries	2.16
China_Policy Rate	2.16
Four Countries_Average GDP	1.75
PC3	1.46

3.4 Results of Structural Change Tests

To test whether the ‘811 exchange rate reform’ of 2015 caused a change in the model structure, this paper incorporates a dummy variable for the exchange rate reform and its interaction terms with all explanatory variables into the baseline model. A joint significance F-test is conducted using Newey-West HAC robust standard errors (with a two-period lag). The results show that the p-value for the joint F-test of the interaction terms is 0.0747, which is marginally significant at the 10% level. However, given that none of the individual interaction terms are significant (minimum $p = 0.1479$) and the dummy variable itself is also insignificant ($p = 0.880$), the overall evidence does not support the existence of significant structural changes, and the full-sample regression results are reliable.

4 Conclusion

Using quarterly data from 2006 to 2025, this paper constructs a forecasting model for government bond yields. The model includes domestic factors (GDP growth, CPI, policy rate, M2, and yield curve principal components) and overseas factors (average M2 and average GDP of four major economies). By comparing the forecasting performance of the domestic factors model, the overseas factors model, and the full model, the following main conclusions are drawn:

First, domestic inflation and monetary policy are the core determinants of government bond yield fluctuations. Specifically, the year-on-year CPI exhibits a significantly negative relationship at the 5% level, whilst the policy interest rate shows a significantly positive relationship at the 5% level; these two factors demonstrate the strongest

predictive power. GDP growth is only marginally significant at the 10% level, and its explanatory power is relatively limited.

Second, whilst overseas factors alone have limited explanatory power, they provide incremental information after controlling for domestic factors. This indicates that, in the context of globalisation, macroeconomic fluctuations in major developed economies exert spillover effects on the domestic bond market through channels such as capital flows and the transmission of expectations.

Thirdly, the full model yields the best fit, indicating that taking both domestic and international factors into account helps to predict movements in government bond yields more accurately. This finding is of reference value to investors conducting cross-market analysis and to policymakers in assessing external shocks.

This study has certain limitations. Firstly, we only include M2 and GDP growth as overseas factors, leaving out variables such as exchange rates and interest rate differentials. Secondly, the model utilised linear regression, not accounting for non-linear relationships. Future research could expand the range of variables, explore the application of machine learning methods, and systematically examine the impact of exchange rate regime changes on the stability of yield forecasting models, thereby enhancing the models' predictive accuracy and policy adaptability.

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