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The Macrodynamics of Indian Rupee Swap Yields

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

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ABSTRACT

This paper econometrically models the dynamics of Indian rupee (INR) swap yields based on key macroeconomic factors using the autoregressive distributive lag (ARDL) approach. It examines whether the short-term interest rate has a decisive influence on long-term INR swap yields after controlling for other factors, such as core inflation, the growth of industrial production, the logarithm of the equity price index, and the logarithm of the INR exchange rate. The estimated models show that the short-term interest rate has an important influence on the swap yields. This implies that the Reserve Bank of India (RBI) can sway borrowing and lending rates not just on Indian government bonds but also INR-denominated private-market financial instruments, such as swaps and swaptions.

KEYWORDS: Interest Rate Swaps; Swap Yields; Inflation; Reserve Bank of India; India

JEL CLASSIFICATIONS: E43; E50; E58; E60; G10; G12

1. INTRODUCTION

Indian rupee–denominated (INR) interest rate swaps are poised to play a vital role in both the Indian banking system and nonbanking financial institutions as the country's financial system evolves and the Indian economy grows in the coming decades. The Indian economy has recovered from the great lockdown and it is expected to grow at a pace of 6.3 percent in the financial year 2023–24, according to the IMF (2023, 9: Table 1.1). In December 2022, the Indian banking sector also experienced credit growth of 17.4 percent, a ten-year high, according to RBI data (Sanglap and Ramos 2023). INR swaps are already in use, both by domestic and overseas entities. Going forward, the usage of INR swaps is likely to increase.

This paper econometrically models INR interest rate swap yields based on macroeconomic and financial variables. It examines whether the short-term interest rate has a decisive influence on long-term swap yields after controlling for several key macroeconomic and financial variables, such as overall inflation and core inflation, the growth of industrial production, the percentage change of the equity price index, and the percent change of the INR–dollar exchange rate.

The econometric modeling of INR swap yields can provide valuable insights regarding the following macro-financial topics: (1) the role and effectiveness of the Reserve Bank of India's (RBI) monetary policy and its transmission into market interest rates; and (2) the impact of overall macroeconomic conditions on Indian financial markets. Furthermore, the econometric modeling of the short-term interest rate's role in setting the long-term swap yield can provide insights on two key issues: (1) whether John Maynard Keynes's (1930) claim that the central bank exerts influence on the long-term interest rate on government bonds extends to over-the-counter (OTC) derivate products, such as interest rate swaps; and (2) whether the stylized relationship between the short-term interest rate and long-term swap yield observed for swaps denominated in "hard currencies," such as those for US dollar–denominated (USD) swaps and British pound sterling (GBP)–denominated swaps, is applicable for emerging market currency–denominated swaps, such as INR swaps.

The Keynesian Approach to Interest Rate Dynamics

The Keynesian approach to interest rate modeling emphasizes the leading role of the central bank's policy rate in setting the long-term interest rate (Akram 2021, 2022). Keynes (1930, [1936] 2007) held that monetary policy drives the long-term interest rate, surmising: "The influence of the short-term rate of interest on the long-term rate is much greater than anyone … would have expected" (Keynes 1930, 315). He asserted that "[t]here is no reason to doubt the ability of a Central Bank to make its short-term rate of interest effective in the market" (363). Keynes appreciated the important function of the central bank's policy rate in financial markets. He opined: "The efficiency of the Bank rate for the management of a managed money was a great discovery … its applications in varying conditions were not clearly understood—and have not been clearly understood to this day" (17). Keynes ([1936] 2007) was acutely aware of the limit, scope, subtleties, and complexities of the central bank's actions. Hence, he made the following observations: (1) "The short-term interest rate is easily controlled by the monetary authority. … But the long-term [interest] rate may be more recalcitrant" (202–3); (2) "If the monetary authority were prepared to deal both ways on the specified terms in debt of maturities, and … in debts of varying degrees of risks, the relationship with the complex rate of interest and the quantities of money would be direct" (205); and (3) "A complex offer by the central bank to buy and sell at stated prices gilt-edged bonds of all maturities, in place of the single bank rate for short-term bills, is the most important practical improvement that can be made in the technique of monetary management" (206).

The Keynesian approach to interest rates stands in contradistinction to the conventional view, which posits that the long-term interest rate is an outcome of the demand for and supply of loanable funds. In the recent literature on the empirical modeling of interest rate dynamics, the Keynesian approach has been revived and has found support in the data. Akram and Li (2020a, 2020b), Atesogulu (2003–4, 2005), Chakraborty (2016), Cook (2008), Deleidi and Levrero (2020), Gabrisch (2021), Kim (2020, 2021), Payne (2006–7), Rahimi, Lavoie, and Chu (2016), Rahimi, Chu, and Lavoie (2017), Simoski (2019), and Vinod, Chakraborty, and Karun (2014) examine the relationship between the short- and long-term interest rates from a Keynesian vantage point. Even though many of these studies have reported that the short-term interest rate appears to be a decisive driver of the long-term interest rate, such studies have been confined to examining the relationship between the short-term interest rate and the long-term government bond yield rather than the effect had by the long-term interest rate on debt instruments issued by the private sector or OTC financial assets. It is germane to examine whether such regularities hold for market interest rates, such as mortgage rates and interest rate swaps. Furthermore, most studies have been confined to examining interest rate dynamics in financial markets of advanced countries, such as the United States, the eurozone, the United Kingdom, and Japan, though a few studies on emerging markets, such as China and Chile, do exist. A study of swap yields in India would be quite useful for economic theory and policy.

Interest Rate Swaps

The total amount of outstanding interest rate swaps in all currencies as of 2021 was almost $400 trillion in notional terms, and $8 trillion in gross market value, according to the Bank for International Settlements (BIS 2022). Interest rate swaps are used both for hedging and speculating, and represent an important part of the OTC derivatives in global financial markets and the global financial system.

The literature on interest rate swaps is voluminous. Corb (2012) provides a useful primer. There are other insightful primers and studies on many aspects of interest rate swaps, such as Bicksler and Chen (1986), Chernenko and Faulkfender (2011), Cortes (2003), Kim and Koppenhaver (1993), Miron and Swanwell (1992), Ron (2000), Sadr (2009), Sawyer (2011), Smith Jr., Smithson, and Wakeman (1988), Visvanathan (1998), and Zhou (2002). However, there is a dearth of literature on swaps with respect to the empirical modeling of the swap yield. The existing empirical literature has not related the dynamics of swap yields to underlying macroeconomic and financial factors; this is a clear shortcoming. For instance, pioneering studies of empirical modeling of swaps yields and swap spreads, such as Duffie and Huang (1996), Duffie and Singleton (1997), and Lekkos and Milas (2001), do not examine the role of macroeconomic factors. Recently, however, Akram and Mamun (2022a, 2022b, 2023a, 2023b) have attempted to econometrically model the swap yield in terms of macroeconomic factors. They also examine whether Keynes's (1930, [1936] 2007) conjecture, which tethers the long-term interest rate to the short-term interest rate, applies for swap yields denominated in USD, GBP, the Chinese yuan (CNY), and the Chilean peso (CLP). This paper extends that research with INR swaps.

An Outline of the Paper

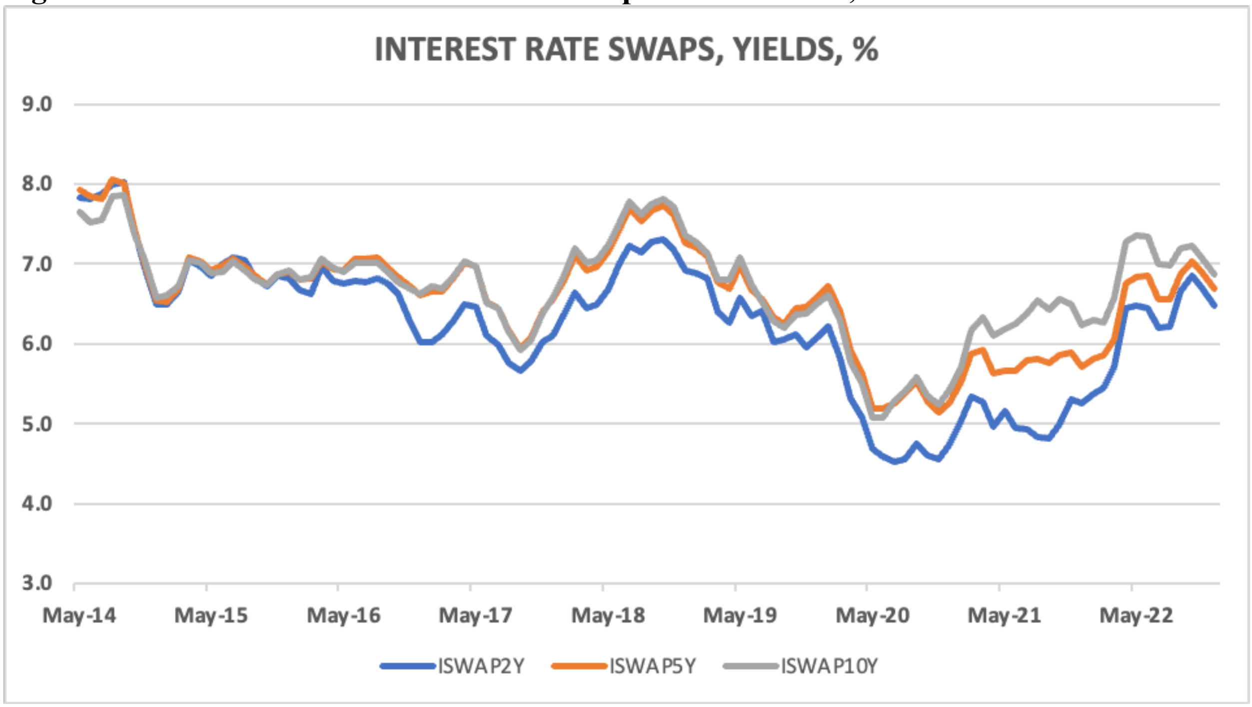
This paper extends the existing literature on interest rate dynamics from a Keynesian perspective in two crucial manners. First, it econometrically models the relationship between the short-term interest rate and long-term swap yield to examine whether Keynes's conjecture holds for the long-term swap yield. Second, whereas most studies of interest rate dynamics have been confined to advanced countries, the current paper examines the interest rate dynamics in India, a rapidly growing key emerging market.

This paper is arranged as follows. Section 2 overviews the evolution of INR interest rate swap yields in India in the context of the country's macroeconomic developments. Section 3 describes the data used in the paper; it also presents the results of unit root and stationary tests. Section 4 covers the econometric models used to analyze the dynamics of the swap yields in India, reporting the findings and interpreting the results. Section 5 considers the policy implications of the results. Section 6 summarizes and concludes.

2. THE EVOLUTION OF INR INTEREST RATE SWAP YIELDS

An understanding of the macroeconomic background and financial market conditions in India, including monetary policy, is useful for understanding the dynamics of INR interest rate swap yields. In particular, the short-term interest rate exerts substantial influence on the long-term swap yields of different maturity tenors, as will be shown using econometric analysis in Section 3.

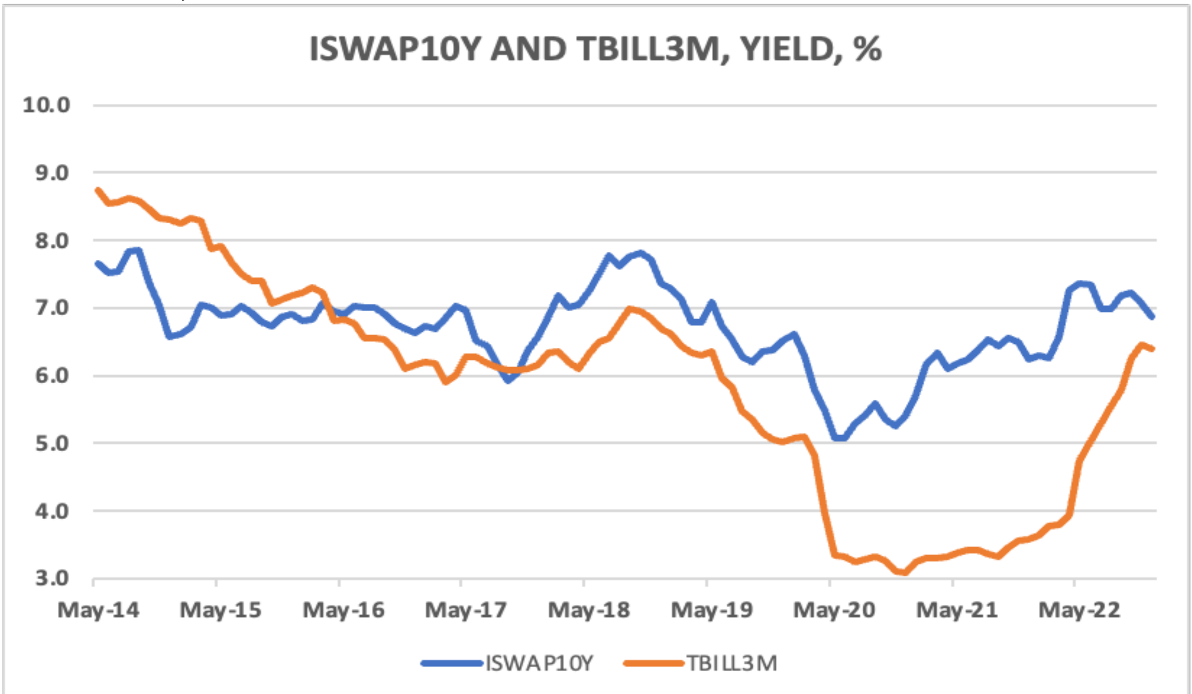
Figure 1. The Evolution of Interest Rate Swap Yields in India, 2014M5–2022M12



Source: See Table 1

Figure 1 displays the evolution of interest rate swap yields between 2014M5 and 2022M12. (The data for this and following figures are listed in Table 1.) It shows that the yields of swaps of different maturity tenors tend to move together most of the time. Indian swap yields fell sharply in late 2014, but remained steady until early 2017. Beginning mid-2017, swap yields began to rise and continued until 2018. From early 2019 to early 2022, swap yields of all maturity tenors declined notably. Swap yields began rising late in 2020 and continued to do so until early 2022, declining a bit by the end of 2022.

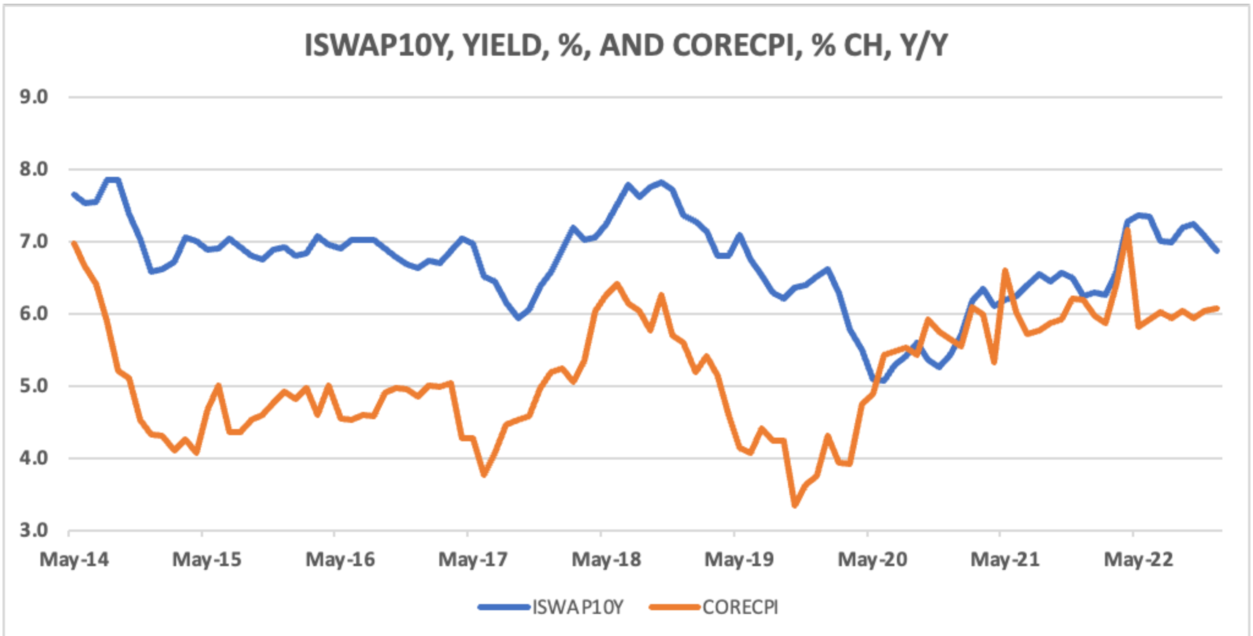
Figure 2. The Coevolution of the 10Y Interest Rate Swaps Yield and the Short-term Interest Rate, 2014M5–2022M12



Source: See Table 1

Figure 2 exhibits the coevolution of the 10-year swap yield and the 3-month Treasury bill rate. It shows that the long-term swap yield (as represented by the 10-year swap yield) and the short-term interest rate (as represented by the 3-month Treasury bill rate) tend to move together most of the time. In the beginning of the study period, the 3-month Treasury bill rate was greater than the 10-year swap yield. However, since April 2016, the 3-month Treasury bill rate has been lower than the 10-year swap yield, except for a brief period between September 2017 and October 2017. Overall, during the study period, the 10-year swap yield and the 3-month Treasury bill rate have been strongly and positively correlated.

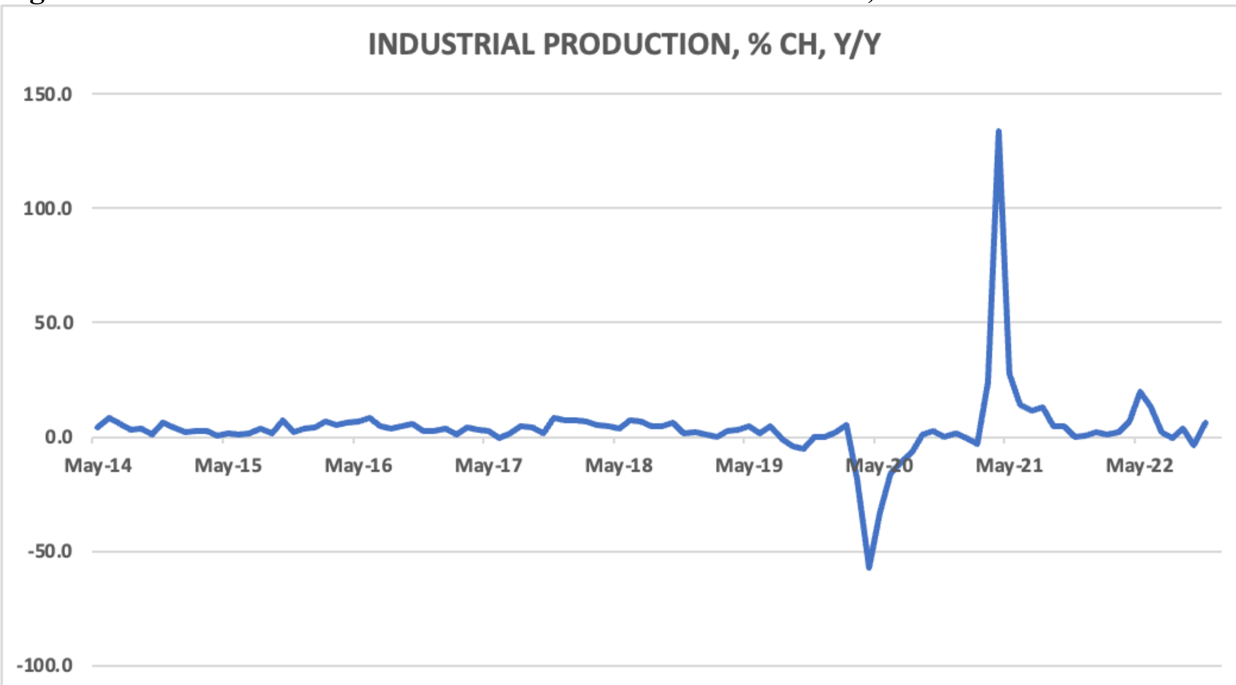
Figure 3. The Coevolution of 10Y Interest Rate Swaps and Core CPI Inflation, 2014M5–2022M12



Source: See Table 1

Figure 3 traces the coevolution of the 10-year swap yield and the year-over-year change in the core consumer price index (CPI). It shows that the 10-year swap yield and core CPI inflation tend to move in the same direction, albeit with varied lags and leads. The two series are positively correlated, but note that the correlation is not particularly strong.

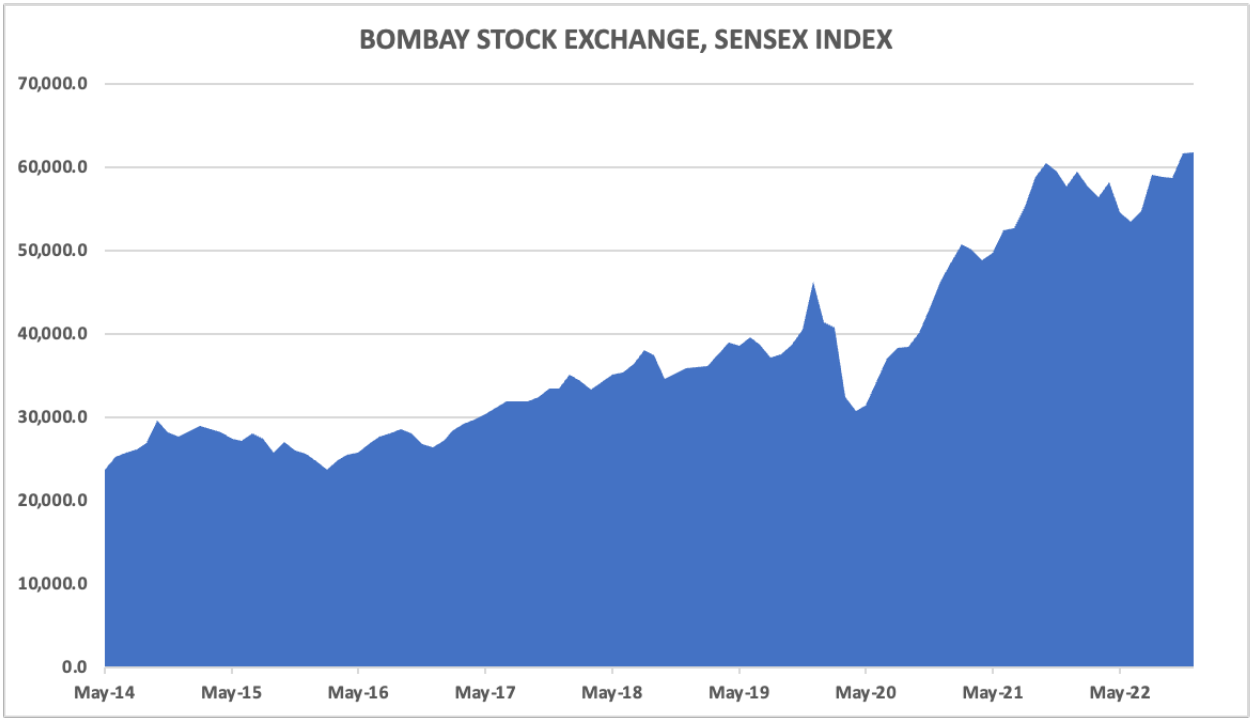
Figure 4. The Evolution of the Growth of Industrial Production, 2014M5–2022M12



Source: See Table 1

Figure 4 presents the evolution of the growth of industrial production during the study period, illustrating that the mean growth of industrial production was close to 4 percent year-over-year. Industrial production fell sharply between March 2020 and August 2020 amid the pandemic's great lockdown, but rebounded strongly between March 2021 to August 2021. The growth in industrial production increased in mid-2022, but it subsided by the end of the same year.

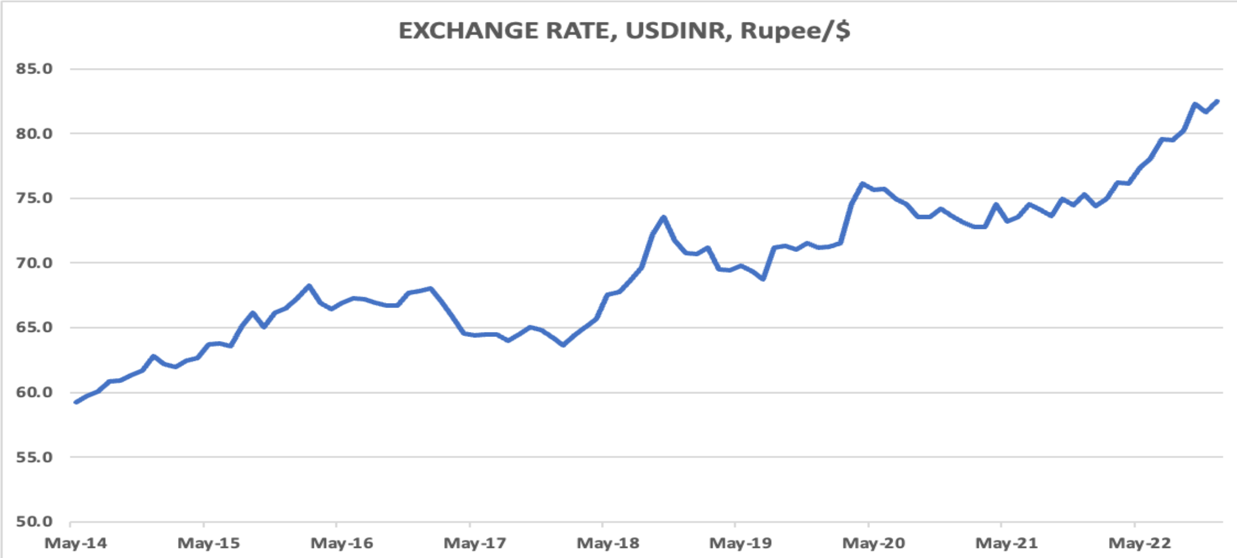
Figure 5. The Evolution of the Bombay Stock Exchange Index (SENSEX), 2014M5–2022M12



Source: See Table 1

Figure 5 depicts the evolution of the Bombay Stock Exchange Index (SENSEX) during the study period. The SENSEX rose from nearly 24,000 in May 2014 to nearly 54,000 in July 2022. Between late 2014 and early 2016, the SENSEX declined almost 20 percent, but rose almost 65 percent between late 2016 and late 2019. The SENSEX began correcting in 2020 and fell sharply with the enforcement of the pandemic lockdown. It bottomed out in May 2020, but rose nearly 50 percent from May 2020 to October 2021. It declined by around 10 percent from October 2021 to July 2022, but reversed the losses by the end of the year.

Figure 6. The Evolution of the Indian Rupee–US Dollar (USD–INR) Exchange Rate, 2014M5–2022M12



Source: See Table 1

Figure 6 presents the evolution of the USD–INR exchange rate. The INR depreciated from INR60/USD in May 2014 to almost INR80/USD in July 2022. The depreciation was steady during these years, with occasional periods of appreciation in 2017 and from late 2018 to mid-2019. The INR was fairly stable from mid-2020 to mid-2022, but depreciated steadily in the second half of 2022.

3. DATA DESCRIPTION AND UNIT ROOT AND STATIONARITY TESTS

Table 1 summarizes the data used in the paper. The first column displays the variable labels. The second column gives a description of the data and the date range. The third column provides the frequency of the data and indicates whether high frequency data have been converted to lower frequency data. The final column catalogs the data sources.

The short-term interest rates are the 3-month Treasury bill rate and the 3-month Mumbai interbank offer rate (MIBOR). The long-term swap rate is based on the yield of INR–denominated onshore swaps of 2-, 5-, and 10-year maturity terms. Year-over-year percentage changes in the CPI and the CPI excluding food, fuel, and light are used, respectively, as measures of total inflation and core inflation. The growth of industrial production, measured as the year-over-year percentage changes, gauges the pace of economic activity in India. The dataset includes several financial variables. Two different indexes are used for the stock market index: the SENSEX from the Bombay Stock Exchange and the Nifty from the National Stock Exchange of India. Two measures of the INR exchange rate are also given: the exchange rate of INR per USD and the nominal effective exchange rate (NEER), an index. The paper uses monthly data from May 2014 to December 2022, consisting of 104 observations.

Table 1. Summary of the Data

Variable	Data description; date range	Frequency	Sources
Short-term interest rates			
TBILL3M	Treasury bill, 3 month, %; May 2014–December 2022	Daily; converted to monthly	Refinitiv
MIBOR	Mumbai interbank offer rate, 3 month, %; May 2014–December 2022	Daily; converted to monthly	Refinitiv
Long-term swap rates			
ISWAP2Y	Onshore Indian rupees interest rate swap vs 6-month MIFOR (Mumbai interbank forward outright rate), 2 year, %, annualized; May 2014–December 2022	Daily; converted to monthly	Tullet Prebon Information
ISWAP5Y	Onshore Indian rupees interest rate swap vs. 6-month MIFOR, 5 year, %, annualized; May 2014–December 2022	Daily; converted to monthly	Tullet Prebon Information
ISWAP10Y	Onshore Indian rupees interest rate swap vs. 6-month MIFOR, 10 year, %, annualized; May 2014–December 2022	Daily; converted to monthly	Tullet Prebon Information
Inflation			
CPI	Consumer price index, % change, y/y, seasonally adjusted, 2012=100; May 2014–December 2022	Monthly	Ministry of Statistics and Programme Implementation
CORECPI	Consumer price index excluding food, fuel and light, % change, y/y, seasonally adjusted; May 2014–December 2022	Monthly	Ministry of Statistics and Programme Implementation
Economic activity			
IPYOY	Industrial production, general index, % change, y/y, seasonally adjusted; May 2014–December 2022	Monthly	Ministry of Statistics and Programme Implementation
Financial variables			
SENSEX	Stock price index, Bombay Stock Exchange, 1978–79=100; May 2014–December 2022	Daily; converted to monthly	Bombay Stock Exchange
NIFTY	Stock price index, National Stock Exchange; May 2014–December 2022	Daily; converted to monthly	National Stock Exchange
USDINR	Exchange rate, Indian rupee per USD, average; May 2014–December 2022	Daily; converted to monthly	Federal Reserve Board
NEER	Nominal Broad Effective Exchange Rate; May 2014–December 2022	Daily; converted to monthly	JPMorgan

Note: LNSENSEX = LN(SENSEX); LNUSDINR = LN(USDINR) where LN = natural log = $\text{Log}_e(.)$

The summary statistics of all variables in their level and at first difference are presented in Table 2A and Table 2B, respectively. The average swap yields rise slightly with the maturity levels as longer maturity indicates higher risk. The average 3-month Treasury bill rate is lower than the average MIBOR. The skewness of the swap yields and short-term interest rates are negative and thus show a slightly fatter tail on the left. The kurtosis for the front end of the swap yield curve and short-term interest rate are below 3.0, displaying a platykurtic distribution with a short tail (i.e., fewer outliers). However, the 10-year swap yield has a kurtosis above 3.0 and thus indicates a leptokurtic distribution with a long tail. The Jarque-Bera tests in Table 2A indicate higher maturity swap yields, industrial production, and equity indexes are not normally distributed.

Table 2A. Summary Statistics of the Variables

Variables	Obs.	Mean	Std. Dev.	Max.	Min	Skewness	Kurtosis	J-B	Prob.
SWAP2Y	104	6.24	0.85	8.03	4.53	-0.35	2.51	3.17	0.21
SWAP5Y	104	6.61	0.68	8.06	5.14	-0.26	2.62	1.81	0.40
SWAP10Y	104	6.70	0.63	7.85	5.07	-0.59	3.25	6.23	0.04
TBILL3M	104	5.86	1.63	8.74	3.09	-0.26	2.10	4.67	0.10
MIBOR	104	6.39	1.58	9.10	3.65	-0.32	2.08	5.46	0.07
CPI	104	4.99	1.51	7.85	1.53	-0.10	2.29	2.39	0.30
CORECPI	104	5.18	0.82	7.15	3.34	0.07	2.20	2.83	0.24
IPYOY	104	3.85	15.74	133.62	-57.34	4.77	48.01	9173.55	0.00
LNSENSEX	104	10.49	0.28	11.03	10.07	0.48	2.01	8.28	0.02
LNNIFTY	104	9.29	0.28	9.82	8.86	0.50	2.09	7.92	0.02
LNUSDINR	104	4.24	0.08	4.41	4.08	0.12	2.26	2.61	0.27
LNNEER	104	4.30	0.05	4.40	4.20	-0.20	1.81	6.89	0.03

Table 2B shows the summary statistics of all the variables at their first difference. The short-term interest rate and swap yields are more volatile at their first difference. All swap yields and short-term interest rates are leptokurtic. The swap yields, CPI, and the exchange rate do not have a normal distribution as per the Jarque-Bera tests. The change in industrial production shows a slowdown in April 2020, indicating the impact of the pandemic on Indian industries, followed by a large increase exactly a year later in April 2021.

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

Variables	Obs.	Mean	Std. Dev.	Max.	Min.	Skewness	Kurtosis	J-B	Prob.
ΔSWAP2Y	103	-0.01	0.22	0.74	-0.60	0.00	3.56	1.36	0.51
ΔSWAP5Y	103	-0.01	0.21	0.71	-0.57	-0.07	3.61	1.66	0.44
ΔSWAP10Y	103	-0.01	0.22	0.70	-0.51	0.02	3.28	0.35	0.84
ΔTBILL3M	103	-0.02	0.20	0.80	-0.86	-0.29	7.77	98.93	0.00
ΔMIBOR	103	-0.02	0.22	0.52	-0.92	-0.36	5.21	23.23	0.00
ΔCPI	103	-0.02	0.73	1.94	-2.33	-0.19	3.45	1.49	0.47
ΔCORECPI	103	-0.01	0.38	1.26	-1.34	-0.11	4.52	10.07	0.01
ΔIPYOY	103	0.00	16.64	109.39	-105.79	0.20	35.10	4421.62	0.00
Δ LNSENSEX	103	0.01	0.05	0.13	-0.23	-1.39	9.62	221.38	0.00
ΔLNNIFTY	103	0.01	0.04	0.09	-0.23	-2.00	12.89	488.35	0.00
ΔLNUSDINR	103	0.00	0.01	0.04	-0.03	0.32	3.36	2.32	0.31
ΔLNEER	103	0.00	0.01	0.03	-0.04	-0.33	3.54	3.10	0.21

The stationarity tests are displayed in Tables 3A and 3B. Table 3A exhibits the unit root tests of the variables at the level. Both the augmented Dickey–Fuller (ADF) unit root tests and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) stationarity tests are shown. The null hypotheses for the ADF and KPSS tests are different. The unit root tests indicate most of the variables are nonstationary. The one strong exception is industrial production, which shows the presence of stationarity by both types of tests.

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

Variables at Level	ADF Unit Root Tests (H_0: Unit Root)			KPSS Tests (H_0: Stationarity) tests	
	None	Intercept	Trend	Intercept	Trend
SWAP2Y	-0.75	-2.41	-2.37	0.69**	0.08
SWAP5Y	-0.65	-2.78*	-2.98	0.61**	0.08
SWAP10Y	-0.46	-2.85*	-2.91	0.34	0.08
TBILL3M	-0.99	-1.63	-0.43	0.86***	0.09
MIBOR	-1.00	-1.58	0.02	0.85***	0.08
CPI	-0.32	-1.57	-2.18	0.32	0.19**
CORECPI	0.31	-2.84*	-2.50	0.37*	0.10
IPYOY	-6.01***	-6.22***	-6.20***	0.07	0.06
LNSENSEX	2.08	-0.38	-2.79	1.16***	0.15**
LNNIFTY	1.52	-0.49	-2.86	1.14***	0.13*
LNUSDINR	2.55	-0.53	-2.11	1.18***	0.07
LNNEER	-0.95	-0.38	-2.74	1.02***	0.18**

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

Table 3B shows the unit root and stationarity tests of the variables in their first difference. All of the variables become stationary at their first difference, as per both ADF and KPSS tests. However, the KPSS tests for short-term interest rates weakly rejected the null hypothesis of stationarity. However, the overall picture supports 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: Unit Root)			KPSS Tests (H_0: Stationarity) tests	
	None	Intercept	Trend	Intercept	Trend
ΔSWAP2Y	-7.04***	-7.02***	-7.08***	0.17	0.07
ΔSWAP5Y	-6.75***	-6.73***	-6.74***	0.14	0.07
ΔSWAP10Y	-6.77***	-6.74***	-6.72***	0.10	0.06
ΔTBILL3M	-5.90***	-5.91***	-6.18***	0.38*	0.16**
ΔMIBOR	-7.55***	-7.55***	-7.87***	0.29	0.14*
ΔCPI	-5.13***	-5.08***	-5.11***	0.13	0.06
ΔCORECPI	-4.06***	-4.07***	-4.19***	0.21	0.08
ΔIPYOY	-10.44***	-10.39***	-10.34***	0.11	0.11
Δ LNSENSEX	-8.31***	-8.53***	-8.52***	0.07	0.04
ΔLNNIFTY	-7.41***	-7.62***	-7.61***	0.07	0.05
ΔLNUSDINR	-8.68***	-9.11***	-9.07***	0.08	0.07
ΔLNEER	-9.27***	-9.31***	-9.39***	0.18	0.04

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

4. ECONOMETRIC MODELS

Following standard time-series tests of the data, the autoregressive distributed lag (ARDL) is deemed as the most appropriate approach for modeling the dynamics of INR interest rate swaps. All variables are either stationary, I(0), or integrated in the first order, I(1), hence, an ARDL approach is suitable. Estimates based on the ARDL approach can reveal both the short-run and long-run effects of the independent variables on swap yields (Pesaran and Shin 1999).

The main results are displayed in Tables 4 and 5. Two different models for the three swap yield term lengths are estimated. In the first model, the swap yield is just a function of the short-term interest rate and inflation or core inflation rates. In the second model, the swap yield is a function of the short-term interest rate, inflation or core inflation, the growth of industrial production, the month-over-month percentage change in the equity price index, and the month-over-month percentage change in the exchange rate.

Table 4 shows estimations using the 3-month Treasury bill rate, i.e., the main variable of interest. In all models with three different maturity levels of swaps, the 3-month Treasury bill affects the swap yield positively and significantly. In particular, a 100-basis point increase in the 3-month Treasury bill increases the 2-year swap yield by 42–46 basis points. The effect declines with higher maturity terms for the swaps. The impact of the short-term interest rate reduces to 35–36 basis points for the 10-year swap.

The long-term relationship between the 3-month Treasury bill rate and the swap yield is also examined. The long-run relationship varies significantly from the 2-year maturity term to the 10-year maturity, from 50 basis points for the 2-year swap to 31 basis points for the 10-year swap. The adjustment rate of any shock to the long-run relationship between the 3-month Treasury bill rate and the swap yield does not differ much for different maturities, dissipating in around 3.6–4 months. Among the control variables, core inflation and the growth of industrial production have a positive but weak effect on the swap yield. A higher level of inflation is associated with a higher swap yield. Likewise, a rise in industrial production is associated with a higher swap yield.

A host of post-model information and diagnostics tests are presented in the bottom panel of Table 4. The adjusted R^2 shows a high degree of explanation for variances in the swap yield by the three-month Treasury bill rate and its lags, as well as the autoregressive variables. The Akaike Information Criterion (AIC) also show a good fit for all models. The joint-significance tests for all models show a strong rejection of insignificance in the regressors. The Durbin-Watson statistics and Breusch-Godfrey LM tests indicate there is no serial correlation in the error terms in these modes. The Breusch–Pagan–Godfrey heteroskedasticity tests fail to reject the null hypothesis of homoscedasticity in all models. The Jarque–Bera tests indicate the error terms are normally distributed in all models for all swap term lengths. Lastly, stability tests of these models are presented. The Ramsey RESET tests indicate all the models are stable. The CUSUM and the CUSUM-SQ tests for these models for all three maturity terms are available upon request. Brown, Durbin, and Evans (1975) showed that the CUSUM test is a test of instability in the equation whereas the CUSUM-SQ test is a test of instability in the variance of the regression errors (Brown, Durbin, and Evans 1975; Hansen 1991). All the CUSUM and CUSUM-SQ tests showed that all the models are stable in both intercept and regression error variances.

Table 4. ARDL (p, q) Model (with TBILL3M and CORECPI)

	SWAP2Y	SWAP2Y	SWAP5Y	SWAP5Y	SWAP10Y	SWAP10Y
	Main Equation					
TBILL3M	0.42*** (0.00)	0.46*** (0.00)	0.32*** (0.00)	0.36*** (0.00)	0.35*** (0.00)	0.36*** (0.00)
TBILL3M(-1)	−0.28*** (0.00)	−0.33*** (0.00)	−0.22** (0.03)	−0.26** (0.01)	−0.26*** (0.00)	−0.28*** (0.00)
SWAP$_i$Y(-1)	1.06*** (0.00)	1.08*** (0.00)	1.09*** (0.00)	1.11*** (0.00)	1.09*** (0.00)	1.11*** (0.00)
SWAP$_i$Y(-2)	−0.34*** (0.00)	−0.33*** (0.00)	−0.37*** (0.00)	−0.38*** (0.00)	−0.36*** (0.00)	−0.36*** (0.00)
CORECPI	0.15** (0.04)	0.15** (0.03)	0.07 (0.10)	0.07 (0.12)	0.10** (0.01)	0.09** (0.03)
IPYOY		0.001** (0.01)		0.001** (0.01)		0.001 (0.51)
ΔLNSENSEX		0.19 (0.68)		0.31 (0.46)		0.46 (0.30)
ΔLNUSDINR		−2.28 (0.14)		−0.87 (0.53)		−0.93 (0.53)
Intercept	0.57** (0.01)	0.48** (0.04)	0.88*** (0.00)	0.92*** (0.00)	0.77*** (0.00)	0.70** (0.01)
	Cointegrating Relationship					
Long-term Coefficient	0.50*** (0.00)	0.51*** (0.00)	0.38*** (0.00)	0.38*** (0.00)	0.31*** (0.00)	0.32*** (0.00)
Rate of Adjustment	−0.28*** (0.00)	−0.25*** (0.00)	−0.28*** (0.00)	−0.27*** (0.00)	−0.27*** (0.00)	−0.25*** (0.00)
	Model Information					
Obs	102	102	102	102	102	102
Adj R^2	0.95	0.95	0.93	0.93	0.92	0.92
AIC	− 0.55	− 0.54	− 0.65	− 0.62	− 0.62	− 0.59
	Diagnostic Tests					
Joint Significance F-Test	351.56 (0.00)	238.32 (0.00)	291.53 (0.00)	151.97 (0.00)	241.27 (0.00)	150.73 (0.00)
Serial Correlation Durbin-Watson Stat	1.89	1.88	1.86	1.90	1.91	1.93
Serial Correlation Breusch–Godfrey LM Test	0.55 (0.58)	0.68 (0.51)	1.08 (0.34)	0.41 (0.66)	0.28 (0.76)	0.16 (0.85)
Heteroskedasticity Breusch–Pagan-Godfrey Test	0.36 (0.90)	0.99 (0.46)	0.58 (0.71)	0.93 (0.50)	0.33 (0.89)	0.94 (0.48)
Normality Test Jarque–Bera Stat	0.88 (0.64)	0.43 (0.81)	0.27 (0.87)	0.55 (0.76)	0.07 (0.96)	0.26 (0.88)
Stability Diagnostic Ramsey RESET Test	2.07 (0.13)	2.53 (0.09)	1.13 (0.33)	2.38 (0.10)	2.94 (0.06)	4.63 (0.01)

Note: *p*-values are in parenthesis. ***, **, * implies statistical significance at 1 percent, 5 percent, and 10 percent, respectively. BG LM is with 2 lags and Ramsey RESET test is fitted with 2 terms.

Table 5 displays the results of the models of swap yields with alternative variables. These models employ different variables for the short-term interest rate and inflation, namely the MIBOR is used as the short-term interest rate instead of the three-month Treasury bill rate and total CPI inflation is used in place of core inflation. Robustness checks with the use of MIBOR, in place of the three-month Treasury bill rate, and CPI inflation, in place of core CPI inflation, provide essentially unchanged results. The effects of the MIBOR on the swap yields are somewhat smaller than the three-month Treasury bill rate.

Table 5. ARDL (p, q) Model (with MIBOR and CPI)

	SWAP2Y	SWAP2Y	SWAP5Y	SWAP5Y	SWAP10Y	SWAP10Y
	Main Equation					
MIBOR	0.38*** (0.00)	0.41*** (0.00)	0.32*** (0.00)	0.35*** (0.00)	0.30*** (0.00)	0.34*** (0.00)
MIBOR(-1)	−0.28*** (0.00)	−0.32*** (0.00)	−0.25*** (0.00)	−0.28*** (0.00)	−0.26*** (0.00)	−0.30*** (0.00)
SWAP_Y(-1)	1.22*** (0.00)	1.22*** (0.00)	1.25*** (0.00)	1.25*** (0.00)	1.29*** (0.00)	1.27*** (0.00)
SWAP_Y(-2)	−0.43*** (0.00)	−0.40*** (0.00)	−0.46*** (0.00)	−0.44*** (0.00)	−0.45*** (0.00)	−0.41*** (0.00)
CPI	0.08** (0.01)	0.09** (0.01)	0.07** (0.02)	0.07** (0.01)	0.07** (0.01)	0.08*** (0.00)
CPI (-1)	−0.07** (0.03)	−0.07** (0.02)	−0.06** (0.03)	−0.06** (0.01)	−0.07** (0.01)	−0.07** (0.01)
IPYOY		0.0003 (0.69)		0.0001 (0.90)		0.0005 (0.66)
ΔLNNIFTY		1.03** (0.01)		1.02** (0.01)		1.27** (0.01)
ΔLNNEER		2.40 (0.20)		1.42 (0.43)		1.72 (0.28)
Intercept	0.61*** (0.00)	0.40*** (0.00)	0.89*** (0.00)	0.75*** (0.00)	0.77** (0.01)	0.65** (0.02)
	Cointegrating Relationship					
Long-term Coefficient	0.46*** (0.00)	0.48*** (0.00)	0.34*** (0.00)	0.36*** (0.00)	0.23** (0.01)	0.27*** (0.00)
Rate of Adjustment	−0.20*** (0.00)	−0.18*** (0.00)	−0.21*** (0.00)	−0.19*** (0.00)	−0.15*** (0.00)	−0.14*** (0.00)
	Model Information					
Obs	102	102	102	102	102	102
Adj R^2	0.95	0.95	0.93	0.93	0.91	0.92
AIC	− 0.44	− 0.48	− 0.56	− 0.58	− 0.47	− 0.53
	Diagnostic Tests					
Joint Significance F-Test	313.24 (0.00)	225.24 (0.00)	223.09 (0.00)	157.33 (0.00)	172.79 (0.00)	150.73 (0.00)
Serial Correlation Durbin–Watson Stat	2.04	2.07	2.00	2.09	1.97	2.05
Serial Correlation Breusch–Godfrey LM Test	0.38 (0.68)	1.14 (0.32)	0.48 (0.62)	2.06 (0.13)	0.27 (0.76)	1.23 (0.30)
Heteroskedasticity Breusch–Pagan–Godfrey Test	0.45 (0.84)	0.48 (0.88)	0.58 (0.75)	0.54 (0.84)	0.48 (0.82)	0.73 (0.68)
Normality Test Jarque–Bera Stat	0.26 (0.88)	1.43 (0.49)	0.61 (0.74)	1.16 (0.56)	0.11 (0.94)	0.12 (0.94)
Stability Diagnostic Ramsey RESET Test	0.17 (0.85)	0.13 (0.88)	0.26 (0.77)	0.13 (0.88)	0.17 (0.84)	0.38 (0.69)

Note: *p*-values are in parenthesis. ***, **, * implies statistical significance at 1 percent, 5 percent, and 10 percent, respectively. BG LM is with 2 lags and Ramsey RESET test is fitted with 2 terms.

While the long-term relationship between the swap yield and MIBOR is similar to the results in Table 4, albeit smaller, the rate of adjustment becomes longer, ranging from five to seven months. The total inflation showed a stronger positive effect on the swap yield, unlike the core inflation in Table 4. The change in industrial production shows no effect on the swap yield. However, the change in the 50-stock index known as the Nifty has a significant positive effect on all maturity tenors of the swap yield. The adjusted R^2, the AIC, and post-diagnostic test results are identical to their counterparts in Table 4.

5. IMPLICATIONS

The findings support two hypotheses presented in the paper. First, the central bank can exert an influence on OTC products as an extension of the Keynesian notion that the short-term interest rate affects the long-term government bond yield. Second, the results suggest that the findings from earlier works on the stylized relationship between the short-term interest rate and the long-term swap yield observed for swaps denominated in "hard currencies" (e.g., those for USD and GBP), is applicable for swap yields denominated in emerging market currencies such as INR.

The findings imply that the Reserve Bank of India (RBI), the nation's central bank, has a critical influence on swap yields of different maturity tenors, based on the effects of the repo rate, the main policy rate, and other monetary policy measures on the short-term interest rate, such as the three-month Treasury bill rate and the MIBOR. This means that the RBI has substantial sway over the country's financial system, as its monetary policy actions influence the borrowing costs and lending rates on a range of fixed-income instruments—not just long-term government bond yields, but also swaps and swaptions denominated in INR, the country's currency.

6. CONCLUSION

The econometric results presented in the paper show that the short-term interest rate has a significant, positive effect on swap yields of different tenors. The effect is generally higher for shorter-term tenors of INR swaps. The lagged effect is negative and significant. The lagged effect of the short-term interest rate on INR swap yields does not vary much by maturity tenor.

The swap yield and the short-term interest rate also exhibit a long-term relationship. The long-term relationship is higher for shorter tenors of INR swaps. The rate of adjustment of any deviation for the long-term relationship is: (1) around four months for a three-month Treasury bill rate; and (2) five to seven months for MIBOR.

The findings of this paper support the view that Keynes's conjecture about the relationship between the short-term interest rate and the long-term interest rate holds for INR swap yields. The findings imply that the RBI's actions exert a crucial influence on INR swap yields of different maturities, after controlling for key macroeconomic and financial variables.

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