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An Inquiry Concerning Japanese Yen Interest Rate Swap Yields

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ABSTRACT

This paper econometrically models Japanese yen (JPY)–denominated interest rate swap yields. It examines whether the short-term interest rate exerts an influence on the long-term JPY swap yield after controlling for several key macroeconomic variables, such as core inflation, the growth of industrial production, the percentage change in the equity price index, and the percentage change in the exchange rate. It also tests whether there are structural breaks in the dynamics of Japanese swap yields and related variables. The estimated econometric models show that the short-term interest rate exerts an important influence on the long-term swap yield in some periods but not in other periods in which core inflation exerts a marked influence on the swap yield. The findings from the econometric models reveal a discernable relationship between the call rate and the swap yield of different maturity tenors clearly held prior to April 2014 but did not in the subsequent period. These findings highlight the limits and scope of John Maynard Keynes's contention that the central bank's policy rate commands a decisive influence over the long-term market rate through the short-term interest rate. The policy implications of the estimated models' results are discussed.

KEYWORDS: Interest Rate Swaps; Swap Yields; Call Rate; Inflation; Bank of Japan (BOJ); Japan

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

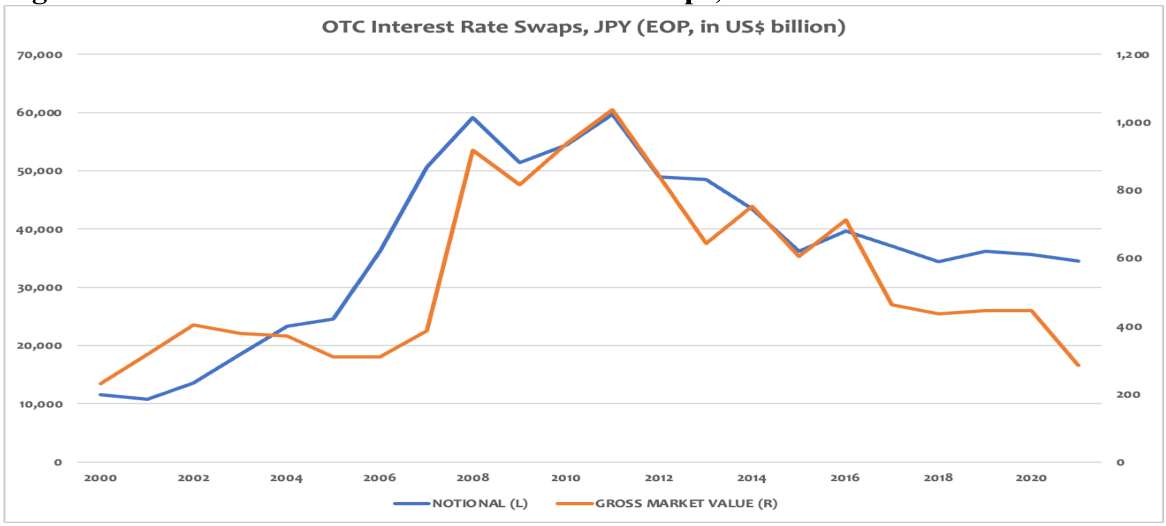
SECTION I: INTRODUCTION

Japanese yen (JPY)–denominated interest rate swaps are an important component of the global swaps market. JPY swaps play a vital role in the global financial system and Japanese financial markets. As of 2021, the notional value of JPY interest rate swaps amounted to nearly $35 trillion, while their gross market value amounted to $265 billion, according to the Bank for International Settlements (BIS) (2022).

This paper econometrically models JPY interest rate swap yields using macroeconomic and financial variables. It examines whether the current short-term interest rate exerts a decisive influence on the long-term swap yield after controlling for several key macroeconomic variables, such as core inflation, the growth of industrial production, the percentage change in the equity price index, and the percentage change in the exchange rate. It also tests whether there are structural breaks in the dynamics of JPY swap yields and related variables that influence the behavior of JPY swap yields.

Figure 1 lays out the evolution of outstanding JPY interest rate swaps both in terms of their notional amount and gross market value. JPY-denominated interest rate swaps constitute more than 95 percent of all JPY interest rate derivatives as of the first half of 2021, according to the BIS (2022). (The source for the data in Figure 1 is the BIS, while the sources of the data in remaining figures in this paper are listed in Table 1.)

Figure 1: The Evolution of JPY Interest Rate Swaps, 2000–21



While JPY interest rate swaps are crucial financial instruments in the universe of Japanese financial assets (as well as in the function and operation of the JPY-denominated financial and banking system), there is a paucity of empirical analyses of JPY swap yields. This paper fills a lacuna in the related literature on interest rate swaps by exploring the macroeconomic determinants of JPY swap yields. John Maynard Keynes (1930) posited that the central bank's monetary policy decisions—particularly its setting of the policy rate—influence the yields of long-term government bonds through their effects on the short-term interest rate. Recent research has vindicated the hypothesis that the current short-term interest rate is a key driver of Japanese government bond (JGB) yields (Akram and Li 2020a, b). This and related findings hold not just for Japan, but also for other advanced countries, such as the United States (Akram 2021a, Akram and Li 2020c). Taking a cue from this literature, this paper examines whether the current short-term interest rate has a decisive effect on swap yields of different maturity tenors in Japan, after controlling for key macroeconomic and financial variables. This is an important theoretical and policy question because it has consequential implications for the efficacy of monetary policy and the monetary transmission mechanism, financial markets, financial intermediation, the financial services industry, corporate finance, fiscal policy, and fiscal-monetary policy coordination.

This paper is arranged as follows. Section II undertakes a brief overview of the literature on interest rate swaps and the literature on the empirics of interest rate dynamics from the Keynesian perspective. Section III provides a synopsis of the evolution of JPY swap yields with reference to Japan's macroeconomic and financial developments during the past two decades. Section IV describes the data used in the econometric modeling; it also undertakes unit root and stationarity tests. Section V econometrically models the dynamics of the JPY swap yield based on key macroeconomic and financial variables. Section VI deliberates the policy implications of the empirical findings. Section VII summarizes and concludes.

SECTION II: A BRIEF OVERVIEW OF THE LITERATURE

The literature on interest rate swaps is vast. Corb (2012) provides a detailed primer on interest rate swaps, covering their functions, pricing, applications, and recent innovations. Bicksler and Chen (1986), Kim and Koppenhaver (1993), Smith Jr., Smithson, and Wakeman (1988), and Visvanathan (1998) render additional analysis of the applications of swaps in business and finance, the function of the swap market, and the various types of swap users. BIS (2022) gives detailed statistics about swaps denominated in major currencies, including interest rate swaps, providing time-series information on the notional and gross market values of outstanding swaps.

The empirical literature modeling swap yields in quantitative finance has fallen short in crucial aspects. Duffie and Hunag (1996), Duffie and Singleton (1997), and Lekkos and Milas (2001) are among the most notable empirical studies of swaps and swap spreads. However, these and most other empirical studies of swap yields in quantitative finance have been deficient in two crucial aspects. First, the modelers often do not relate swap yields to fundamental macroeconomic variables. Second, the modelers do not assess whether Keynes's conjecture, which connects the long-term interest rate to the current short-term interest rate, is applicable for swap yields.

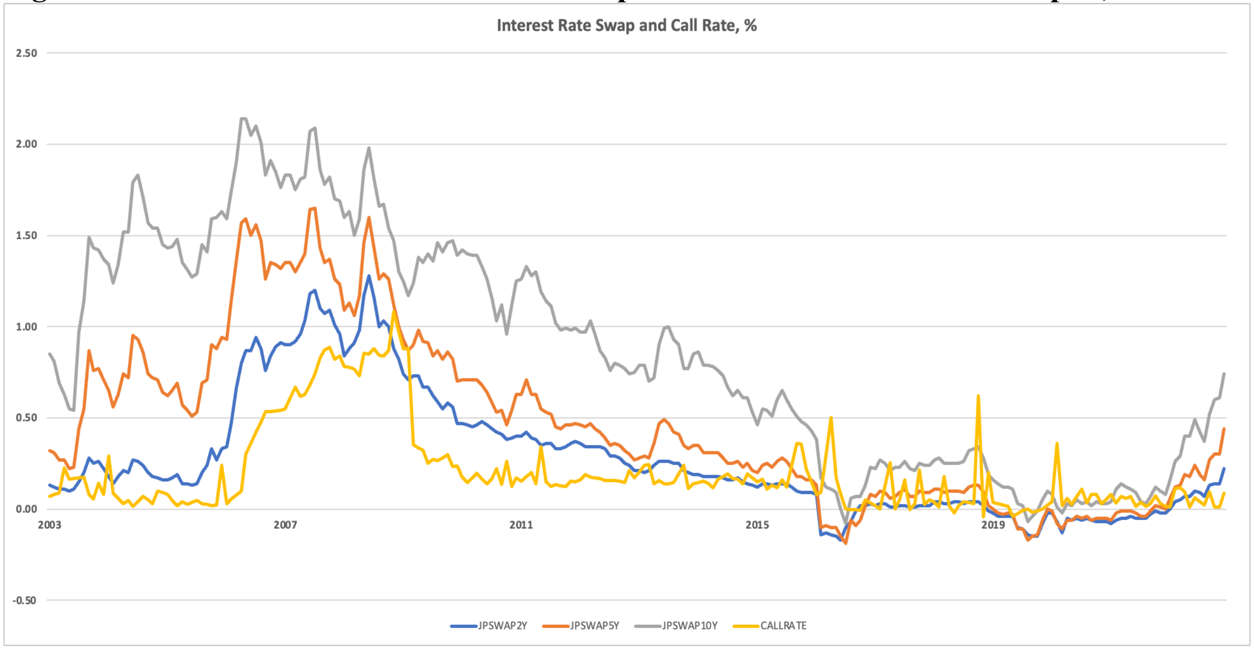
Keynes's conjecture on interest rate dynamics has a plausible theoretical and behavioral basis (Keynes 1930, [1936] 2007) and has found support in the data. The recent empirical literature has given credence to Keynes's conjecture regarding the connection between the short-term interest rate and the long-term interest rate based on Keynes's own theoretical perspective and Riefler's (1930) trailblazing statistical analysis. A good number of empirical studies, such as

Akram and Li (2020a, b, c), Atesogulu (2003–4, 2005), Chakraborty (2016), Deleidi and Levrero (2020), Gabrisch (2021), Kim (2021), Li and Su (2021), Payne (2006–7), Simoski (2019), and Vinod, Chakraborty, and Karun (2014), have covered both advanced economies and emerging markets. These studies report that there is strong evidence of statistically significant and economically meaningful passthrough from the short-term interest rate to the relevant long-term market interest rate after controlling for the appropriate macroeconomic and financial factors. Akram (2021b) has formalized Keynes's conjecture linking the long-term interest rate to the short-term interest rates in a quantitative framework. Most research on the empirical modeling of interest rate dynamics has been limited to the examination of the relationship between the short-term interest rate and the long-term benchmark government bond yield. However, Akram and Mamun (2022a, b) have recently evinced that Keynes's conjecture is applicable for understanding the dynamics of the yields of long-term swaps denominated in US dollars (USD) and British pounds (GBP). In a similar vein, this paper examines whether Keynes's conjecture applies for Japanese yen (JPY) swaps.

SECTION III: THE EVOLUTION OF JPY SWAP YIELDS IN JAPAN'S MACROECONOMIC CONTEXT

Figure 2 displays the evolution of JPY swap yields and the call rate in Japan. It shows that the swap yields and call rate usually move together over time. For instance, as the call rate rose between early 2006 to late 2008, swap yields began to rise, and as the call rate declined between early 2009 and to late 2010, swap yields began to decline. As the call rate declined to near-zero levels, swap yields fell sharply and stayed low between early 2017 to late 2021. However, swap yields, particularly in the front end of the swap yield curve, rose in early 2022 and continued throughout the remainder of the year.

Figure 2: The Evolution of Interest Rate Swap Yields and the Call Rate in Japan, 2003–22

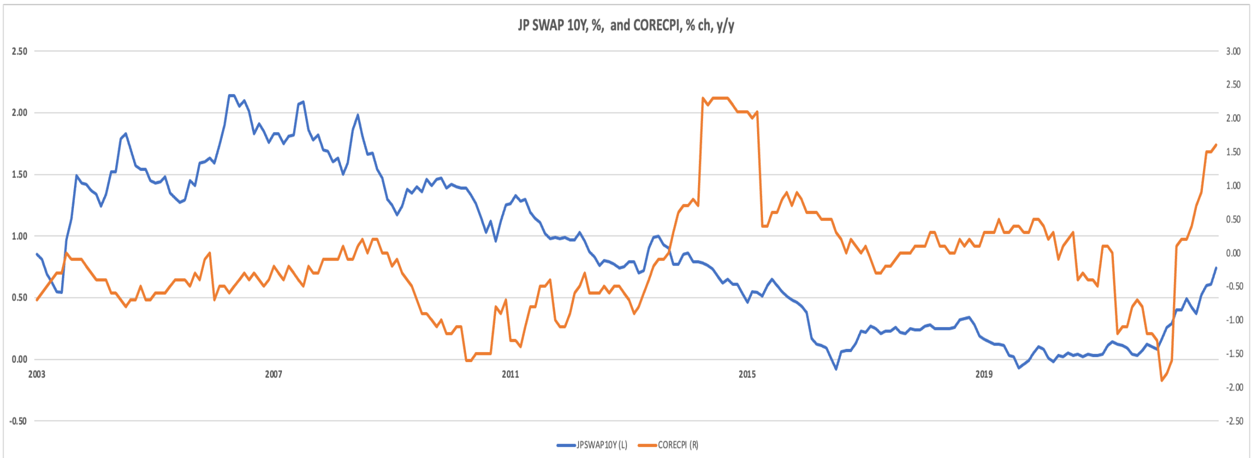


Source: See Table 1

Figure 2 indicates that swap yields and the call rate had structural breaks during the study period. Around mid-2000, swap yields rose and stayed high until the late 2000s. However, the swap yields fell to near zero in the 2010s. In a later section, econometric tests are conducted to identify the breakpoints during the study period.

Figure 3 provides the coevolution of the 10-year swap yield and the core consumer price index (CPI) inflation between 2003 and 2022. It suggests that the connection, if any, between the swap yield and core inflation is weak.

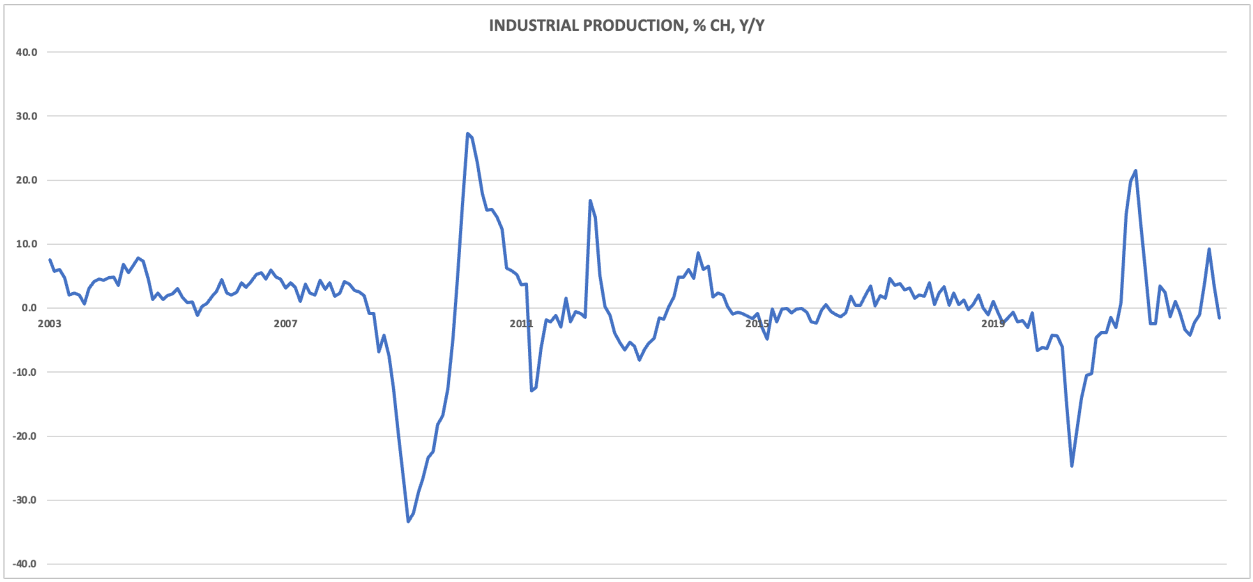
Figure 3: The Coevolution of the 10-year Swap Yield and Core CPI Inflation, 2003–22



Source: See Table 1

Figure 4 depicts the growth of industrial production in Japan. Industrial production was growing between 2003 and mid-2008. Industrial production fell sharply during the global financial crisis. It grew as the Japanese economy recovered from the global financial crisis. It declined again in the aftermath of Japan's earthquake and tsunami in 2011. Following a brief recovery, industrial production fell in late 2012 and early 2013. Between 2014 and mid-2019, industrial production moderated with some months of growth and some months of contraction. By late 2019, the Japanese economy was slowing down and industrial production was contracting. With the onset of the global pandemic and lockdown, industrial production fell sharply. However, it started growing again in early 2021 as the global pandemic subsided and restrictions were eased. In late 2021, industrial production fell again with the onset of the omicron variant of COVID-19 and the slowdown in economic activity; it remained weak until the end of the study period in 2022.

Figure 4: The Growth of Industrial Production in Japan, 2003–22



Source: See Table 1

Figure 5 presents the evolution of the JPY (¥) against the USD ($). The exchange rate stood at around ¥120/$ in early 2003. It appreciated to ¥103/$ in early 2005 but it reverted back to ¥120/$ later the same year and remained stable until mid-2007. However, it gradually appreciated from late 2007 to late 2012 to around ¥75/$. With the advent of Abenomics and quantitative and qualitative monetary easing (QQME), the JPY depreciated from early 2013 to late 2015. By late 2015, the JPY had appreciated to around ¥120/$. In the following months, the JPY appreciated steadily until it reached around ¥100/$. This was followed by a depreciation to around ¥115/$ in early 2017. Between 2017 and late 2021 the JPY hovered between ¥100/$ and ¥115/$. However, in 2022 the JPY began to depreciate noticeably and, by the third quarter of 2022, it had depreciated to nearly ¥150/$. By the end of 2022, it appreciated slightly, to about ¥135/$.

Figure 5: The Exchange Rate (USDJPY), Japanese Yen per US Dollar, 2003–22

Source: See Table 1

Figure 6 displays the evolution of the Nikkei 225 stock price index during the period covered in this paper. The Nikkei index was around 8,500 at the start of the period. It continued to rise until mid-2007 to around 18,000. The Nikkei index declined during the global financial crisis, bottoming out at around 7,800 in early 2009. It remained steady from early 2009 to late 2012, gradually rising from 10,000 in January 2014 to nearly 30,000 in December 2021. But in 2022, the Nikkei index experienced some correction and declined a bit.

Figure 6: The Stock Price Index, Nikkei 225, 2003–22

Source: See Table 1

SECTION IV: DATA DESCRIPTION AND UNIT ROOT AND STATIONARITY TESTS

Table 1, below, provides a summary of the data used in this paper. The first column lists the variables. The second column provides a description of the data and the date range of each variable. The third column shows the frequency of the data and whether high-frequency data have been converted to low-frequency equivalents. The final column gives the sources of the data.

The variable used for the short-term interest rate is the call money rate. For long-term swap yields, swaps of three different maturity tenors are chosen: 2-year, 5-year, and 10-year interest rate swaps. Core inflation is measured as the year-over-year percentage change in the CPI, excluding food, non-alcoholic beverages, and energy. Economic activity is gauged by the year-over-year percentage change in the index of industrial production. The value of the currency is given by the spot exchange rate of the JPY per USD and the nominal effective exchange rate of the JPY. The stock market data are covered by the Nikkei index and the Topix index. The natural logarithm of the exchange rate and the natural logarithm of the stock price index are used. The monthly data used in the empirical portions of the paper, which covers January 2003 to December 2022, have more than 240 observations.

Table 1: Summary of the Data

Variables	Data description, date range	Frequency	Sources
Short-term interest rates			
CALLRATE	Call money rate, %, September 2002–December 2022	Daily; converted to monthly	Association of Call & Discount Companies/Nikkei
TIBOR	Tokyo interbank offer rate (TIBOR), three months, %, September 2002–December 2022	Daily; converted to monthly	Refinitiv
Long-term swap yields			
JPSWAP2Y	Interest rate swap, 2-year, %, September 2002–December 2022	Daily; converted to monthly	Refinitiv
JPSWAP5Y	Interest rate swap, 5-year, %, September 2002–December 2022	Daily; converted to monthly	Refinitiv
JPSWAP10Y	Interest rate swap rate, 10-year, %, September 2002–December 2022	Daily; converted to monthly	Refinitiv
Core inflation			
CORECPI	Consumer price index, all items excluding food, non-alcoholic beverages, and energy, % change, y/y, September 2002–December 2022	Monthly	Ministry of Internal Affairs and Communications
Economic activity			
IPYOY	Industrial production, seasonally adjusted, % change, y/y, September 2002–December 2022	Monthly	Organization for Economic Cooperation and Development
Currency			
USDJPY	The exchange rate, spot, Japanese yen per US dollar, USDJPY, September 2002–December 2022	Daily; converted to monthly	Bank of Japan
NEER	The nominal effective exchange rate, September 2022–December 2022	Monthly	Bank of Japan
Financial markets			
NIKKEI	Stock price index, Nikkei 225, index, September 2002–December 2022	Daily; converted to monthly	*The Financial Times*
TOPIX	Stock price Index, Topix, cash price index, September 2002–December 2022	Daily; converted to monthly	*The Financial Times*

The summary statistics of all variables in their levels and first differences are provided in Tables 2A and 2B, respectively. The mean of the swap yields increases with the maturity tenors, as higher maturity indicates higher risk. The skewness measures indicate that the 2-year swap rate, call rate, and core CPI are right-skewed. Other variables are not skewed in either side. All the time series are leptokurtic, indicating a narrower, bell-shaped distribution. Lastly, the Jarque-Bera tests indicate none of the variables are normally distributed in Table 2A.

Table 2A: Summary Statistics of the Variables

Vars	Obs.	Mean	Std. Dev.	Max.	Min.	Skewness	Kurtosis	J-B	Probability
JPSWAP2Y	244	0.27	0.33	1.28	-0.17	1.17	3.49	57.68	0.00
JPSWAP5Y	244	0.47	0.46	1.65	-0.19	0.80	2.74	26.73	0.00
JPSWAP10Y	244	0.86	0.62	2.14	-0.08	0.20	1.80	16.17	0.00
CALLRATE	244	0.20	0.24	1.08	-0.05	1.83	5.49	199.18	0.00
CORECPI	244	-0.14	0.80	2.30	-1.90	1.01	4.83	75.28	0.00
IPYOY	244	0.33	8.27	27.32	-33.33	-0.88	7.17	208.41	0.00
LNNIKKEI	244	9.61	0.38	10.31	8.95	0.05	1.81	14.39	0.00
LNTOPIX	244	7.15	0.30	7.63	6.59	-0.34	1.83	18.70	0.00
LNUSDJPY	244	4.66	0.13	4.99	4.34	-0.73	3.28	22.49	0.00
LNNEER	244	4.46	0.10	4.71	4.26	0.46	2.82	9.08	0.01

Table 2B shows the summary statistics of all the variables at their first difference. All the variables are more volatile at their first differences. None of the variables have a normal distribution, according to the Jarque-Bera tests. The higher-maturity swap yields are right-skewed and the distributions for the first difference of the stock indices are left-skewed. All the variables are leptokurtic, showing a narrow, bell-shaped distribution. The change in the growth of industrial production shows a large decline in March 2011, following the Tohoku earthquake and tsunami.

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

Vars	Obs.	Mean	Std. Dev.	Max.	Min.	Skewness	Kurtosis	J-B	Probability
ΔJPSWAP2Y	243	0.0004	0.04	0.19	-0.22	0.13	8.78	339.08	0.00
ΔJPSWAP5Y	243	0.0003	0.07	0.32	-0.23	0.91	6.96	192.06	0.00
ΔJPSWAP10Y	243	-0.0015	0.09	0.43	-0.23	1.14	6.61	184.06	0.00
ΔCALLRATE	243	0.0001	0.10	0.59	-0.67	-0.91	16.63	1913.93	0.00
ΔCORECPI	243	0.01	0.27	1.70	-1.70	0.29	21.19	3351.77	0.00
ΔIPYOY	243	-0.03	3.48	18.27	-16.66	0.39	9.36	415.96	0.00

ΔLNNIKKEI	243	0.004	0.05	0.12	-0.29	-1.19	7.92	302.45	0.00
ΔLNTOPIX	243	0.003	0.05	0.10	-0.24	-1.04	6.41	161.34	0.00
ΔLNUSDJPY	243	0.0005	0.02	0.07	-0.06	0.15	3.84	7.98	0.02
ΔLNNEER	243	-0.0006	0.02	0.11	-0.06	0.44	5.75	84.42	0.00

The unit root and stationarity test results are presented in Tables 3A and 3B. Table 3A exhibits the unit root and stationarity tests of the variables at the level. It presents both the augmented Dickey-Fuller (ADF) (Dickey and Fuller 1979, 1981) unit root tests and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (Kwiatkowski et al. 1992) stationarity tests. The null hypotheses for the ADF and KPSS tests are different. The unit root tests indicate that most of the variables are nonstationary or have a unit root. The one strong exception is the growth in industrial production, which shows the presence of no 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: unit root)**			**KPSS tests (H_0: stationarity) tests**	
	None	**Intercept**	**Trend**	**Intercept**	**Trend**
JPSWAP2Y	–1.06	–1.50	–2.11	0.95***	0.22***
JPSWAP5Y	–1.00	–1.54	–2.52	1.32***	0.20**
JPSWAP10Y	–0.91	–1.35	–2.45	1.61***	0.21**
CALLRATE	–1.76*	–2.31	–2.66	0.54**	0.16**
CORECPI	–2.35**	–2.28	–2.52	0.40*	0.12
IPYOY	–3.43***	–3.42**	–3.45**	0.09	0.04
LNNIKKEI	1.15	–1.19	–1.97	1.34***	0.27***
LNTOPIX	0.82	–1.51	–1.83	0.82***	0.25***
LNUSDJPY	0.08	–1.54	–1.72	0.35*	0.31***
LNNEER	-0.26	–1.95	–1.99	0.18	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. The KPSS tests rejected the null hypothesis of stationarity with the trend assumption for the swap yield. 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

	ADF unit root tests (H_0: unit root)			KPSS tests (H_0: stationarity) tests	
	None	Intercept	Trend	Intercept	Trend
ΔJPSWAP2Y	–11.02***	–11.00***	–10.98***	0.17	0.15**
ΔJPSWAP5Y	–12.40***	–12.37***	–12.35***	0.15	0.15*
ΔJPSWAP10Y	–12.50***	–12.47***	–12.45***	0.13	0.13*
ΔCALLRATE	–23.26***	–23.21***	–23.17***	0.08	0.06
ΔCORECPI	–15.82***	–15.81***	–15.79***	0.06	0.05
ΔIPYOY	–8.73***	–8.72***	–8.70***	0.02	0.02
ΔLNNIKKEI	–12.65***	–12.72***	–12.69***	0.07	0.06
ΔLNTOPIX	–12.41***	–12.43***	–12.41***	0.08	0.07
ΔLNUSDJPY	–11.90***	–11.88***	–12.01***	0.27	0.06
ΔLNNEER	–11.75***	–11.73***	–11.75***	0.11	0.06

SECTION V: ECONOMETRIC MODELS AND FINDINGS

Three different models of the swap yield with structural breaks are estimated. In the first model, the swap yield is just a function of the short-term interest rate, core inflation, and the growth of industrial production. In the second model, the swap yield is a function of the short-term interest rate, core inflation, the growth of industrial production, the percentage change in the Nikkei stock index, and the percentage change in the exchange rate. In the third model, the swap yield is modeled as a function of the short-term interest rate, core inflation, the growth of industrial production, the percent change in the Topix stock index, and the percentage change in the nominal effective exchange rate. For each model, swap yields of three different maturity tenors—namely 2-year, 5-year, and 10-year—are used as the dependent variables in the regression equations.

Econometric Results

Tables 4A, 4B, and 4C report the Bai-Perron break tests (Bai and Perron 2003) of the three models for each maturity term of the swaps. The 2-year swap yield showed one break in April 2014. However, the higher maturity-term swap yields, namely the 5-year and 10-year swap, have two breakpoints. For the 5-year swap, breaks occur in August 2007 and April 2014. The 10-year swap yields have breakpoints in July 2009 and April 2014. Thus, all swap maturities showed a breakpoint in April 2014. However, higher maturity swap rates have one additional breakpoint that comes earlier, during the 2007–9 global financial crisis.

Table 4A: Bai-Perron Break Tests for the 2-year Swap Yield

	SW2Y	SW2Y	SW2Y
F (1|0)	79.11*	85.01*	85.27*
F (2|1)	4.32	4.49	4.42
F (3|2)			
Number of breaks	1	1	1
Nonbreaking controls	C, IPYOY	C, IPYOY, ΔLNNIKKEI, ΔLNUSJPY	C, IPYOY, ΔLNTOPIX, ΔLNNEER
Break dates	2014M04	2014M04	2014M04

Note: Bai-Perron (2003) critical values for 0 to 1, 1 to 2, and 2 to 3 breakpoints are 11.47, 12.95, and 14.03, respectively.

Table 4B: Bai-Perron Break Tests for the 5-year Swap Yield

	SW5Y	SW5Y	SW5Y
	Break Tests		
F (1|0)	14.30*	15.45*	15.49*
F (2|1)	43.13*	36.83*	35.80*
F (3|2)	1.35	1.83	1.78
Number of breaks	2	2	2
Nonbreaking controls	C, IPYOY	C, IPYOY, ΔLNNIKKEI, ΔLNUSJPY	C, IPYOY, ΔLNTOPIX, ΔLNNEER
Break dates	2007M08 2014M04	2007M08 2014M04	2007M08 2014M04

Note: Bai-Perron (2003) critical values for 0 to 1, 1 to 2, and 2 to 3 breakpoints are 11.47, 12.95, and 14.03, respectively.

Table 4C: Bai-Perron Break Tests for the 10-year Swap Yield

	SW10Y	SW10Y	SW10Y
F (1|0)	53.34*	17.76*	17.87*
F (2|1)	14.58*	54.29*	52.39*
F (3|2)	1.86	4.48	4.44
Number of breaks	2	2	2
Nonbreaking controls	C, IPYOY	C, IPYOY, ΔLNNIKKEI, ΔLNUSJPY	C, IPYOY, ΔLNTOPIX, ΔLNNEER
Break dates	2009M07 2014M04	2009M07 2014M04	2009M07 2014M04

Note: Bai-Perron (2003) critical values for 0 to 1, 1 to 2, and 2 to 3 breakpoints are 11.47, 12.95, and 14.03, respectively.

The 2-year swap yield models are presented in Table 5A. In the pre-breakpoint period, a 100-basis point increase in the call rate will increase the 2-year swap yield by 121–122 basis points. The effect is remarkably stable with different nonbreaking control variables. The core inflation rate has a negative impact on the swap rates before April 2014. However, in the post-break period, from April 2014 to December 2022, the call rate does not statistically affect the 2-year swap yield. The core inflation rate reversed the sign, and has a positive and statistically significant relationship to the swap yield, albeit the size of the estimate is smaller than before the breakpoint. None of the control variables have any impact on the swap yield. Various model data are also displayed in Table 5A. The adjusted R^2 implies that much of the variance in the swap yield is explained by the call rate, core inflation, and other nonbreaking variables. The Akaike Information Criterion (AIC) also shows a good fit for all the models.

Table 5A: 2-year Swap Yield

	JPSWAP2Y	**JPSWAP2Y**	**JPSWAP2Y**
Observation dates	2002M09–2014M03 (139 obs.)	2002M10–2014M03 (138 obs.)	
CALLRATE	1.21*** (0.00)	1.22*** (0.00)	1.22*** (0.00)
CORECPI	–0.16*** (0.00)	–0.16*** (0.00)	–0.16*** (0.00)
Observation dates	2014M04–2022M12 (105 obs.)		
CALLRATE	–0.09 (0.46)	–0.08 (0.52)	–0.08 (0.49)
CORECPI	0.05*** (0.00)	0.05*** (0.00)	0.05*** (0.00)
Break dates	2014M04		
Nonbreaking variables			
Intercept	0.03 (0.12)	0.02 (0.17)	0.02 (0.15)
IPYOY	0.003 (0.23)	0.003 (0.19)	0.003 (0.19)
ΔLNNIKKEI		0.15 (0.44)	
ΔLNUSDJPY		0.60 (0.23)	
ΔLNTOPIX			–0.002 (0.99)
ΔLNNEER			–0.97 (0.11)
Model information			
Obs.	244	243	243
Adj R^2	0.86	0.86	0.86
AIC	–1.28	–1.28	–1.29
Diagnostic tests			
Joint significance F-test	294.87 (0.00)	213.86 (0.00)	215.68 (0.00)
Serial correlation Durbin-Watson stat	0.46	0.49	0.49
Serial correlation Breusch-Godfrey LM test	175.99 (0.00)	157.30 (0.00)	153.92 (0.00)

Heteroskedasticity Breusch-Pagan-Godfrey test	7.39 (0.00)	4.99 (0.00)	4.83 (0.00)
Normality test Jarque-Bera stat	91.44 (0.00)	93.05 (0.00)	89.24 (0.00)

Note: p-values in parenthesis. HAC (Newey-West) standard errors. LM tests have two lags.

A panel of postestimation diagnostic tests is also displayed in table 5A. The joint significance tests show a strong rejection of the insignificance of the regressors. The Durbin-Watson statistics and the Breusch-Godfrey Lagrange Multiplier tests indicate there is serial correlation for the error terms in these models. The Breusch-Pagan-Godfrey heteroskedasticity tests reject the null hypothesis of homoscedasticity in all models, indicating the presence of the heteroskedasticity in all three models. To account for the presence of serial correlation and heteroskedasticity, HAC (Newey-West) standard errors are estimated for these models. The Jarque-Bera tests indicate that the error terms are not normally distributed, which is not an uncommon phenomenon for financial variables.

The econometric models for 5-year and 10-year swap yields are displayed in table 5B and table 5C, respectively. In both cases, there are two breakpoints with a second breakpoint that is identical to the 2-year swap yield breakpoint of April 2014. In both maturity levels, the call rate's impact is higher before the first break than the second break and statistically significant. The core inflation rate also showed a negative relationship before the first two breaks. Similar to the call rate, the magnitude reduces before the second break. The post–April 2014 data yields no statistically significant relationship between 5-year and 10-year swap yields and the call rate. Similar to the 2-year swap yield, the core inflation reverses to exert a positive and significant impact on higher-maturity swap yields. For the 5-year swap yield, none of the nonbreaking variables are statistically significant. However, for the 10-year swap yield, the growth of industrial production is statistically significant.

Table 5B: 5-Year Swap Yield

	JPSWAP5Y	JPSWAP5Y	JPSWAP5Y
Observation dates	2002M09–2007M07 (59 obs.)	2002M10–2007M07 (58 obs.)	
CALLRATE	1.77*** (0.00)	1.75*** (0.00)	1.75*** (0.00)
CORECPI	–0.75*** (0.00)	–0.80*** (0.00)	–0.80*** (0.00)
Observation dates	2007M08–2014M03 (80 obs.)		
CALLRATE	1.34*** (0.00)	1.38*** (0.00)	1.38*** (0.00)
CORECPI	–0.20*** (0.00)	–0.20*** (0.00)	–0.20*** (0.00)
Observation dates	2014M04–2022M12 (105 obs.)		
CALLRATE	–0.19 (0.32)	–0.14 (0.43)	–0.14 (0.43)
CORECPI	0.07*** (0.00)	0.07*** (0.00)	0.07*** (0.00)
Break dates	2007M08 and 2014M04		
Nonbreaking variables			
Intercept	0.11*** (0.00)	–0.10*** (0.00)	0.10*** (0.00)
IPYOY	0.003 (0.37)	0.003 (0.29)	0.003 (0.31)
ΔLNNIKKEI		0.42 (0.23)	
ΔLNUSDJPY		0.30 (0.72)	
ΔLNTOPIX			0.45 (0.32)
ΔLNNEER			–0.22 (0.83)
Model information			
Obs.	244	243	243
Adj R^2	0.79	0.80	0.80
AIC	–0.26	–0.27	–0.27
Diagnostic tests			
Joint significance F-test	135.18 (0.00)	108.80 (0.00)	108.77 (0.00)
Serial correlation Durbin-Watson stat	0.36	0.38	0.38
Serial correlation Breusch-Godfrey LM test	226.18 (0.00)	202.69 (0.00)	203.32 (0.00)
Heteroskedasticity Breusch-Pagan-Godfrey test	8.22 (0.00)	6.25 (0.00)	6.28 (0.00)
Normality test Jarque-Bera stat	52.04 (0.00)	46.22 (0.00)	45.53 (0.00)

Note: p-values in parenthesis. HAC (Newey-West) standard errors. LM tests have two lags.

The diagnostic tests in Tables 5B and 5C indicate the presence of serial correlation and heteroskedasticity in all the models. Similar to the earlier models, HAC (Newey-West) standard errors are estimated here.

Table 5C: 10-year Swap Yield

	JPSWAP10Y	JPSWAP10Y	JPSWAP10Y
Observation dates	2002M09–2009M06 (82 obs.)	2002M10–2009M06 (81 obs.)	
CALLRATE	1.57*** (0.00)	1.59*** (0.00)	1.59*** (0.00)
CORECPI	–1.56*** (0.00)	–1.60*** (0.00)	–1.60*** (0.00)
Observation dates	2009M07–2014M03 (57 obs.)		
CALLRATE	3.12*** (0.00)	3.12*** (0.00)	3.12*** (0.00)
CORECPI	–0.21*** (0.00)	–0.21*** (0.00)	–0.21*** (0.00)
Observation dates	2014M04–2022M12 (105 obs.)		
CALLRATE	–0.24 (0.40)	–0.22 (0.44)	–0.21 (0.45)
CORECPI	0.16*** (0.00)	0.15*** (0.00)	0.15*** (0.00)
Break dates	2009M07 and 2014M04		
Nonbreaking variables			
Intercept	0.31*** (0.00)	0.30*** (0.00)	0.30*** (0.00)
IPYOY	0.01*** (0.00)	0.01*** (0.00)	0.01*** (0.00)
ΔLNNIKKEI		0.24 (0.67)	
ΔLNUSDJPY		0.63 (0.61)	
ΔLNTOPIX			0.43 (0.56)
ΔLNNEER			–0.001 (0.99)
Model information			
Obs.	244	243	243
Adj R^2	0.78	0.79	0.79
AIC	0.38	0.38	0.38
Diagnostic tests			
Joint significance F-test	128.09 (0.00)	101.72 (0.00)	101.57 (0.00)
Serial correlation Durbin-Watson stat	0.46	0.48	0.48
Serial correlation Breusch-Godfrey LM test	177.88 (0.00)	162.54 (0.00)	161.83 (0.00)
Heteroskedasticity Breusch-Pagan-Godfrey test	4.10 (0.00)	2.98 (0.00)	3.13 (0.00)
Normality test Jarque-Bera stat	23.16 (0.00)	23.87 (0.00)	20.29 (0.00)

Note: p-values in parenthesis. HAC (Newey-West) standard errors. LM tests have two lags.

SECTION VI: POLICY IMPLICATIONS

The results of the estimated econometric models suggest that the Bank of Japan's (BOJ) influence on JPY swap yields has varied from period to period. Prior to April 2014, the BOJ could wield its considerable influence on swap yields of different maturity tenors through the effect of the policy rate on the short-term interest rate. However, from April 2014 to the end of the study period, the BOJ's influence on swaps yields appears to have been muted, as the call rate does not show any statistically significant effect on swaps yields of various maturity tenors. These findings imply that the BOJ's influence on market interest rates may have declined in spite of the use of several unconventional monetary policy measures. It is conceivable that, with the implementation of unconventional monetary policies, the BOJ's influence on the long-term market rate is intermediated through other channels, such as the long-term JGB yield or through yield curve control rather the short-term interest rate. Hence, the effect of the short-term interest rate on the swap yield has dissipated since April 2014. It would be useful to examine whether the connection between the call rate and the swap yield would be restored if the BOJ were to abandon some of its unconventional monetary policy measures, such as targeting the long-term interest rate on 10-year JGBs and the yield curve control.

The findings expose in three important ways the limits and scope of Keynes's hypothesis that the central bank affects the long-term interest rate through the short-term interest rate. First, they show that the effect of the central bank's policy rate is not universally applicable to all market interest rates, such as swap yields. Second, while Keynes's conjecture holds in some financial markets, such as for USD and GBP swaps (Akram and Mamun 2022a, b), the findings reveal that it does not always hold, as shown for JPY swaps in the period since April 2014. Third, it demonstrates that Keynes's conjecture is circumscribed by macroeconomic context and institutional settings. Hence, a detailed reading of the macroeconomic context and institutional setting is necessary for understanding the dynamics of swap yields and long-term market interest rates.

SECTION VII: CONCLUSION

The models estimated in the paper show that the short-term interest rate was an important driver of swap yields from late 2002 to 2014. However, since early 2014, the relationship between the short-term interest rate and the swap yields of different maturity tenors has been splintered. Since early 2014, core inflation has had a positive and statistically significant effect on the JPY swap yield of different maturity tenors. During this period, the BOJ was pursuing unconventional monetary policy measures amid persistently low inflation, deflationary pressure, and weak effective demand.

This paper's findings can inform the limit and scope of Keynes's conjecture regarding the influence of the policy rate on long-term market interest rates, as the relationship between the short-term interest rate and market rates can be circumscribed by macroeconomic developments and institutional contexts. While Keynes's conjecture held for JPY swaps between late 2002 and early 2014, it did not do so between April 2014 and December 2021, a period in which core inflation swayed the swap yields of different maturity tenors. The findings of this paper can contribute to a better understanding of the workings of the financial system and capital markets and a more accurate assessment of the effectiveness of the monetary transmission mechanism and swap yield dynamics, not just in Japan but also in other countries. It can be useful for policymakers, investors, risk managers, scholars, and the public.

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