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Chinese Yuan Interest Rate Swap Yields

by

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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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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 macro-financial 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 long-term 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.

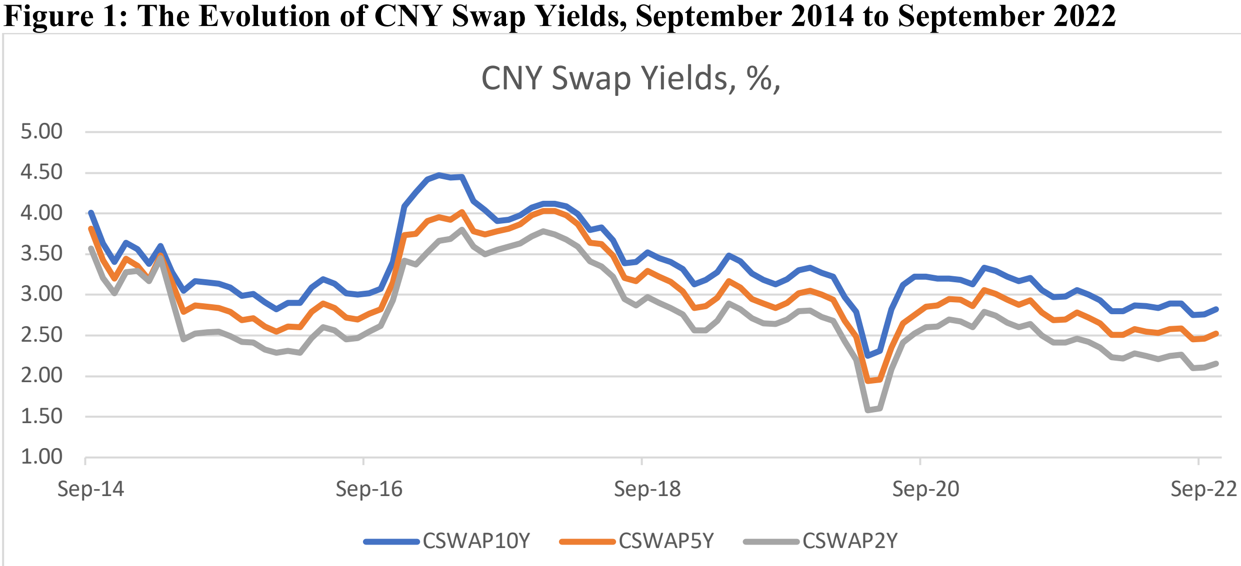
Most empirical studies showing the strong connection have been confined to government bond yields in advanced countries. Hence, it is relevant to ask whether Keynesian insight is generalizable beyond government bond yields in advanced countries. This paper contributes to the empirical literature by examining: (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.

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

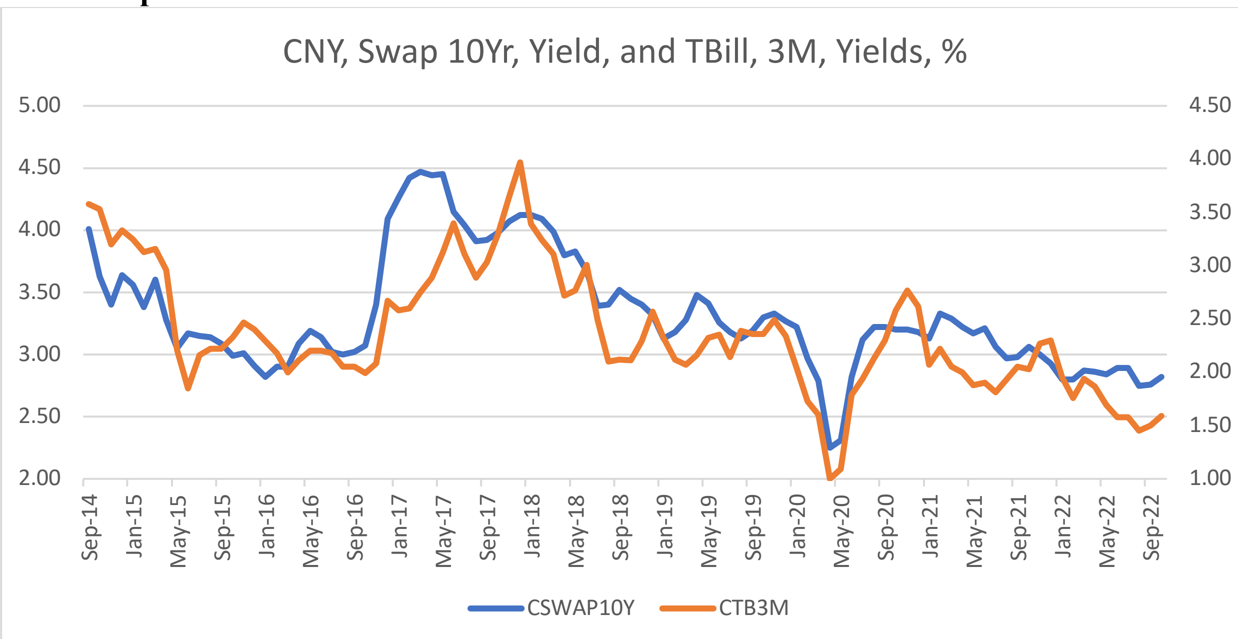


Figure 3 exhibits the evolution of the consumer price index (CPI) and core CPI inflation, year over year. Overall inflation and core inflation generally move in unison in China. However, overall inflation tends to be more volatile, owing to the higher volatility of energy and food prices. As a result,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

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

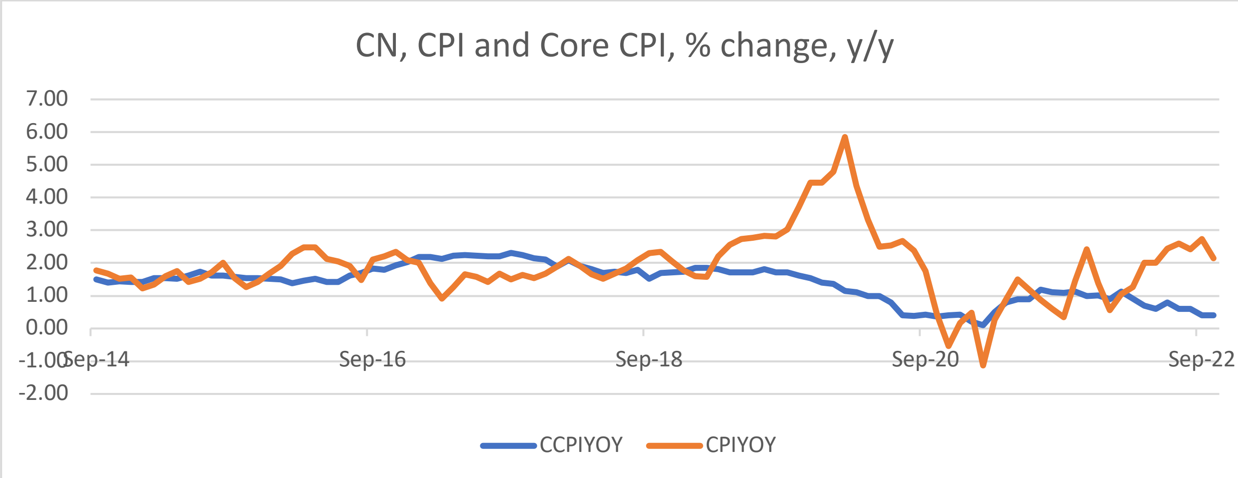


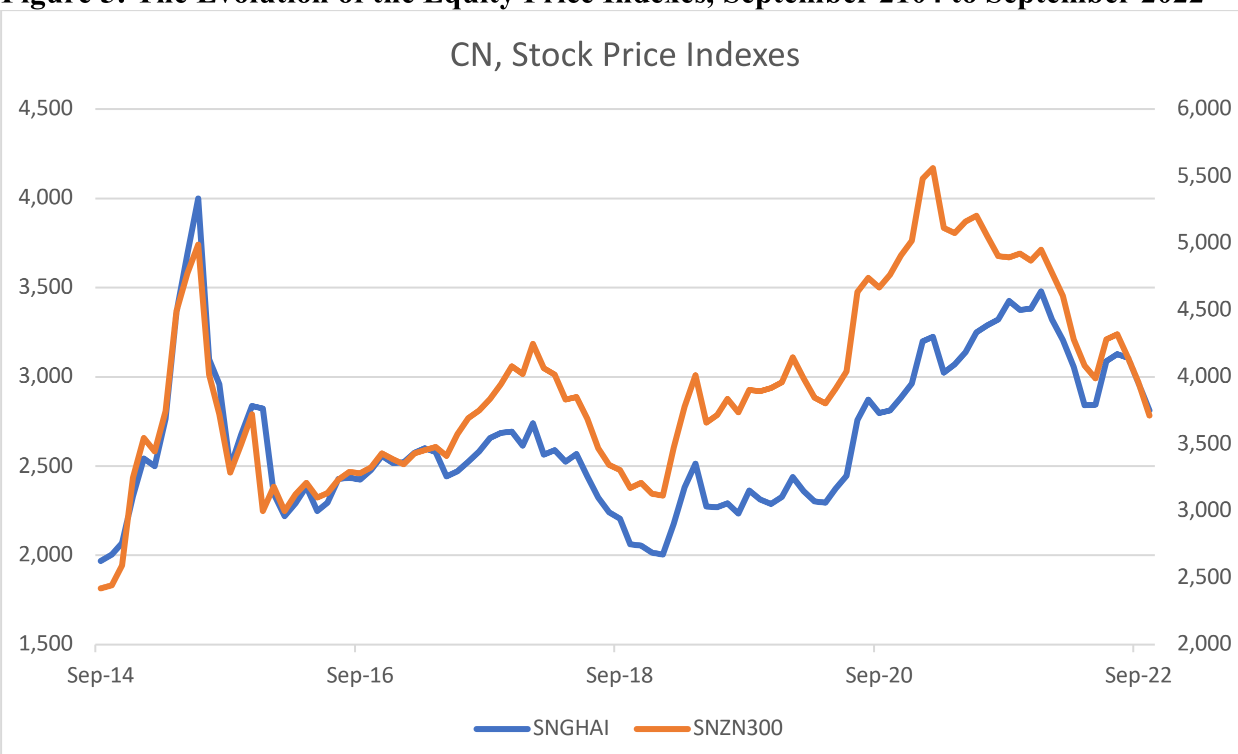
Figure 4 displays the growth of industrial production in China. Industrial production in China has been growing at a robust pace. However, industrial production fell sharply in early 2020 amid the Great Lockdown. It picked up in mid-2020. Industrial production again slowed down in early 2022 due to lockdowns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

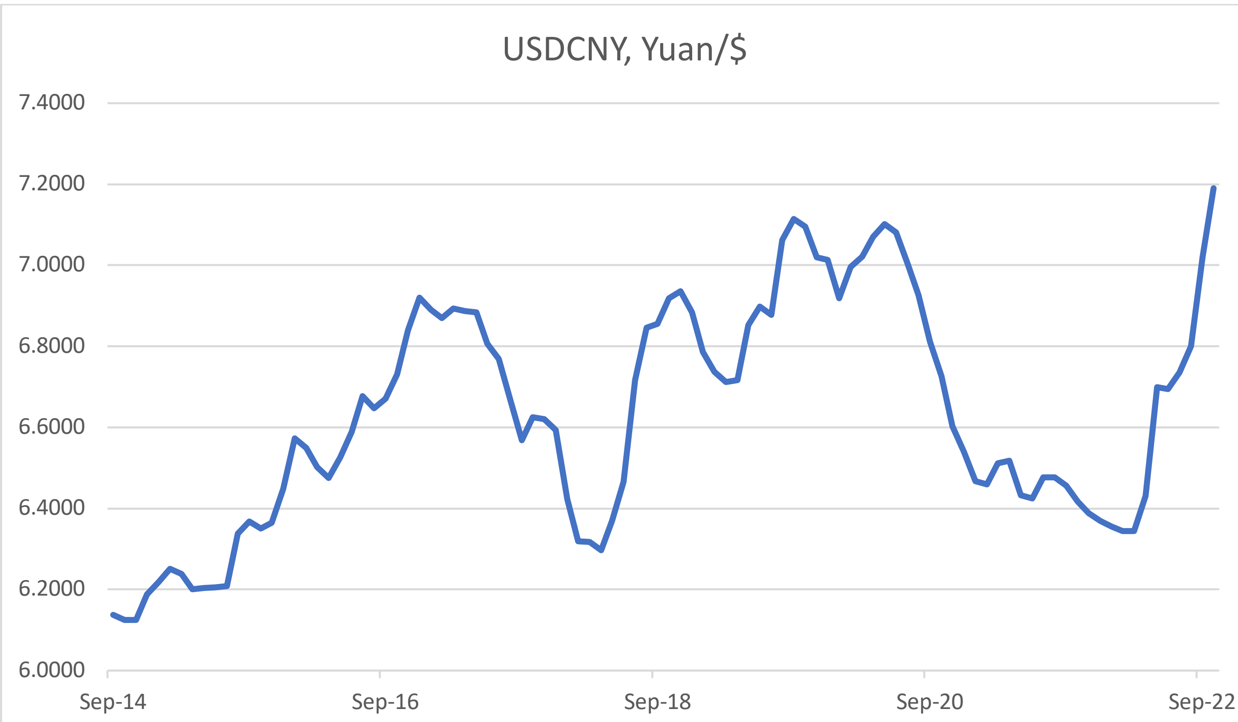
The equity price indexes rose at the beginning of the study period, reaching a peak in mid-2015, but tumbled in the following months and bottomed out in early 2016. The equity price indexes gradually recovered from early 2016 to late 2016, undergoing a moderate correction in 2017. The indexes continued 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.

Table 1: Summary of the Data

Variable label	Description, date range	Frequency	Sources
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			
CTB3M	Treasury bill, 3 months, %, September 2014–September 2022	Daily; converted to monthly	People's Bank of China
CTB6M	Treasury bill, 6-months, %, September 2014–September 2022	Daily; converted to monthly	People's Bank of China
Inflation			
CPIYOY	Consumer price index, % change, y/y, September 2014–September 2022	Monthly	China National Bureau of Statistics
CCPIYOY	Consumer price index excluding food and energy, %, change, y/y, September 2014–September 2022	Monthly	China National Bureau of Statistics

Variable label	Description, date range	Frequency	Sources
Economic activity			
IPYOY	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.

Table 2A: Summary Statistics of the Variables

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
CTB3M	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
IPYOY	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 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.

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

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
ΔCTB3M	97	-0.021	0.24	0.70	-0.75	-0.28	4.04	5.68	0.06
ΔCTB6M	97	-0.021	0.21	0.75	-0.61	0.04	4.98	15.85	0.00
ΔCPIYOY	97	0.004	0.51	1.39	-1.62	-0.50	4.43	12.31	0.00
ΔCCPIYOY	97	-0.011	0.13	0.40	-0.40	0.22	4.17	6.30	0.04
ΔIPYOY	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
ΔLNSNZN300	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

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 Level	ADF Unit Root Tests (H_0: Has Unit Root)			KPSS Tests (H_0: Stationarity)	
	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**
CTB3M	–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**
IPYOY	–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.

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

Variables at First Difference	ADF Unit Root Tests (H_0: Has Unit Root)			KPSS Tests (H_0: Stationarity)	
	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
ΔCTB3M	–7.32***	–7.29***	–7.25***	0.60*	0.09
ΔCTB6M	–7.32***	–7.29***	–7.25***	0.49*	0.10
ΔCPIYOY	–5.36***	–5.33***	–5.31***	0.05	0.05
ΔCCPIYOY	–9.40***	–9.41***	–9.56***	0.22	0.07
ΔIPYOY	–10.81***	–10.76***	–10.70***	0.30	0.30***
ΔLNSNGHAI	–6.15***	–6.13***	–6.12***	0.08	0.07
ΔLNSNZN300	–7.92***	–7.91***	–8.02***	0.18	0.08
ΔLNUSDCNY	–5.50***	–5.57***	–5.54***	0.09	0.09

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, 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.

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

	SWAP2Y	SWAP2Y	SWAP2Y	SWAP5Y	SWAP5Y	SWAP5Y	SWAP10Y	SWAP10Y	SWAP10Y
Main equation									
CTB3M	0.45*** (0.00)	0.43*** (0.00)	0.43*** (0.00)	0.41*** (0.00)	0.39*** (0.00)	0.40*** (0.00)	0.37*** (0.00)	0.36*** (0.00)	0.36*** (0.00)
CTB3M(-1)	–0.51*** (0.00)	–0.47*** (0.00)	–0.49*** (0.00)	–0.49*** (0.00)	–0.47*** (0.00)	–0.49*** (0.00)	–0.49*** (0.00)	–0.48*** (0.00)	–0.51*** (0.00)
SWAP*i*Y(-1)	1.10*** (0.00)	1.07*** (0.00)	1.08*** (0.00)	1.11*** (0.00)	1.08*** (0.00)	1.09*** (0.00)	1.24*** (0.00)	1.21*** (0.00)	1.22*** (0.00)
CCPIYOY		0.06** (0.04)	0.07** (0.02)		0.06* (0.08)	0.06* (0.05)		0.08** (0.04)	0.08** (0.02)
IPYOY		0.005*** (0.00)	0.004** (0.01)		0.005*** (0.00)	0.004*** (0.00)		0.005*** (0.00)	0.005*** (0.00)
ΔLNSNGHAI			0.35 (0.24)			0.41* (0.07)			0.50** (0.03)
ΔLNUSDCNY			–0.37 (0.72)			–0.18 (0.88)			0.12 (0.91)
Intercept	0.15* (0.05)	0.18** (0.03)	0.19** (0.01)	0.20** (0.01)	0.24*** (0.00)	0.23*** (0.00)	0.26** (0.01)	0.36*** (0.00)	0.34*** (0.00)
Cointegrating relationship									
Long-term Coefficient	0.81*** (0.00)	0.61*** (0.00)	0.55*** (0.00)	0.72*** (0.00)	0.48*** (0.00)	0.40* (0.05)	0.61*** (0.00)	0.29*** (0.00)	0.21 (0.34)
Rate of Adjustment	–0.18*** (0.00)	–0.22*** (0.00)	–0.21*** (0.00)	–0.15** (0.01)	–0.19*** (0.00)	–0.17*** (0.00)	–0.14*** (0.00)	–0.19*** (0.00)	–0.17*** (0.00)
Model information									
Obs	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
Diagnostic Tests									
Joint Significance F-Test	309.56 (0.00)	230.51 (0.00)	182.64 (0.00)	236.96 (0.00)	184.70 (0.00)	151.97 (0.00)	248.65 (0.00)	164.51 (0.00)	137.68 (0.00)
Serial Correlation Durbin-Watson Stat	1.94	1.99	1.98	1.99	2.05	2.03	1.96	2.03	2.04
Serial Correlation Breusch-Godfrey LM Test	0.26 (0.77)	0.39 (0.67)	0.81 (0.45)	0.01 (0.99)	0.92 (0.40)	0.62 (0.53)	0.11 (0.89)	0.72 (0.49)	0.68 (0.51)
Heteroskedasticity Breusch-Pagan-Godfrey Test	1.34 (0.25)	0.97 (0.46)	2.64 (0.01)	1.39 (0.23)	1.24 (0.28)	2.22 (0.02)	1.75 (0.13)	1.44 (0.19)	1.86 (0.06)
Normality Test Jarque-Bera Stat	20.58 (0.00)	19.96 (0.00)	76.21 (0.00)	1.13 (0.57)	1.10 (0.57)	9.12 (0.01)	4.58 (0.11)	1.55 (0.46)	14.35 (0.00)
Stability Diagnostic Ramsey RESET Test	0.64 (0.53)	0.47 (0.63)	0.56 (0.57)	0.30 (0.74)	0.28 (0.76)	0.13 (0.88)	0.24 (0.79)	0.36 (0.70)	0.23 (0.80)

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.

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

	SWAP2Y	SWAP2Y	SWAP2Y	SWAP5Y	SWAP5Y	SWAP5Y	SWAP10Y	SWAP10Y	SWAP10Y
Main equation									
CTB6M	0.52*** (0.00)	0.55*** (0.00)	0.52*** (0.00)	0.47*** (0.00)	0.50*** (0.00)	0.48*** (0.00)	0.43*** (0.00)	0.43*** (0.00)	0.42*** (0.00)
CTB6M(-1)	–0.53*** (0.00)	–0.46*** (0.00)	–0.57*** (0.00)	–0.48*** (0.00)	–0.43*** (0.00)	–0.47*** (0.00)	–0.52*** (0.00)	–0.50*** (0.00)	–0.55*** (0.00)
SWAP_Y(-1)	1.04*** (0.00)	0.86*** (0.00)	1.05*** (0.00)	1.05*** (0.00)	0.88*** (0.00)	0.93*** (0.00)	1.21*** (0.00)	1.18*** (0.00)	1.23*** (0.00)
CPIYOY		0.01 (0.17)	0.07 (0.58)		0.02 (0.14)	0.01 (0.31)		0.01 (0.38)	0.04 (0.70)
IPYOY		0.005** (0.01)	0.003 (0.12)		0.005*** (0.00)	0.004*** (0.01)		0.004** (0.01)	0.003* (0.08)
ΔLNSNZN300			0.48 (0.14)			0.56** (0.02)			0.62** (0.02)
ΔLNUSDCNY			0.08 (0.92)			0.40 (0.70)			0.42 (0.73)
Intercept	0.14** (0.049)	0.08 (0.29)	0.12* (0.05)	0.19** (0.01)	0.12 (0.22)	0.12 (0.21)	0.27** (0.01)	0.23** (0.03)	0.23** (0.01)
Cointegrating relationship									
Long-term Coefficient	0.82*** (0.00)	0.69*** (0.00)	0.73*** (0.00)	0.76*** (0.00)	0.59** (0.03)	0.22 (0.77)	0.60*** (0.00)	0.58*** (0.00)	0.42 (0.14)
Rate of Adjustment	–0.20*** (0.00)	–0.14** (0.02)	–0.16** (0.01)	–0.17*** (0.00)	–0.12** (0.02)	–0.07** (0.03)	–0.15*** (0.00)	–0.14*** (0.00)	–0.11** (0.01)
Model information									
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
Diagnostic tests									
Joint Significance F-Test	310.71 (0.00)	294.35 (0.00)	179.32 (0.00)	289.04 (0.00)	274.24 (0.00)	209.06 (0.00)	249.15 (0.00)	179.69 (0.00)	148.86 (0.00)
Serial Correlation Durbin-Watson Stat	1.97	1.71	1.98	2.01	1.71	1.69	1.99	2.00	2.02
Serial Correlation Breusch-Godfrey LM Test	0.21 (0.81)	2.35 (0.11)	1.15 (0.32)	0.01 (0.99)	1.13 (0.32)	1.25 (0.29)	0.03 (0.96)	0.15 (0.86)	0.27 (0.76)
Heteroskedasticity Breusch-Pagan-Godfrey Test	1.20 (0.31)	1.03 (0.40)	2.64 (0.01)	0.09 (0.91)	0.64 (0.67)	1.67 (0.13)	2.37 (0.05)	1.64 (0.13)	1.95 (0.06)
Normality Test Jarque-Bera Stat	24.09 (0.00)	6.82 (0.03)	123.52 (0.00)	4.16 (0.12)	4.11 (0.13)	8.89 (0.01)	4.99 (0.08)	6.34 (0.04)	31.16 (0.00)
Stability Diagnostic Ramsey RESET Test	0.14 (0.87)	0.29 (0.74)	0.33 (0.72)	0.003 (0.99)	0.10 (0.90)	0.30 (0.74)	0.31 (0.73)	0.32 (0.72)	0.04 (0.96)

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 = φ^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
		2	-0.040	-0.041	0.2499	0.883
		3	0.141	0.144	2.2681	0.519
		4	-0.147	-0.162	4.4813	0.345
		5	0.082	0.115	5.1843	0.394
		6	0.199	0.160	9.3293	0.156
		7	-0.035	-0.003	9.4567	0.222
		8	0.184	0.167	13.071	0.109
		9	0.003	-0.045	13.072	0.159
		10	-0.108	-0.041	14.349	0.158
		11	0.000	-0.083	14.349	0.214
		12	-0.069	-0.057	14.889	0.248
		13	-0.155	-0.181	17.602	0.173
		14	-0.025	-0.102	17.673	0.222
		15	0.044	0.070	17.899	0.268
		16	-0.075	-0.077	18.566	0.292
		17	0.020	0.054	18.615	0.351
		18	-0.099	-0.074	19.787	0.345
		19	-0.257	-0.161	27.885	0.086
		20	0.008	0.026	27.893	0.112
		21	0.050	0.099	28.203	0.134
		22	-0.131	-0.095	30.387	0.109
		23	0.157	0.100	33.548	0.072
		24	-0.055	-0.019	33.939	0.086
		25	-0.162	-0.084	37.418	0.053
		26	0.110	0.063	39.058	0.048
		27	-0.187	-0.161	43.842	0.021
		28	0.057	0.121	44.288	0.026
		29	0.134	-0.048	46.820	0.019
		30	-0.046	0.091	47.116	0.024
		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
		35	0.005	-0.011	55.969	0.014
		36	-0.082	-0.108	57.016	0.014

*Probabilities may not be valid for this equation specification.

Table A2: SWAP2Y = φ^2(C, CTB3M, CCPIYOY, IPYOY)

Sample (adjusted): 2014M11 2022M10
Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.004	0.004	0.0016	0.968
		2	-0.070	-0.070	0.4876	0.784
		3	0.141	0.142	2.4932	0.477
		4	-0.122	-0.133	4.0102	0.405
		5	0.105	0.136	5.1396	0.399
		6	0.192	0.152	8.9961	0.174
		7	-0.074	-0.033	9.5743	0.214
		8	0.127	0.119	11.285	0.186
		9	-0.002	-0.041	11.286	0.257
		10	-0.059	0.005	11.667	0.308
		11	0.024	-0.065	11.732	0.384
		12	-0.093	-0.093	12.708	0.391
		13	-0.162	-0.182	15.680	0.267
		14	-0.042	-0.108	15.879	0.321
		15	0.032	0.054	15.998	0.382
		16	-0.078	-0.091	16.722	0.404
		17	0.028	0.066	16.812	0.467
		18	-0.099	-0.076	17.985	0.457
		19	-0.271	-0.188	26.944	0.106
		20	-0.002	-0.004	26.944	0.137
		21	0.056	0.078	27.344	0.160
		22	-0.155	-0.109	30.393	0.109
		23	0.137	0.107	32.819	0.084
		24	-0.062	-0.022	33.325	0.097
		25	-0.168	-0.099	37.068	0.057
		26	0.116	0.038	38.865	0.050
		27	-0.196	-0.193	44.123	0.020
		28	0.038	0.106	44.322	0.026
		29	0.112	-0.053	46.068	0.023
		30	-0.056	0.085	46.516	0.028
		31	0.005	-0.142	46.519	0.036
		32	-0.031	-0.113	46.656	0.046
		33	-0.161	-0.118	50.538	0.026
		34	0.178	0.136	55.338	0.012
		35	0.026	0.027	55.439	0.015
		36	-0.059	-0.050	55.990	0.018

*Probabilities may not be valid for this equation specification.

Table A3: SWAP2Y = φ^3(C, CTB3M, CCPIYOY, IPYOY, ΔLNSNGHAI, ΔLNUSDCNY)

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
		2	-0.106	-0.106	1.1275	0.569
		3	0.134	0.138	2.9564	0.398
		4	-0.126	-0.147	4.5908	0.332
		5	0.052	0.095	4.8720	0.432
		6	0.185	0.136	8.4608	0.206
		7	-0.049	-0.010	8.7155	0.274
		8	0.132	0.146	10.576	0.227
		9	0.003	-0.045	10.577	0.306
		10	-0.077	0.003	11.230	0.340
		11	0.028	-0.040	11.319	0.417
		12	-0.084	-0.089	12.108	0.437
		13	-0.152	-0.161	14.718	0.325
		14	0.026	-0.044	14.795	0.392
		15	0.078	0.091	15.501	0.416
		16	-0.063	-0.070	15.972	0.455
		17	0.041	0.067	16.168	0.512
		18	-0.075	-0.066	16.840	0.534
		19	-0.239	-0.164	23.792	0.204
		20	0.012	-0.000	23.808	0.251
		21	0.033	0.018	23.946	0.296
		22	-0.160	-0.139	27.183	0.204
		23	0.112	0.059	28.794	0.187
		24	-0.068	-0.066	29.396	0.206
		25	-0.186	-0.121	34.003	0.108
		26	0.117	0.074	35.857	0.094
		27	-0.214	-0.202	42.128	0.032
		28	0.015	0.136	42.159	0.042
		29	0.105	-0.061	43.707	0.039
		30	-0.043	0.128	43.969	0.048
		31	0.012	-0.105	43.989	0.061
		32	-0.022	-0.075	44.062	0.076
		33	-0.187	-0.100	49.257	0.034
		34	0.137	0.090	52.124	0.024
		35	0.006	-0.026	52.130	0.031
		36	-0.067	-0.067	52.840	0.035

*Probabilities may not be valid for this equation specification.

Table A4: SWAP5Y = φ^4(C, CTB3M)

Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.000	-0.000	9.E-06	0.998
		2	0.007	0.007	0.0051	0.997
		3	0.100	0.100	1.0020	0.801
		4	-0.229	-0.231	6.3137	0.177
		5	-0.007	-0.004	6.3184	0.276
		6	0.149	0.152	8.6081	0.197
		7	-0.059	-0.021	8.9666	0.255
		8	0.276	0.238	17.034	0.030
		9	0.030	-0.013	17.127	0.047
		10	-0.090	-0.033	18.011	0.055
		11	-0.039	-0.108	18.179	0.078
		12	-0.074	0.013	18.779	0.094
		13	-0.116	-0.091	20.292	0.088
		14	-0.033	-0.130	20.414	0.118
		15	0.081	0.101	21.175	0.131
		16	-0.052	-0.120	21.487	0.161
		17	0.020	0.017	21.533	0.203
		18	-0.054	-0.080	21.878	0.237
		19	-0.242	-0.162	28.961	0.067
		20	0.059	0.092	29.392	0.080
		21	0.112	0.162	30.944	0.075
		22	-0.135	-0.081	33.247	0.058
		23	0.151	0.001	36.167	0.040
		24	-0.078	-0.051	36.950	0.044
		25	-0.186	-0.117	41.505	0.020
		26	0.128	0.102	43.682	0.016
		27	-0.188	-0.128	48.486	0.007
		28	0.095	0.138	49.730	0.007
		29	0.123	-0.095	51.833	0.006
		30	-0.076	0.039	52.641	0.006
		31	-0.029	-0.145	52.763	0.009
		32	-0.039	-0.070	52.980	0.011
		33	-0.163	-0.018	56.942	0.006
		34	0.136	0.131	59.741	0.004
		35	-0.009	0.031	59.753	0.006
		36	-0.022	-0.163	59.831	0.008

*Probabilities may not be valid for this equation specification.

Table A5: SWAP5Y = φ^5(C, CTB3M, CCPIYOY, IPYOY)

Sample (adjusted): 2014M12 2022M10

Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.035	-0.035	0.1193	0.730
		2	-0.019	-0.020	0.1540	0.926
		3	0.105	0.103	1.2486	0.741
		4	-0.207	-0.202	5.5676	0.234
		5	0.027	0.022	5.6424	0.343
		6	0.147	0.136	7.8667	0.248
		7	-0.106	-0.066	9.0420	0.250
		8	0.216	0.184	13.966	0.083
		9	0.012	-0.004	13.982	0.123
		10	-0.045	0.030	14.202	0.164
		11	-0.013	-0.092	14.221	0.221
		12	-0.092	-0.041	15.167	0.232
		13	-0.125	-0.122	16.931	0.202
		14	-0.058	-0.135	17.320	0.240
		15	0.062	0.095	17.757	0.276
		16	-0.059	-0.120	18.159	0.315
		17	0.027	0.031	18.244	0.374
		18	-0.056	-0.102	18.615	0.416
		19	-0.250	-0.193	26.174	0.125
		20	0.056	0.070	26.554	0.148
		21	0.113	0.149	28.155	0.136
		22	-0.163	-0.095	31.516	0.086
		23	0.128	0.001	33.608	0.071
		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	-0.174	50.152	0.016
		32	-0.038	-0.104	50.364	0.021
		33	-0.156	-0.048	53.977	0.012
		34	0.144	0.107	57.093	0.008
		35	-0.001	0.067	57.093	0.011
		36	-0.002	-0.121	57.094	0.014

*Probabilities may not be valid for this equation specification.

Table A6: SWAP5Y = φ^6(C, CTB3M, CCPIYOY, IPYOY, ΔLNSNGHAI, ΔLNUSDCNY)

Sample (adjusted): 2014M12 2022M10
Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.027	-0.027	0.0692	0.793
		2	-0.047	-0.048	0.2924	0.864
		3	0.105	0.102	1.3875	0.708
		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
		7	-0.077	-0.038	8.7577	0.271
		8	0.226	0.211	14.169	0.077
		9	0.031	-0.011	14.275	0.113
		10	-0.067	0.014	14.761	0.141
		11	-0.008	-0.066	14.768	0.193
		12	-0.085	-0.032	15.574	0.212
		13	-0.121	-0.096	17.224	0.189
		14	0.008	-0.066	17.232	0.244
		15	0.103	0.128	18.460	0.239
		16	-0.048	-0.112	18.725	0.283
		17	0.048	0.041	19.002	0.328
		18	-0.035	-0.070	19.146	0.383
		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
		25	-0.206	-0.170	37.686	0.050
		26	0.129	0.081	39.924	0.040
		27	-0.233	-0.208	47.301	0.009
		28	0.061	0.138	47.806	0.011
		29	0.105	-0.088	49.348	0.011
		30	-0.067	0.065	49.988	0.012
		31	-0.015	-0.126	50.020	0.017
		32	-0.019	-0.075	50.075	0.022
		33	-0.194	-0.040	55.655	0.008
		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

*Probabilities may not be valid for this equation specification.

Table A7: SWAP10Y = φ^7(C, CTB3M)

Sample (adjusted): 2014M11 2022M10
Q-statistic probabilities adjusted for 2 dynamic regressors

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.018	0.018	0.0325	0.857
		2	-0.004	-0.005	0.0343	0.983
		3	0.130	0.130	1.7359	0.629
		4	-0.193	-0.202	5.5644	0.234
		5	-0.018	-0.004	5.5984	0.347
		6	0.114	0.101	6.9499	0.326
		7	-0.058	-0.017	7.3096	0.397
		8	0.216	0.196	12.282	0.139
		9	0.024	-0.029	12.345	0.195
		10	-0.084	-0.039	13.124	0.217
		11	0.022	-0.035	13.179	0.282
		12	-0.079	-0.022	13.872	0.309
		13	-0.066	-0.031	14.373	0.348
		14	-0.055	-0.127	14.715	0.398
		15	0.043	0.086	14.933	0.456
		16	-0.048	-0.103	15.200	0.510
		17	0.027	0.043	15.284	0.575
		18	-0.087	-0.118	16.198	0.579
		19	-0.189	-0.163	20.571	0.361
		20	0.003	0.039	20.572	0.423
		21	0.113	0.149	22.169	0.390
		22	-0.117	-0.074	23.917	0.352
		23	0.105	0.006	25.341	0.333
		24	-0.062	-0.084	25.851	0.361
		25	-0.159	-0.082	29.210	0.255
		26	0.109	0.115	30.807	0.236
		27	-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
		30	-0.070	0.037	36.284	0.199
		31	-0.012	-0.101	36.305	0.235
		32	0.001	-0.015	36.305	0.275
		33	-0.126	-0.028	38.691	0.228
		34	0.104	0.047	40.345	0.210
		35	0.003	0.064	40.347	0.246
		36	-0.074	-0.195	41.200	0.254

*Probabilities may not be valid for this equation specification.

Table A8: SWAP10Y = φ^8(C, CTB3M, CCPIYOY, IPYOY)

Sample (adjusted): 2014M12 2022M10
Q-statistic probabilities adjusted for 2 dynamic regressors

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

*Probabilities may not be valid for this equation specification.

Table A9: SWAP10Y = φ^9(C, CTB3M, CCPIYOY, IPYOY, ΔLNSNGHAI, ΔLNUSDCNY)

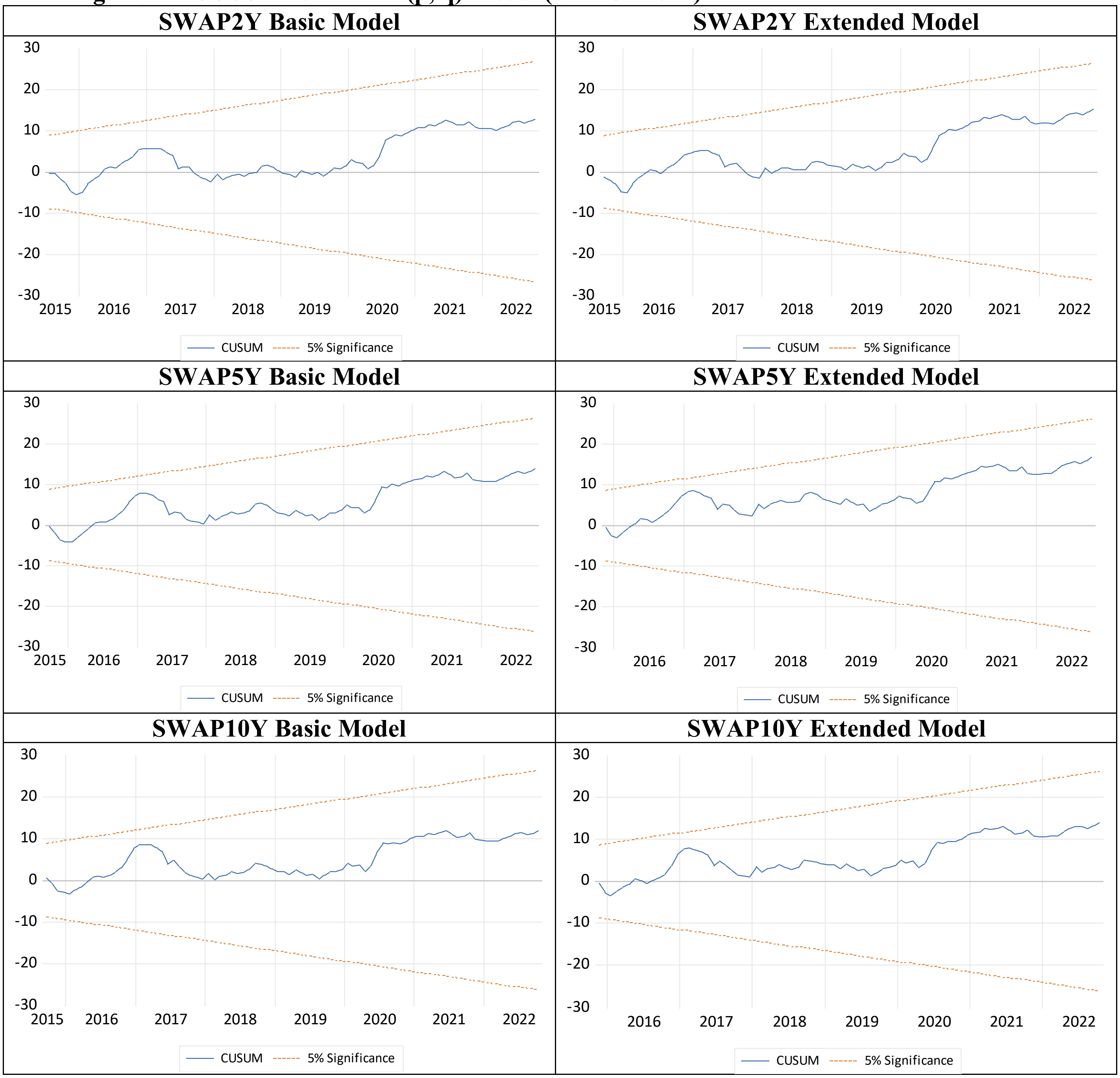
Sample (adjusted): 2014M12 2022M10
Q-statistic probabilities adjusted for 2 dynamic regressors

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

*Probabilities may not be valid for this equation specification.

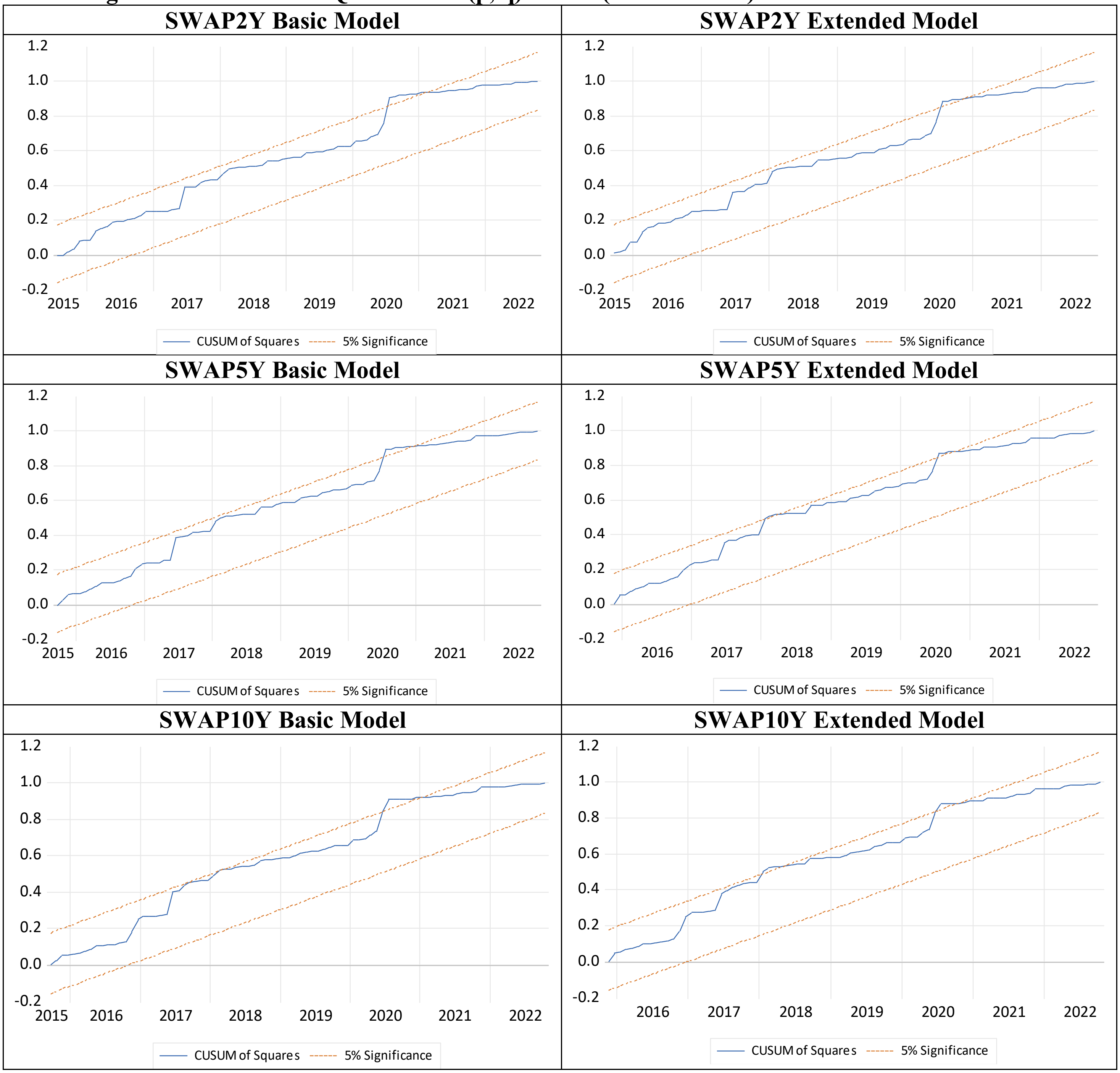
APPENDIX B: CUSUM and CUSUM-SQ tests

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, ΔLNSNGHAI, and ΔLNUSDCNY 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, ΔLNSNGHAI, and ΔLNUSDCNY in the extended model).