PSL Quarterly Review

vol. 78 n. 313 (June 2025)

Article

# What factors influence Chinese government bond yields?

TANWEER AKRAM, SHAHIDA PERVIN*

Akram: Bermuda Monetary Authority, Bermuda
email: tanweer.akram@gmail.com
Pervin: Waseda University, Japan
email: shahidapervin.sp@gmail.com

**Abstract:**
*This paper models the dynamics of long-term Chinese government bond (CGB) yields based on an autoregressive distributive lag (ARDL) approach. It examines whether the current short-term interest rate has a decisive influence on long-term CGB yields, after controlling for various macroeconomic variables. The estimated models all show that the current short-term interest rate has an economically and statistically significant effect on the long-term CGB yields of various maturity tenors. John Maynard Keynes claimed that a central bank's policy rate exerts an important influence over long-term government bond yields through the current short-term interest rate. The paper's findings evince that Keynes's claim holds for China, implying that the actions of the People's Bank of China(PBoC) are a key driver of the long-term CGB yields.*

**How to cite this article:**
Akram T, Pervin S. (2025), "What factors influence Chinese government bond yields?", *PSL Quarterly Review*, 78 (313), pp. 247-282.

**DOI**: https://doi.org/10.13133/2037-3643/18503

**JEL codes:**
E43, E50, G12

**Keywords:**
Chinese government bonds (CGBs), interest rates, People's Bank of China (PBoC)

**Journal homepage:**
https://rosa.uniroma1.it/rosa04/psl_quarterly_review

This paper econometrically models factors that influence long-term Chinese government bond (CGB) yields based on key macroeconomic and financial variables. It deploys an autoregressive distributive lag (ARDL) econometric approach to examine whether the current short-term interest rate has a decisive influence on long-term CGB yields, after controlling for various macroeconomic and financial variables.

* The authors thank Professor Carlo D'Ippoliti (Editor, *PSL Quarterly Review*) and an anonymous referee for their valuable comments on an earlier version of this paper. They also thank Dr. Mark Zandi and Mrs. Marisa DeNatali for their help in obtaining the relevant data and Ms. Elizabeth Dunn and Ms. Lindsey Carter for their copyediting support.
The authors' institutional affiliations are provided solely for identification purposes. Views expressed are merely those of the authors. The standard disclaimers hold.
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
The dataset is available for replication: the dataset used in the empirical part of this paper is available upon request to bona fide researchers for the verification of the results.
The authors declare that they have no competing interests. They confirm that there are no relevant financial or nonfinancial competing interests to report.

CGBs are government bonds issued by the central government of the People's Republic of China (PRC). It does *not* include bonds issued by local/provincial governments, state-owned enterprises (SOEs), and special purpose vehicles, such as local government funding vehicles (LGFVs). The yield on CGBs is computed by determining the interest rate that will make the present value of the cash flow from the bond equal to its market price.[1] CGBs represent the PRC's creditworthiness as a sovereign entity.

Armstad and He (2020, pp. 105-147) provide an overview of the Chinese bond and interbank markets, pointing out that CGBs issued by the country's Ministry of Finance are among the People's Bank of China's (PBoC) – the country's central bank – "key instruments for implementing its monetary policy through open market operations". Further, they assert that CGBs are "one of the most important financial products in today's Chinese financial markets" (p. 111). According to the Asian Development Bank (various years), CGBs are mainly held by commercial banks, the PBoC, insurance companies, trusts, securities corporations, and some foreign entities.

With the rapid growth of the Chinese economy over the past several decades, China's capital markets have expanded notably. While investors and analysts have often focused on equities, the rise of capital markets has also resulted in the development of China's bond market. In particular, the volume of outstanding CGBs has risen dramatically, from merely 915 billion yuan in 2000 to 25,194 billion yuan in 2022, as shown in figure 1. During the same period, the claims on the central government as a share of nominal GDP have doubled, from nearly 9 percent of nominal GDP in 2000 to almost 21 percent of nominal GDP in 2022, as shown in figure 2. This sharp increase in outstanding CGBs as a share of nominal GDP, the growing importance of the bond market, and the ongoing financialization of the Chinese economy warrant a detailed empirical study of CGBs' dynamics.

During the study period, the ratio of general gross government debt to GDP rose. (This is the ratio of total gross debt of the government, which includes the debt issued by the central government, social security funds, local governments, and central agencies. For this ratio, the financial assets are not subtracted from the financial liabilities of the government). More recently, the Chinese authorities resorted to issuing more government debt to stimulate the economy, support local governments, and address problems in the housing and construction sector (Bloomberg, 2024; *The Economist*, 2024).

Figure 3 shows the evolution of the general government debt ratio and general government fiscal balance (net borrowing/net lending) ratios in China during the study period, while figure 4 displays the evolution of the central government's debt ratio, 2005-2022. The sharp rise in the general government debt and deficit ratios since 2015 is indicative of the use of leverage in local government financing, rather than central government debt and deficit. Nonetheless, it underscores the importance of studying the dynamics of CGB yields.

---

[1] Let $\boldsymbol{p}$ be the price of the bond, $\boldsymbol{C_t}$, the cash flow in year $\boldsymbol{t}$, and $\boldsymbol{N}$ the number of years. The yield to maturity, $\boldsymbol{y}$, on any bond is the interest rate that will make the following equation hold:

$$\boldsymbol{p} = \frac{\boldsymbol{C_1}}{(\boldsymbol{1}+\boldsymbol{y})^{\boldsymbol{1}}} + \frac{\boldsymbol{C_2}}{(\boldsymbol{1}+\boldsymbol{y})^{\boldsymbol{2}}} + \frac{\boldsymbol{C_3}}{(\boldsymbol{1}+\boldsymbol{y})^{\boldsymbol{3}}} + \cdots + \frac{\boldsymbol{C_N}}{(\boldsymbol{1}+\boldsymbol{y})^{\boldsymbol{N}}} = \sum_{\boldsymbol{t}=\boldsymbol{1}}^{\boldsymbol{N}} \frac{\boldsymbol{C_t}}{(\boldsymbol{1}+\boldsymbol{y})^{\boldsymbol{t}}}$$

The right-hand side of the equation represents the present value of the cash flow that equals the price of the bond given on the left-hand side of the equation. The yield is also known as the internal rate of return.

Figure 1 – *The increase in the volume of outstanding Chinese government bonds, 2000-2022*

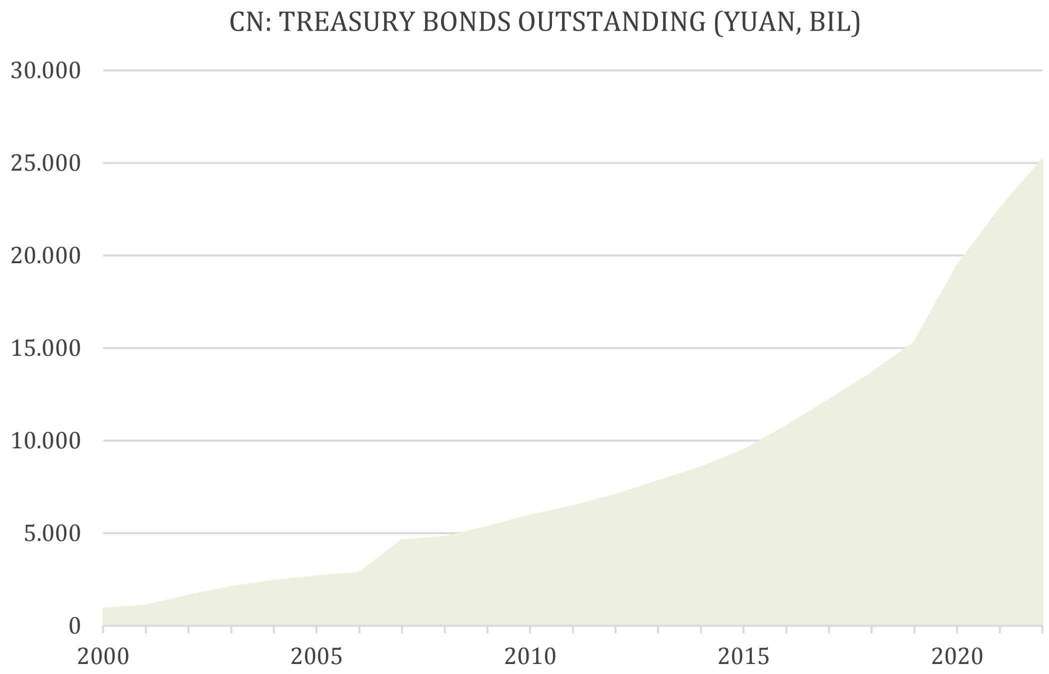



Figure 2 – *The rise in the volume of outstanding Chinese government bonds as a share of nominal GDP, 2000-2022*

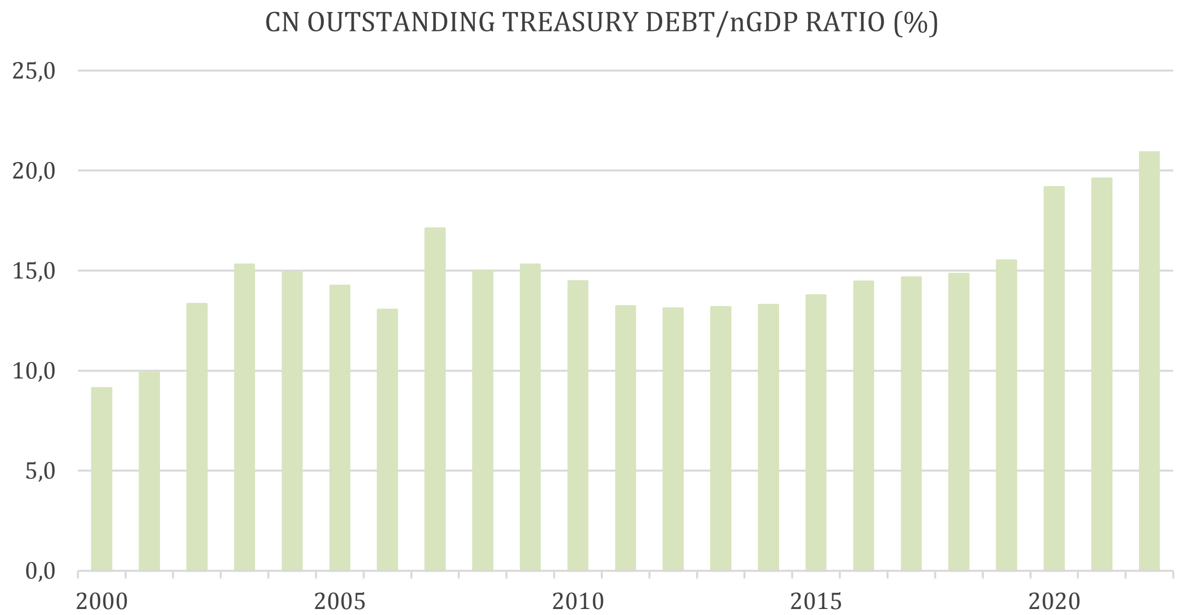


Figure 3 – *The evolution of the general government debt ratio and general government fiscal balance ratio in China, 2000-2022*

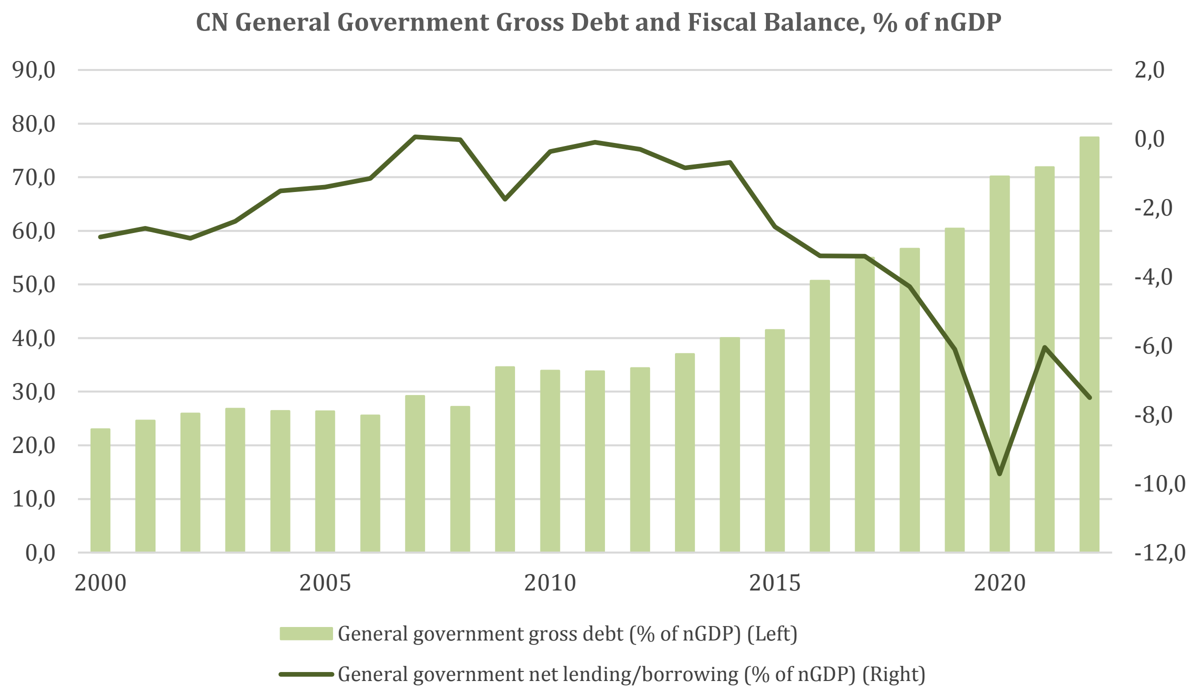
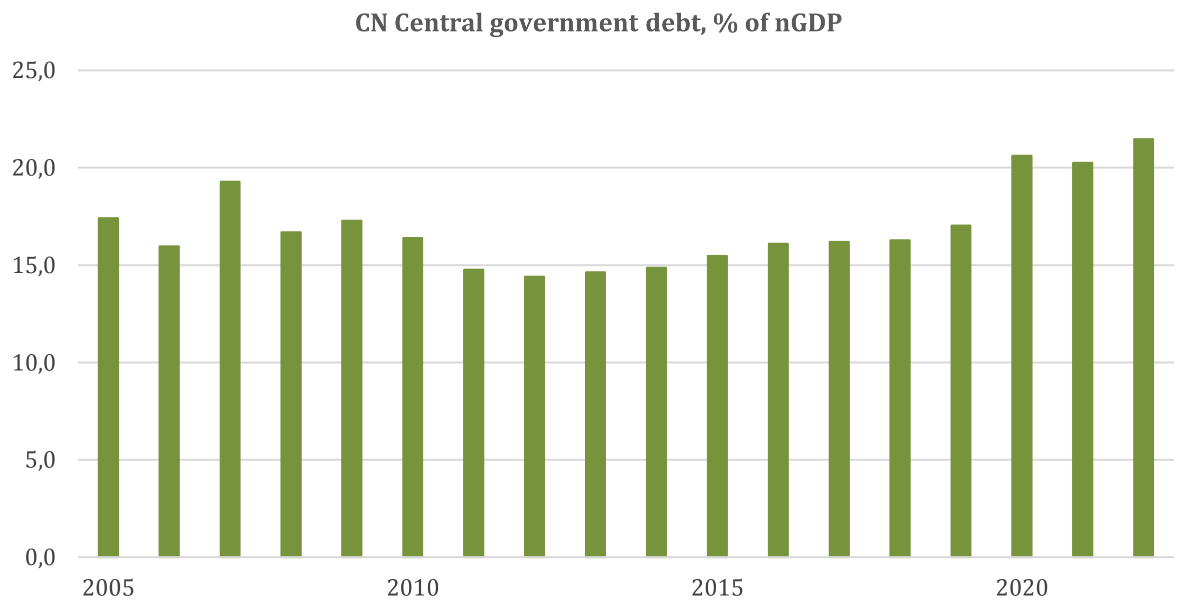



Figure 4 – *The evolution of the central government debt ratio, 2005-2022*



This paper models CGB yields from a Keynesian perspective, demonstrating that the current short-term interest rate has an important influence on long-term CGB yields of various maturity tenors, after controlling for relevant macroeconomic and financial variables. The findings of the study lend credence to John Maynard Keynes's (1930, pp. 352-363) claim that the central bank's policy rate has an influential role in setting the long-term interest rate on government bonds, mainly through its effect on the current short-term interest rate, which generally moves in lockstep with the central bank's policy rate.[2]

The paper is organized as follows. Section 1 provides an overview of the Keynesian perspective of interest rate dynamics and the related literature. Section 2 presents the macroeconomic backdrop to the evolution of CGB yields during the study period. Section 3 describes and summarizes the time series data used in the study, undertaking tests to divulge the time series properties of these variables. Section 4 covers the econometric models used to analyze the interest rate dynamics and reports the findings of the estimated models. Section 5 concludes with a summary of the findings and their implications for economic policy in China. Several appendixes provide additional information and analysis.

## 1. An overview of the Keynesian perspective on interest rate dynamics and related literature

### 1.1. Keynes on interest rate dynamics

Keynes ([1936] 2007, pp. 167-168) emphatically rejected the mainstream view on interest rates, noting:

> The rate of interest is not the "price" which brings into equilibrium the demand for resources to invest with the readiness to abstain from present consumption. […] Liquidity-preference is a potentiality or functional tendency, which fixes the quantity of money which the public will hold when the rate of interest is given. […] [W]hy such a thing as a liquidity-preference exists. […] This necessary condition is the existence of uncertainty as to the future of the rate of interest, i.e. as to the complex of rates of interest for varying maturities will rule at future dates.

For Keynes the foundation of interest rates rests in human psychology, social convention, and liquidity preference that emanate from uncertainty about the unknown future, even though the central bank's actions – particularly its setting of the policy rate – drive the short-term interest rate, which, in turn, influences the long-term interest rate on gilt-edged government bonds. For Keynes, interest rates were based on liquidity preference, which he held arises from investors' fundamental uncertainty about the future. Liquid assets, such as cash, offer safety against price volatility, whereas investors demand interest payments to hold illiquid assets, such as bonds and stocks, whose values can fluctuate.

Contrast Keynes with the mainstream view of interest rates, which is based on the loanable funds theory. The mainstream view regards the interest rate at any given time as the price of funds available at the time and holds that the interest rate depends on the demand for and supply of loanable funds. The interest rate equilibrates desired savings and desired investment. In the mainstream view, the current short-term interest rate's influence over the long-term interest rate is – and should be – rather limited. The mainstream view of interest rates is expressed in Alfred

[2] The close relationship between monetary policy rates and short-term interest rates in China is shown in appendix E.

Marshall (1890), Knut Wicksell ([1918] 1965), Gustav Cassel (1903), Frank William Taussig (1918), John R. Hicks ([1939] 2001), Ludwig von Mises (1963) and in modern mainstream textbooks. However, Irving Fisher ([1907] 1997a; [1943] 1997b) renders the most logically coherent exposition of the loanable funds theory of interest rates from the mainstream perspective.

In the mainstream view, the long-term interest rate would depend not just on the current short-term interest rate but also on the forward rate. Thus, the relationship between the long-term interest rate, the current short-term interest rate, and the forward rate would be as follows:

$$(1 + R_u^{LT})^u = (1 + r_t^{ST})^t \left(1 + f_{t,u-t}\right)^{u-t}$$

where $R_u^{LT}$ is the long-term interest rate, $r_t^{ST}$ is the current short-term interest rate, and $f_{t,u-t}$ is the forward interest rate for the period $[t, u]$. In the mainstream view, under rational expectations, the forward rate represents the path of future spot rates, i.e., the forward rate represents the spot rates from $t$ to $u$. Often, however, the mainstream view is slightly revised to claim that the forward rate is based on the expected spot rate and some term premium to compensate long-term investors for risks that arise from holding long-term bonds. Thus, the mainstream view is that long-term government bond yields depend not just on the current short-term interest rate but also on the path of future short-term interest rates and perhaps some term premium.

In contradistinction to the mainstream view, for Keynes the central bank's monetary policy rate sets the base rate for the economy. He pointed out that "the [current] short-term rate of interest is easily controlled by monetary authority, both because it is not difficult to produce a conviction that its policy will not greatly change in the very near future, and also because the possible loss is small compared with the running yield (unless it is approaching the vanishing point)" (Keynes, [1936] 2007, pp. 202-203].

Keynes (1930, p. 352) emphasized the exorbitant influence of the *current* short-term interest rate on long-term government bond yields. He opined: "For whilst it is reasonable that long-term rates should bear a definite relation to the prospective short-term rates, quarter by quarter, over the years to come, the contribution of the current three-monthly period to this aggregate expectation should be insignificant in amount – so one might suppose" (ibid.). He argued that "the influence of the [current] short-term rate of interest on the long-term rate is much greater than anyone ... would have expected" (p. 353).

Keynes held that there are several reasons for the current short-term interest rate and the long-term interest rate to be correlated and move in tandem. First, he believed that institutional factors and investor behavior are responsible for this connection. When the short-term interest rate is lower (higher) than the long-term interest rate, financial institutions and investors find it profitable to borrow (lend) on a long-term basis. When the short-term interest rate is low (high), investors are willing to shift into (out of) long-term bonds. This causes long-term bonds to rally (sell off) as investors reallocate their portfolios. Second, the need for institutional investors to generate income from financial assets causes the short-term and long-term interest rates to move together (Keynes, 1930, pp. 357–358). Third, investors have limited knowledge about the future and must take their cues from current conditions when forming their outlook for the future. The changes in the current short-term interest rate reflect those same forces that affect the long-term interest rate. Fourth, interest rate dynamics are reinforced by the herding and crowd psychology of investors. Investors succumb to "the preys and hope and fears aroused by transient events"

(Keynes, 1930, p. 361). The unanticipated news and shocks that affect the front end of the Treasury yield curve are the same ones that affect the belly or the back end of the curve.

These factors provide the psychological, social, conventional, and institutional bases for the central bank's current policy rate to exert its influence on the long-term interest rate via the current short-term interest rate. Thus, Keynes maintained that "there is no reason to doubt the ability of a central bank to make its short-term rate of interest effective in the [government bond] market" (1930, p. 363).

Jan Kregel (2024, pp. 94-96, 103-117) correctly points out that Keynes held that interest rates are a monetary phenomenon that occurs in the money market. Keynes (1937a, p. 250) stated: "The function of the rate of interest is to modify the money-prices of other capital assets in such a way as to equalize the attraction of holding them and of holding cash. This has nothing whatever to do with current saving or new investment".

For Keynes, interest rates are determined by the liquidity preference of agents in an economy. Economic agents' liquidity preferences are influenced by the social, conventional, psychological, and institutional features of a monetary production economy. The central bank exogenously sets the policy rate, which functions as the base interest rate throughout the financial system and in financial markets. Liquidity preference drives the complex set of interest rates on government bonds and other fixed-income securities of different maturity tenors.

Stephen Marglin (2021, pp. 376-430) has expounded an alternative theory of the interest rate that revises Keynes's theory without fully repudiating it. He claims that Keynes offers a theory of spreads rather than a theory of the level of the interest rate. He supports Keynes's claim that investors' liquidity preference – which originates from risk aversion, reversion to normal, and default risk – is the main driver of interest rates. However, he maintains that it is not the sole determinant of the equilibrium interest rate. Marglin (p. 430) argues that, since the central bank imposes a short-term interest rate, a theory of spreads is sufficient to explain long-term interest rates.

### 1.2. Keynesian and post-Keynesian views of expectations

In contradistinction to the mainstream view, Keynes maintained that investors rely on current conditions and trends to formulate their outlook of the economy and financial markets because of ontological uncertainty about the future. He wrote: "By 'uncertain' knowledge […] I do not mean merely to distinguish between what is known for certain from what is only probable. […] About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know. Nevertheless, the necessity for action and for decision compels us practical men to do our best to overlook this awkward fact […]" (Keynes, 1937b, pp. 213-214).

Keynes (1930, p. 359) recognized that, even for well-informed investors, their outlook tends to be "oversensitive […] to the near future". He held that investors "know almost nothing about the more remote future" and that their "ignorance about […] the remote future is much greater than knowledge" (p. 360) about the current economic and market conditions. This leads investors to give much greater prominence to current data and current economic conditions than anything else. Moreover, Keynes (1930, [1936] 2007) realized that there are herding and bandwagon effects in financial markets and that investors are motivated by the ebb and flow of "animal spirits". He shrewdly noted that "as long as a crowd can be relied on to act in a certain way, even if it is misguided, it will be to the advantage of the better-informed professional [investors] to act in the same way – a short period ahead" (Keynes, 1930, pp. 357-361).

Keynes, ([1936] 2007, p. 50) recognized that "the state of expectations is liable to constant change, a new expectation being superimposed long before the previous change has fully worked itself out". He admitted that "in practice the process of short-term expectation is a gradual and continuous one, carried on largely in light of realized results" while "it is the nature of long-term expectations that they cannot be checked at short intervals in light of realized results" (pp. 50-51). He believed that investors' "usual practice" is "to take the existing situation and to project it into the future, modified only to the extent that we have more or less definite reasons for expecting a change" (p. 148).

Keynes, ([1936] 2007, pp. 161-163) insisted that investment decisions are "a result of animal spirits," which cannot be viewed as "the outcome of weighted average of quantitative benefits multiplied by quantitative probabilities," "human decisions affecting the future […] cannot depend on strict mathematic expectations" because (Keynes, 1937b, p. 214):

> About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know. Nevertheless, the necessity for action and for decision compels us as practical men to do our best to overlook this awkward fact and to behave exactly as we should if we had behind us a good Benthamite calculation of a series of prospective advantages and disadvantages, each multiplied by its appropriate probability, waiting to be summed.

Other arguments have subsequently been advanced that reinforce the limits of probability calculus and its role in investment and economic decision making.

Kregel (1976, 2024, pp. 11-14) maintains that Keynes rejected the notions of perfect foresight and uncertainty and that he deemed these as inapplicable for a monetary-production economy. He holds that Keynes used three models of expectations. First, the model of static equilibrium, where the state of long-run expectations is independent of the system and may shift autonomously due to economic and non-economic factors. Second, the model of stationary equilibrium, where short-run expectations are subject to disappoint. Third, the model of shifting equilibrium, where disappointment in short-run expectations may affect long-run expectations and vice versa.

Paul Davidson (1991) held that an economic system is non-ergodic and that it is affected by the decisions, behavior, intentions, and expectations of human agents. George Shackle (1955) argued that economic life is characterized by radical uncertainty: investors rely on imagination to evaluate possible scenarios, investment brings out critical and often irreversible changes, economic life is full of surprises, and probability-based quantitative models fail to highlight unique, nonrepetitive events, such as: (i) financial, economic, social, and political crises, and (ii) innovations. Similarly, David Dequesh (1999) maintained that long-term expectations have little to do with probability calculus because they are driven by unpredictable changes in business confidence, animal spirits, uncertainty, creativity, and randomness. Nassim Taleb (2004, 2005) has argued the many aspects of human activity and financial markets are marked by so-called "black swans", rare and unpredictable events that have massive effects on the world. He has highlighted the limitations and inapplicability of quantitative and statistical models for complex systems, such as the economy and financial markets. In particular, he has emphasized that modelers and economists misapply the Gaussian normal distribution for complex systems with fat tails.

It is due to these perennial and essential features of investor behavior and expectation formation that the long-term interest rate tends to often – but by no means always – move in tandem with the current short-term interest rate.

### 1.3. Keynesian and mainstream empirical literature on interest rates

Keynes's (1930, pp. 352-362) claims about interest rate dynamics had solid empirical foundations and arguably found support in the empirical regularities observed in major financial markets, such as W. W. Riefler's (1930) statistical analysis of interest rate behavior in the United States in the 1920s, as well as his own analysis of interest rates in the United Kingdom's bond market around the same period. Riefler (1930, p. 123; cited in Keynes, 1930, pp. 354-355) summarized his own findings thusly: "[T]he surprising fact is not that [long-term] bond yields are relatively stable in comparison to short-term [interest] rates, but they have reflected fluctuations in short-term [interest] rates so strikingly and to a such a considerable extent".

In concordance with Keynes's astute insights, Akram (2022a, 2022b) has presented some simple models that formalize the ties between the long-term interest rate on government bonds and the central bank's policy rate through its effect on the short-term interest rate.

In recent years, empirical studies of government bond yields have provided ample evidence to corroborate Keynes's claim of a connection between the current short-term interest rate and the long-term interest rate. This literature appears to show that Keynes's claims hold in advanced countries, such as the United States, the United Kingdom, the member countries of the eurozone, Japan, Canada, and Australia, as well as several selected emerging markets, such as India, Brazil, and Mexico. However, the connection between the short-term interest rate and government bond yields in China has *not* been previously explored.

Lavoie (2014, pp. 186-188, 232-234) provides a comprehensive overview of the Keynesian empirical literature on interest rate dynamics. An examination of the papers cited and discussed by Lavoie (2014), as well as other related papers, reveals that empirical research supports the close connection between the short-term interest rate and the long-term interest rate. However, there are lively and still-unresolved debates among Keynesian scholars about: (1) "causality", or at least the temporal precedence between the short-term interest rate and the government bond yield, (2) the determinants of the long-term interest rate, (3) the shape of the Treasury yield curve, (4) term premiums, and so forth.

The relationship between short-term and long-term interest rates has been examined in advanced countries, such as the United States (Akram and Li, 2020a) and Japan (Akram and Li, 2020b, 2020c), as well as in emerging markets, such as Brazil (Akram and Uddin, 2021) and Mexico (Akram and Uddin, 2022). Vinod et al. (2014) examine government bond yields in India. They uncover that monetary policy, inflation expectations, and the volatility of capital flows affect the long-term interest rate, while the fiscal deficit has no discernable effect. Simoski (2019) corroborates that the short-term interest rate is the key determinant of the long-term government bond yield in several Latin American countries, including Brazil, Mexico, and Colombia. Gabrisch (2022) has modeled interest rate dynamics in six major financial markets, finding that the long-term government bond yield is related to the short-term interest rate in these markets. Kim's (2020, 2021) two separate panel-data studies of nine eurozone countries and seventeen advanced countries clarifies that, in countries with monetary sovereignty, the central bank's policy rate influences the long-term government bond yield, usually irrespective of the government debt ratio and market sentiment. As mentioned earlier, while no similar studies have been conducted for CGBs, Akram and Mamun (2023) have demonstrated that the short-term interest rate has a statistically significant and economically relevant effect on market interest rates, such as long-term interest rate swap yields, in China.

The direction of Granger causality between the short-term interest rate and the long-term government bond yield is an active topic of contention among post-Keynesian economists. Pollin

(1991, 2008) has argued that market forces, rather than central bank's actions, determine market interest rates. Li and Su (2021) have proclaimed that the relationship between the short-term interest rate and government bond yields is asymmetric, contending that the direction of temporal precedence varies in different financial markets. The findings from Rahimi et al. (2016,2017) regarding the United States and Canada are mixed. They report evidence of bidirectional causality, but they also note that, in recent US business cycles, the short-term interest rate Granger causes (precedes) the Fed funds target rate. In contrast, besides the studies mentioned earlier, Atesogulu (2003-4, 2005), Cook (2008), Deleidi and Levrero (2020), and Payne (2006-7) evince that the short-term interest rate rules the roost and has an important role, whether it is setting the long-term government bond yield or some other benchmark market interest rate. Recently there has been a spate of studies revealing that the Keynesian conjecture about the tight connection between the short-term interest rate and long-term interest rate holds for long-term interest rate swap yields denominated in different currencies.

This overview of the Keynesian perspective and the empirical literature reveals that there are vigorous debates regarding the determinants of interest rate dynamics and that these controversies have not been settled. This suggests that the econometric modeling of CGB yields is worthwhile because it can further illuminate the interest rate dynamics in emerging markets, such as China, and provide useful insights for policymakers, particularly in emerging markets, regarding the monetary transmission mechanism, fiscal and monetary operations, and central government debt management. It can also be useful for both domestic and foreign investors for asset allocation and risk management.

## 2. The macroeconomic backdrop to the evolution of CGB yields

It is pertinent to begin with a review of the macroeconomic backdrop to the evolution of CGB yields during the study period (2007-23).

Figure 5 displays the evolution of government bond yields in China during the study period, showing that CGB's yields varied substantially, ranging from 1.3 percent to 4.7 percent.

Figure 6 shows the coevolution of the 10-year CGB yield and the 3-month Chinese Treasury bill (CTB) yield. It reveals that the long-term CGB yield and the short-term interest rate are positively and strongly correlated in China. The current short-term interest rates are very closely tied with the PBoC's monetary policy rates (see appendix E for additional details.)

Inflation and CGB yields also tend to move in tandem. Figure 7 reveals that the 10-year CGB yield tends to be high (low) when core consumer price index (CCPI) inflation is high (low). The correlation between the CGB yield and core inflation is positive, but not so high. Moreover, there are periods when the CGB yield and core inflation tend to move in opposite directions and periods when the CGB yield may lead or lag CCPI inflation.

Figure 8 traces the evolution of headline and core inflation in China during the study period. Headline and core inflation are moderately positively correlated.

Figure 9 exhibits the growth of industrial production in China. Industrial production increased at an average pace of 9.2 percent year over year during the study period. Industrial production slowed during the global financial crisis, declined during the lockdowns at the start of the COVID-19 pandemic, and briefly declined again during the later lockdowns in March-April of 2022. Since then, industrial production has grown at a moderate pace.

Figure 10 traces the evolution of the exchange rate of the Chinese yuan against the US dollar. It shows that, during the first year of the study period, the yuan appreciated against the dollar, but it remained steady during the global financial crisis. The yuan again appreciated from mid-2010 to early 2014. Since early 2016 to the end of the study period, the yuan fluctuated in the range between 6.2 yuan per dollar to 7.3 yuan per dollar. The yuan's exchange rate is not determined by market forces, as the Chinese authorities have imposed a regime of managed float for the exchange rate.

Figure 11 heralds the evolution of two stock price indexes in China: the Shanghai and the Shanghai-Shenzhen 300. The stock price indexes in China fluctuated considerably and have undergone some large appreciations followed by marked corrections several times during the study period.

Figure 12 displays the evolution of the total assets on the PBoC's balance sheet. It shows that the size of the PBoC's balance sheet has expanded substantially during the study period, rising from 13.2 trillion yuan in January 2007 to 41.7 trillion yuan in August 2023. The steady growth and elevated size of the PBoC's balance sheet reflects the central bank's vital role in the country's financial system. It is also a testimony to the PBoC's crucial role in trying to ensure stability in China's financial system and financial markets.

Figure 5 – *The evolution of government bond yields in China, 2007M01–2023M08*

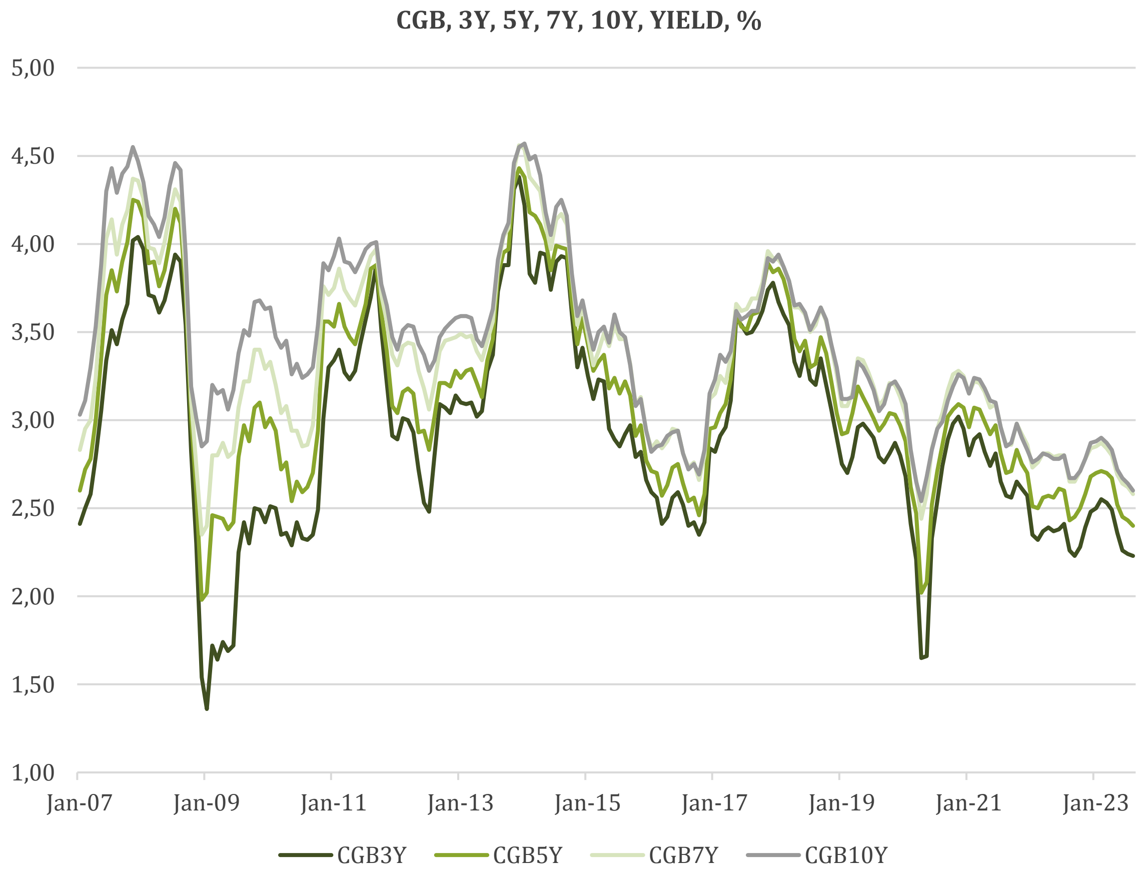


Figure 6 – *The coevolution of 10-year government bond yields and 3-month Treasury bill yields, 2007M01–2023M08*

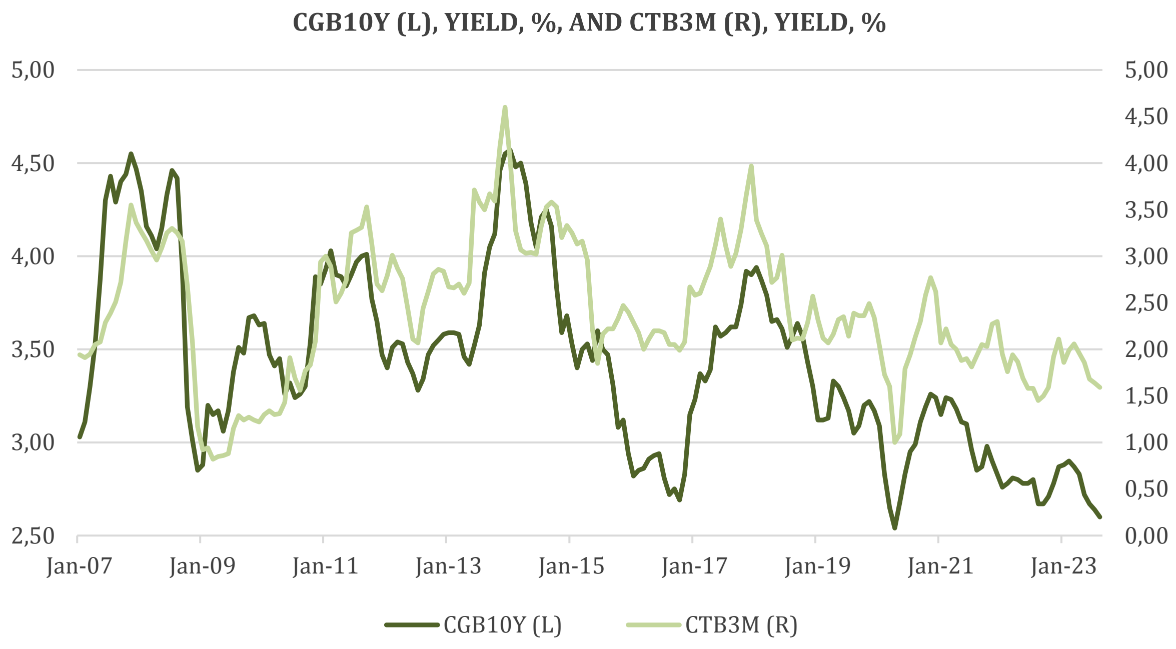



Figure 7 – *The coevolution of 10-year government bond yields and CCPI inflation, 2007M01–2023M08*

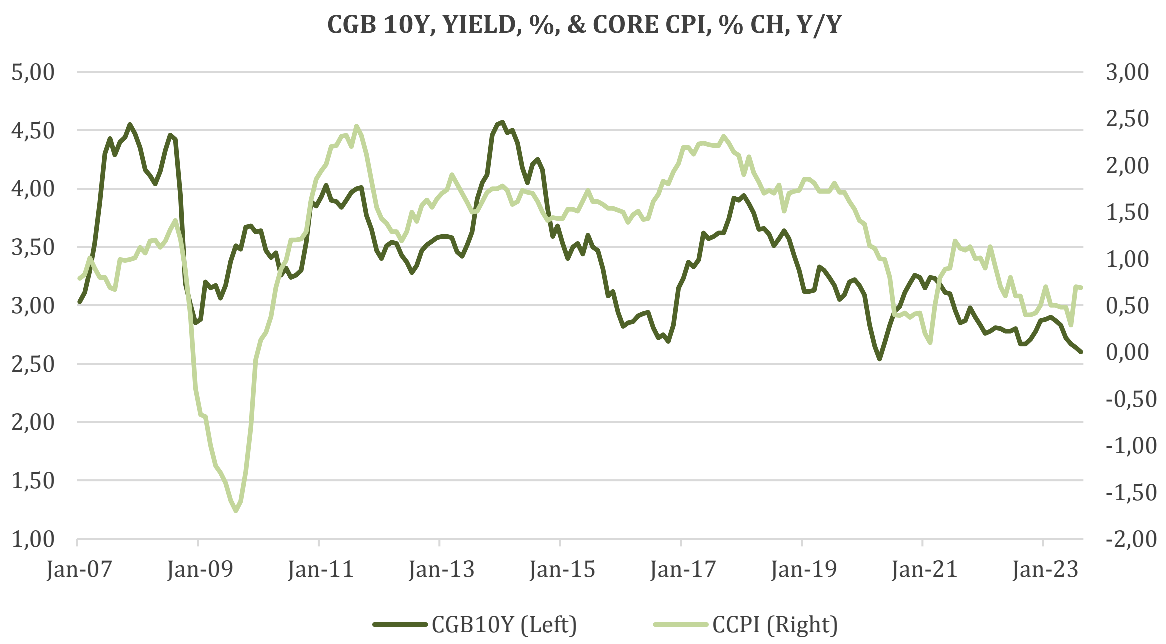


Figure 8 – *Inflation and core inflation in China, 2007M01-2023M08*

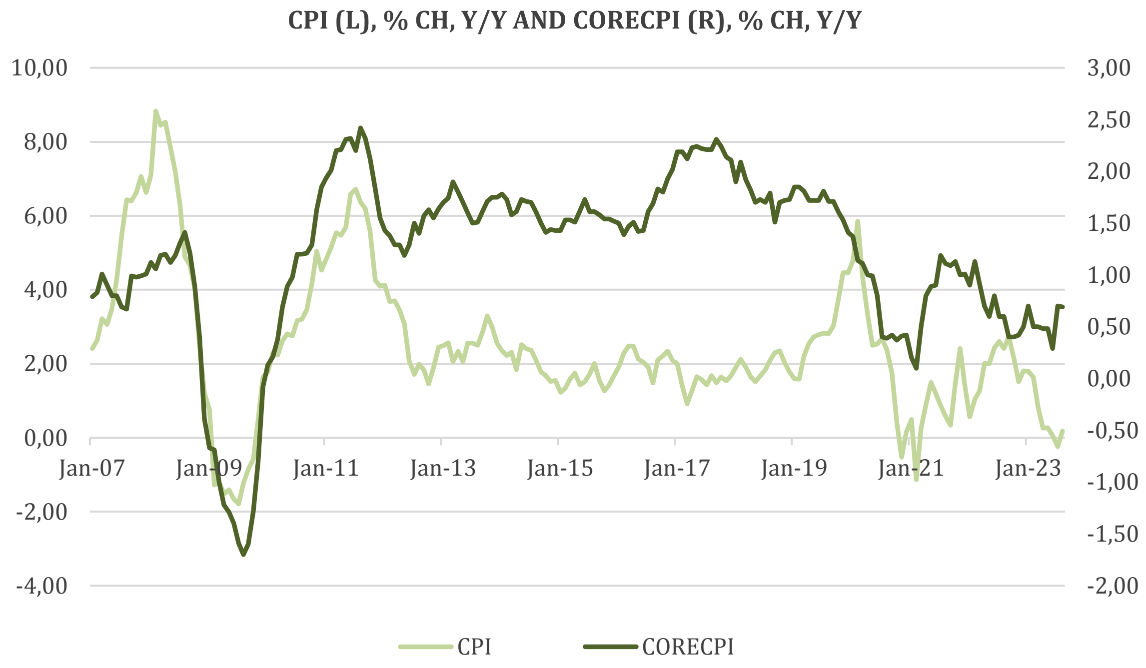



Figure 9 – *The growth of industrial production in China, 2007M01-2023M08*

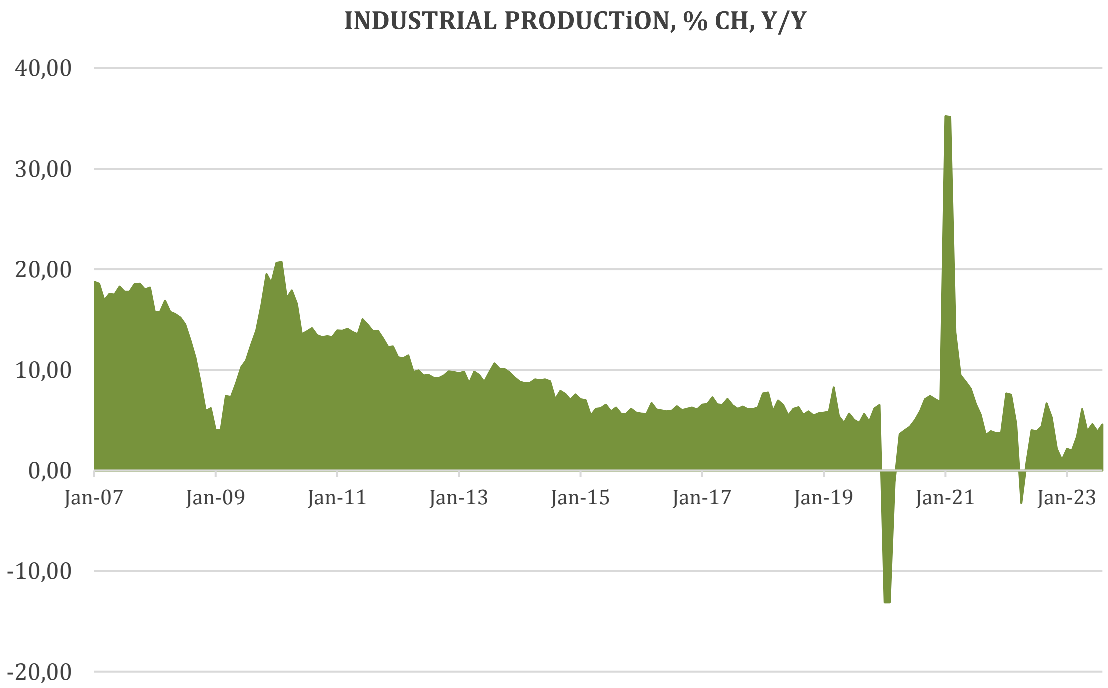


Figure 10 – *The evolution of the exchange rate of the Chinese yuan, 2007M01-2023M08*

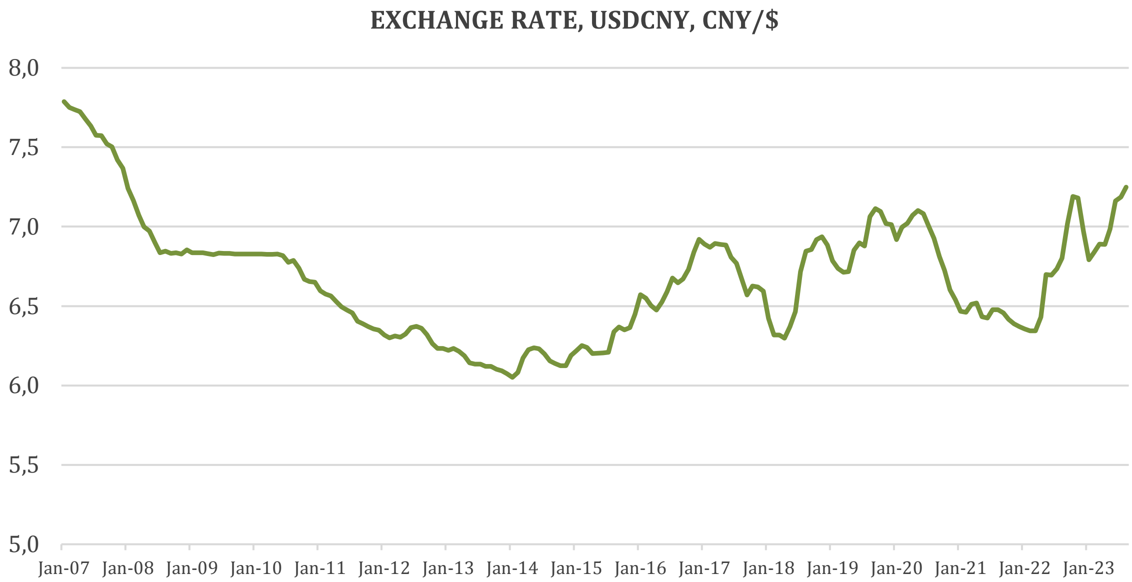



Figure 11 – *The evolution of the Shanghai and the Shanghai-Shenzhen 300 stock price indexes, 2007M01-2023M08*

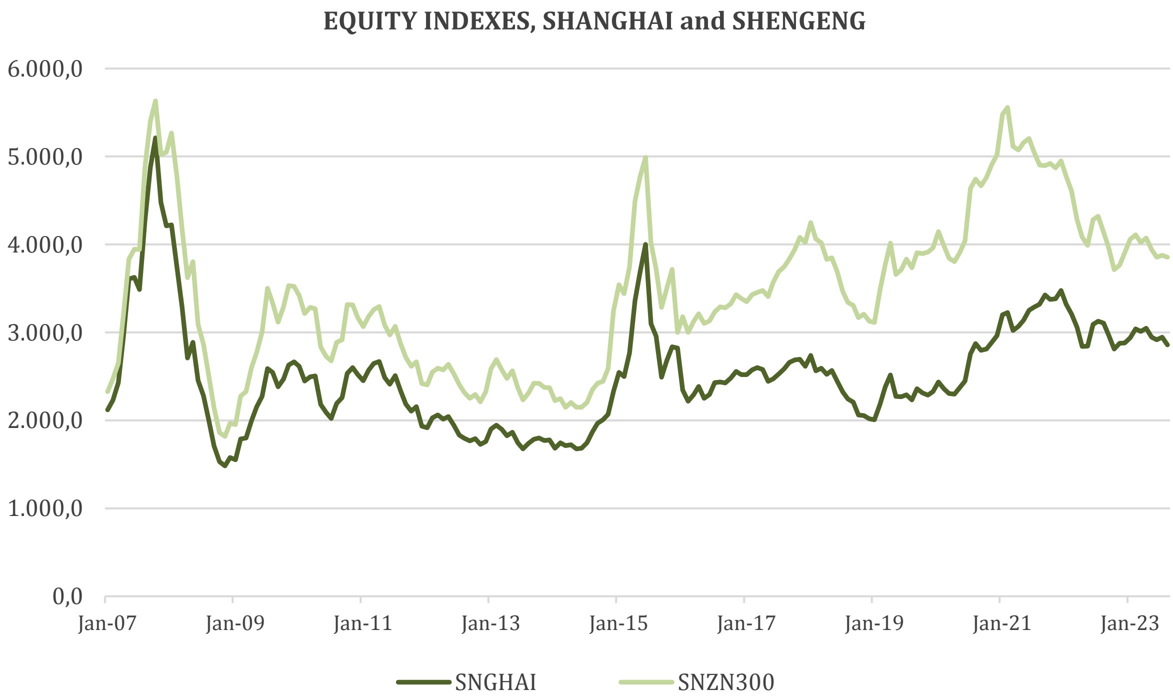
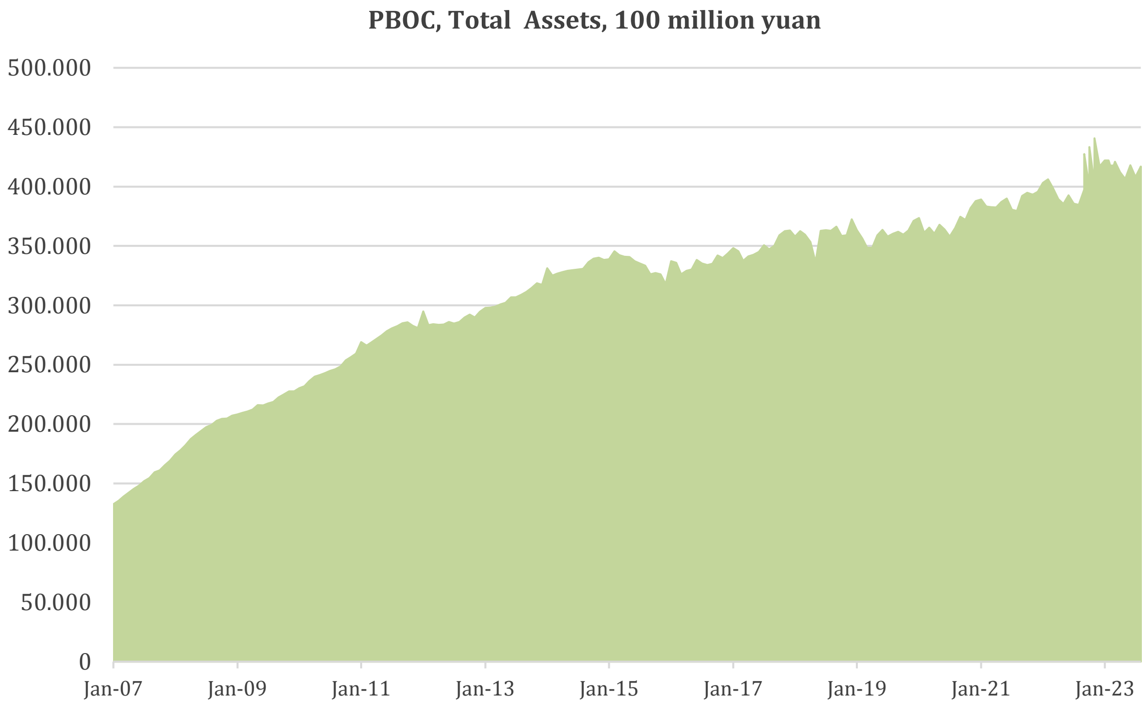


Figure 12 – *The evolution of the People's Bank of China's balance sheet, 2007M01-2023M08*




## 3. Data description and the time series properties of the variables

Table 1 summarizes the data used in the econometric models estimated in the paper. The first column lists the labels of the variables. The second column gives a description of the data and the date range of the time series. The third column contains information about the frequency of the data and whether higher-frequency data have been converted to monthly frequency. The final column provides the primary sources of the data.

The paper uses monthly time series data from January 2007 to August 2023. Each variable consists of 200 observations. There are two variables for the short-term interest rate: the 3-month and the 6-month Treasury bill rates. The long-term bond yields are the yields of CGBs of 3-, 5-, 7- and 10-year tenors, representing bonds of various maturities across the CGB yield curve. Two different measures of inflation are used: the year-over-year percentage changes in the total consumer price index (CPI), which is headline inflation, and the CPI excluding food and energy, which is core inflation (CCPI). Economic activity is gauged by the growth of industrial production, obtained as its year-over-year percentage change. Several financial variables have been incorporated in the dataset. There are two different indexes for the stock market, namely, the Shanghai stock price index and the Shanghai-Shenzhen 300 stock price index. The two measures of the exchange rate of Chinese yuan (CNY) are: CNY per US dollar (USDCNY) and CNY per euro (EURCNY). The PBoC's balance sheet is expressed as the total assets of the PBoC.

Table 1 – *Summary of the data*

| Variable | Data description, date range | Frequency | Source |
|---|---|---|---|
| ***Short-term interest rates*** | | | |
| **CTB3M** | Chinese Treasury bill, 3-month, yield, %, average, January 2007–August 2023 | Daily; converted to monthly | People's Bank of China |
| **CTB6M** | Chinese Treasury bill, 6-month, yield, %, average, January 2007–August 2023 | Daily; converted to monthly | People's Bank of China |
| ***Long-term interest rates*** | | | |
| **CGB3Y** | Chinese government bond, 3-year, yield, %, January 2007–August 2023 | Daily; converted to monthly | People's Bank of China |
| **CGB5Y** | Chinese government bond, 5-year, yield, %, January 2007–August 2023 | Daily; converted to monthly | People's Bank of China |
| **CGB7Y** | Chinese government bond, 7-year, yield, %, January 2007–August 2023 | Daily; converted to monthly | People's Bank of China |
| **CGB10Y** | Chinese government bond, 10-year, yield, %, January 2007–August 2023 | Daily; converted to monthly | People's Bank of China |
| ***Inflation*** | | | |
| **CPI** | Consumer price index, all items, seasonally adjusted, % change, y/y, January 2007–August 2023 | Monthly | China National Bureau of Statistics |
| **CCPI** | Consumer price index, all items excluding food and energy, seasonally adjusted, % change, y/y, January 2007–August 2023 | Monthly | China National Bureau of Statistics |
| ***Economic activity*** | | | |
| **IP** | Index of industrial value added, seasonally adjusted, 2005=100, % change, y/y January 2007–August 2023 | Monthly | China National Bureau of Statistics |
| ***Financial variable and stock index*** | | | |
| **USDCNY** | Exchange rate, yuan per US dollar, USDCNY, January 2007–August 2023 | Daily; converted to monthly | Federal Reserve Board |
| **EURCNY** | Exchange rate, yuan per euro, EURCNY, January 2007–August 2023 | Daily; converted to monthly | European Central Bank |
| **SHNGHAI** | Shanghai stock price index, January 2007–August 2023 | Daily; converted to monthly | Shanghai Stock Exchange |
| **SNZN300** | Shanghai Shenzhen 300 stock price index, January 2007–August 2023 | Daily; converted to monthly | Shanghai Stock Exchange |
| **PBOC** | People's Bank of China, balance sheet, total assets., end of period, not seasonally adjusted, 100 million yuan, January 2007–August 2023 | Monthly | People's Bank of China |

*Notes:* LNUSDCNY = LN(USDCNY); LNEURCNY = LN(EURCNY); LNSHNGHAI = LN(SHNGHAI); and LNSNZN300 =LN(SNZN300); where LN = natural log = $Log_e(.)$

The first difference of the natural log of several variables is used in the econometric models if the percent change from one month to the next is the relevant metric of concern for modeling purposes.

## 4. Econometric models and the findings of the estimated models

The results of the unit root and stationarity tests, displayed in appendix A, show that the time series of variables are integrated at either I(0) or I(1). The objective here is to model long-term CGB yields; therefore, the short-run and the long-run effects of the short-term interest rate on long-term CGB yields for different maturity tenors are examined. Given the time series properties of the data and the research question, the ARDL approach is the most germane for modeling the dynamics of CGB yields.

The ARDL models estimated here can be used to examine the dynamic relationships within time series data in a single-equation framework. In its error correction (EC) representation, the ARDL model may be used to distinguish the long-run and the short-run effects. It can be applied to test if there is any cointegration between the short-term interest rate and CGB yields. It can also be used to examine if there are any long-run relationships among the variables that have been selected to econometrically model the dynamics of CGB yields.

The regression specification for the ARDL(p,q) models is as follows:

$$\mathrm{CGB_iY_t} = \alpha_0 + \sum_{p=1}^{3} \alpha_p \left(\mathrm{CGB_iY_{t-p}}\right) + \sum_{q=0}^{3} \beta_q \left(\mathrm{CTB3M_{t-q}}\right) + \sum_{j=1}^{m} \gamma_j X_{j,t} + \varepsilon_t$$

where i is used for 3-, 5-, 7- and 10-year tenors.

Here, the dependent variable is the CGB yield of different maturity tenors, represented by i. The main independent variables are the short-term interest rate and its lags (up to a maximum lag of 3). The other independent variables are the lagged government bond yield (up to maximum lag of 3) and $X_{j,t}$, which represents other control variables, namely: core inflation (CCPI) and the growth of industrial production (IP), as well as the percent changes in the USDCNY exchange rate (ΔLNUSDCNY), the Shanghai stock price index (ΔLNSNGHAI), and the central bank's total assets (ΔLNPBOC).

There are two different model specifications. The *simple model* is based on the 3-year Treasury bill rate and its lags, the lags of the dependent variable, and two control variables: core inflation and the growth of industrial production. The *extended model* is also based on the 3-year Treasury bill rate and its lags, the lags of the dependent variable, and five control variables: core inflation and the growth of industrial production, as well as the percentage changes in the USDCNY exchange rate, the Shanghai stock price index, and the total assets of the PBoC.

The time series data used in this study is monthly. The maximum lag chosen for the estimation is 3. The lags for the models are automatically selected based on the Akaike information criteria (AIC).

The results from the front end and the back end of the CGB yield curve are presented in table 2 and table 3, respectively. However, the results from the belly of the CGB yield curve are presented in appendix B. Model information and diagnostic tests are displayed at the bottom of each table.

Table 2 presents regression results for CGB3Y as dependent on CTB3M. The model selected is ARDL(2,2) for both the simple and the extended model specifications. The current 3-month Treasury bill rate is positively associated with the CGB3Y yield. The effect for lags of CTB3M on CGB3Y varies widely, depending on the lags. Core inflation is not statistically significant. The growth of industrial production is statistically significant but its effect is miniscule. In the extended model, the percentage change in the USDCNY exchange rate has a negative effective, but it is statistically insignificant. The percentage change in the Shanghai stock price index has a positive and statistically significant effect. However, the percentage change in the PBoC's total assets has a positive but statistically insignificant effect.

Table 2 – *Regression results and tests, ARDL(2,2): simple and extended models for CGB3Y (with CTB3M)*

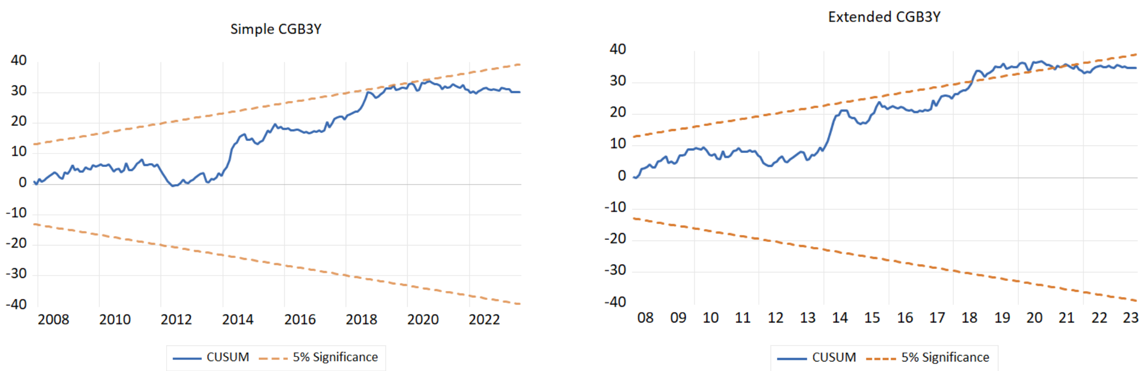
| Variable | Coefficient (SE) | Coefficient (SE) |
|---|---|---|
| CGB3Y(–1) | 1.08 *** (0.07) | 1.09 *** (0.07) |
| CGB3Y(–2) | –0.32 *** (0.07) | –0.31 *** (0.07) |
| CTB3M | 0.49 *** (0.04) | 0.49 *** (0.04) |
| CTB3M(–1) | –0.45 *** (0.06) | –0.46 *** (0.06) |
| CTB3M(–2) | 0.12 ** (0.05) | 0.11 ** (0.05) |
| CCPI | 0.003 (0.01) | 0.01 (0.01) |
| IP | 0.01*** (0.002) | 0.004*** (0.002) |
| Δ(LNUSDCNY) | | –0.22 (0.93) |
| Δ(LNSNGHAI) | | 0.33 ** (0.13) |
| Δ(LNPBOC) | | 0.50 (0.54) |
| Constant | 0.26 *** (0.05) | 0.23*** (0.05) |
| **Model information** | | |
| **Included observations** | 198 | 198 |
| R-squared | 0.96 | 0.96 |
| Adjusted R-squared | 0.96 | 0.96 |
| S.E. of regression | 0.12 | 0.12 |
| Sum squared resid. | 2.65 | 2.55 |
| Log likelihood | 146.27 | 150.01 |
| F-statistic (prob) | 680.87 (0.00) | 487.88 (0.00) |
| Akaike info criterion | –1.40 | –1.40 |
| Durbin-Watson stat | 2.04 | 2.05 |
| **Diagnostic tests** | | |
| **Breusch-Godfrey Serial Correlation LM test (null hypothesis: no serial correlation at up to 2** | | |
| F-statistic (prob) | 1.82 (0.17) | 2.85 (0.06) |
| **Heteroskedasticity test: Breusch-Pagan-Godfrey (null hypothesis: homoskedasticity)** | | |
| F-statistic (prob) | 1.30 (0.25) | 0.82 (0.6082) |
| **Bounds test (null hypothesis: no relationship in levels; that is, no cointegration)** | | |
| F-statistic<br>10%: I(0) 3.020 I(1) 3.510;<br>5%: I(0) 3.620 I(1) 4.160;<br>1%: I(0) 4.940 I(1) 5.580 | 11.00 | 8.83 |
| **Ramsey RESET test:** | | |
| F-statistic for 2 fitted terms | 0.81 (0.45) | 0.48 (0.62) |
| **Error correction** | | |
| COINTEQ* (prob) | –0.24 (0.00) | –0.21 (0.00) |

*Notes*: The model is run in EViews 13 using ARDL models.
Heteroskedasticity and autocorrelation corrected (HAC [Newey-West]) standard errors.
Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Both of these models have a strong fit, as shown by the $R^2$ and adjusted $R^2$, which are 0.96. In the Breusch-Godfrey serial correlation test, the null hypothesis is that the residuals are serially uncorrelated. An F-statistic p-value higher than 0.05 in both models indicates the failure to reject the null hypothesis of serially uncorrelated residuals. In the Breusch-Pagan-Godfrey heteroskedasticity test, the null hypothesis is that the residuals are homoscedastic. The F-statistic p-value for the model indicates the failure to reject the null hypothesis of homoscedasticity. The F-statistic value for the bounds test is evidently above the I(0) and I(1) critical value bound. Hence, the null hypothesis that there is no equilibrating relationship can be rejected. The bounds test rejects the null hypothesis of no relationship in the levels (no cointegration) for both the simple model and the extended model. The Ramsey RESET test fails to reject the null hypothesis that the model is correctly specified. The negative and highly significant EC term suggests that the variables are indeed cointegrated in both models. The EC terms suggest that about 21-24 percent of any movements into disequilibrium are corrected within one month.

Figure 13 – *CUSUM and CUSUMSQ stability diagnostic for simple and extended models of CGB3Y*

Panel A: CUSUM for both models




Panel B: CUSUMSQ for both models

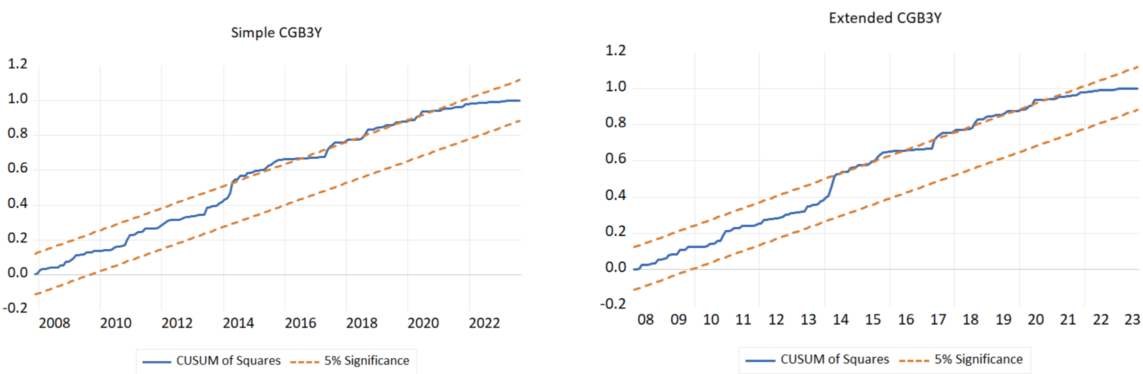


Figure 13 displays the results of the CUSUM and CUSUMSQ tests (Brown et al., 1975) in panels A and B. The left charts are for the simple model, while the right charts are for the extended model. The CUSUM tests for both models indicate stability in the estimated equations during the sample period. The CUSUMSQ of both models is within the 5-percent significance lines, suggesting that the residual variance is stable in both models. Model selection criteria other than AIC, such as Schwarz information criterion (SIC), change the lag structure of the models, but the overall effects of CTB3M on CGB3Y are similar in most cases.

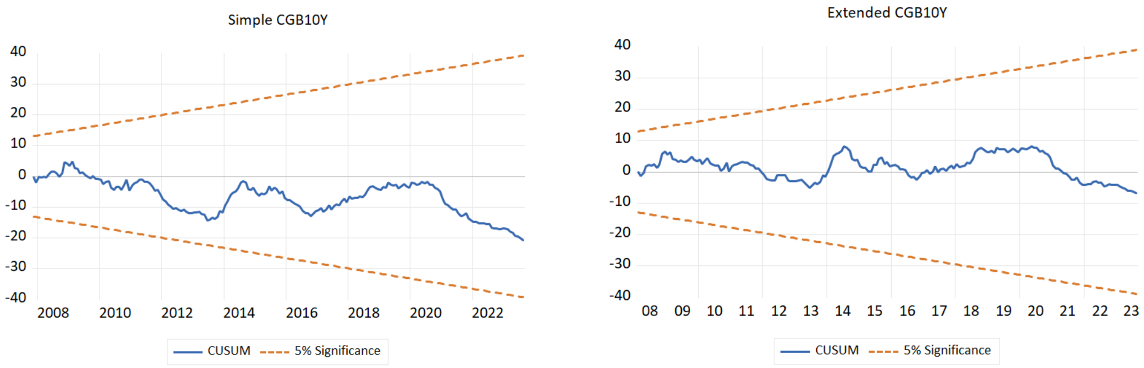
Table 3 – *Regression results and tests, ARDL(2,2): Simple and extended models of CGB10Y (with CTB3M)*

| **Variable** | **Coefficient (SE)** | **Coefficient (SE)** |
|---|---|---|
| CGB10Y(−1) | 1.29*** (0.07) | 1.28*** (0.07) |
| CGB10Y(−2) | −0.42*** (0.07) | −0.39*** (0.07) |
| CTB3M | 0.19*** (0.04) | 0.20*** (0.03) |
| CTB3M(−1) | −0.22*** (0.05) | −0.23*** (0.05) |
| CTB3M(−2) | 0.08*** (0.04) | 0.08** (0.03) |
| CCPI | −0.01 (0.01) | −0.004 (0.01) |
| IP | 0.01*** (0.001) | 0.01*** (0.002) |
| ΔLNUSDCNY | | −0.47 (0.83) |
| ΔLNSNGHAI | | 0.57*** (0.12) |
| ΔLNPBOC | | 0.67 (0.48) |
| Constant | 0.27*** (0.06) | 0.22*** (0.06) |
| **Model information** | | |
| Included observations | 198 | 198 |
| R-squared | 0.95 | 0.96 |
| Adjusted R-squared | 0.95 | 0.96 |
| S.E. of regression | 0.11 | 0.10 |
| Sum squared resid. | 2.35 | 2.05 |
| Log likelihood | 158.08 | 171.52 |
| F-statistic (prob) | 552.96 (0.00) | 439.06 (0.00) |
| Akaike info criterion | −1.52 | −1.62 |
| Durbin-Watson stat | 2.01 | 2.05 |
| **Diagnostic tests** | | |
| **Breusch-Godfrey Serial Correlation LM test (null hypothesis: no serial correlation at up to lags** | | |
| F-statistic (prob) | 0.38 (0.68) | 1.73 (0.18) |
| **Heteroskedasticity test: Breusch-Pagan-Godfrey (null hypothesis: homoskedasticity)** | | |
| F-statistic (prob) | 1.66 (0.12) | 1.62 (0.10) |
| **Bounds test (null hypothesis: no relationship in levels)** | | |
| F-statistic | 7.27 | 6.16 |
| 10%: I(0) 3.020 I(1) 3.510; | | |
| 5%: I(0) 3.620 I(1) 4.160; | | |
| 1%: I(0) 4.940 I(1) 5.580 | | |
| **Ramsey RESET test:** | | |
| F-statistic for 2 fitted terms (prob) | 0.10 (0.91) | 1.07 (0.35) |
| **Error correction** | | |
| COINTEQ* (prob) | −0.13 (0.00) | −0.11 (0.00) |

*Notes*: The model is run in EViews 13 using ARDL models.
Heteroskedasticity and autocorrelation corrected (HAC [Newey-West]) standard errors.
Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Figure 14 – *CUSUM and CUSUMSQ stability diagnostic for simple and extended models of CGB10Y*

## Panel A: CUSUM for both models




## Panel B: CUSUMSQ or both models

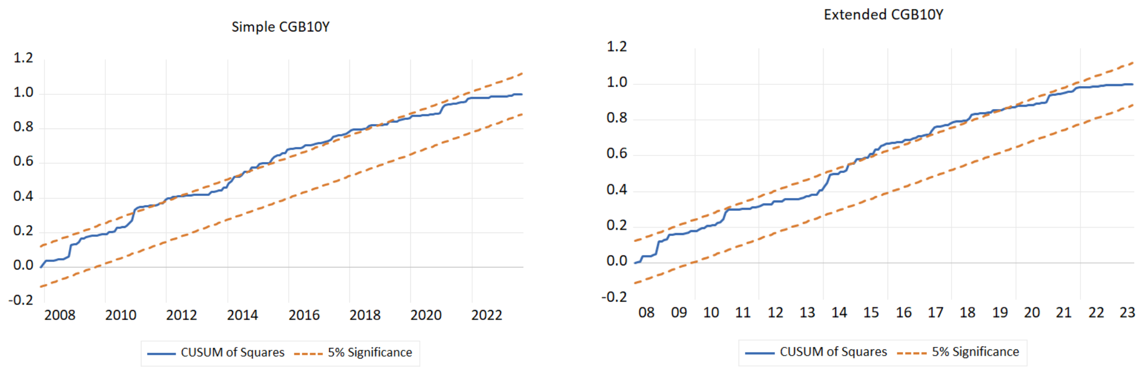



Table 3 presents regression results for CGB10Y as a function of CTB3M. In the automatic AIC lag selection process, both simple and extended specifications of the model are ARDL(2,2). The 3-month Treasury bill rate is positively associated with the 10-year CGB yield, which is unchanged for additional controls. The effect for lags of CTB3M on CGB10Y varies with the lags. Core inflation does not have any statistically significant effect. However, once again, the growth of industrial production has an extremely minute effect, even though it is statistically significant. The effect of the percentage change on the USDCNY exchange rate is negative but statistically insignificant. The effect of the percentage changes of the Shanghai stock price index is positive and statistically significant. Again, the PBoC's total assets have a positive but statistically insignificant effect on CGB10Y yields.

The estimated models have a strong fit, as shown by the $R^2$ and adjusted $R^2$, which are between 0.95 and 0.96. In the serial correlation test, the null hypothesis is that the residuals are serially uncorrelated. An F-statistic p-value higher than 0.05 in both models indicates the failure to reject this null hypothesis. In the heteroskedasticity test, the null hypothesis is that the residuals are homoscedastic. The F-statistic p-values for the models indicate the failure to reject the null hypothesis of homoskedasticity. The F-statistic value for the bounds test for the extended model suggests that the null hypothesis of no cointegration can be rejected. The F-statistic value for the bounds test for the simple model suggests that the null hypothesis of no cointegration can be rejected. The Ramsey RESET test fails to reject the null hypothesis that the model is correctly specified. The negative and highly significant EC term suggests that the variables are indeed cointegrated. About 11-13 percent of a movement into disequilibrium is corrected within one month.

The results for the CUSUM and CUSUMSQ tests are displayed in figure 14 in the same manner as in the previous figure. The CUSUM tests for both models indicate instability of the equation's parameters during the sample period. The CUSUMSQ moves outside of and within the 5-percent significance lines, suggesting that the estimated parameters are somewhat unstable. In essence, the CUMSUM and the CUSUMSQ tests suggest the estimated coefficients sometimes breach the bounds of stability.

Based on the above findings from the models estimated here and the additional findings from models estimated in appendix B, it is clear that the 3-month Treasury bill rate is positively associated with long-term CGB yields of different maturity tenors. However, the magnitude of the association declines with CGB yields of higher tenors – 0.49 for CGB3Y, 0.34–0.35 for CGB5Y, 0.26 for CGB7Y, and 0.19–0.20 for CGB10Y. This shows that the effect of the current CTB3M is more pronounced for a long-term CGB with a shorter maturity tenor than a longer maturity tenor. Hence, the change in the current CTB3M rate has a stronger effect on: (1) CGB3Y than CGB5Y, (2) CGB5Y than CGB7Y, and (3) CGB7Y than CGB10Y.

The models are more reliable and stable for CGBs in the front end and the belly of the CGB yield curve compared to the back end of the curve, as can be seen from different diagnostic tests. Nevertheless, all of these models have a good fit and highlight the connection between the current short-term interest rate and the CGB yield, as reflected in the positive and statistically and economically significant effects.

### 4.1. Robustness checks with alternative independent variables

To check the robustness of the findings, an alternative specification of both the simple and the extended models is undertaken. The alternative specification uses the 6-month Treasury bill (CTB6M) rate for the short-term interest rate instead of the 3-month Treasury bill rate. Moreover, the control variables that are used in the alternative specification are changed as follows: CPI instead of CCPI; ΔLNEURCNY instead of ΔLNUSDCNY; and ΔLNSNZN300 instead of ΔLNSNGHAI. However, two of the control variables remain the same, namely, the growth of industrial production (IP) and the percentage change in the central bank's total assets (ΔLNPBOC). The simple version employs two control variables (i.e., CPI and IP), while the extended version has five control variables (i.e., CPI, IP, ΔLNEURCNY, ΔLNSNZN300, and ΔLNPBOC).

The government bond yields of different maturity tenors are modeled as follows:

$$\mathrm{CGB_iY_t} = \alpha_0 + \sum_{p=1}^{3} \alpha_p\left(\mathrm{CGB_iY_{t-p}}\right) + \sum_{q=0}^{3} \beta_q\left(\mathrm{CTB6M_{t-q}}\right) \gamma_j X_{j,t} + \varepsilon_t$$

where $i$ is used for 3-, 5-, 7-, and 10-year tenors. Here, $X_{j,t}$ represents the other control variables.

Table 4 presents the regression results from the extended models for CGBs of different maturity tenors, dependent on CTB6M. (The results of the simple modes for CGBs are presented in appendix C). The lag structures chosen for the models below are the same as those for the relevant extended models estimated earlier. Hence, the models are ARDL(2,2).

The 6-month Treasury bill rate is positively associated with all CGB yields. The effect of the current CTB6M is more pronounced for CGBs with a lower maturity tenor than for those of a higher maturity tenor. Hence, the change in the current CTB6M rate has a stronger effect on: (1) CGB3Y than CGB5Y, (2) CGB5Y than CGB7Y, and (3) CGB7Y than CGB10Y. The magnitude of the association declines with CGB yields of higher tenors – 0.63 for CGB3Y, 0.46 for CGB5Y, 0.33 for CGB7Y, and 0.25 for CGB10Y.

Table 4 – *Regression results ARDL(p,q): extended models for $CGB_J$ (with CTB6M)*

| **Variable** | **CGB3Y (2,2)** | **CGB5Y (2,2)** | **CGB7Y (2,2)** | **CGB10Y (2,2)** |
|---|---|---|---|---|
| | **Coefficient (SE)** | **Coefficient (SE)** | **Coefficient (SE)** | **Coefficient (SE)** |
| $CGB_J$(-1) | 1.00 *** (0.07) | 1.06*** (0.07) | 1.21*** (0.06) | 1.23*** (0.06) |
| $CGB_J$(-2) | –0.19* (0.07) | –0.22*** (0.07) | –0.35*** (0.06) | –0.32*** (0.06) |
| CTB6M | 0.63*** (0.03) | 0.46*** (0.04) | 0.33*** (0.04) | 0.25*** (0.04) |
| CTB6M(–1) | –0.57*** (0.06) | –0.46*** (0.06) | –0.37*** (0.06) | –0.30*** (0.05) |
| CTB6M(–2) | 0.08 (0.05) | 0.09* (0.05) | 0.11 (0.04) | 0.09** (0.04) |
| CPI | 0.003 (0.004) | 0.004 (0.005) | 0.005 (0.004) | 0.004 (0.004) |
| IP | 0.004*** (0.001) | 0.005*** (0.002) | 0.005*** (0.002) | 0.005*** (0.002) |
| ΔLNEURCNY | 0.12*** (0.04) | 0.15*** (0.05) | 0.14*** (0.04) | 0.13*** (0.04) |
| ΔLNSNZN300 | 0.38*** (0.11) | 0.55*** (0.12) | 0.55*** (0.11) | 0.59*** (0.11) |
| ΔLNPBOC | –0.28 (0.45) | 0.02 (0.51) | –0.09 (0.46) | 0.05 (0.46) |
| Constant | 0.15*** (0.05) | 0.19*** (0.06) | 0.23*** (0.06) | 0.18*** (0.06) |
| **Model information** | | | | |
| Included observations | 198 | 198 | 198 | 198 |
| R-squared | 0.97 | 0.96 | 0.96 | 0.96 |
| Adjusted R-squared | 0.97 | 0.96 | 0.96 | 0.96 |
| S.E. of regression | 0.10 | 0.11 | 0.10 | 0.10 |
| Sum squared resid. | 1.80 | 2.28 | 1.92 | 1.86 |
| Log likelihood | 184.60 | 161.08 | 177.94 | 181.38 |
| F-statistic | 699.77 | 436.13 | 442.10 | 487.00 |
| Prob (F-statistic) | 0.00 | 0.00 | 0.00 | 0.00 |
| Mean dependent var. | 2.94 | 3.15 | 3.35 | 3.44 |
| S.D. dependent var. | 0.59 | 0.53 | 0.49 | 0.50 |
| Akaike info criterion | –1.75 | –1.52 | –1.69 | –1.72 |
| Durbin-Watson stat | 2.149332 | 2.17 | 2.14 | 2.13 |

*Notes*: $CGB_J(t)$ indicates the relevant bond, where $_J$=3, 5, 7, and 10, respectively, when the dependent variables are, respectively, CGB3Y, CGB5Y, CGB7Y, and CGB10Y in the second, third, fourth, and fifth columns of the table.
The model is run in EViews 13 using ARDL models.
Heteroskedasticity and autocorrelation corrected (HAC [Newey-West]) standard errors.
The model selection criterion is the same lag structure as the extended models estimated earlier.
Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

The overall results obtained under alternative specifications are similar to those obtained when using CTB3M for the short-term interest rate, though the magnitude for the association of the CTB6M rate with CGB yields is always higher than that of the CTB3M rate. The CPI inflation has a slightly positive but statistically insignificant effect. The growth of industrial production has a miniscule but statistically significant positive effect. The percentage change of the EURCNY exchange rate has a positive and statistically significant effect. The percentage change of the Shanghai-Shenzhen 300 stock price index has a positive and statistically significant effect. The percentage change of the PBoC's total assets has a positive but statistically insignificant effect.

## 5. Conclusion

The empirical findings of the estimated models are pertinent for macroeconomics, quantitative finance, public finance, and development and emerging market economics. The findings show that an increase (decrease) in the current short-term interest rate is associated with an increase (decrease) in CGB yields, after controlling for macroeconomic and financial variables, including lagged values of the CGB yield, lagged values of the short-term interest rate, inflation or core inflation, the growth of industrial production, and the percentage changes in the stock price index, the exchange rate, and the PBoC's total asset balance. Two different models of CGB yields from across the CGB yield curve are estimated. Both models show similar results for the short-term interest rate's effect on CGB yields of different maturity tenors. Alternative independent variables are used to examine if the findings are well grounded. The models that use alternative independent variables produce similar results.

The estimated CGB models show that the current short-term interest rate has an economically and statistically significant effect on CGB yields of different maturity tenors, even after controlling for relevant macroeconomic and financial variables. This means that the PBoC's actions can have marked effects on CGB yields through the influence of its policy rate and other monetary policy measures on current short-term interest rates, such as the CTB3M and CTB6M rates. When the PBoC sets its monetary policy rates, undertakes various monetary policy measures, and adjusts its balance sheet, it affects CGB yields and the shape of the CGB yield curve.

Besides using its monetary policy rates to influence the long-term CGB yield via the current short-term interest rate, the PBoC can also resort to other tools, such as forward guidance, long-term asset purchases (including outright purchases of CGBs), yield curve control, and so forth. But the close association of current short-term interest rates with CGB yields shows the potency of the PBoC's monetary policy rate decisions on CGB yields and the CGB yield curve.

These findings imply that policymakers in China have considerable leeway in fiscal and monetary operations, government deficit finance, and central government debt management, as the PBoC's actions influence borrowing and lending rates in the banking system and affect a range of fixed income products, including bonds and derivatives. With the rise in outstanding CGBs in the previous decades, the empirical modeling of CGB yields undertaken in this paper could be useful for policymakers and investors who are interested in examining the workings of the monetary transmission mechanism and the operational dynamics of the financial system and capital markets in China.

The results of the estimated models further vindicate Keynes's claim that the central bank influences long-term government bond yields through the short-term interest rate. These results confirm that Keynes's (1930, pp. 352-353) claim also holds for financial markets in China.

Previous studies have disclosed that Keynes's conjecture holds in financial markets in advanced countries, such as the United States, Great Britain, Japan, Australia, Canada, and the countries of the euro zone, as well as for some emerging markets, such as Brazil, Mexico, and India. This paper shows that the empirical relationship between short-term interest rates and long-term government bond yields observed in other financial markets is also manifest in China's financial market.

## Appendix A. Tables on summary statistics and unit root tests

Table A1 – *Summary statistics (level)*

| Variable | Obs. | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Probability |
|---|---|---|---|---|---|---|---|---|---|---|
| CGB10Y | 200 | 3.43 | 3.41 | 4.57 | 2.54 | 0.50 | 0.42 | 2.40 | 8.84 | 0.01 |
| CGB7Y | 200 | 3.34 | 3.28 | 4.56 | 2.35 | 0.49 | 0.42 | 2.40 | 8.75 | 0.01 |
| CGB5Y | 200 | 3.15 | 3.07 | 4.43 | 1.98 | 0.53 | 0.34 | 2.42 | 6.69 | 0.04 |
| CGB3Y | 200 | 2.94 | 2.90 | 4.38 | 1.36 | 0.59 | 0.06 | 2.67 | 1.01 | 0.60 |
| CTB6M | 200 | 2.50 | 2.46 | 4.21 | 0.86 | 0.70 | −0.07 | 2.58 | 1.66 | 0.44 |
| CTB3M | 200 | 2.41 | 2.33 | 4.60 | 0.82 | 0.73 | 0.08 | 2.69 | 1.05 | 0.59 |
| CPI | 200 | 2.50 | 2.13 | 8.83 | −1.79 | 1.96 | 0.83 | 4.14 | 33.67 | 0.00 |
| CCPI | 200 | 1.20 | 1.43 | 2.42 | −1.70 | 0.81 | −1.43 | 5.43 | 117.11 | 0.00 |
| IP | 200 | 8.99 | 7.36 | 33.94 | −13.91 | 5.68 | 0.54 | 7.57 | 183.40 | 0.00 |
| LNPBOC | 200 | 12.61 | 12.72 | 12.95 | 11.79 | 0.27 | −1.19 | 3.66 | 50.88 | 0.00 |
| LNSNGHAI | 200 | 7.81 | 7.81 | 8.56 | 7.30 | 0.23 | 0.33 | 3.22 | 3.98 | 0.14 |
| LNSNZN300 | 200 | 8.12 | 8.14 | 8.64 | 7.51 | 0.26 | −0.15 | 2.27 | 5.23 | 0.07 |
| LNEURCNY | 200 | 2.10 | 2.07 | 2.40 | 1.90 | 0.12 | 0.78 | 2.77 | 20.47 | 0.00 |
| LNUSDCNY | 200 | 1.90 | 1.90 | 2.05 | 1.80 | 0.06 | 0.50 | 2.96 | 8.34 | 0.02 |

Table A2 – *Summary statistics (first difference)*

| Variable | Obs. | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | Probability |
|---|---|---|---|---|---|---|---|---|---|---|
| ΔCGB10Y | 199 | 0.00 | 0.01 | 0.42 | −0.75 | 0.14 | −0.58 | 7.56 | 183.46 | 0.00 |
| ΔCGB7Y | 199 | 0.00 | 0.00 | 0.47 | −0.71 | 0.15 | −0.25 | 5.83 | 68.36 | 0.00 |
| ΔCGB5Y | 199 | 0.00 | 0.00 | 0.62 | −0.71 | 0.17 | −0.19 | 5.76 | 64.41 | 0.00 |
| ΔCGB3Y | 199 | 0.00 | −0.01 | 0.67 | −0.76 | 0.19 | −0.26 | 6.19 | 86.45 | 0.00 |
| ΔCTB6M | 199 | 0.00 | 0.02 | 0.81 | −0.91 | 0.23 | −0.12 | 5.43 | 49.35 | 0.00 |
| ΔCTB3M | 199 | 0.00 | 0.01 | 1.00 | −0.90 | 0.26 | −0.04 | 5.24 | 41.77 | 0.00 |
| ΔCPI | 199 | −0.01 | 0.02 | 1.72 | −2.03 | 0.55 | −0.41 | 4.48 | 23.81 | 0.00 |
| ΔCCPI | 199 | 0.00 | 0.00 | 0.72 | −0.79 | 0.16 | −0.02 | 7.12 | 141.00 | 0.00 |
| ΔIP | 199 | −0.07 | −0.03 | 26.85 | −20.87 | 3.22 | 0.62 | 42.87 | 13193.96 | 0.00 |
| ΔLNPBOC | 199 | 0.01 | 0.01 | 0.08 | −0.05 | 0.02 | 0.15 | 4.94 | 31.97 | 0.00 |
| ΔLNSNGHAI | 199 | 0.00 | 0.01 | 0.20 | −0.26 | 0.07 | −0.23 | 4.93 | 32.47 | 0.00 |
| ΔLNSNZN300 | 199 | 0.00 | 0.01 | 0.23 | −0.22 | 0.07 | 0.00 | 4.85 | 28.50 | 0.00 |
| ΔLNEURCNY | 199 | −0.00 | −0.00 | 0.06 | −0.08 | 0.02 | −0.35 | 4.12 | 14.40 | 0.00 |
| ΔLNUSDCNY | 199 | 0.00 | 0.00 | 0.04 | −0.03 | 0.01 | 0.93 | 6.39 | 123.83 | 0.00 |

Table A3 – *Unit root and stationarity test (level)*

| Variable | ADF | | | PP | | | KPSS | |
|---|---|---|---|---|---|---|---|---|
| | With constant | With constant & trend | Without constant & trend | With constant | With constant & trend | Without constant & trend | With constant | With constant & trend |
| CGB10Y | −3.00** | −4.36*** | −0.61 | −2.33 | −3.55** | −0.48 | 0.90*** | 0.08 |
| CGB7Y | −3.52*** | −4.22*** | −0.63 | −2.50 | −3.18* | −0.41 | 0.54** | 0.11 |
| CGB5Y | −3.38** | −3.87** | −0.65 | −2.79* | −3.28* | −0.44 | 0.41* | 0.11 |
| CGB3Y | −3.51*** | −3.71** | −0.74 | −2.90** | −3.10 | −0.56 | 0.23 | 0.13* |
| CTB6M | −3.49*** | −3.55** | −0.81 | −2.84* | −2.90 | −0.79 | 0.19 | 0.17** |
| CTB3M | −3.48*** | −3.58** | −0.87 | −2.92** | −3.01 | −0.86 | 0.23 | 0.19** |
| CPI | −4.02*** | −4.26*** | −2.60*** | −2.92** | −3.37* | −1.92* | 0.44* | 0.04 |
| CCPI | −2.50 | −2.49 | −1.23 | −2.39 | −2.35 | −1.35 | 0.26 | 0.23*** |
| IP | −3.26** | −4.28*** | −1.95** | −4.09*** | −5.53*** | −2.15** | 1.21*** | 0.10 |
| LNPBOC | −6.20*** | −4.92*** | 4.77 | −6.51*** | −5.07*** | 4.20 | 1.55*** | 0.38*** |
| LNSNGHAI | −2.90** | −2.99 | 0.08 | −3.01** | −3.08 | 0.13 | 0.33 | 0.19** |
| LNSNZN300 | −2.67* | −2.99 | 0.23 | −2.93** | −3.24* | 0.27 | 0.83*** | 0.20** |
| LNEURCNY | −2.03 | −2.32 | −0.79 | −1.98 | −2.24 | −0.80 | 1.29*** | 0.33*** |
| LNUSDCNY | −2.66* | −2.44 | −0.30 | −2.55 | −2.19 | −0.44 | 0.32 | 0.31*** |

*Notes*: a. Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.
b. Lag length based on Schwartz information criterion (SIC).
c. Probability based on MacKinnon (1996) one-sided p-values (ADF and PP) and Kwiatkowski-Phillips-Schmidt-Shin (1992, table 1) (KPSS).
d. Null hypothesis ($H_0$): ADF and PP: the variable has a unit root; KPSS: the variable is stationary.

Table A4 – *Unit root and stationarity tests (first difference)*

| Variable | ADF | | | PP | | | KPSS | |
|---|---|---|---|---|---|---|---|---|
| | With constant | With constant & trend | Without constant & trend | With constant | With constant & trend | Without constant & trend | With constant | With constant & trend |
| ΔCGB10Y | −8.64*** | −8.64*** | −8.65*** | −8.00*** | −8.01*** | −8.03*** | 0.11 | 0.06 |
| ΔCGB7Y | −8.52*** | −8.52*** | −8.54*** | −7.75*** | −7.75*** | −7.78*** | 0.14 | 0.03 |
| ΔCGB5Y | −9.34*** | −9.34*** | −9.36*** | −8.95*** | −8.95*** | −8.98*** | 0.12 | 0.05 |
| ΔCGB3Y | −9.02*** | −9.017*** | −9.05*** | −8.55*** | −8.54*** | −8.57*** | 0.07 | 0.03 |
| ΔCTB6M | −9.36*** | −9.35*** | −9.38*** | −9.14*** | −9.12*** | −9.17*** | 0.05 | 0.03 |
| ΔCTB3M | −10.02*** | −10.01*** | −10.04*** | −9.80*** | −9.78*** | −9.83*** | 0.06 | 0.03 |
| ΔCPI | −6.36*** | −6.41*** | −6.30*** | −10.68*** | −10.66*** | −10.70*** | 0.04 | 0.03 |
| ΔCCPI | −9.24*** | −9.23*** | −9.26*** | −9.80*** | −9.79*** | −9.82*** | 0.06 | 0.03 |
| ΔIP | −14.75*** | −14.72*** | −14.78*** | −18.15*** | −18.18*** | −17.87*** | 0.07 | 0.05 |
| ΔLNPBOC | −14.99*** | −11.99*** | −13.44*** | −15.03*** | −16.19*** | −14.29*** | 1.16*** | 0.28*** |
| ΔLNSNGHAI | −10.06*** | −10.04*** | −10.09*** | −10.18*** | −10.15*** | −10.20*** | 0.03 | 0.03 |
| ΔLNSNZN300 | −10.25*** | −10.23*** | −10.27*** | −10.54*** | −10.52*** | −10.55*** | 0.03 | 0.03 |
| ΔLNEURCNY | −10.91*** | −10.93*** | −10.90*** | −10.92*** | −10.94*** | −10.93*** | 0.11 | 0.03 |
| ΔLNUSDCNY | −8.13*** | −8.39*** | −8.15*** | −8.17*** | −8.25*** | −8.18*** | 0.46* | 0.06 |

*Notes*: a. Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.
b. Lag length based on Schwartz information criterion (SIC).
c. Probability based on MacKinnon (1996) one-sided p-values (ADF and PP) and Kwiatkowski-Phillips-Schmidt-Shin (1992, table 1) (KPSS).
d. Null hypothesis ($H_0$): ADF and PP: the variable has a unit root; KPSS: the variable is stationary.

Table A1 and table A2 present summary statistics of the variables at their level and first difference, respectively. There are 200 observations at the level and 199 observations at the first difference for all the variables. CGB yields are higher for longer maturities, as can be seen in the mean, median, maximum, and minimum values for CGB3Y, CGB5Y, CGB7Y, and CGB10Y in table A1. The same is evident for the Treasury bill rates, CTB3M and CTB6M.

Several types of unit root tests (Dickey and Fuller, 1979, 1981; Phillips and Perron, 1988) are undertaken. Several types of stationarity tests (Kwiatkowski et al., 1992) are also conducted. The null hypothesis for these two tests is different. The null hypothesis of the unit root test is the presence of a unit root in the time series, whereas the null hypothesis of the stationarity test is that the time series is stationary. Table A3 shows that most of the variables are free of unit roots and are stationary at their level. At first difference, all the variables are stationary in one test or the other (table A4). Hence, each of the variables is either I(0) or I(1).

## Appendix B. Models of CGB yields in the belly of the CGB yield curve

### B1. Models for CGB5Y

Table B1 presents regression results for CGB5Y outcomes dependent on CTB3M and other control variables. Using the AIC model selection method, the simple specification of the model is ARDL(2,2) and the extended model is also ARDL(2,2). The CTB3M is positively associated with the CGB5Y yield, which is unchanged for additional controls. The effect for lags of CTB3M on CGB5Y varies with respect to the lags. The growth of industrial production has a positive and significant effect but the magnitude is small. The extended model shows that the percentage change in the Shanghai stock price index and the percentage change in the total assets of the PBoC both have statistically significant effects. Inflation has a negligible negative effect but it is statistically insignificant.

Several diagnostic tests are conducted to evaluate the models. In the serial correlation test, the null hypothesis is that the residuals are serially uncorrelated. An F-statistic p-value bigger than 0.05 in the simple specification indicates the failure to reject this null hypothesis of serially uncorrelated residuals, but rejects the null hypothesis for the extended specification. The F-statistic p-value for the model indicates the failure to reject the null hypothesis of homoscedasticity. The F-statistic value for the bounds test is evidently above the I(0) and I(1) critical value bound for both the simple and the extended models. Hence, the null hypothesis that there is no equilibrating relationship can be rejected for both models. The bounds test rejects the null hypothesis of no relationship in the levels, indicating the possibility of cointegration. The Ramsey RESET test fails to reject the null hypothesis that the model is correctly specified. The negative and highly significant EC term suggests that the variables are indeed cointegrated. The coefficients of the EC term of –0.21 and –0.18 suggest that about 18-21 percent of the discrepancy between the long run and the short run is corrected within a month. The CUSUM and the CUSUMSQ tests shown in figure B1 are displayed as in the previous figures in the paper. The CUSUM test for both models indicates stability in the equation during the sample period. However, the CUSUMSQ tests of both models are sometimes outside the 5 percent significance line, indicating instability of the residual variance.

The models are well suited to explain the behavioral dynamics, as shown by $R^2$ and adjusted $R^2$, which are each 0.95.

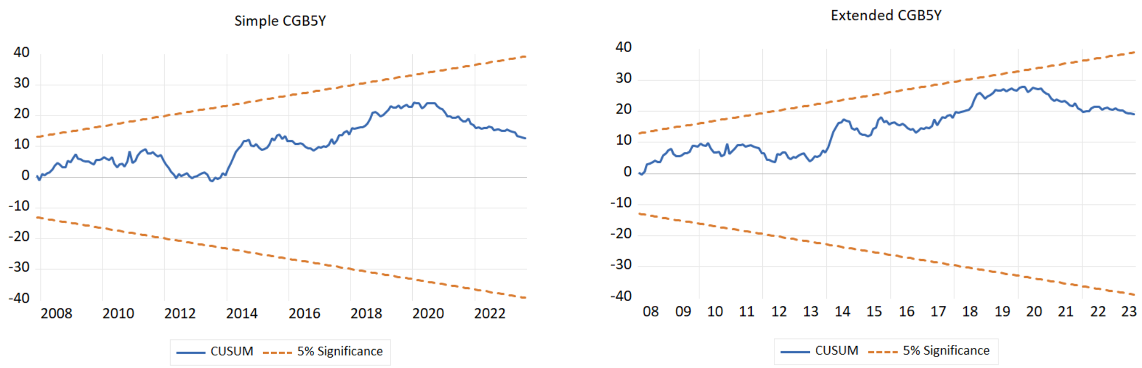
Table B1 – *Regression results and tests, ARDL(2,2): CGB5Y and CTB3M*

| **Variable** | **Coefficient (SE)** | **Coefficient (SE)** |
|---|---|---|
| CGB5Y(−1) | 1.11*** (0.07) | 1.13*** (0.07) |
| CGB5Y(−2) | −0.33*** (0.07) | −0.31*** (0.07) |
| CTB3M | 0.37*** (0.04) | 0.36*** (0.04) |
| CTB3M(−1) | −0.34*** (0.06) | −0.35*** (0.06) |
| CTB3M(−2) | 0.11** (0.05) | 0.11** (0.04) |
| CCPI | −0.02 (0.02) | −0.01 (0.02) |
| IP | 0.01*** (0.002) | 0.005*** (0.002) |
| ΔLNUSDCNY | | −0.41 (0.97) |
| ΔLNSNGHAI | | 0.52*** (0.14) |
| ΔLNPBOC | | 0.80 (0.56) |
| Constant | 0.32*** (0.07) | 0.27*** (0.07) |
| **Model information** | | |
| **Included observations** | 198 | 198 |
| R-squared | 0.95 | 0.95 |
| Adjusted R-squared | 0.94 | 0.95 |
| S.E. of regression | 0.13 | 0.12 |
| Sum squared resid. | 3.01 | 2.76 |
| Log likelihood | 133.49 | 142.00 |
| F-statistic (prob) | 472.48 (0.00) | 356.20 (0.00) |
| Akaike info criterion | −1.27 | −1.32 |
| Durbin-Watson stat | 2.03 | 2.07 |
| **Diagnostic tests** | | |
| **Breusch-Godfrey Serial Correlation LM test (null hypothesis: no serial correlation at up to model** | | |
| F-statistic (prob) | 1.37 (0.26) | 3.59 (0.03) |
| **Heteroskedasticity test: Breusch-Pagan-Godfrey (null hypothesis: homoskedasticity)** | | |
| F-statistic (prob) | 1.00 (0.43) | 0.64 (0.78) |
| **Bounds test (null hypothesis: no relationship in levels)** | | |
| F-statistic<br>10%: I(0) 3.020 I(1) 3.510;<br>5%: I(0) 3.620 I(1) 4.160;<br>1%: I(0) 4.940 I(1) 5.580 | 10.27 | 7.97 |
| **Ramsey RESET test** | | |
| F-statistic (2 fitted terms) | 1.22 (0.30) | 0.97 (0.38) |
| **Error correction** | | |
| COINTEQ* (prob) | −0.21 (0.00) | −0.18 (0.00) |

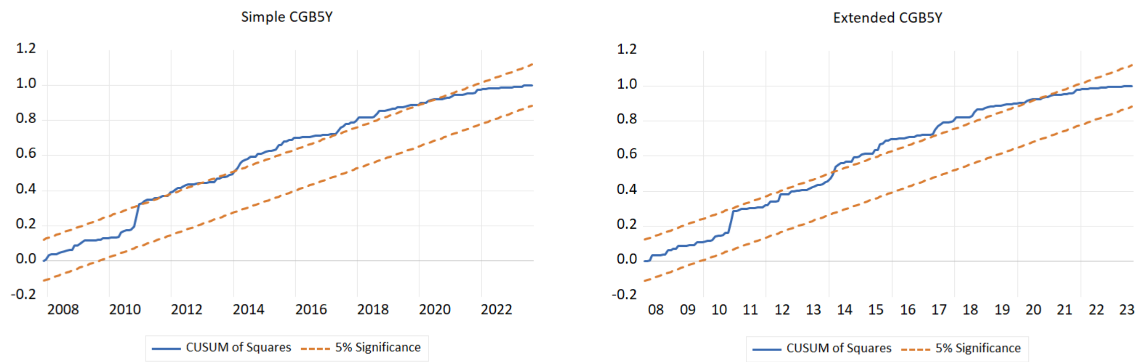
*Notes*: 1. The model is run in EViews 13 using ARDL models.
2. Heteroskedasticity and autocorrelation corrected (HAC [Newey-West]) standard errors.
3. Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Figure B1 – *CUSUM and CUSUMSQ stability diagnostic for simple and extended models of CGB5Y*

### Panel A: CUSUM for both models




### Panel B: CUSUMSQ for both models




## B1.2. Models for CGB7Y

Table B2 presents regression results for CGB7Y's outcome, dependent on CTB3M and other variables. The 3-month Treasury bill rate is positively associated with the 7-year government bond yield, which is unchanged for additional controls. The effect for the lags of CTB3M on CGB7Y varies with the lags. Here again the growth of industrial production has a very small positive effect on the bond yield, even though it is statistically significant. In the extended model, the percentage changes in the Shanghai stock market index and the PBoC's total assets have positive and statistically significant effects.

Some diagnostics tests are carried out to assess the models. In the serial correlation test, the null hypothesis is that the residuals are serially uncorrelated. The F-statistic p-value is greater than 0.05 in all the models, indicating the failure to reject this null hypothesis. In the heteroskedasticity test, the null hypothesis is that the residuals are homoscedastic. The F-statistic p-value for the model indicates the failure to reject the null hypothesis, even at the 10 percent significance level for the simple specification, but rejects it at the 5 percent level for the extended specification. The F-statistic value for the bounds test of the simple model is above the I(0) and I(1) critical value bound for both models' specifications. Hence, the null hypothesis that there is no equilibrating relationship can be rejected. The Ramsey RESET test fails to reject the null hypothesis that the model is correctly specified. The negative and highly significant EC term suggests that the variables are indeed cointegrated. About 18-21 percent of the discrepancy between the short run and the long run is corrected in one month. The CUSUM and CUSUMSQ tests are displayed in figure B2. The CUSUM test for both models indicates stability in the equation during the sample period. The models are quite judicious, as shown by $R^2$ and adjusted $R^2$, which are 0.95.

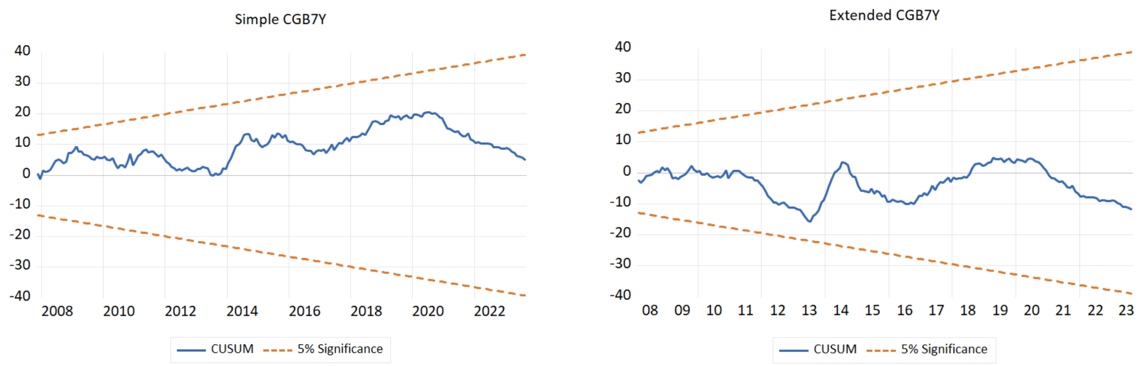
Table B2 – *Regression results and tests, ARDL(2,2): CGB7Y and CTB3M*

| **Variable** | **Coefficient (SE)** | **Coefficient (SE)** |
|---|---|---|
| CGB7Y(–1) | 1.26*** (0.07) | 1.22*** (0.07) |
| CGB7Y(–2) | –0.44*** (0.07) | –0.44*** (0.06) |
| CTB3M | 0.26*** (0.04) | 0.26*** (0.04) |
| CTB3M(–1) | –0.27*** (0.05) | –0.26*** (0.05) |
| CTB3M(–2) | 0.11*** (0.04) | 0.11*** (0.04) |
| CCPI | –0.01 (0.01) | –0.003 (0.01) |
| IP | 0.01*** (0.002) | 0.003 (0.002) |
| ΔLNUSDCNY | | –0.14 (0.22) |
| ΔLNSNGHAI | | 0.05 (0.04) |
| ΔLNPBOC | | 0.12** (0.05) |
| Constant | 0.35*** (0.07) | 1.77** (0.88) |
| **Model information** | | |
| **Included observations** | 198 | 198 |
| R–squared | 0.95 | 0.95 |
| Adjusted R–squared | 0.95 | 0.95 |
| S.E. of regression | 0.11 | 0.11 |
| Sum squared resid. | 2.46 | 2.37 |
| Log likelihood | 153.53 | 156.97 |
| F–statistic (prob) | 495.54 (0.00) | 354.14 (0.00) |
| Akaike info criterion | –1.47 | –1.47 |
| Durbin–Watson stat | 2.01 | 1.99 |
| **Diagnostic tests** | | |
| **Breusch-Godfrey Serial Correlation LM test (null hypothesis: no serial correlation at up to lags)** | | |
| F-statistic (prob) | 0.71 (0.49) | 0.11 (0.90) |
| **Heteroskedasticity test: Breusch-Pagan-Godfrey (null hypothesis: homoskedasticity)** | | |
| F-statistic (prob) | 1.30 (0.25) | 2.17 (0.02) |
| **Bounds test (null hypothesis: no relationship in levels)** | | |
| F-statistic | 9.92 | 11.87 |
| 10%: I(0) 3.020 I(1) 3.510; | | |
| 5%: I(0) 3.620 I(1) 4.160; | | |
| 1%: I(0) 4.940 I(1) 5.580 | | |
| **Ramsey RESET test:** | | |
| F-statistic (2 fitted terms) | 0.91 (0.41) | 0.67 (0.51) |
| **Error correction** | | |
| COINTEQ* (prob) | –0.18 (0.00) | –0.21 (0.00) |

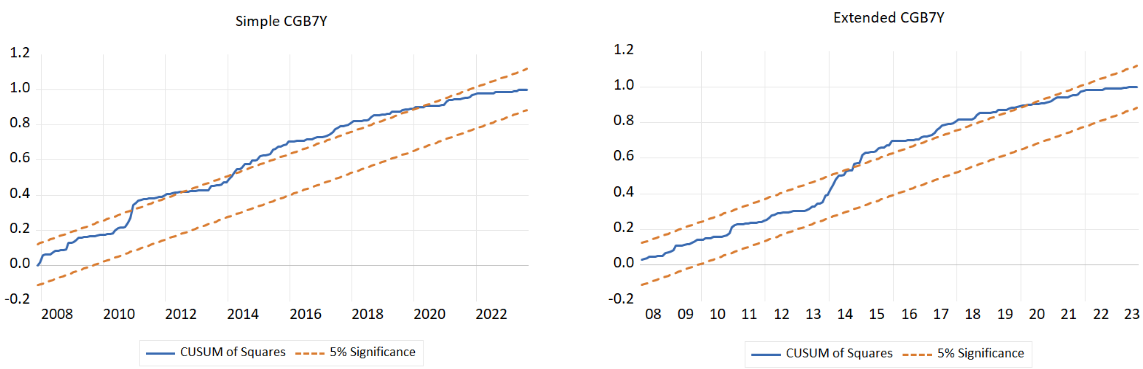
*Notes*: 1. The model is run in EViews 13 using ARDL.
2. Heteroskedasticity and autocorrelation corrected (HAC [Newey-West]) standard errors.
3. Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Figure B2 – *CUSUM and CUSUMSQ stability diagnostic for simple and extended models for CGB7Y*

## Panel A: CUSUM for both models




## Panel B: CUSUMSQ for both models




## Appendix C. The simple model with alternative independent variables

Table C1 – *Regression results ARDL(p,q): simple models of CGB$_j$Y (with CTB6M)*

| Variable | Coefficient (std. error) | Coefficient (std. error) | Coefficient (std. error) | Coefficient (std. error) |
|---|---|---|---|---|
| | CGB3Y (2,2) | CGB5Y (2,2) | CGB7Y (2,2) | CGB10Y (2,2) |
| CGB$_j$Y(−1) | 1.01*** (0.07) | 1.07*** (0.07) | 1.23*** (0.07) | 1.27*** (0.07) |
| CGB$_j$Y(−2) | −0.25*** (0.07) | −0.27*** (0.07) | −0.40*** (0.07) | −0.39*** (0.07) |
| CTB6M | 0.62*** (0.04) | 0.44*** (0.04) | 0.31*** (0.04) | 0.23*** (0.04) |
| CTB6M(−1) | −0.55*** (0.07) | −0.43*** (0.07) | −0.35*** (0.06) | −0.28*** (0.06) |
| CTB6M(-2) | 0.11** (0.06) | 0.10* (0.05) | 0.12*** (0.04) | 0.09** (0.04) |
| CPI | 0.001 (0.004) | 0.0002 (0.01) | 0.001 (0.005) | 0.0002 (0.005) |
| IP | 0.005*** (0.001) | 0.06*** (0.002) | 0.01*** (0.002) | 0.006*** (0.002) |
| C | 0.22*** (0.05) | 0.28*** (0.06) | 0.32*** (0.07) | 0.24*** (0.06) |

| Model information | | | | |
|---|---|---|---|---|
| Included observations | 198 | 198 | 198 | 198 |
| R-squared | 0.97 | 0.95 | 0.95 | 0.95 |
| Adjusted R-squared | 0.97 | 0.95 | 0.95 | 0.95 |
| S.E. of regression | 0.10 | 0.12 | 0.11 | 0.11 |
| Sum squared resid. | 2.02 | 2.71 | 2.34 | 2.29 |
| Log likelihood | 172.95 | 143.85 | 158.48 | 160.52 |
| F-statistic | 899.90 | 527.62 | 522.36 | 567.40 |
| Prob(F-statistic) | 0.00 | 0.00 | 0.00 | 0.00 |
| Mean dependent var. | 2.94 | 3.15 | 3.35 | 3.44 |
| S.D. dependent var. | 0.59 | 0.53 | 0.49 | 0.50 |
| Akaike info criterion | –1.67 | –1.37 | –1.52 | –1.54 |
| Durbin-Watson stat | 2.05 | 2.03 | 2.02 | 2.02 |

*Notes*: 1. The model is run in EViews 13 using ARDL.
2. Heteroskedasticity and autocorrelation corrected (HAC [Newey-West]) standard errors.
3. Significance levels: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

## Appendix D. Granger causality tests

Table D1 – *Granger causality with two lags between $\Delta CGB_iY$ and ΔCTB3M, and between $\Delta CGB_iY$ and ΔCTB6M*

| Null hypothesis: | Obs. | F-Statistic | Prob. |
|---|---|---|---|
| **CTB3M** | | | |
| ΔCTB3M does not Granger cause ΔCGB3Y | 197 | 0.045 | 0.955 |
| ΔCGB3Y does not Granger cause ΔCTB3M | | 5.917 | 0.003 |
| ΔCTB3M does not Granger cause ΔCGB5Y | 197 | 0.075 | 0.927 |
| ΔCGB5Y does not Granger cause ΔCTB3M | | 6.216 | 0.002 |
| ΔCTB3M does not Granger cause ΔCGB7Y | 197 | 0.392 | 0.676 |
| ΔCGB7Y does not Granger cause ΔCTB3M | | 7.950 | 0.000 |
| ΔCTB3M does not Granger cause ΔCGB10Y | 197 | 0.517 | 0.597 |
| ΔCGB10Y does not Granger cause ΔCTB3M | | 7.307 | 0.000 |
| **CTB6M** | | | |
| ΔCTB6M does not Granger cause ΔCGB3Y | 197 | 0.431 | 0.650 |
| ΔCGB3Y does not Granger cause ΔCTB6M | | 4.927 | 0.008 |
| ΔCTB6M does not Granger cause ΔCGB5Y | 197 | 0.197 | 0.820 |
| ΔCGB5Y does not Granger cause ΔCTB6M | | 6.182 | 0.002 |
| ΔCTB6M does not Granger cause ΔCGB7Y | 197 | 0.078 | 0.924 |
| ΔCGB7Y does not Granger cause ΔCTB6M | | 9.015 | 0.000 |
| ΔCTB6M does not Granger cause ΔCGB10Y | 197 | 0.082 | 0.920 |
| ΔCGB10Y does not Granger cause ΔCTB6M | | 9.193 | 0.000 |

Granger causality tests are conducted to examine for any presence of "causality" and/or "reverse causality" between the short-term interest rate and the long-term interest rate. The Granger causality test results are reported in table D1, below. The results show that the long-term interest rate at first difference Granger "causes" the short-term interest rate at its first difference.

Several important caveats need to be emphasized here. First, Granger causality tests can be conducted only on stationary time series data. Thus, the first-differenced data have been used for these tests. The ARDL models, estimated in the paper, are suitable and germane for both stationary and nonstationary time series. Thus, the level variables are used for the ARDL models estimated in tables 2, 3, 4, B1, B2, and C1. The ARDL models incorporate the lagged value of the dependent and independent regressors. Second, these Granger causality tests provide some insights regarding only the *temporal precedence* of the given CGB yield and the short-term interest rate at their *first differences*. These results do not provide any insight about temporal precedence, let alone the *causal relationship*, between the *levels* of the CGB yield and the short-term interest rate. The ARDL models estimated here, however, are relevant for understanding the underlying dynamics of CGB yields. Third, the results of Granger tests could be dependent on the choice of the lag length. Fourth, if the two variables under consideration are driven by some other variables, then the test may fail to reject the alternative hypothesis of Granger causality.

## Appendix E. Monetary policy rates and short-term interest rates in China

Monetary policy rates and short-term interest rates tend to be closely tied and positively correlated in China, providing vindication of Keynes's (2007 [1936], pp. 202-3) observation that "the short-term rate of interest is easily controlled by the monetary authority". However, this does *not* mean that short-term interest rates depend *only* on monetary policy rates; other economic factors – including financial stress, volatility, the exchange rate, macroeconomic fundamentals, liquidity, and credit conditions – also influence short-term interest rates.

Figure E1 – *The evolution of monetary policy rates and short-term interest rates in China, 2007Q1–2023Q2*

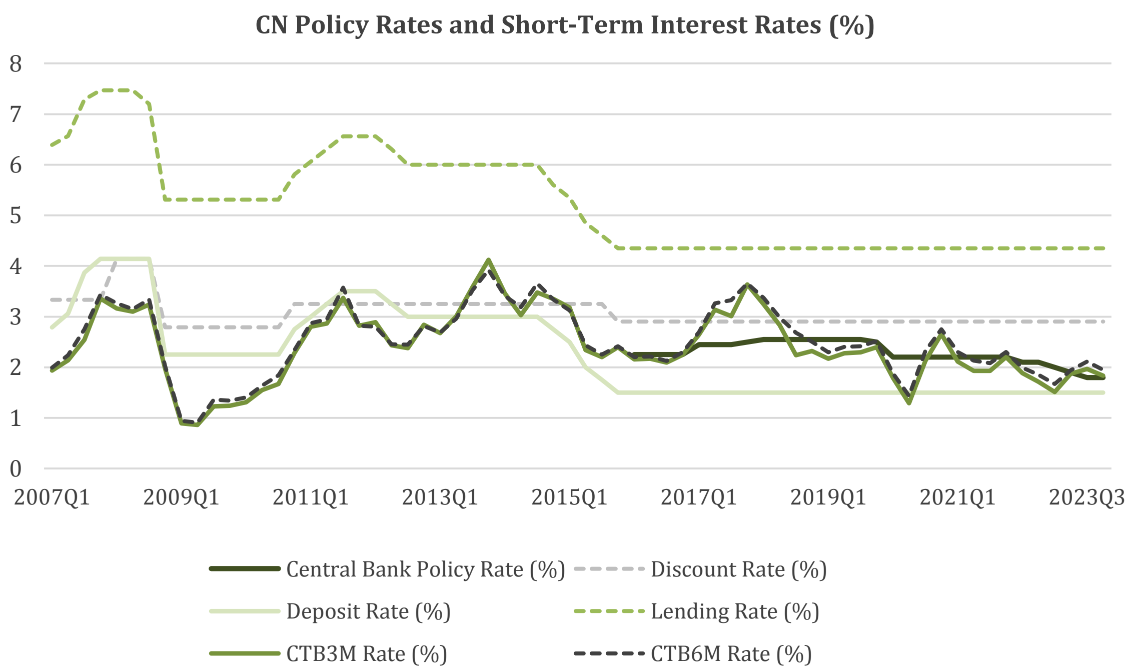


Figure E1, below, traces the evolution of the PBoC's assorted monetary policy rates and short-term interest rates, based on quarterly data from the International Monetary Fund (IMF, various years). Table E1 shows the correlations between various monetary policy rates and short-term interest rates.

Table E1 – *Correlations between monetary policy rates and short-term interest rates, 2007Q1–2023Q2*

| **Correlation** | **Central bank policy rate (%)** | **Discount rate (%)** | **Deposit rate (%)** | **Lending rate (%)** |
|---|---|---|---|---|
| **With CTB3M rate (%)** | 0.63 | 0.56 | 0.46 | 0.41 |
| **With CTB6M rate (%)** | 0.66 | 0.54 | 0.43 | 0.38 |

*Sources*: IMF, authors' calculations.

## References


Akram T. (2022a), "One-factor Keynesian models of the long-term interest rate", *Journal of Economic Issues*, 56(2), pp. 356-361.

Akram T. (2022b), "Multifactor Keynesian models of the long-term interest rate", *Applied Economics Letters*, 30(9), pp. 1222-1227.

Akram T. and Li H. (2020a), "An inquiry concerning long-term U.S. interest rates", *Applied Economics*, 52(24), pp. 2594-2621.

Akram T. and Li H. (2020b), "JGBs' chronically low nominal yields: A VEC approach", *Applied Economics*, 52(53), pp. 5873-5893.

Akram T. and Li H. (2020c), "An analysis of the impact of the Bank of Japan's monetary policy on Japanese government bonds' low nominal yields", in Stenfors A. and Toporowski J. (eds.), *Unconventional monetary policy and financial stability: The case of Japan* (pp. 88-109), London: Routledge.

Akram T. and Mamun K. (2023), "Chinese yuan interest rate swap yields", *PLOS ONE*, 18(8), art. e0289687. Available online.

Akram T. and Uddin S.A.H. (2021), "An empirical analysis of long-term Brazilian interest rates", *PLOS ONE*, 16(9), art. e0257313. Available online.

Akram T. and Uddin S.A.H. (2022), "The empirics of long-term Mexican government bond yields", *Macroeconomics and Finance in Emerging Market Economies*, 17(2), pp. 333-355.

Amstad M. and He Z. (2020), "Chinese Bond Market and Interbank Market", in Amstad M., Sun G. and Xiong W. (eds.), *The Handbook of China's Financial System* (pp. 105-147), Princeton (NJ) and Oxfordshire (UK): Princeton University Press.

Asian Development Bank (various years), *Asia Bond Monitor*, various issues. Available online.

Atesogulu H.S. (2003-4), "Monetary transmission—federal funds rate and prime rate", *Journal of Post Keynesian Economics*, 26(2), pp. 357-362.

Atesogulu H.S. (2005), "Monetary policy and long-term interest rates", *Journal of Post Keynesian Economics*, 27(3), pp. 533-540.

Bloomberg (2024), "China unveils $1.4 trillion debt swaps, saves stimulus for Trump", *Bloomberg News*, November 8. Available online.

Brown R.L., Durbin J. and Evans J.M. (1975), "Techniques for testing the constancy of regression relationships over time", *Journal of the Royal Statistical Society*, series B (methodological), 37(2), pp. 149-192. Available online.

Cassel G. (1903), *The nature and necessity of interest*, London: Macmillan.

Cook S. (2008), "Econometric analysis of interest rate pass through", *Applied Financial Economic Letters*, 4(4), pp. 249-251.

Davidson P. (1991), “Is probability theory relevant for uncertainty?”, *Journal of Economic Perspectives*, 5(1), pp. 129-143. Available online.
Deleidi M. and Levrero E.S. (2020), “Monetary policy and long-term interest rates: Evidence from the US Economy”, *Metroeconomica*, 72(1), pp. 121-147.
Dequesh D. (1999), “Expectations and confidence under uncertainty”, *Journal of Post Keynesian*, 21(3), pp. 415-429.
Dickey D.A. and Fuller W.A. (1979), “Distribution of the estimators for autoregressive time series with a unit root”, *Journal of the American Statistical Association*, 74(366), pp. 427-431.
Dickey D.A. and Fuller W.A. (1981), “Likelihood ratio statistics for autoregressive time series with a unit root”, *Econometrica*, 49(4), pp. 1057-1072.
Fisher I. ([1907] 1997a), *The rate of interest*, in Barber W.J. (ed.), *The works of Irving Fisher*, vol 3, London: Pickering and Chatto.
Fisher I. ([1943] 1997b), *The theory of interest*, in Barber W.J. (ed.), *The Works of Irving Fisher*, vol 9, London: Pickering and Chatto.
Gabrisch H. (2022), “Keynes vs. Kalecki: Risk and uncertainty in their theories of the rate of interest”, *Review of Keynesian Economics*, 10(1), pp. 46-62.
Hicks J.R. ([1939] 2001), *Value and capital: An enquiry into some fundamental principles of economic theory*, Oxford (UK): Clarendon Press.
IMF – International Monetary Fund (various years), *IMF data portal*. Available online.
Keynes J.M. ([1936] 2007), *The general theory of employment, interest, and money*, New York: Palgrave Macmillan.
Keynes J.M. (1930), *A treatise on money, vol. II: The applied theory of money*, London, UK: Macmillan.
Keynes J.M. (1937a), “Alternative theories of the rate of interest”, *Economic Journal*, 47(186), pp. 241-252.
Keynes J.M. (1937b), “The general theory of employment”, *Quarterly Journal of Economics*, 51(2), pp. 209-223.
Kim H. (2020), “The relationship between public debt accumulation and default risk under the ECB’s conventional vs. non-standard monetary policy: A panel data analysis of 9 eurozone countries (2000–2015)”, *Journal of Post Keynesian Economics*, 43(1), pp. 112-130.
Kim H. (2021), “Sovereign currency and long-term interest rates”, *International Review of Applied Economics*, 35(3-4), pp. 577-596.
Kregel J.A. (1976), “Economic methodology in the face of uncertainty: The modeling methods of Keynes and the Post Keynesian”, *Economic Journal*, 85(342), pp. 209-225.
Kregel J.A. (2020), *Financial stability, systems and regulation*, ed. by Felipe C. Rezende, New York: Routledge.
Kregel J.A. (2024), *Financial macroeconomics*, London and New York: Anthem Press.
Kwiatkowski D., Phillips P.C.B., Schmidt P. and Shin Y. (1992), “Testing the null hypothesis of stationarity against the alternative of a unit root”, *Journal of Econometrics*, 54(1-3), pp. 159-178.
Lavoie M. (2014), *Post-Keynesian economics: New foundations*, Cheltenham (UK) and Northampton (MA): Edward Elgar.
Li H. and Su Y. (2021), “The nonlinear causal relationship between short- and long-term interest rates: An empirical assessment of the United States, the United Kingdom, and Japan”, *International Finance*, 24(3), pp. 332-355.
MacKinnon J. G. (1996), “Numerical distribution functions for unit root and cointegration tests”, *Journal of Applied Econometrics*, 11(6), pp. 601-618.
Marglin S.A. (2021), *Raising Keynes: A twenty-first-century general theory*, Cambridge (MA): Harvard University Press.
Marshall A. (1890), *Principles of economics*, London: Macmillan.
Payne J.E. (2006-07), “More on the transmission mechanism: Mortgage rates and the federal funds rate”, *Journal of Post Keynesian Economics*, 29(2), pp. 247-259.
Phillips P.C.B. and Perron P. (1988), “Testing for a unit root in time series regression”, *Biometrika*, 75(2), pp. 335-346.
Pollin R. (1991), “Two theories of money supply endogeneity: Some empirical evidence”, *Journal of Post Keynesian Economics*, 13(3), pp. 366-396.
Pollin R. (2008), “Considerations on interest rate exogeneity”, *PERI Working Paper*, no. 177, Amherst (MA): Political Economy Research Institute. Available online.
Rahimi A., Chu B.M. and Lavoie M. (2017), “Linear and non-linear granger causality between short-term and long-term interest rates: A rolling window strategy”, *Metroeconomica*, 68(4), pp. 882-902.
Rahimi A., Lavoie M. and Chu B. (2016), “Linear and nonlinear Granger-causality between short-term and long-term interest rates during business cycles”, *International Review of Applied Economics*, 30(6), pp. 714-728.
Riefler W.W. (1930), *Money rates and money markets in the United States*, New York and London: Harper & Brothers.
Shackle G.L.S. (1955), *Uncertainty in economics*, Cambridge (UK): Cambridge University Press.
Simoski S. (2019), “A Keynesian exploration of the determinants of government bond yields for Brazil, Colombia, and Mexico”, Master of Science thesis, Annandale-on-Hudson (NY): Levy Economics Institute of Bard College. Available online.
Taleb N.N. (2004), *Fooled by randomness: The hidden role of chance in life and in the markets*, London: Penguin Books.
Taleb N.N. (2005), *The black swan: Why don’t we learn that we don’t learn*, New York: Random House.

Taussig F.W. (1918), *Principles of Economics* (in two volumes), Second revision, New York: Macmillan.

*The Economist* (2024), “How China’s communists fell in love with privatization”, *Economist.com*, September 15. Available online.

Vinod H.D., Chakraborty L. and Karun H. (2014), “If deficits are not the culprit, what determines Indian interest rates? An evaluation using the maximum entropy bootstrap method”, *Levy Institute Working Paper*, no. 811, Annandale-on-Hudson (NY): Levy Economics Institute of Bard College. Available online.

Von Mises L. (1963), *Human action: A treatise on economics*, New Haven (CT): Yale University Press.

Wicksell K. ([1918] 1965), *Interest and prices: A study of the causes regulating the value of money*, New York: August M. Kelly.