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Akram, Tanweer; al Mamun, Khawaja Abdullah

Working Paper Chinese yuan interest rate swap yields

Working Paper, No. 1014

Provided in Cooperation with: Levy Economics Institute of Bard College

Suggested Citation: Akram, Tanweer; al Mamun, Khawaja Abdullah (2023) : Chinese yuan interest rate swap yields, Working Paper, No. 1014, Levy Economics Institute of Bard College, Annandale-on-Hudson, NY

This Version is available at: https://hdl.handle.net/10419/283205

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Working Paper No. 1014

Chinese Yuan Interest Rate Swap Yields

by

Tanweer Akram Senior Vice President/Senior Economist at Citibank

Khawaja Mamun Associate Professor at Sacred Heart University

February 2023

* The authors thank participants at various workshops for their valuable comments.

Important disclaimer: The authors' institutional affiliations are provided only for identification purposes. Views expressed are solely those of the authors. The standard disclaimer holds.

The data set is available for replication: The data set used in the empirical part of this paper is available upon request to bona fide researchers for the replication and verification of the results.

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ISSN 1547-366X

ABSTRACT

This paper models the dynamics of Chinese yuan (CNY)–denominated long-term interest rate swap yields. The financial sector plays a vital role in the Chinese economy, which has grown rapidly in the past several decades. Going forward, interest rate swaps are likely to have an important role in the Chinese financial system. This paper shows that the short-term interest rate exerts a decisive influence on the long-term swap yield after controlling for various macrofinancial variables, such as inflation or core inflation, the growth of industrial production, percent change in the equity price index, and the percentage change in the CNY exchange rate. The autoregressive distributed lag (ARDL) approach is applied to model the dynamics of the long-term swap yield. The empirical findings show that the People's Bank of China's influence extends even to the over-the-counter derivative products, such as CNY interest rate swap yields, through the short-term interest rate. The findings reinforce and extend John Maynard Keynes's notion that the central bank's actions have a decisive role in setting the long-term interest rate in emerging market economies, such as China.

KEYWORDS: Chinese Yuan (CNY) Swaps; Interest Rate Swaps; Short-Term Interest Rate; Monetary Policy; The People's Bank of China (PBOC)

JEL CLASSIFICATIONS: E43; E50; E60; G10; G12

SECTION I: INTRODUCTION

This paper econometrically models the dynamics of Chinese yuan (CNY)–denominated longterm interest rate swaps using monthly macroeconomic and financial data. The financial sector plays a vital role in the Chinese economy, which has grown rapidly in the past several decades. There has been a rapid growth of outstanding debt and fixed-income instruments, with notable developments in interest rate liberalization. Alongside these developments, there has been a spectacular rise in the country's bond market and total social financing since the global financial crisis.

Interest rate swaps are likely to play an important role in the Chinese financial system, which has been changing from a bank-dominated system to one with more diverse financial institutions and increased market dominance, often characterized by liquidity shocks and spikes in interest rates in the interbank market. Although there is a growing literature studying the Chinese financial system (Armstrong-Taylor 2016; Walter and Howie 2012), CNY-denominated interest rate swap yields have not been econometrically modeled. The analysis of CNY-denominated swaps warrants careful study because of the increased financialization of the Chinese economy and the rise of the nation's shadow banking system in which over-the-counter (OTC) derivatives, such as swaps, are likely to have an instrumental role.

This paper shows that the short-term interest rate exerts a decisive influence on the long-term swap yield after controlling for various macroeconomic and financial variables, such as inflation or core inflation, the growth of industrial production, the percentage change in the equity price index, and the CNY exchange rate. This finding is in concordance with John Maynard Keynes's (1930, [1936] 2007) astute insight about the relationship between the long-term interest rate and the current short-term interest rate. The autoregressive distributed lag (ARDL) approach is applied to model the dynamics of the long-term swap yield using monthly data.

The paper proceeds as follows. Section II provides a short primer on interest rate swaps and briefly reviews the relevant literature on swaps and their applications. Section III outlines the macroeconomic environment in which the interest rate swap yields in China are evolving.

Section IV presents the data and sources used in the econometric modeling of swap yields, displays the summary statistics, and undertakes unit root and stationary tests. Section V lays out the framework for econometric models, reports and interprets the findings from the estimated models, and discusses the implications of the results. Section VI concludes.

SECTION II: INTEREST RATE SWAPS AND A BRIEF REVIEW OF THE LITERATURE

Interest rate swaps are contracts that enable two parties to exchange two interest rate cash flows with different features. Swaps are derivative contracts that trade over the counter. The principal amount, which is known as the notional principal of a swap, is the same for both parties. For plain-vanilla interest rate swaps, the swap buyer pays the fixed interest rate and receives the variable interest rate. The buyer is known as the receiver. The swap seller pays the variable interest rate and receives the fixed interest rate. The swap seller is known as the payer. The floating rate payments are based on some benchmark interest rates, such as the London Interbank Offer Rate (LIBOR), plus some agreed-upon markup. The swap yield, or the swap rate, is the fixed interest rate that the buyer or the receiver demands in exchange for the uncertainty of having to pay the short-term benchmark interest rate over time. Swaps are usually quoted in terms of this fixed rate. Swaps are also quoted in terms of the swap spread, which is the difference between the swap yield and the relevant benchmark government bond yield of the same maturity tenor. Corb (2012) explains the functions of interest rate swaps including usage, pricing, risks, and innovations.

Besides plain-vanilla interest rate swaps, there are other types of interest rate swaps, such as those that trade one floating rate for another. However, plain-vanilla swaps constitute the majority of the global swaps market. Swaps are used to hedge, speculate, and manage risks.

Bicksler and Chen (1986), Chernenko and Faulkender (2011), Kim and Koppenhaver (1993), and Visvanathan (1998) give overviews of the assorted use of swaps in various business and finance applications. Remolona and Wooldridge's (2003) survey of euro-denominated interest

rate swaps provides a valuable perspective on the size and the growth of the euro swap markets, the key participants of the market, pricing of the instruments, and market liquidity. The Bank for International Settlements' (2022) report on OTC derivatives statistics render comprehensive details about swaps, including interest rate swaps denominated in various currencies, in global financial markets.

Though there is a vast literature on swaps, the empirical modeling of swap yields has some critical gaps. Duffie and Huang (1996) and Duffie and Singleton (1997) have pioneered the empirical modeling of swaps yields, but these models fail to incorporate Keynes's (1930, [1936] 2007) insight, which tethers the long-term interest rate to the short-term interest rate. Kregel (2011) shows Keynes's insight drew on his own theoretical perspectives and Riefler's (1930) pioneering statistical analysis of bond yields in the United States in the 1920s. Keynes's insight on interest rate dynamics has also found support in recent empirical research. Several studies (Akram and Li 2020a, 2020b; Atesogulu 2003–4, 2005; Cook 2008; Deleidi and Levrero 2020; Gabrisch 2021; Kim 2020, 2021; Payne 2006–7; Simoski 2019; Vinod, Chakraborty, and Karun 2014) evince that there is a meaningful economic and statistically significant pass through from the central bank's policy rate to market interest rates. Akram (2021, 2022) has advanced quantitative models that formalize Keynes's insight linking the long-term interest rate to the short-term interest rate.

Most empirical studies showing the strong connection have been confined to government bond yields in advanced countries. Hence, it is relevant to ask whether Keynesian insight is generalizable beyond government bond yields in advanced countries. This paper contributes to the empirical literature by examining: (i) whether Keynes's conjecture is applicable to spread products and OTC financial derivatives, such as interest rate swaps, and (ii) whether it holds in emerging markets with rapidly evolving financial systems, such as China. Recently, Akram and Mamun (2022a, 2022b, 2022c) have shown that Keynes's conjecture is supported for Chilean peso (CLP), US dollar (USD), and UK pound (GBP) swaps.

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SECTION III: THE MACROECONOMIC ENVIRONMENT SURROUNDING THE DYNAMICS OF SWAP YIELDS

An overview of the macroeconomic context surrounding the evolution of CNY-denominated swap yields in recent years is quite useful because it can provide an understanding of the relations between interest rate swap yields and key macroeconomic and financial variables.

Figure 1 displays the evolution of interest rate swaps in China during the study period, which is from September 2014 to September 2022. (The sources of the data used in the figures below are listed in Table 1 below). It shows that swap yields of various maturity tenors have generally moved together. Swap yields were trading between 3.5 percent to 4 percent in September 2014 but had gradually declined to a range of about 2.5 percent to 3 percent by September 2015. However, swap yields rose sharply in the following months, peaking between March and April of 2017. Subsequently, swap yields gradually declined from May 2017 to December 2019. With the onset of COVID-19 and the Great Lockdown, swap yields fell precipitously and sharply, bottoming out in May 2020. Swap yields recovered between June 2020 and August 2020, but were mostly unchanged from September 2020 until mid-2021, when they again gradually declined until the end of the study period in September 2022.



Figure 1: The Evolution of CNY Swap Yields, September 2014 to September 2022

The 10-year swap yield and the 3-month Treasury bill yield tend to move in concert, as shown in Figure 2, below. There are times when the long-term swap yield and the short-term interest rate diverge, such as in the first half of 2017, but these are the exceptions.



Figure 2: The Coevolution of the 10-Year Swap Yield and 3-Month T-Bill Yield, September 2014 to September 2022

Figure 3 exhibits the evolution of the consumer price index (CPI) and core CPI inflation, year over year. Overall inflation and core inflation generally move in unison in China. However, overall inflation tends to be more volatile, owing to the higher volatility of energy and food prices. As a result, there are occasions when overall inflation and core inflation diverge.



Figure 3: The Evolution of Core CPI Inflation, September 2014 to September 2022

Figure 4 displays the growth of industrial production in China. Industrial production in China has been growing at a robust pace. However, industrial production fell sharply in early 2020 amid the Great Lockdown. It picked up in mid-2020. Industrial production again slowed down in early 2022 due to lockdowns in China.



Figure 4: The Evolution of the Growth of Industrial Production, September 2014 to September 2022

There are two main equity price indexes in China: the Shanghai and the Shenzhen composite indexes. The Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) are the two major stock exchanges in mainland China. The companies listed on the SSE include state-owned

enterprises and large firms in financial services, real estate, energy, and infrastructure. In contrast, the SZSE includes more small- and medium-sized enterprises and private companies, with strong representation of technology firms. Figure 5 renders the evolution of the two equity price indexes.

The equity price indexes rose at the beginning of the study period, reaching a peak in mid-2015, but tumbled in the following months and bottomed out in early 2016. The equity price indexes gradually recovered from early 2016 to late 2016, undergoing a moderate correction in 2017. The indexes continued to rise from January 2018 to January 2020. During the Great Lockdown the indexes fell, but less sharply than in advanced countries. However, the equity price indexes started recovering in April 2020 and continued to rise for several months thereafter. The SZSE index peaked in early 2021, while the SSE index peaked in late 2021. After peaking, both indexes declined until the end of the study period.



Figure 5: The Evolution of the Equity Price Indexes, September 2104 to September 2022

Chinese authorities have instituted a system of managed float for the CNY. The authorities allow a managed float against a basket of major currencies that includes the US dollar. During the study period, the exchange rate varied from slightly above USDCNY 6.1 to USDCNY 7.2. Figure 6 charts the evolution of the USDCNY exchange rate from September 2014 to September 2022.



Figure 6: The Evolution of the USDCNY Exchange Rate, September 2014 to September 2022

SECTION IV: DATA, SUMMARY STATISTICS, AND UNIT ROOT AND STATIONARITY TESTS

Table 1 displays a summary of the data used in the paper. The first column lists the variable labels. The second column furnishes the description of the variable and its date range. The third column tallies the frequency of the data and indicates whether daily data have been converted to monthly frequency. The final column catalogs the sources of the data.

Swap yields of three different maturity tenors are used. Two different variables for the short-term interest rate are obtained. These are based on Treasury bills of three-month and six-month tenors. Two different measures of inflation are used. These are the year-over-year percent change in the total CPI and the year-over-year percent change in the total CPI excluding food and energy, which is regarded as the core inflation. Economic activity is calibrated from the year-over-year growth of industrial production. Two different indexes of equity prices are used: one is based on an index of the SSE, while the other is the SZSE 300 stock index. The exchange rate is the value of CNY per US dollar. In the text and tables below, LN(.) indicates the (natural) logarithm of a variable.

Monthly data for these variables is used. The time-series data cover observations from September 2014 to September 2022. Thus, each time series consists of 98 observations.

Variable label	Description, date	Frequency	Sources
	range		
Swap yields			
SWAP2Y	Interest rate swap, 2 years, CNY, % September 2014–September 2022	Daily; converted to monthly	Tullet Prebon Information
SWAP5Y	Interest rate swap, 5 years, CNY, % September 2014–September 2022	Daily; converted to monthly	Tullet Prebon Information
SWAP10Y	Interest rate swap, 10 years, CNY, %, September 2014–September 2022	Daily; converted to monthly	Tullet Prebon Information
Short-term interest	rates		
СТВЗМ	Treasury bill, 3 months, %, September 2014–September 2022	Daily; converted to monthly	People's Bank of China
СТВ6М	Treasury bill, 6-months, %, September 2014–September 2022	Daily; converted to monthly	People's Bank of China
Inflation			
СРІУОУ	Consumer price index, % change, y/y, September 2014–September 2022	Monthly	China National Bureau of Statistics
ССРІУОУ	Consumer price index excluding food and energy, %, change, y/y, September 2014–September 2022	Monthly	China National Bureau of Statistics

 Table 1: Summary of the Data

Variable label	Description, date range	Frequency	Sources
Economic activity			
ΙΡΥΟΥ	Industrial production: % change, y/y, September 2014–September 2022	Monthly	China National Bureau of Statistics
Financial market			
SNGHAI	Shanghai Stock Exchange, Stock Price Index, close price, September 2014–September 2022	Daily; converted to monthly	Shanghai Stock Exchange
SNZN300	Shanghai-Shenzhen 300 Stock Price Index, close price, September 2014–September 2022	Daily; converted to monthly	Shanghai Stock Exchange
Exchange rate			
USDCNY	Exchange rate, ¥/US\$, average, September 2014–September 2022	Daily; converted to monthly	Federal Reserve Board

The summary statistics of all variables in levels and first differences are presented in Tables 2A and 2B respectively. The average swap yields increase with the maturity tenors, as higher maturity indicates higher risk. Similarly, the mean of the six-month Treasury bill rate is higher than the mean of the three-month Treasury bill. The Jarque-Bera tests indicate that higher maturity swap yields, inflation and core inflation, and the growth of industrial production are not normally distributed in table 2A.

Vars	Obs	Mean	Std. Dev.	Max	Min	Skewness	Kurtosis	J-B	Probability
SWAP2Y	98	2.77	0.51	3.80	1.58	0.42	2.53	3.72	0.16
SWAP5Y	98	3.04	0.48	4.03	1.94	0.54	2.62	5.28	0.07
SWAP10Y	98	3.32	0.47	4.47	2.25	0.72	3.12	8.53	0.01
СТВЗМ	98	2.36	0.57	3.97	1.00	0.48	3.02	3.78	0.15
CTB6M	98	2.48	0.56	3.92	1.10	0.42	2.93	2.88	0.24
CPIYOY	98	1.90	1.01	5.85	-1.13	0.77	6.10	48.95	0.00
CCPIYOY	98	1.41	0.56	2.31	0.10	-0.51	2.40	5.79	0.06
ΙΡΥΟΥ	98	6.14	5.35	35.23	-13.12	2.29	21.77	1523.83	0.00
LNSNGHAI	98	7.87	0.15	8.29	7.59	0.37	2.54	3.11	0.21
LNSNZN300	98	8.26	0.18	8.62	7.79	-0.05	2.80	0.21	0.90
LNUSDCNY	98	1.89	0.04	1.97	1.81	-0.02	1.94	4.60	0.10

 Table 2A: Summary Statistics of the Variables

Table 2B shows the summary statistics of all the variables at their first difference. The short-run interest rates and swap rates are both more volatile at their first differences. None of the variables

have a normal distribution, according to the Jarque-Bera tests. The change in the growth of industrial production shows a large decline in March 2021, indicating the impact of the lockdowns on China's industrial sector.

Vars	Obs	Mean	Std. Dev.	Max	Min	Skewness	Kurtosis	J-B	Probability
ΔSWAP2Y	97	-0.015	0.17	0.49	-0.62	-0.32	6.01	38.27	0.00
ΔSWAP5Y	97	-0.013	0.16	0.58	-0.54	0.20	5.43	24.51	0.00
ΔSWAP10Y	97	-0.012	0.16	0.69	-0.54	0.70	6.98	72.05	0.00
АСТВЗМ	97	-0.021	0.24	0.70	-0.75	-0.28	4.04	5.68	0.06
ΔСТВ6М	97	-0.021	0.21	0.75	-0.61	0.04	4.98	15.85	0.00
ΔСΡΙΥΟΥ	97	0.004	0.51	1.39	-1.62	-0.50	4.43	12.31	0.00
ΔССРІΥΟΥ	97	-0.011	0.13	0.40	-0.40	0.22	4.17	6.30	0.04
ΔΙΡΥΟΥ	97	-0.027	4.57	28.43	-21.42	0.78	25.04	1972.83	0.00
ΔLNSNGHAI	97	0.004	0.06	0.19	-0.26	-0.82	6.90	72.27	0.00
ALNSNZN300	97	0.004	0.06	0.23	-0.22	-0.19	6.63	53.97	0.00
ΔLNUSDCNY	97	0.002	0.01	0.04	-0.03	0.80	4.38	17.92	0.00

Table 2B: Summary Statistics of the First Differences of the Variables

The unit root and stationarity tests' results are given in Tables 3A and 3B. Table 3A exhibits the unit root and stationarity tests of the variables at the level. It presents both augmented Dickey-Fuller (ADF) unit root tests and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity tests. The null hypotheses for the ADF and the KPSS tests are different. The unit root tests indicate most of the variables are stationary. The one strong exception is the growth in industrial production, which shows the presence of a unit root by both types of tests.

Table 3A: Unit Root and Stationarity Tests of the Variables

Variables at	ADF Unit R	oot Tests (Ho: Ha	ıs Unit Root)	KPSS Tests (H	0: Stationarity)
Level	None	Intercept	Trend	Intercept	Trend
SWAP2Y	-0.77	-2.11	-2.46	0.44*	0.14*
SWAP5Y	-0.67	-2.11	-2.34	0.42*	0.14*
SWAP10Y	-0.58	-2.37	-2.69	0.41*	0.15**
СТВЗМ	-1.38	-2.69*	-3.41*	0.60**	0.09
CTB6M	-1.49	-2.65*	-2.93	0.50**	0.10*
CPIYOY	-1.10	-2.53	-2.52	0.10	0.10
CCPIYOY	-0.96	-0.38	-1.57	0.75***	0.21**
ΙΡΥΟΥ	-2.03**	-3.06**	-3.58**	0.05	0.05
LNSNGHAI	-0.54	-2.44	-2.37	0.50**	0.18**
LNSNZN300	-0.64	-2.84*	-2.49	0.81***	0.07
LNUSDCNY	-0.88	-2.21	-2.41	0.36*	0.17**

Note: Significance levels: *** for 1 percent, ** for 5 percent, and * for 10 percent

Table 3B shows the unit root and the stationarity tests of the variables in their first difference. All the variables become stationary at their first difference per both ADF and KPSS tests. In a few cases, KPSS tests rejected the null hypothesis of stationarity. However, the overall picture provides pretty strong support for stationarity at the first difference.

Variables at	ADF Unit R	oot Tests (H ₀ : Ha	ıs Unit Root)	KPSS Tests (H	0: Stationarity)	
First Difference	None	Intercept	Trend	Intercept	Trend	
ΔSWAP2Y	-7.32***	-7.29***	-7.25***	0.07	0.07	
ΔSWAP5Y	-7.59***	-7.55***	-7.51***	0.07	0.07	
ΔSWAP10Y	-7.09***	-7.06***	-7.02***	0.06	0.06	
ΔСТВ3Μ	-7.32***	-7.29***	-7.25***	0.60*	0.09	
ΔСТВ6М	-7.32***	-7.29***	-7.25***	0.49*	0.10	
ΔСΡΙΥΟΥ	-5.36***	-5.33***	-5.31***	0.05	0.05	
ΔССРІУОУ	-9.40***	-9.41***	-9.56***	0.22	0.07	
ΔΙΡΥΟΥ	-10.81***	-10.76***	-10.70***	0.30	0.30***	
ΔLNSNGHAI	-6.15***	-6.13***	-6.12***	0.08	0.07	
ALNSNZN300	-7.92***	-7.91***	-8.02***	0.18	0.08	
ΔLNUSDCNY	-5.50***	-5.57***	-5.54***	0.09	0.09	

Table 3B: Unit Root and Stationarity Tests of the First Differences of the Variables

Note: Significance levels: *** for 1 percent, ** for 5 percent, and * for 10 percent

SECTION V: ECONOMETRIC FRAMEWORK, FINDINGS OF THE ESTIMATED MODELS, AND INTERPRETATIONS

Econometric Framework

Given the time-series properties of the data examined in the previous section, the ARDL approach is deemed the most appropriate for modeling the dynamics of CNY interest rate swaps as the variables are either stationary, I(0), or integrated in the first order, I(1). Estimates based on the ARDL approach can reveal both the short- and long-run effects of the independent variables on swap yields.

Three different models are estimated. In the simple model, the swap yield is just a function of the short-term interest rate. In the basic model, the swap yield is a function of the short-term interest rate, inflation or core inflation, and the growth of industrial production. In the extended model, the swap yield is a function not just of the short-term interest rate, inflation or core inflation, and the growth of industrial production or core inflation, and the growth of the short-term interest rate, inflation or core inflation, and the short-term interest rate, inflation or core inflation, and the growth of the short-term interest rate, inflation or core inflation, and the growth of industrial production, but also the month-over-month percentage change in the

equity price index and the month-over-month percentage change in the exchange rate. For each model, swap yields of three different maturity tenors—namely two-year, five-year, and ten-year—are used as the dependent variables in the regression equations.

Econometric Results

The main results are displayed in Tables 4 and 5. Table 4 shows estimations using the yield of three-month Treasury bills, which is the main variable of interest. In all models with three different maturity levels of swap yields, the yield of the three-month Treasury bills has a positive and statistically significant effect on the swap yield. A 100-basis point increase in three-month Treasury bill increases the two-year swap yield by 43–45 basis points. The effect declines with a higher maturity tenor for the swap. The effect of the Treasury bill yield declines to 36-37 basis points for a 10-year swap. The long-term relationship between the three-month Treasury bill yield and the swap yield is also revealed. The long-run relationship varies significantly from the two-year maturity term to 10-year maturity. The rate of adjustment to any shock to the long-run relationship between the Treasury bill yield and the swap yield differs for different maturities. A shock dissipates somewhere between 4.5 months to 7 months, after which the relation between the Treasury bill and the swap yield returns to its long-run equilibrium. Among the control variables, the core inflation rate, the growth of industrial production, and the percentage change in the SSE have a positive impact on the swap rates. A higher level of core inflation requires a higher swap yield, whereas stronger growth in industrial production and/or a rise in the equity index leads to a higher swap yield.

The adjusted R^2 implies that much of the variance in the swap yield is explained by the Treasury bill yield and its lags as well as the autoregressive variables. The Akaike Information Criterion (AIC) also shows a good fit for all the models.

	SWAD2V	SWAP2V	SWAP2V	SWAP5V	SWAD5V	SWAD5V	SWAD10V	SWAD10V	SWAD10V
	5WA121	SWAL21	5 WAI 21	Main ag	SWAISI	SWAIJI	5WAI 101	5WAI 101	SWAITOT
CTDAM	0 45***	0 10 ****	0 10 ****	Main eq		0 10***	0.07***	0.0 (****	0.2(***
СТВЗМ	0.45***	0.43***	0.43***	0.41***	0.39***	0.40***	0.3/***	0.36***	0.36***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CTB3M(-1)	-0.51***	-0.47***	-0.49***	-0.49***	-0.47***	-0.49***	-0.49***	-0.48***	-0.51***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SWAP _i Y(-1)	1.10***	1.07***	1.08***	1.11***	1.08***	1.09***	1.24***	1.21***	1.22***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CCPIYOY		0.06**	0.07**		0.06*	0.06*		0.08**	0.08**
		(0.04)	(0.02)		(0.08)	(0.05)		(0.04)	(0.02)
IPYOY		0.005***	0.004**		0.005***	0.004***		0.005***	0.005***
		(0.00)	(0.01)		(0.00)	(0.00)		(0.00)	(0.00)
ΔLNSNGHAI			0.35			0.41*			0.50**
			(0.24)			(0.07)			(0.03)
ALNUSDCNY			-0.37			-0.18			0.12
			(0.72)			(0.88)			(0.91)
Intercept	0.15*	0.18**	0.19**	0.20**	0.24***	0.23***	0.26**	0.36***	0.34***
	(0.05)	(0.03)	(0, 01)	(0,01)	(0, 00)	(0, 00)	(0.01)	(0, 00)	(0, 00)
	(****)	(*****)	(****)	Cointegrati	ng relations	hin	(0.01)	(0000)	(0.00)
Long-term	0.81***	0.61***	0.55***	0 72***	0 48***	0.40*	0.61***	0 29***	0.21
Coefficient	(0,00)	(0,00)	(0,00)	(0,00)	(0,00)	(0.05)	(0,00)	(0,00)	(0.21)
Doto of	0.18***	0.22***	0.21***	0.15**	0.10***	0.17***	0.14***	0.10***	0.17***
A diustmont	-0.18	(0.00)	-0.21	(0.01)	(0,00)	(0,00)	-0.14	-0.19	(0,00)
Aujustment	(0.00)	(0.00)	(0.00)	(0.01) Madala	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
	0(0(07	Niodel I	normation	05	0(0.5	0.5
	96	96	96	95	95	95	96	95	95
Adj R ²	0.94	0.94	0.94	0.94	0.95	0.94	0.93	0.93	0.94
AIC	- 1.32	-1.34	- 1.34	- 1.32	- 1.34	- 1.34	-1.27	- 1.29	- 1.32
	1	1	1	Diagn	ostic Tests	1	1	1	1
Joint	309.56	230.51	182.64	236.96	184.70	151.97	248.65	164.51	137.68
Significance	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
F-Test									
Serial	1.94	1.99	1.98	1.99	2.05	2.03	1.96	2.03	2.04
Correlation									
Durbin-									
Watson Stat									
Serial	0.26	0.39	0.81	0.01	0.92	0.62	0.11	0.72	0.68
Correlation	(0.77)	(0.67)	(0.45)	(0.99)	(0.40)	(0.53)	(0.89)	(0.49)	(0.51)
Breusch-									
Godfrey LM									
Test									
Heteroskedasti	1.34	0.97	2.64	1.39	1.24	2.22	1.75	1.44	1.86
city Breusch-	(0.25)	(0.46)	(0.01)	(0.23)	(0.28)	(0.02)	(0.13)	(0.19)	(0.06)
Pagan-	× ,	~ /	× ,	, í	× ,				× ,
Godfrey Test									
Normality Test	20.58	19.96	76.21	1.13	1.10	9.12	4.58	1.55	14.35
Jarque-Bera	(0.00)	(0.00)	(0.00)	(0.57)	(0.57)	(0.01)	(0.11)	(0.46)	(0.00)
Stat	(((()	(()
Stability	0.64	0.47	0.56	0.30	0.28	0.13	0.24	0.36	0.23
Diagnostic	(0.53)	(0.63)	(0.57)	(0.74)	(0.76)	(0.88)	(0.79)	(0,70)	(0.80)
Ramsev	(0.55)	(0.05)	(0.07)		(0.70)	(0.00)	(0.75)	(0.70)	(0.00)
RESET Test									

Table 4: ARDL (p. q) Model (with CTB3M)

Note: *p*-values are in parenthesis. ***, **, * implies statistical significance at 1 percent, 5 percent, and 10 percent, respectively. BG LM is with two lags and Ramsey RESET test is fitted with two terms.

A panel of postestimation diagnostic tests is also displayed. The joint significance tests show a strong rejection of the insignificance of the regressors. The Durbin-Watson statistics and Breusch-Godfrey Lagrange Multiplier tests indicate there is no serial correlation for the error terms in these models. The correlogram Q-statistics (reported in appendix A) show that the mean equations in these models are correctly specified and there are no remaining serial correlations. The Breusch-Pagan-Godfrey heteroskedasticity tests fail to reject the null hypothesis of homoscedasticity in all models except one at the five-percent significance level. The Jarque-Bera tests indicate that the error terms are not normally distributed, which is a not an uncommon phenomenon for financial variables. Last but not least, tests of model specification and stability tests are conducted. The Ramsey RESET tests indicate all the models are well-specified. CUSUM and CUSUM-SQ tests of the basic and extended models for all three maturity tenors are reported in Appendix B. Brown, Durbin, and Evans (1975) showed that the CUSUM test is a test of instability in the equation. Hansen (1991) established that the CUSUM-SQ is a test of the instability in the variance of the regression errors (. The CUSUM and the CUSUM-SQ tests show that all these models are well specified and stable in both intercept- and regression-error variances.

Robustness checks are conducted by changing some variables. The three-month Treasury bill yield is replaced with the six-month Treasury bill yield. A measure of total CPI inflation instead of the core CPI inflation is used, and the SZSE index replaces the SSE index. The main findings are essentially unchanged, as displayed in Table 5. However, the effects of the six-month Treasury bill yield on the swap yield are somewhat larger than the three-month Treasury bill yield. While the long-term relation between the swap yield and six-month Treasury bill yield remain very similar to the results in Table 4, the rate of adjustment takes longer: increasing from five months to nine months. Unlike the core inflation, the total inflation shows no statistically significant effect on the swap yield. The SZSE index has a slightly stronger positive effect on the swap yield. The adjusted R^2 , AIC, and diagnostic test results in Table 5 are identical to their counterparts in Table 4.

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Tuble e		y , q) mou		Dowl					
	SWAP2Y	SWAP2Y	SWAP2Y	SWAP5Y	SWAP5Y	SWAP5Y	SWAP10Y	SWAP10Y	SWAP10Y
	-			Main equ	ation	-	-	-	-
CTB6M	0.52***	0.55***	0.52***	0.47***	0.50***	0.48***	0.43***	0.43***	0.42***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CTB6M(-1)	-0.53***	-0.46***	-0.57***	-0.48***	-0.43***	-0.47***	-0.52***	-0.50***	-0.55***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SWAP Y(-1)	1.04***	0.86***	1.05***	1.05***	0.88***	0.93***	1.21***	1.18***	1.23***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
СРІУОУ	(0000)	0.01	0.07	(0000)	0.02	0.01	(0.000)	0.01	0.04
011101		(0.17)	(0.58)		(0.14)	(0.31)		(0.38)	(0,70)
ΙΡΥΟΥ		0.005**	0.003		0.005***	0.004***		0.004**	0.003*
11101		(0.005)	(0.12)		(0,000)	(0,01)		(0,004)	(0.003)
AT NSN/7N200		(0.01)	0.12)		(0.00)	0.56**		(0.01)	0.62**
ALINSINZINJUU			(0.14)			(0.30^{-1})			(0.02)
			(0.14)			(0.02)			(0.02)
ALNUSDCINY			0.08			(0.40)			(0.42)
T	0.1.4.4.4	0.00	(0.92)	0.1044	0.10	(0.70)	0.07***	0.0044	(0.73)
Intercept	0.14**	0.08	0.12*	0.19**	0.12	0.12	0.2/**	0.23**	0.23**
	(0.049)	(0.29)	(0.05)	(0.01)	(0.22)	(0.21)	(0.01)	(0.03)	(0.01)
	1	1	C	ointegrating	<u>relationship</u>)	I	I	1
Long-term	0.82***	0.69***	0.73***	0.76***	0.59**	0.22	0.60***	0.58***	0.42
Coefficient	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.77)	(0.00)	(0.00)	(0.14)
Rate of	-0.20***	-0.14**	-0.16**	-0.17***	-0.12**	-0.07**	-0.15***	-0.14***	-0.11**
Adjustment	(0.00)	(0.02)	(0.01)	(0.00)	(0.02)	(0.03)	(0.00)	(0.00)	(0.01)
				Model inf	ormation				
Obs	96	97	96	95	97	97	96	96	96
Adj R ²	0.94	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93
AIC	- 1.32	- 1.27	- 1.32	- 1.34	- 1.29	- 1.33	- 1.27	- 1.25	- 1.30
				Diagnos	tic tests				
Joint Significance	310.71	294.35	179.32	289.04	274.24	209.06	249.15	179.69	148.86
F-Test	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Serial Correlation	1.97	1.71	1.98	2.01	1.71	1.69	1.99	2.00	2.02
Durbin-Watson									
Stat									
Serial Correlation	0.21	2.35	1.15	0.01	1.13	1.25	0.03	0.15	0.27
Breusch-Godfrey	(0.81)	(0.11)	(0.32)	(0.99)	(0.32)	(0.29)	(0.96)	(0.86)	(0.76)
LM Test	(0.01)	(0.11)	(0.02)	(0.55)	(0.22)	(0))	(0.50)	(0.00)	(0.70)
Heteroskedasticity	1 20	1.03	2.64	0.09	0.64	1.67	2 37	1 64	1.95
Breusch-Pagan-	(0.31)	(0.40)	(0,01)	(0.91)	(0.67)	(0.13)	(0.05)	(0.13)	(0.06)
Godfrey Test	(0.01)	(0.10)	(0.01)	(0.21)	(0.07)	(0.15)	(0.00)	(0.10)	(0.00)
Normality Test	24.09	6.82	123 52	4 16	A 11	8 89	4 99	6 34	31.16
Jarane-Rera Stat	(0,00)	(0.02)	(0,00)	(0.12)	(0.13)	(0,01)	(0, 08)	(0.04)	(0,00)
Stability	0.14	0.00	0.33	0.003	0.10	0.01)	0.31	0.32	0.04
Diagnostic	(0.87)	(0.29)	(0.33)	(0.00)	(0.00)	(0.30)	(0.31)	(0.32)	(0.04)
Diagnostic Domgov DESET	(0.07)	(0.74)	(0.72)	(0.99)	(0.90)	(0.74)	(0.75)	(0.72)	(0.90)
Tost									
I COL	1	1	1	1	1	1	1	1	1

Table 5: ARDL (p, q) Model (with CTB6M)

 I est
 Image: Note: p-values are in parenthesis. ***, **, * implies statistical significance at 1 percent, 5 percent, and 10 percent, respectively.

 BG LM is with two lags and Ramsey RESET test is fitted with two terms.

Implications of the Findings

These findings imply that the People's Bank of China (PBOC), the country's central bank, can influence interest rate swap yields of different maturity tenors through the effects of its policy rate and monetary policy actions on the short-term interest rate. This suggest that the PBOC can influence borrowing and lending rates on a range of fixed-income instruments, including swaps and swaptions. This gives the PBOC enormous clout over China's financial system. It vindicates and extends Keynes's view that the central bank's actions have a decisive effect on the long-term interest rate in two consequential ways. First, it shows that Keynes's hypothesis about the effect of a central bank's actions on the long-term interest rate is also applicable for interest rate swap yields, not just government bond yields. Second, it shows that Keynes's conjecture about the strong connection between the current short-term interest rate and the long-term interest rate is not merely confined to advanced capitalist economies, such as the United States and the United Kingdom, but also holds in emerging market economies, such as China.

SECTION VI: CONCLUSION

The empirical findings presented in this paper illustrate that the short-term interest rate has an economically and statistically significant effect on the CNY-denominated, long-term interest rate swap yield, after controlling for key macroeconomic variables, such as inflation or core inflation, the growth of industrial production, the percentage change in the equity market index, and the percentage change in the exchange rate of the currency. Three different models of the long-term swap yield of different maturity tenors are estimated to show these results are quite robust, irrespective of the specifications of the estimated regression equation. Alternative choices of independent variables bare that the empirical findings are well-grounded.

There is a lacuna in the empirical modeling of interest rate swap yields in emerging markets. However, the role of interest rate swaps in the financial systems of an emerging market economy, such as China, is likely to grow with the rise of the financial sector in such emerging markets and their increasing financialization. The financial sector already plays a stalwart role in the Chinese economy. This paper fills a gap in the empirical modeling of interest rate swap yields in China. The empirical modeling of interest rate swaps in emerging markets, such as China, can enable policymakers and investors to go beyond just understanding the dynamics of swap yields. It can illuminate the workings of the financial system and capital markets and assess the effectiveness of the monetary transmission mechanism in China and other emerging economies. It can be valuable in asset allocation, risk management, and real investment decisions.

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APPENDIX A: Correlogram – Q -Stat ARDL (p, q) Models with CTB3M

Table A1: SWAP2Y = $\varphi^1(C, CTB3M)$ Sample (adjusted): 2014M11 2022M10

Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.030	0.030	0.0909	0.763
ı İ ı	, , (, ,	2	-0.040	-0.041	0.2499	0.883
ı 🗖 i		3	0.141	0.144	2.2681	0.519
ı 🗖 i		4	-0.147	-0.162	4.4813	0.345
ı İ D ı	i <u>i</u>	5	0.082	0.115	5.1843	0.394
· 👝	i <u>i</u>	6	0.199	0.160	9.3293	0.156
ı 🚺 ı	1 1	İ 7	-0.035	-0.003	9.4567	0.222
· 👝	i i 🗖 i	8	0.184	0.167	13.071	0.109
1 1	I I I I	9	0.003	-0.045	13.072	0.159
ı 🗖 i	I I I I	10	-0.108	-0.041	14.349	0.158
1 1	I I I I	11	0.000	-0.083	14.349	0.214
ı 🛛 i	וםי	12	-0.069	-0.057	14.889	0.248
ı d i i		13	-0.155	-0.181	17.602	0.173
1 [] 1		14	-0.025	-0.102	17.673	0.222
ı () i		15	0.044	0.070	17.899	0.268
ı 🛯 i	I D I	16	-0.075	-0.077	18.566	0.292
1 🕴 1	ן וףי	17	0.020	0.054	18.615	0.351
ı 🗖 i	I I I I	18	-0.099	-0.074	19.787	0.345
		19	-0.257	-0.161	27.885	0.086
1 1	i 🛛 i	20	0.008	0.026	27.893	0.112
i 🏼 i	· ·	21	0.050	0.099	28.203	0.134
י 🖪 י	· 🛛 ·	22	-0.131	-0.095	30.387	0.109
· 📮	· ·	23	0.157	0.100	33.548	0.072
יםי	111	24	-0.055	-0.019	33.939	0.086
n i i i i i i i i i i i i i i i i i i i	יםי	25	-0.162	-0.084	37.418	0.053
· 🗗 ·	I I	26	0.110	0.063	39.058	0.048
		27	-0.187	-0.161	43.842	0.021
1 D 1		28	0.057	0.121	44.288	0.026
۱ ۵ ۱		29	0.134	-0.048	46.820	0.019
1 Q 1		30	-0.046	0.091	47.116	0.024
1 1		31	0.004	-0.139	47.119	0.032
		32	-0.042	-0.109	47.377	0.039
		33	-0.174	-0.098	51.879	0.019
· 🗖 ·		34	0.164	0.153	55.965	0.010
1 1		35	0.005	-0.011	55.969	0.014
· 🛛 ·		36	-0.082	-0.108	57.016	0.014

Table A2: SWAP2Y = $\varphi^2(C, CTB3M, CCPIYOY, IPYOY)$ Sample (adjusted): 2014M11 2022M10Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
	. .	1	0.004	0.004	0.0016	0.968
i 🖬 i	ן ום י	İ 2	-0.070	-0.070	0.4876	0.784
ı 🗖 i	j i 🗖 i	3	0.141	0.142	2.4932	0.477
ı∎i ı	100 1	4	-0.122	-0.133	4.0102	0.405
· 🗐 ·	ı (b i	5	0.105	0.136	5.1396	0.399
· 🛑	ı (b i	6	0.192	0.152	8.9961	0.174
יםי	ן יון י	7	-0.074	-0.033	9.5743	0.214
· 🗖 ·	ı (b i	8	0.127	0.119	11.285	0.186
1 1 1	(])	9	-0.002	-0.041	11.286	0.257
1 0 1		10	-0.059	0.005	11.667	0.308
1 1 1	וםי	11	0.024	-0.065	11.732	0.384
יםי	ים, י	12	-0.093	-0.093	12.708	0.391
i 🗐 i		13	-0.162	-0.182	15.680	0.267
1 1 1	I I	14	-0.042	-0.108	15.879	0.321
i 🖡 i	ן וףי	15	0.032	0.054	15.998	0.382
1 0 1	יםי	16	-0.078	-0.091	16.722	0.404
т р т	ן ום	17	0.028	0.066	16.812	0.467
י 🗐 י	וםי	18	-0.099	-0.076	17.985	0.457
· ·		19	-0.271	-0.188	26.944	0.106
1 1 1	1 1	20	-0.002	-0.004	26.944	0.137
i 🏚 i	ן יוםי	21	0.056	0.078	27.344	0.160
י 🗖 י	ים י	22	-0.155	-0.109	30.393	0.109
· 🗖 ·	ים י	23	0.137	0.107	32.819	0.084
יםי	1 1 1	24	-0.062	-0.022	33.325	0.097
· ا	יםי	25	-0.168	-0.099	37.068	0.057
· 📮 ·	ן וויי	26	0.116	0.038	38.865	0.050
Щ I	🗖 '	27	-0.196	-0.193	44.123	0.020
1 Q 1	יםי	28	0.038	0.106	44.322	0.026
· 📮 ·	ן ים,	29	0.112	-0.053	46.068	0.023
· 🗓 ·	יםי	30	-0.056	0.085	46.516	0.028
1 1 1	ים י	31	0.005	-0.142	46.519	0.036
I 🚺 I	ļ ⊔ '	32	-0.031	-0.113	46.656	0.046
u 🗖 🚬 '	□	33	-0.161	-0.118	50.538	0.026
· 📮	ļ ' P '	34	0.178	0.136	55.338	0.012
1 () 1	I I	35	0.026	0.027	55.439	0.015
· 🛛 ·	ן ים י	36	-0.059	-0.050	55.990	0.018

Table A3: SWAP2Y = $\phi^3(C, CTB3M, CCPIYOY, IPYOY, \Delta LNSNGHAI, \Delta LNUSDCNY)$ Sample (adjusted): 2014M11 2022M10 Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
	 	1	0.009	0.009	0.0075	0.931
i 🖬 i i	ן ובן ו	İ 2	-0.106	-0.106	1.1275	0.569
ı 🛄 i	j i 🏚 i	3	0.134	0.138	2.9564	0.398
ı∎i ı	i E i	4	-0.126	-0.147	4.5908	0.332
1 þ í		5	0.052	0.095	4.8720	0.432
· 🛑	ı (b i	6	0.185	0.136	8.4608	0.206
1 0 1		7	-0.049	-0.010	8.7155	0.274
r 🗖 i	ı 🗖 ı	8	0.132	0.146	10.576	0.227
1 1 1	ן ון י	9	0.003	-0.045	10.577	0.306
יםי	I I	10	-0.077	0.003	11.230	0.340
i 🖡 i	I I	11	0.028	-0.040	11.319	0.417
יםי	ים,	12	-0.084	-0.089	12.108	0.437
ים י		13	-0.152	-0.161	14.718	0.325
1 () 1	ון ו	14	0.026	-0.044	14.795	0.392
i 🏚 i	l (D)	15	0.078	0.091	15.501	0.416
יםי	יםי	16	-0.063	-0.070	15.972	0.455
1 Q 1	ן יםי	17	0.041	0.067	16.168	0.512
יםי	ים,	18	-0.075	-0.066	16.840	0.534
Щ I	••••	19	-0.239	-0.164	23.792	0.204
1 1 1	1 1 1 1	20	0.012	-0.000	23.808	0.251
1 Q 1	1 1 1 1	21	0.033	0.018	23.946	0.296
· ا	יםי ו	22	-0.160	-0.139	27.183	0.204
۱ D ۱	I I	23	0.112	0.059	28.794	0.187
1 Q 1	יםי	24	-0.068	-0.066	29.396	0.206
	ן יםןי	25	-0.186	-0.121	34.003	0.108
		26	0.117	0.074	35.857	0.094
	ļ L '	27	-0.214	-0.202	42.128	0.032
1 1		28	0.015	0.136	42.159	0.042
I ∎ I		29	0.105	-0.061	43.707	0.039
1 1 1		30	-0.043	0.128	43.969	0.048
1 j 1	ים י	31	0.012	-0.105	43.989	0.061
<u> </u>		32	-0.022	-0.075	44.062	0.076
	│ ' ■ '	33	-0.187	-0.100	49.257	0.034
1 🔲 1		34	0.137	0.090	52.124	0.024
۰ ۱ ۰	ים י	35	0.006	-0.026	52.130	0.031
י ון י	יואי	36	-0.067	-0.067	52.840	0.035

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.000	-0.000	9.E-06	0.998
1 i 1		2	0.007	0.007	0.0051	0.997
ı İ D ı	j j	<u>ј</u> з	0.100	0.100	1.0020	0.801
–		4	-0.229	-0.231	6.3137	0.177
1 i 1	I I	5	-0.007	-0.004	6.3184	0.276
· 🗖 ·	ı 🗐 ı	6	0.149	0.152	8.6081	0.197
1 0 1		7	-0.059	-0.021	8.9666	0.255
· 🗖		8	0.276	0.238	17.034	0.030
1 þ í		9	0.030	-0.013	17.127	0.047
י ב ו		10	-0.090	-0.033	18.011	0.055
1 U 1	ı d ı	11	-0.039	-0.108	18.179	0.078
1 🗹 - I		12	-0.074	0.013	18.779	0.094
ı 🗖 i		13	-0.116	-0.091	20.292	0.088
1 1 1	I I I I	14	-0.033	-0.130	20.414	0.118
1 D 1	ı ı	15	0.081	0.101	21.175	0.131
1 Q 1	I I I I	16	-0.052	-0.120	21.487	0.161
1 1 1	1 1	17	0.020	0.017	21.533	0.203
1 Q 1	I I I I	18	-0.054	-0.080	21.878	0.237
· ا	l i ∎i	19	-0.242	-0.162	28.961	0.067
i 🏚 i	ן וים	20	0.059	0.092	29.392	0.080
· 📮 ·	ı = ı	21	0.112	0.162	30.944	0.075
י 🔲 י	וםי	22	-0.135	-0.081	33.247	0.058
· 📮 ·	1 1	23	0.151	0.001	36.167	0.040
יםי	יםי	24	-0.078	-0.051	36.950	0.044
· ا	י ב י ו	25	-0.186	-0.117	41.505	0.020
· 📮 ·	· ·	26	0.128	0.102	43.682	0.016
· ا	י ב י	27	-0.188	-0.128	48.486	0.007
· 📮 ·	· ·	28	0.095	0.138	49.730	0.007
· 🗖 ·	I I I I	29	0.123	-0.095	51.833	0.006
יםי		30	-0.076	0.039	52.641	0.006
т ц т	l ı ∎ı	31	-0.029	-0.145	52.763	0.009
т ц т	יםי	32	-0.039	-0.070	52.980	0.011
· Щ ·		33	-0.163	-0.018	56.942	0.006
۱ 📮 ۱	ļ ' Þ '	34	0.136	0.131	59.741	0.004
1 (1	I I	35	-0.009	0.031	59.753	0.006
I ()	'🗐 '	36	-0.022	-0.163	59.831	0.008

Table A4: SWAP5Y = $\phi^4(C, CTB3M)$ Q-statistic probabilities adjusted for 2 dynamic regressors

Table A5: SWAP5Y = $\phi^5(C, CTB3M, CCPIYOY, IPYOY)$ Sample (adjusted): 2014M12 2022M10Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.035	-0.035	0.1193	0.730
i 🖡 i	j i j i	2	-0.019	-0.020	0.1540	0.926
ı 🗖 ı		3	0.105	0.103	1.2486	0.741
		4	-0.207	-0.202	5.5676	0.234
i 🏚 i		5	0.027	0.022	5.6424	0.343
· 🗐 ·		6	0.147	0.136	7.8667	0.248
י ם י	וםי	7	-0.106	-0.066	9.0420	0.250
· 🛑	ı 🗖 ı	8	0.216	0.184	13.966	0.083
1 1		9	0.012	-0.004	13.982	0.123
1 0 1		10	-0.045	0.030	14.202	0.164
. ↓ I	יםי	11	-0.013	-0.092	14.221	0.221
י 🛄 י	ן ון ו	12	-0.092	-0.041	15.167	0.232
י 🗐 י	יםי ו	13	-0.125	-0.122	16.931	0.202
יני	ı □ ı	14	-0.058	-0.135	17.320	0.240
1 D 1	יםי	15	0.062	0.095	17.757	0.276
ינןי	ı □ ı	16	-0.059	-0.120	18.159	0.315
1 Q 1		17	0.027	0.031	18.244	0.374
ינו	יםי ו	18	-0.056	-0.102	18.615	0.416
– 1	ļ 🗖 '	19	-0.250	-0.193	26.174	0.125
1 D 1		20	0.056	0.070	26.554	0.148
		21	0.113	0.149	28.155	0.136
	ן ים, י	22	-0.163	-0.095	31.516	0.086
· ∎ ·	']'	23	0.128	0.001	33.608	0.071
· U ·		24	-0.085	-0.048	34.547	0.075
		25	-0.186	-0.151	39.097	0.036
		26	0.134	0.050	41.482	0.028
		27	-0.201	-0.167	46.959	0.010
		28	0.077	0.137	47.775	0.011
		29	0.096	-0.093	49.052	0.011
		30	-0.085	0.024	50.082	0.012
		31	-0.022	-0.1/4	50.152	0.016
		32 22	-0.038	-0.104	50.364	0.021
		33 24	-0.150	-0.048	53.977	0.012
		34 25	0.144	0.107	57.093	0.008
		1 30	-0.001	0.007	57.093	0.011
· • •	'4 '	1 20	-0.002	-0.121	57.094	0.014

Table A6: SWAP5Y = $\varphi^{6}(C, CTB3M, CCPIYOY, IPYOY, \Delta LNSNGHAI, \Delta LNUSDCNY)$ Sample (adjusted): 2014M12 2022M10

Q-statistic probabilities	adjusted for 2	2 dynamic regressors	s
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Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.027	-0.027	0.0692	0.793
ı 🖞 i		İ 2	-0.047	-0.048	0.2924	0.864
ı 🗖 ı	j i 🗖 i	3	0.105	0.102	1.3875	0.708
– –	j 🖬 -	4	-0.214	-0.214	6.0386	0.196
. ()		5	-0.031	-0.028	6.1349	0.293
· 🗐 ·		6	0.139	0.114	8.1398	0.228
יםי	• 0 •	7	-0.077	-0.038	8.7577	0.271
· 📛		8	0.226	0.211	14.169	0.077
i 🏚 i		9	0.031	-0.011	14.275	0.113
1 0 1	1 1	10	-0.067	0.014	14.761	0.141
(.	1 1 1 1	11	-0.008	-0.066	14.768	0.193
י 🛄 י	I I	12	-0.085	-0.032	15.574	0.212
י 🗖 י	יםי	13	-0.121	-0.096	17.224	0.189
1 1 1	יםי	14	0.008	-0.066	17.232	0.244
· 📮 ·	! ' ₽ '	15	0.103	0.128	18.460	0.239
1 Q 1	ן יםןי	16	-0.048	-0.112	18.725	0.283
I D I	I I	17	0.048	0.041	19.002	0.328
1 I 1		18	-0.035	-0.070	19.146	0.383
L L L L L L L L L L L L L L L L L L L		19	-0.230	-0.168	25.581	0.142
· 📙 ·		20	0.059	0.076	26.014	0.165
' ₽ '		21	0.087	0.099	26.949	0.173
		22	-0.155	-0.102	29.979	0.119
· • •		23	0.098	-0.046	31.214	0.118
		24	-0.082	-0.081	32.078	0.125
		20	-0.200	-0.170	37.000	0.050
		20	0.129	0.001	J9.924	0.040
		121	-0.233	-0.200	47.301	0.009
		20	0.001	0.130	47.000	0.011
· • •		20	0.103	0.000	49.540	0.011
		1 21	-0.007	0.005	49.900	0.012
		32	-0.013	-0.120	50.020	0.017
		32 33	-0.019	-0.075	55 655	0.022
		34	0 104	0.055	57 284	0.007
		35	-0.015	0.030	57 320	0.010
		36	-0.009	-0.114	57.334	0.013
1	. –	1		•··· •		

Table A7: SWAP10Y = $\phi^7(C, CTB3M)$ Sample (adjusted): 2014M11 2022M10Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
	i i	1	0.018	0.018	0.0325	0.857
1 j 1	j i j i	İ 2	-0.004	-0.005	0.0343	0.983
ı İ Di		3	0.130	0.130	1.7359	0.629
		4	-0.193	-0.202	5.5644	0.234
1 ()	i i	5	-0.018	-0.004	5.5984	0.347
· 🗐 ·		6	0.114	0.101	6.9499	0.326
1 0 1		7	-0.058	-0.017	7.3096	0.397
· 🗖		8	0.216	0.196	12.282	0.139
1 🕴 1	ן ון י	9	0.024	-0.029	12.345	0.195
· 🗖 ·	(1)	10	-0.084	-0.039	13.124	0.217
1 🕴 1	I I	11	0.022	-0.035	13.179	0.282
1 0 1	1 1 1	12	-0.079	-0.022	13.872	0.309
1 0 1	ן ון ו	13	-0.066	-0.031	14.373	0.348
יםי	ים י	14	-0.055	-0.127	14.715	0.398
i 🗓 i	ן ום ד	15	0.043	0.086	14.933	0.456
1 Q 1	ים י	16	-0.048	-0.103	15.200	0.510
1 Q 1	ן יםי	17	0.027	0.043	15.284	0.575
יםי	ים י	18	-0.087	-0.118	16.198	0.579
· ·	ļ 🗖 '	19	-0.189	-0.163	20.571	0.361
1 1 1	I I	20	0.003	0.039	20.572	0.423
	l ' □ '	21	0.113	0.149	22.169	0.390
	ן ים,	22	-0.117	-0.074	23.917	0.352
I ∎ I		23	0.105	0.006	25.341	0.333
· U ·	'¶'	24	-0.062	-0.084	25.851	0.361
u <u></u> '	╎╵┩╵	25	-0.159	-0.082	29.210	0.255
· •		26	0.109	0.115	30.807	0.236
' U '		21	-0.132	-0.085	33.186	0.191
		28	0.102	0.155	34.626	0.181
· 🛛 ·		29	0.082	-0.110	35.581	0.186
· Щ ·		30	-0.070	0.037	36.284	0.199
		31	-0.012	-0.101	30.305	0.235
· • •		32	0.001	-0.015	30.305	0.275
	U , b .	33	-0.126	-0.028	38.691	0.228
	1 1 1 1 1 . h .	34 25	0.104	0.047	40.345	0.210
· • ·		35	0.003	0.064	40.347	0.246
ישי		36	-0.074	-0.195	41.200	0.254

Table A8: SWAP10Y = $\varphi^{8}(C, CTB3M, CCPIYOY, IPYOY)$ Sample (adjusted): 2014M12 2022M10Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.033	-0.033	0.1049	0.746
1 ()	j i j i	2	-0.022	-0.023	0.1517	0.927
i 🗐 i		3	0.096	0.094	1.0664	0.785
, ⊡ , ,	ı = ı	4	-0.151	-0.147	3.3895	0.495
1 1		5	0.017	0.014	3.4184	0.636
· 📮 ·		6	0.114	0.103	4.7733	0.573
ı 🗖 i	ı D ı	7	-0.127	-0.099	6.4551	0.488
· 🗖 ·		8	0.143	0.125	8.6290	0.375
1 1	I I	9	0.007	-0.010	8.6336	0.472
1 0 1	1 1	10	-0.057	-0.005	8.9852	0.534
1 () 1	I I	11	0.025	-0.030	9.0538	0.617
יםי	יםי	12	-0.097	-0.076	10.090	0.608
י 🗐 י	ים י	13	-0.110	-0.091	11.458	0.573
י 🛄 י	י 🖪 י	14	-0.080	-0.143	12.189	0.591
i 🎙 i	ן וים ו	15	0.028	0.070	12.282	0.658
. .	יםי	16	-0.043	-0.075	12.500	0.709
i 🏚 i	ן וויין	17	0.040	0.033	12.686	0.757
י 🛄 י	ים י	18	-0.089	-0.108	13.626	0.753
– –		19	-0.194	-0.190	18.194	0.509
1 1 1		20	0.007	0.006	18.200	0.574
· 🗖 ·	' '	21	0.132	0.148	20.379	0.497
י 🔲 י	יםי	22	-0.117	-0.075	22.120	0.453
· 📮 ·	1 1	23	0.082	0.001	22.991	0.461
יםי	יםי	24	-0.071	-0.077	23.637	0.483
· ا	יםי ו	25	-0.146	-0.129	26.426	0.385
		26	0.116	0.042	28.220	0.348
	יםי	27	-0.130	-0.124	30.521	0.291
I 🔲 I		28	0.107	0.165	32.082	0.271
I ∏ I	יםי ו	29	0.029	-0.120	32.196	0.311
i 🛄 i		30	-0.085	-0.020	33.224	0.313
1 J 1	' □ '	31	-0.022	-0.149	33.291	0.356
·] ·	ים י	32	-0.020	-0.108	33.351	0.401
۱ ۵ ۱	I []	33	-0.112	-0.049	35.206	0.364
۱ 📮 ۱	I I	34	0.127	0.062	37.625	0.307
1 [1		35	-0.015	0.068	37.660	0.348
1 Q 1	I I	36	-0.032	-0.147	37.818	0.386

Table A9: SWAP10Y = $\varphi^9(C, CTB3M, CCPIYOY, IPYOY, \Delta LNSNGHAI, \Delta LNUSDCNY)$ Sample (adjusted): 2014M12 2022M10Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.032	-0.032	0.1030	0.748
ı di i	i i i	2	-0.044	-0.046	0.2989	0.861
ı İD ı	j j	3	0.101	0.098	1.3106	0.727
i 🗐 i	ı ⊟ ı	4	-0.157	-0.155	3.8081	0.433
i 🖬 i	ן ום י	5	-0.061	-0.062	4.1944	0.522
· 🗐 ·		6	0.091	0.067	5.0510	0.537
יםי	10 1	7	-0.087	-0.062	5.8490	0.557
· 🗖 ·		8	0.154	0.152	8.3766	0.398
i 🏚 i		9	0.037	0.003	8.5263	0.482
יםי	I ()	10	-0.084	-0.041	9.2838	0.505
1 Q 1	1 1 1	11	0.034	-0.002	9.4139	0.584
1 D 1	וםי	12	-0.072	-0.058	9.9860	0.617
i 🛛 i	ום ו	13	-0.096	-0.052	11.032	0.608
1 (1	1 1 1 1	14	-0.021	-0.078	11.082	0.680
i 🏚 i	ı ı	15	0.076	0.101	11.742	0.698
1 () 1	וםי	16	-0.033	-0.053	11.870	0.753
i 🏚 i	ן ום	17	0.072	0.048	12.481	0.770
יםי	י ב ו י	18	-0.068	-0.085	13.030	0.790
· ا	י <mark>ום</mark> י	19	-0.174	-0.166	16.702	0.610
1 1 1		20	0.012	0.012	16.718	0.671
י נ ו י	ı 🗐 ı	21	0.098	0.121	17.921	0.654
י 🗒 י	· • • •	22	-0.103	-0.061	19.259	0.629
i 🖡 i	· • • •	23	0.033	-0.064	19.397	0.678
י 🌒 י	י 🖪 י	24	-0.076	-0.117	20.137	0.689
· ا	l I	25	-0.183	-0.173	24.552	0.488
· 📮 ·	· ·	26	0.111	0.091	26.184	0.453
י 🔲 י	י 🗖 י	27	-0.166	-0.149	29.928	0.317
· 📮 ·	l i 🗖 i	28	0.102	0.163	31.351	0.302
1 D 1	יםי	29	0.042	-0.113	31.592	0.338
יםי		30	-0.062	-0.000	32.132	0.361
111	יםי	31	-0.010	-0.083	32.145	0.410
	ים י	32	0.005	-0.070	32.148	0.459
· ا ب	ן ים,	33	-0.160	-0.050	35.949	0.332
· 📮 ·	I I	34	0.091	0.039	37.203	0.324
1 j 1		35	-0.018	0.029	37.255	0.366
1 Q 1	י 🗖 י	36	-0.045	-0.124	37.569	0.397

APPENDIX B: CUSUM and CUSUM-SQ tests



Figure B1: CUSUM for ARDL (p, q) Model (with CTB3M)

Note: ARDL (p, q) models include the change in the short-term interest rate (CTB3M) and the controls (namely CCPIYOY and IPYOY in the basic model and CCPIYOY, IPYOY, ALNSNGHAI, and ALNUSDCNY in the extended model).



Figure B2: CUSUM – SQ for ARDL (p, q) Model (with CTB3M)

Note: ARDL (p, q) models include the change in the short-term interest rate (CTB3M) and the controls (namely CCPIYOY and IPYOY in the basic model and CCPIYOY, IPYOY, Δ LNSNGHAI, and Δ LNUSDCNY in the extended model).