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Macro-Financial Models of Canadian Dollar Interest Rate Swap Yields

by

Tanweer Akram
Independent Scholar

Khawaja Mamun
Longwood University

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Affiliations: Tanweer Akram is an independent scholar**.** He was formerly senior vice president/senior economist at Citi. Khawaja Mamun is dean and professor at Longwood University; **Acknowledgements**: The authors thank participants at various workshops for their valuable comments; **Disclaimer:** The authors' institutional affiliations are provided solely for identification purposes. Views expressed are solely those of the authors. The standard disclaimer holds; **The dataset is available for replication**: The dataset used in the empirical part of this paper is available upon request to bona fide researchers for the replication and verification of the results; **Competing interests**: The authors declare that they have no competing interests.

Email: tanweer.akram@gmail.com. **ORCID**: http://orcid.org/0000-0002-6646-0902; **Email**: mamunka@longwood.edu. **ORCID**: https://orcid.org/0000-0001-9669-2897

Levy Economics Institute
P.O. Box 5000
Annandale-on-Hudson, NY 12504-5000
http://www.levyinstitute.org

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ABSTRACT

This paper analyzes the dynamics of Canadian dollar–denominated (CAD) interest rate swap yields. It applies autoregressive distributive lag (ARDL) models, using monthly time series data, to estimate the effects of the current short-term interest rate and other relevant macro-financial variables on interest rate swap yields. It shows that the current short-term interest rate is a crucial driver of the swap yields of different maturity tenors. Similar patterns of interest rate swaps denominated in other hard currencies, such as the US dollar, euro, British pound sterling, and Japanese yen, have been discerned in previous empirical research testing the Keynesian hypothesis, which maintains that the current short-term interest rate has a decisive influence on the long-term interest rate. Thus, the findings of this paper lend additional support to the Keynesian hypothesis by showing that the same pattern holds for CAD interest rate swap yields. The results obtained in the paper can be useful for portfolio managers, corporate leaders, and policymakers.

KEYWORDS: Canadian Dollar Swaps; Interest Rate Swap Yields; Short-Term Interest Rate; Monetary Policy; Bank of Canada

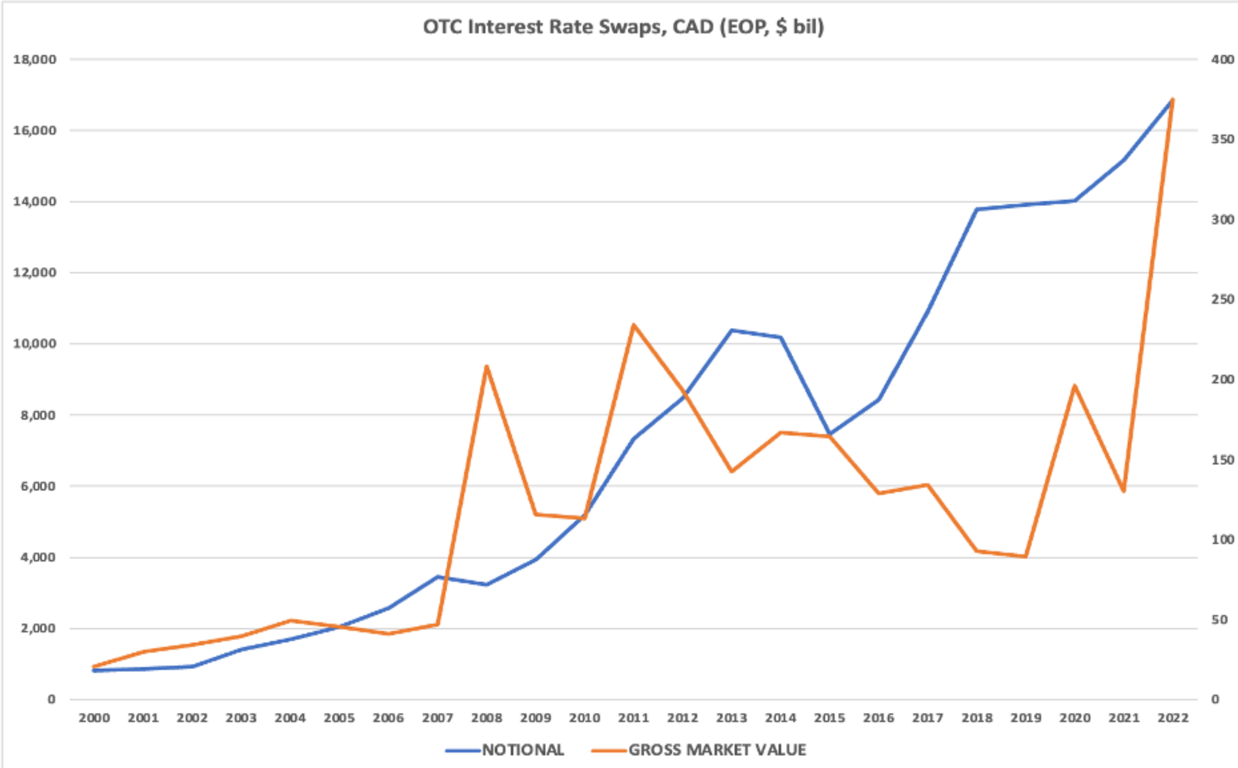
JEL CLASSIFICATIONS: E43; E50; E60; G10; G12

SECTION I: INTRODUCTION

Interest rate swaps are important fixed income instruments not only for banks but also for other financial institutions and corporations. An interest rate swap enables the exchange of two cash flow streams based on certain interest rates. Usually, two parties exchange a stream of fixed interest rate payments and a stream of floating interest rate payments between each other; the payments are often in the same currency and based on a notional principal. Interest rate swaps are used both for hedging interest rate risks as well as for speculating on future interest rates. An accessible primer on interest rate swaps is available in Corb (2012). Detailed analysis of the demand for and supply of interest rate swaps and the use of swaps for both speculating and hedging is available in Bicksler and Chen (1986), Chernenko and Faulkender (2011), Smith Jr., Smithson, and Wakeman (1988), and Visvanathan (1998).

Figure 1 shows the evolution of outstanding over-the-counter (OTC) Canadian dollar–denominated (CAD) interest rate swaps, giving both their nominal amount and gross market value. As of 2022, the notional value of CAD-denominated swaps amounted to $16.8 trillion (in US dollars [USD]) and the gross market value was $375 billion. The notional value of CAD interest rate swaps rose steadily through the period under study, except for a brief decline in 2014–15. The gross market value has since fluctuated, reaching a peak in 2022. The data displayed implies that CAD swaps are important financial instruments in CAD-denominated financial markets. Hence, econometrically modeling their dynamics could provide valuable insights for portfolio managers, corporate leaders, and policymakers.

Figure 1. The Evolution of Canadian Dollar–Denominated OTC Interest Rate Swaps, 2000–2022



In recent years, there has been an advancement of empirical research that models interest rate swap yields from a Keynesian vantage point (Akram and Mamun 2023a, b, c, d, e, f; 2024a, b). This research ties the long-term swap yield to the current short-term interest rate, after controlling for relevant macro-financial variables. In his writings, Keynes (1930, 352–67; [1936] 2007, 147–64) noted: (1) investors' propensity toward relying on their assessment of current conditions using their view of the near future to extrapolate the outlook for the distant future, (2) the technical characteristics of financial markets, and (3) the nature of financial institutions. Based on these stylized facts, Keynes (1930, 363) maintained that "there is no reason to doubt the ability of a Central Bank to make its short-term rate of interest effective in the market." He hypothesized on the connection between gilt-edged, long-term government bond yields and the current short-term interest rate, supporting his claims based on: (1) the statistical relationship that Riefler (1930) analyzed and uncovered in capital markets in the United States in the 1920s, and (2) Keynes's own discernment of capital markets in the United Kingdom during the same period. The recent empirical research, cited earlier, has shown that the connection appears to hold for long-term yields on interest rate swaps denominated in several hard currencies, such as USD, euro (EUR), British pound sterling (GBP), and Japanese yen (JPY).

This paper is a part of a research project to model swap yields from a Keynesian perspective, as undertaken by Akram and Mamun (2023a, b, c, d, e, f; 2024a, b). It explores whether the Keynesian conjecture relating the long-term interest rate to the current short-term interest rate holds for CAD interest rate swap yields. Previously, Das and Akram (2020) showed that the Keynesian conjecture holds for CAD government bond yields, but did not explore the case for CAD interest rate swap yields. Given this critical lacuna, it is pertinent to delve into the relationship between CAD swap yields and the current short-term interest rate because it may provide insight about the monetary transmission mechanism in Canada and the effects of the Bank of Canada's (BOC) monetary policy decisions on CAD-denominated financial markets.

The empirical modeling of swap yields from a Keynesian perspective constitutes a marked paradigm shift from the earlier literature, which was primarily focused on the credit, liquidity, and market technical conditions that affect swap yields rather than the macroeconomic and financial market conditions to explain their behavior dynamics. This strand of the literature—exemplified by Cortes (2003), Duffie and Huang (1996), Duffie and Singleton (1997), Kim and Koppenhaver (1993), Klingler and Sundaresan (2019), Lekkos and Milas (2001), and Sundaresan and Wang (1993)—is not without some useful insights, but failed to connect the effects of monetary policy, fiscal policy, effective demand, and national and global financial markets on swap yields. In contradistinction, this paper places the dynamics of CAD swap yields in the proper macroeconomic financial context by modeling them as a function of the current short-term interest rate and a host of other relevant macroeconomic and financial variables.

The paper is structured as follows. Section II provides the macroeconomic milieu to the evolution of CAD swap yields during the study period. Section III describes the data and undertakes unit root and stationarity tests. Section IV presents the estimated econometric models and deliberates on the estimated models' findings. Section V concludes with a summary and reflection on the policy implications of the findings.

SECTION II: MACROECONOMIC MILIEU

Prior to undertaking the econometric modeling of CAD swap yields, it is worthwhile to have an overview of the swap yields' macroeconomic milieu and its evolution during the study period.

Figure 2 displays the evolution of CAD swap yields of 2-year, 5-year, and 10-year maturity tenors. (The source used in the figures are listed in Table 1). The swap yields ranged between 5.0 percent to 5.6 percent in the beginning of the period, peaking in January 2000 and gradually declining until June 2005; this trend reserved and continued to rise until August 2007, followed by a steep decline until mid-2009. Swap yields stayed range-bound from mid-2009 until late 2018, but then declined in the subsequent months. With the onset of the global pandemic, swap yields experienced a steep decline in early 2020. In September 2022, swap yields began to increase as the BOC began to tighten its monetary policy.

Figure 2. Canadian Dollar Interest Rate Swap Yields, 1998M01–2023M12

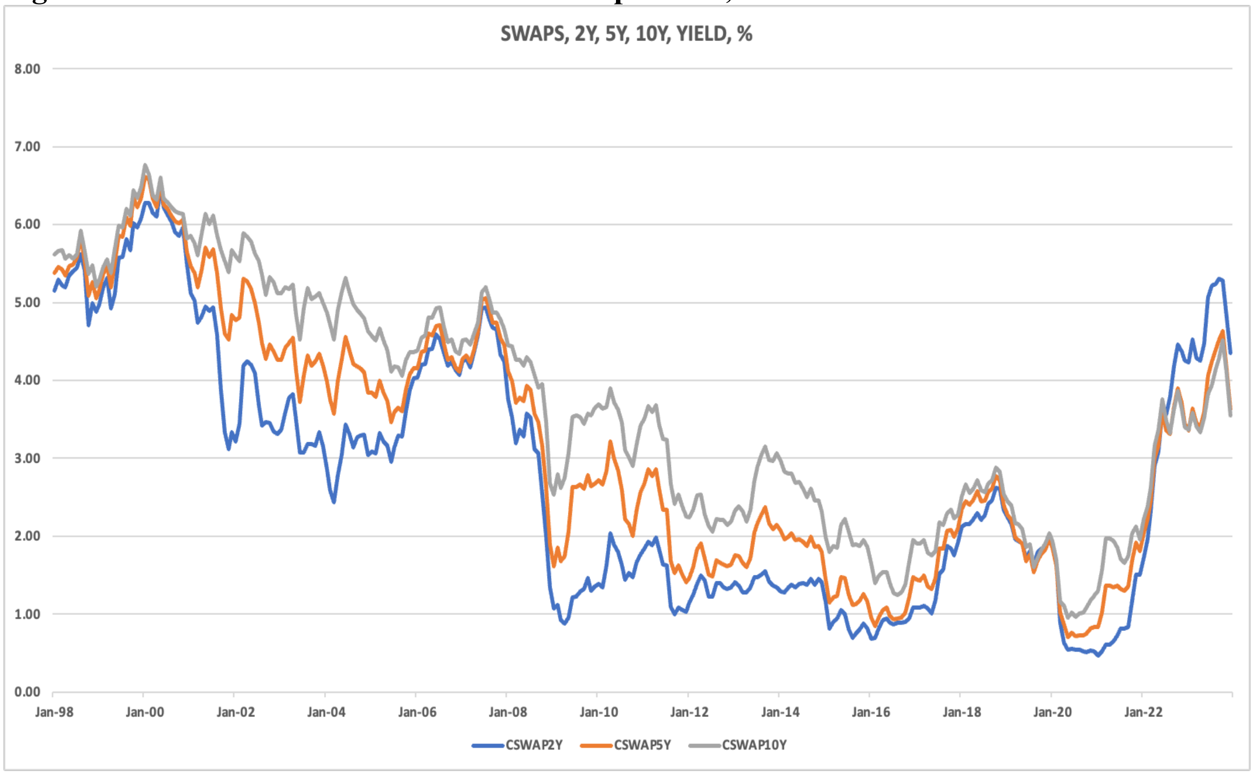


Figure 3 exhibits the evolution of the 10-year swap yield and the 3-month Treasury bill rate. It shows that the 3-month Treasury bill rate was lower than the 10-year swap yield. The 10-year swap yield tends to move together with the 3-month Treasury bill rate most of the time, but not always. Moreover, the swap yield appears to be more volatile than the Treasury bill rate during the period covered in this paper.

Figure 3. Canadian Swap Yields and the Short-Term Interest Rate on T-bills, 1998M01–2023M12

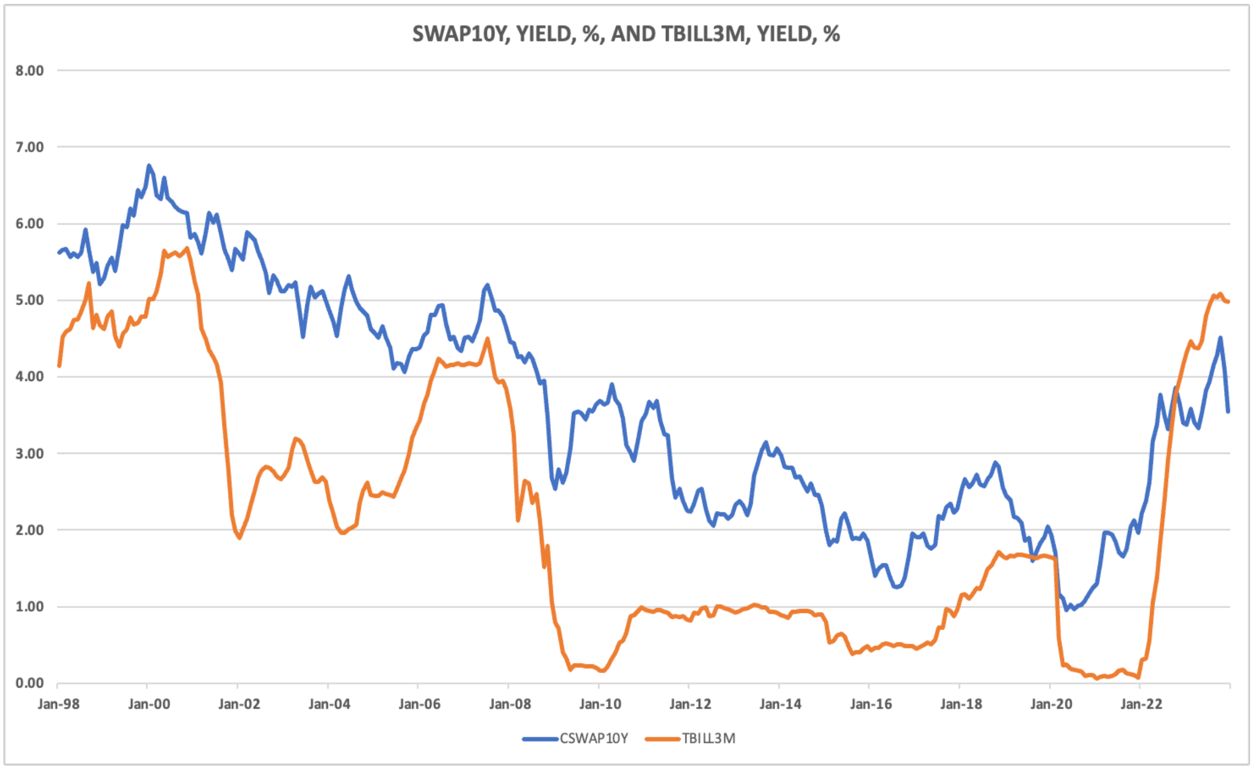


Figure 4 presents the evolution of the 10-year swap yield and core inflation. The correlation between 10-year swap yield and core inflation is positive but weak. However, as core inflation rose following the global pandemic, the 10-year swap yield rose in tandem.

Figure 4. Canadian Swap Yields and Core Inflation, 1998M01–2023M12

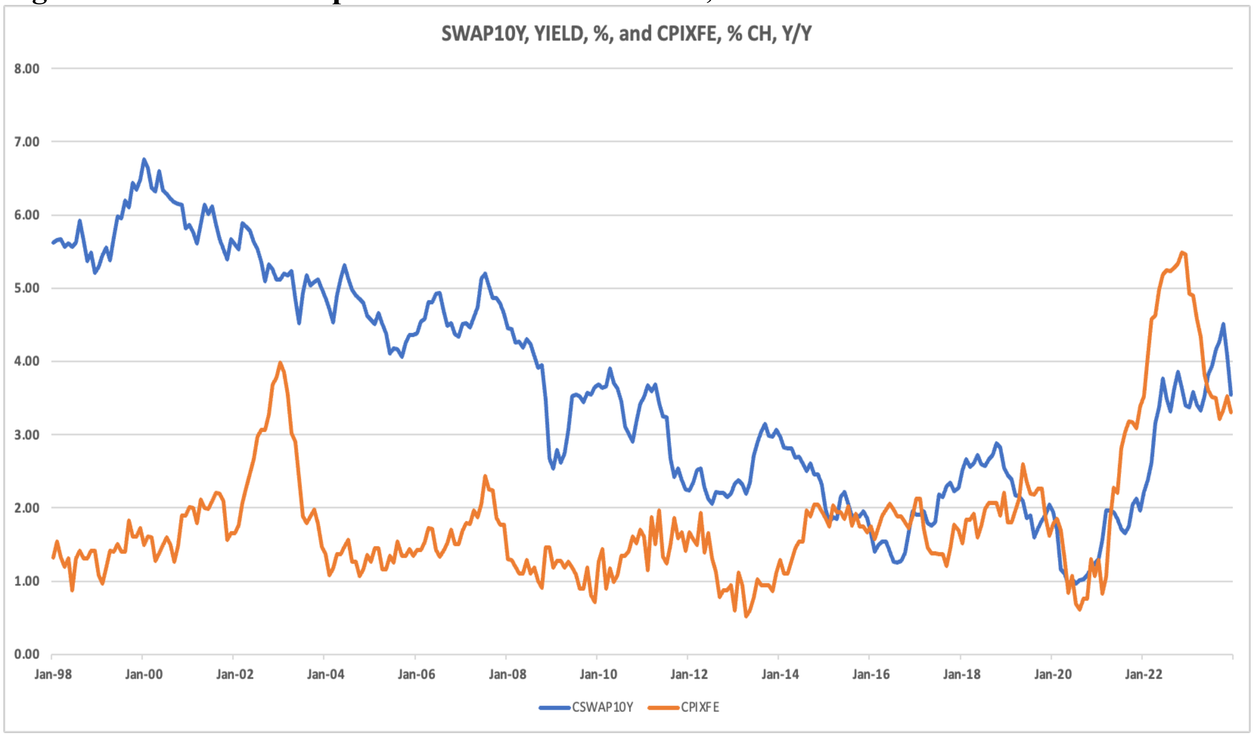


Figure 5 depicts the trajectory of industrial production in Canada. Typically, industrial production grows. However, in recessionary periods, industrial production experiences slowdowns and outright declines, as shown in the recessions of 2001, 2008, and 2020.

Figure 5. The Growth of Industrial Production, 1998M01–2023M12

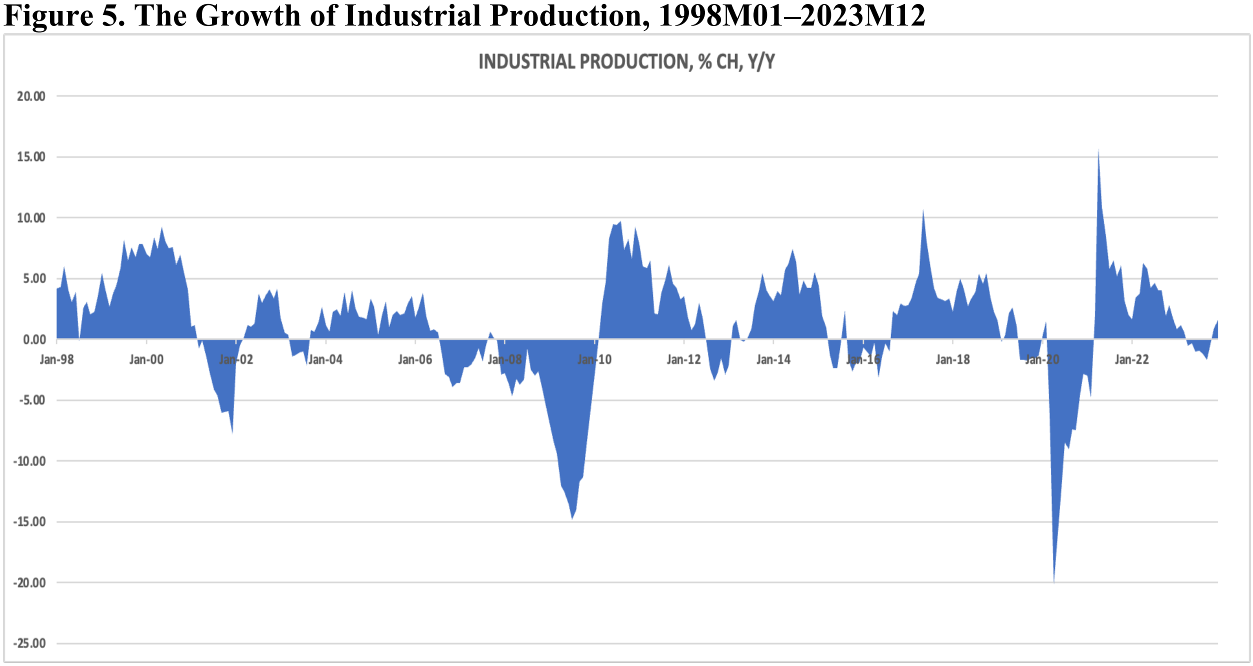
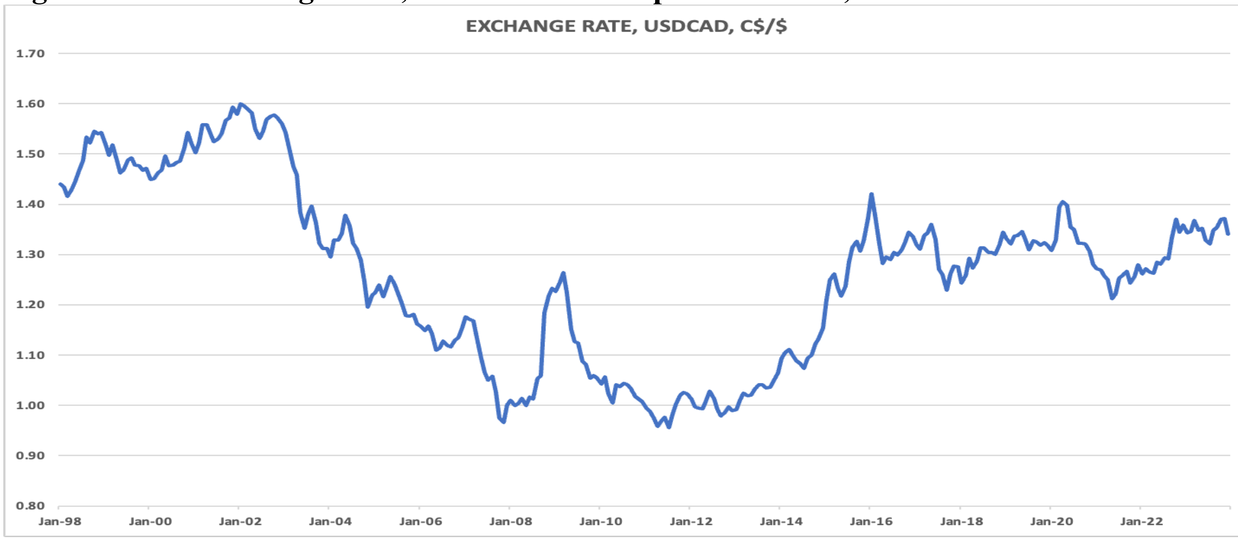


Figure 6 charts the S&P/TSX 60 equity index. It shows that the index rose over the covered period, albeit with some volatility and periods of decline, particularly during recessions.

Figure 6. The S&P/TSX60 Equity Index, 1998M01–2023M12

Figure 7 displays the exchange rate of the CAD against the USD. It shows that the CAD had depreciated against the USD to around $1.60 in 2002. This was followed by an appreciation of the CAD until it reached parity in mid-2007. It appreciated in late 2007, followed by a depreciation to around $1.25 in late 2008. However, the CAD appreciated, reaching parity once again in early 2010 and remaining stable against the USD until mid-2013. Subsequently, the CAD depreciated until early 2016. Since then, the CAD has been stable—declining moderately in mid-2020 but stabilizing by mid-2021—and remained range-bound between $1.20–1.30 against the USD.

Figure 7. The Exchange Rate, Canadian Dollar per US Dollar, 1998M01–2023M12



SECTION III: DATA, UNIT ROOTS, AND STATIONARITY TESTS

This paper uses time series macroeconomic and financial data to model CAD swap yields. Monthly data for key macroeconomic and financial variables, such as interest rate swap yields, short-term interest rates, core inflation, the growth in industrial production, equity indexes, the exchange rate, and the size of the central bank's balance sheet, are deployed. The period covered for most of the variables begins in January 1998 and ends in December 2023, consisting of 312 observations.

Long-term interest rate swaps are yields of CAD swaps of 2-year, 5-year, and 10-year maturity tenors. Short-term interest rates are based on 3-month and 6-month Canadian Treasury bills. Core inflation is measured as the year-over-year percentage change in: 1) the consumer price index (CPI) excluding food and energy, and 2) the CPI, excluding eight volatile components[1] and indirect taxes. Economic activity is given by the year-over-year percentage change in industrial production in Canada. Two different measures of the equity index are used, namely the S&P/TSX composite index and the S&P/TSX 60 index. Exchange rate data are based on the spot

[1] According to Statistics Canada, the most volatile components of the CPI, as identified by the BOC, are as follows: (1) fruit, fruit preparations, and nuts, (2) vegetables and vegetable preparations, (3) mortgage interest cost, (4) natural gas, (5) fuel oil and other fuel, (6) gasoline, (7) inter-city transportation, and (8) tobacco products and smokers' supplies.

rates for the CAD per USD and the CAD’s nominal effective exchange rate (NEER). The central bank’s balance sheet is captured by the total assets of the BOC. The natural log is taken for several variables, including the equity index, exchange rate, and the central bank’s balance sheet. The first difference is the natural log of these variables and is used to obtain the variables’ percentage changes.

Table 1 provides a summary of the data. The first column provides the label for each variable. The second column lists each variable’s description, units, and the date range for the data. The third column displays the data’s frequency, while the final column gives the data’s source(s).

Table 1. Data Description

Variable label	Description, data range	Frequency	Sources
Swap yields			
CSWAP2Y	Interest rate swap, 2-year, Canadian dollar, %, January 1998–December 2023	Daily; converted to monthly	Refinitiv
CSWAP5Y	Interest rate swap, 5-year, Canadian dollar, %, January 1998–December 2023	Daily; converted to monthly	Refinitiv
CSWAP10Y	Interest rate swap, 5-year, Canadian dollar, %, January 1998–December 2023	Daily; converted to monthly	Refinitiv
Short-term interest rates			
TBILL3M	Treasury bill, 3 months, %, January 1998–December 2023	Daily; converted to monthly	Bank of Canada
TBILL6M	Treasury bill, 6 months, %, January 1998–December 2023	Daily; converted to monthly	Bank of Canada
Inflation			
CPIXFE	Consumer price index excluding food and energy, %, change, y/y, January 1998–December 2023	Monthly	Bank of Canada, Statistics Canada
CPIXV	Consumer price index excluding 8 volatile components and indirect taxes, % change, y/y, January 1998–December 2023	Monthly	Bank of Canada, Statistics Canada
Economic activity			
IPYOY	Industrial production: manufacturing, mining, and utilities, index, % change, y/y, January 1998–December 2023	Monthly	Statistics Canada
Financial market			
TSX	S&P/TSX composite index, close price, January 1998–December 2023	Daily; converted to monthly	Toronto Stock Exchange
TSX60	S&P/TSX 60 index, close price, January 1999– December 2023	Daily; converted to monthly	Toronto Stock Exchange
Exchange rate			
USDCAD	Exchange rate, CAD/USD, average, January 1998–December 2023	Daily; converted to monthly	Bank of Canada
NEER	Nominal broad effective exchange rate, Canada, [2010 = 100] January 1998–December 2023	Monthly	JPMorgan
Central bank balance sheet			
ASSETS	Bank of Canada, balance sheet, total assets, end of period, not seasonally adjusted, January 1998–December 2023	Monthly	Bank of Canada

Summary Statistics

The summary statistics of all variables in their level and at first difference are presented in Tables 2A and 2B, respectively. The average swap yields rise with the maturity levels, as longer maturity indicates higher risk. Similarly, the average 3-month Treasury bill rate is lower than the average 6-month Treasury bill rate. The skewness of the swap yields is positive and close to 0.50 or less, showing somewhat symmetrical distributions. The short-term Treasury bill rates have a skewness of just over 0.60, thus showing a slightly fatter tail to the right. The price indices and the BOC's total assets show significant positive skewness and exhibit a longer tail on the right. The other control variables have smaller negative skewness, revealing a slightly left-sided tail. The kurtosis for the swap yield curve and short-term interest rates is below 3.0, displaying a platykurtic distribution with a short tail (i.e., fewer outliers). A similar short tail can be found for most of the control variables. However, the inflation and core inflation indices, industrial production index, and BOC's total assets have kurtosis above 3.0 and thus indicate a leptokurtic distribution with a long tail. The Jarque-Bera (J-B) tests in Table 2A imply that all variables examined are not normally distributed, which is common in financial literature.

Table 2a. Summary Statistics of the Variables

Vars.	Obs.	Mean	Std. Dev.	Max.	Min.	Skewness	Kurtosis	J-B	Prob.
CSWAP2Y	300	2.67	1.61	6.47	0.47	0.53	2.12	23.81	0.00
CSWAP5Y	300	3.08	1.55	6.61	0.71	0.38	2.05	18.39	0.00
CSWAP10Y	300	3.55	1.50	6.76	0.96	0.24	1.92	17.52	0.00
TBILL3M	300	2.06	1.64	5.68	0.06	0.63	2.09	30.23	0.00
TBILL6M	300	2.16	1.66	5.93	0.10	0.61	2.08	29.18	0.00
CPI	300	2.21	1.38	7.87	-0.95	1.50	6.61	275.84	0.00
CPIXFE	300	1.88	0.97	5.48	0.52	1.91	6.75	357.27	0.00
IPYOY	300	1.05	4.88	19.57	-21.18	-0.84	5.90	140.91	0.00
LNTSX	300	9.41	0.32	9.98	8.72	-0.34	2.26	12.68	0.00
LNTSX60	300	6.57	0.34	7.18	5.85	-0.29	2.26	10.91	0.00
LNUSDCAD	300	0.22	0.14	0.47	-0.05	-0.15	2.02	13.17	0.00
LNNEER	300	4.47	0.11	4.66	4.25	-0.33	2.32	11.14	0.00
LNASSETS	300	11.35	0.80	13.26	10.36	1.14	3.29	65.78	0.00

Table 2B shows the summary statistics of all the variables at their first difference. The short-term interest rates and swap yields are more volatile at their first difference. The coefficient of variation is much higher than the level data for the variables.[2] The skewness of first-differenced swap yields is negative but less than 0.50, representing a symmetric distribution. However, the first-differenced Treasury bill rates are negative and much larger. Thus, they clearly show longer, left-sided tails. All swap yields and short-term interest rates, as well as all the remaining control variables, are leptokurtic. Only the first-differenced core inflation indices exhibit a normal distribution as per the J-B tests.

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

Vars.	Obs.	Mean	Std. Dev.	Max.	Min.	Skewness	Kurtosis	J-B	Prob.
ΔCSWAP2Y	299	0.002	0.20	0.75	-0.79	-0.34	4.97	54.30	0.00
ΔCSWAP5Y	299	-0.005	0.20	0.57	-0.74	-0.17	3.70	7.44	0.02
ΔCSWAP10Y	299	-0.006	0.19	0.54	-0.80	-0.15	4.01	13.88	0.00
ΔTBILL3M	299	0.001	0.18	0.55	-1.12	-1.81	13.22	1463.17	0.00
ΔTBILL6M	299	0.0006	0.17	0.54	-1.04	-1.45	10.56	816.27	0.00
ΔCPI	299	0.01	0.46	1.17	-1.44	-0.14	3.31	2.25	0.32
ΔCPIXFE	299	0.01	0.24	0.76	-0.63	0.08	3.41	2.43	0.30
ΔIPYOY	299	-0.01	2.13	16.35	-14.62	0.49	21.85	4438.78	0.00
Δ LNTSX	299	0.004	0.04	0.10	-0.25	-2.07	14.11	1750.06	0.00
ΔLNTSX60	299	0.004	0.04	0.10	-0.24	-1.90	12.74	1361.00	0.00
ΔLNUSDCAD	299	-0.0004	0.02	0.11	-0.06	0.53	7.36	250.78	0.00
ΔLNEER	299	0.001	0.02	0.05	-0.08	-0.34	5.71	97.09	0.00
ΔLNASSETS	299	0.01	0.06	0.69	-0.18	6.36	68.05	54742.05	0.00

Unit Root Tests

The unit root and stationarity tests are displayed in Tables 3A and 3B, respectively. Table 3A exhibits the unit root and stationarity tests of the variables at their level. Results from both the augmented Dickey-Fuller (ADF) unit root tests (Dickey and Fuller 1979, 1981) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity tests (Kwiatkowski et al. 1992) are shown. The null hypotheses for the ADF and KPSS tests are different. The ADF test has a null hypothesis of the presence of a unit root (i.e., nonstationarity), whereas the KPSS test has a null hypothesis of stationarity. The unit root tests indicate most of the variables are nonstationary.

[2] Coefficients of variation are not reported in the tables; these results are available upon request.

The one notable exception is industrial production, which shows the presence of stationarity in 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)	
	None	Intercept	Trend	Intercept	Trend
CSWAP2Y	-1.18	-1.90	-1.38	1.12***	0.30***
CSWAP5Y	-1.22	-1.87	-1.82	1.54***	0.32***
CSWAP10Y	-1.16	-1.71	-2.03	1.66***	0.29***
TBILL3M	-1.25	-2.06	-1.50	1.00***	0.27***
TBILL6M	-1.15	-1.93	-1.38	1.00***	0.27***
CPI	-0.38	-2.21	-2.34	0.28	0.19**
CPIXFE	0.12	-1.64	-1.98	0.47**	0.23***
IPYOY	-3.52***	-3.69***	-3.68**	0.09	0.08
LNTSX	1.13	-1.33	-3.61**	1.93***	0.08
LNTSX60	1.33	-1.46	-3.30*	1.85***	0.07
LNUSDCAD	-1.02	-1.65	-1.49	0.53**	0.45***
LNNEER	0.40	-1.78	-1.65	0.79***	0.44***
LNASSETS	1.33	-0.69	-2.46	1.71***	0.30***

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

Table 3B shows the unit root and stationarity tests of the variables in their first difference. All the variables become stationary at their first difference, as per both ADF and KPSS tests.

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)	
	None	Intercept	Trend	Intercept	Trend
ΔCSWAP2Y	-12.02***	-12.00***	-12.09***	0.26	0.07
ΔCSWAP5Y	-12.93***	-12.92***	-12.95***	0.18	0.06
ΔCSWAP10Y	-13.49***	-13.49***	-13.50***	0.14	0.06
ΔTBILL3M	-6.24***	-6.23***	-11.45***	0.25	0.08
ΔTBILL6M	-7.21***	-7.20***	-7.34***	0.25	0.07
ΔCPI	-8.36***	-8.35***	-8.34***	0.03	0.03
ΔCPIXFE	-7.75***	-7.77***	-7.76***	0.04	0.03
ΔIPYOY	-6.62***	-6.66***	-6.68***	0.02	0.02
Δ LNTSX	-13.31***	-13.37***	-13.34***	0.03	0.02
ΔLNTSX60	-13.09***	-13.19***	-13.17***	0.03	0.03
ΔLNUSDCAD	-13.13***	-13.11***	-13.13***	0.18	0.07
ΔLNEER	-14.04***	-14.03***	-14.03***	0.14	0.06
ΔLNASSETS	-11.12***	-11.22***	-11.22***	0.07	0.04

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

SECTION IV: ECONOMETRIC MODELS AND FINDINGS

The two models under consideration are constructed is as follows:

$$SWAP_t = \varphi(STIR_t, INFL_t, ACTIVITY_t) \quad \textbf{[1]}$$

$$SWAP_t = F(STIR_t, INFL_t, ACTIVITY_t, \Delta LN[EQUITY_t], \Delta LN[CURRENCY_t], \Delta LN[BS_t]) \quad \textbf{[2]}$$

where:

$SWAP \in \{SWAP2Y, SWAP5Y, SWAP10Y\}$

$STIR \in \{TBILL3M, TBILL6M\}$

$INFL \in \{CPIXFE, CPIXV\}$

$ACTIVITY_t \in \{IPYOY\}$

$EQUITY \in \{TSX, TSX60\}$

$CURRENCY \in \{USDCAD, NEER\}$

$BS \in \{ASSETS\}$

Equation [1] states that the swap yield depends on the short-term interest rate, inflation, economic activity, and percentage changes in the equity index, exchange rate, and the BOC's balance sheet. Long-term swap yields (SWAP) are based on swaps of three different maturity tenors: SWAP2Y, SWAP5Y, and SWAP10Y. The short-term interest rate is based on the 3-month and 6-month Treasury bill rates (TBILL3M, TBILL6M). Economic activity (ACTIVTIY) is given by the year-over-year percentage change in industrial production (IPYOY). Equity indices (EQUITY) come from two different indices (i.e., TSX, TSX60). The exchange rate (CURRENCY) is constituted of the bilateral exchange rate (USDCAD) and nominal effective exchange rate (NEER). The balance sheet (BS) is based on the central bank's total assets (ASSETS).

Regressions

As per Tables 3A and 3B, industrial production is not stationary at the level, but all variables become stationary at first difference. Granger causality tests between the Treasury bill rates and swap yields were undertaken, revealing a unidirectional relationship between the various tenures of swap yields and the short-term Treasury bill rate.[3]

The autoregressive distributed lag (ARDL) is deemed the most appropriate approach for modeling the dynamics of Canadian interest rate swap yields because this approach can be applied whether the regressors are I(1) and/or I(0). Estimates based on the ARDL approach can reveal both the short- and long-run effects of the independent variables on the dependent variable (Pesaran and Shin 1999). Moreover, the ARDL approach can incorporate a wide range of lags, as warranted by the dynamics of the data-generating process in the financial markets.

The main results are displayed in Tables 4 and 5. Two different models for all three maturity tenors of the swap yield are estimated. In the first model, the swap yield is a function of the short-term interest rate, growth in industrial production, and inflation or core inflation. In the second model, the swap yield is a function of the short-term interest rate, growth in industrial production, inflation or core inflation, and the month-over-month percentage changes in the equity price index, exchange rate, and BOC's total assets.

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 tenors of swaps, the 3-month Treasury bill rate affects the swap yield positively and significantly. A 100-basis point increase in the 3-month Treasury bill rate increases the 2-year swap yield by 72–78 basis points. This impact is comparable in size to the similar relationship for interest rate swap yields in hard currencies such as the USD, British pound sterling, and Japanese yen (Akram and Mamun, 2023a, c, d). The effect declines with higher maturity terms for the swaps: the impact of the short-term interest rate reduces to 55–60 basis points for the 5-year swap and to 42–46 basis points for the 10-year swaps. Thus, the longer-term interest rate swap yields denominated in CAD respond less to the BOC's changes in the short-term interest rates.

The long-term relationship between the 3-month Treasury bill rate and the swap yield is also estimated. The long-run relationship does not vary significantly from the 2-year maturity term to

[3] The results of the Granger causality tests are available upon request.

the 10-year maturity, moving from 88 basis points for the 2-year swap to 72 basis points for the 10-year swap. The long-term relationship differs from the short-term by showing the persistent co-movement of the two variables. Again, the long-term coefficient between the 3-month Treasury bill rate and swap yield of different maturities is similar to patterns found for swaps denominated in other hard currencies, such as the USD (Akram and Mamun 2023a). The rate of adjustment to any shock to the long-run relationship between the 3-month Treasury bill rate and the swap yield is generally long and differs significantly for different maturities, dissipating in around 12–33 months. The rate of adjustment to any shock to the long-term relationship is much slower compared to other mature currencies, such as British pound sterling (Akram and Mamun 2023c). This may show that the Canadian swap market is very slow to react to the BOC's monetary policy decisions.

The 3-month Treasury bill rate has a significant negative-lagged effect on swap yields. The lagged impact of the Treasury bill rate on swap yields is negative and larger than the contemporaneous impact, showing a reversion of the trend. In general, the lagged impact of the short-term interest rate shows a longer memory. The swap yields also exhibit a significant impact up to two to four lags, showing an autoregressive trend in the models. Among the control variables, only the monthly percentage change of the USD–CAD exchange rate showed a negative impact on the swap yields.

A host of post-model information and diagnostic tests are presented in the bottom panel of Table 4. The adjusted R^2 shows a very high degree of explanation for variances in the swap yield by the 3-month Treasury bill rate and its lags, as well as the autoregressive variables. The Akaike information criterion (AIC) also shows a good fit for all models. The joint-significance tests for all models show strong rejection of the insignificance of the regressors. The Durbin-Watson statistics and Breusch-Godfrey LM tests indicate there is no serial correlation in the error terms in these models. The Breusch-Pagan-Godfrey heteroskedasticity tests reject the null hypothesis of homoscedasticity in all models. However, all models include the heteroskedasticity- and autocorrelation-consistent standard errors. The J-B tests indicate the error terms are not normally distributed in all models for all swap term lengths. Lastly, the Ramsey RESET tests indicate that all the models are stable.

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

	CSWAP2Y	CSWAP2Y	CSWAP5Y	CSWAP5Y	CSWAP10Y	CSWAP10Y
			Main Equation			
TBILL3M	0.78*** (0.00)	0.72*** (0.00)	0.60*** (0.00)	0.54*** (0.00)	0.46*** (0.00)	0.42*** (0.00)
TBILL3M(-1)	–0.91*** (0.00)	-0.85*** (0.00)	–0.79*** (0.00)	–0.75*** (0.00)	–0.67*** (0.00)	–0.65*** (0.00)
TBILL3M(-2)	0.21 (0.13)	0.23* (0.09)	0.19* (0.07)	0.27** (0.01)	0.34*** (0.00)	0.38*** (0.00)
TBILL3M(-3)	–0.32** (0.05)	-0.32* (0.07)	–0.13 (0.28)	–0.20 (0.17)	–0.29** (0.01)	–0.26** (0.02)
TBILL3M(-4)	0.30*** (0.00)	0.29*** (0.00)	0.16** (0.02)	0.16** (0.03)	0.18** (0.01)	0.14** (0.03)
CSWAP*i*Y(-1)	1.17*** (0.00)	1.18*** (0.00)	1.22*** (0.00)	1.24*** (0.00)	1.26*** (0.00)	1.26*** (0.00)
CSWAP*i*Y(-2)	–0.34*** (0.00)	–0.36*** (0.00)	–0.26*** (0.00)	–0.38*** (0.00)	–0.43*** (0.00)	–0.42*** (0.00)
CSWAP*i*Y(-3)	0.23* (0.05)	0.24** (0.05)		0.10 (0.12)	0.23** (0.01)	0.14** (0.03)
CSWAP*i*Y(-4)	–0.14* (0.07)	–0.13* (0.08)			–0.08 (0.11)	
CPIXFE	0.01 (0.42)	0.01 (0.30)	–0.005 (0.66)	–0.002 (0.86)	–0.01 (0.53)	–0.01 (0.61)
IPYOY	0.002 (0.22)	0.003 (0.10)	–0.002 (0.92)	–0.003 (0.90)	–0.002 (0.48)	–0.002 (0.48)
ΔLNTSX		0.18 (0.56)		–0.02 (0.94)		–0.21 (0.44)
ΔLNUSDCAD		–1.50** (0.02)		–1.85** (0.02)		–1.38** (0.05)
ΔLNASSETS		–0.05 (0.67)		–0.17 (0.13)		–0.26** (0.03)
Intercept	0.05** (0.05)	0.04 (0.14)	0.06** (0.03)	0.06** (0.06)	0.06* (0.07)	0.06** (0.06)
			Cointegrating Relationship			
Long-term coefficient	0.88*** (0.00)	0.85*** (0.00)	0.81*** (0.00)	0.76*** (0.00)	0.79*** (0.00)	0.72*** (0.00)
Rate of adjustment	–0.08*** (0.00)	–0.07*** (0.00)	–0.04** (0.01)	–0.04** (0.01)	–0.02** (0.04)	–0.03** (0.03)
			Model Information			
Obs.	300	299	300	299	300	299
Adj R^2	0.99	0.99	0.99	0.99	0.99	0.99
AIC	–0.89	–0.92	–0.64	–0.66	–0.72	–0.73
			Diagnostic Tests			
Joint significance F-test	3023.66 (0.00)	2453.01 (0.00)	2640.41 (0.00)	1891.51 (0.00)	2217.73 (0.00)	1900.16 (0.00)
Serial correlation Durbin-Watson stat	1.98	2.01	1.95	2.04	1.98	2.01
Serial correlation Breusch-Godfrey LM test	0.09 (0.91)	1.07 (0.34)	1.76 (0.17)	1.65 (0.23)	0.11 (0.90)	2.02 (0.13)
Heteroskedasticity Breusch-Pagan-Godfrey test	4.22 (0.00)	3.36 (0.00)	3.29 (0.00)	2.23 (0.01)	2.63 (0.00)	2.35 (0.00)
Normality test J-B stat	46.91 (0.00)	33.63 (0.00)	26.92 (0.00)	17.84 (0.00)	18.93 (0.00)	17.39 (0.00)
Stability diagnostic Ramsey RESET test	0.22 (0.80)	0.37 (0.69)	0.04 (0.96)	0.01 (0.99)	0.19 (0.83)	0.10 (0.91)

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 some alternative variables. Specifically, these models employ the 6-month short-term interest rate and a super core inflation rate (i.e., CPI without eight volatile categories and indirect taxes) instead of the 3-month Treasury bill rates and core inflation rate, respectively. The control variables also replace the stock index with a select 60 stock index and employ the nominal effective exchange rate in place of the USD–CAD exchange rate. The robustness-checked results in Table 5 provide essentially unchanged results. The effects of the 6-month Treasury bill rates on the swap yields are somewhat larger than the 3-month Treasury bill rate. The lagged values of 6-month Treasury bill rates and the autoregressive terms are very similar to the results in table 4. Among the control variables, the percentage change in the nominal effective exchange rate and percentage change in the BOC's total assets showed some relationship to the swap yields.

The long-term relationship between the swap yield and 6-month Treasury bill rate is similar to the results in Table 4, albeit a little stronger. The rate of adjustment to any shock to the long-term relationship between the swap yields and 6-month Treasury bill rates is very similar to those in table 4. The adjusted R^2, AIC, and post-diagnostic test results are identical to their counterparts in Table 4.

Table 5. ARDL (p, q) Model (with TBILL6M and CPIXV)

	CSWAP2Y	CSWAP2Y	CSWAP5Y	CSWAP5Y	CSWAP10Y	CSWAP10Y
	Main Equation					
TBILL6M	1.05*** (0.00)	1.00*** (0.00)	0.88*** (0.00)	0.81*** (0.00)	0.67*** (0.00)	0.63*** (0.00)
TBILL6M(-1)	-1.32*** (0.00)	–1.27*** (0.00)	–1.22*** (0.00)	–1.21*** (0.00)	–0.99*** (0.00)	–0.96*** (0.00)
TBILL6M(-2)	0.34** (0.02)	0.36** (0.02)	0.30** (0.03)	0.43*** (0.00)	–0.33*** (0.00)	–0.35*** (0.00)
TBILL6M(-3)	–0.26* (0.05)	–0.27* (0.07)	–0.03 (0.78)			
TBILL6M(-4)	0.27*** (0.00)	0.26*** (0.00)	0.10* (0.09)			
CSWAP*i*Y(-1)	1.17*** (0.00)	1.18*** (0.00)	1.23*** (0.00)	1.28*** (0.00)	1.25*** (0.00)	1.26*** (0.00)
CSWAP*i*Y(-2)	–0.34*** (0.00)	–0.37*** (0.00)	–0.27*** (0.00)	–0.40*** (0.00)	–0.35*** (0.00)	–0.37*** (0.00)
CSWAP*i*Y(-3)	0.24** (0.03)	0.25** (0.03)		0.08* (0.09)	0.08 (0.13)	0.09* (0.097)
CSWAP*i*Y(-4)	-0.16** (0.02)	-0.15** (0.03)				
CPIXV	0.005 (0.54)	0.01 (0.42)	–0.01 (0.51)	–0.01 (0.43)	–0.01 (0.40)	–0.01 (0.42)
IPYOY	0.001 (0.51)	0.001 (0.39)	–0.001 (0.55)	–0.002 (0.28)	–0.003 (0.15)	–0.003* (0.10)
ΔLNTSX60		–0.06 (0.80)		–0.27 (0.36)		–0.39 (0.14)
ΔLNNEER		1.23** (0.03)		1.92** (0.02)		1.36 (0.10)
ΔLNASSETS		–0.07 (0.50)		–0.22** (0.05)		–0.27** (0.01)
Intercept	0.05** (0.02)	0.04** (0.05)	0.05** (0.06)	0.06** (0.03)	0.05 (0.14)	0.06* (0.06)
	Cointegrating Relationship					
Long-term coefficient	0.92*** (0.00)	0.91*** (0.00)	0.86*** (0.00)	0.78*** (0.00)	0.84*** (0.00)	0.77*** (0.00)
Rate of adjustment	–0.09*** (0.00)	–0.09*** (0.00)	–0.03** (0.01)	–0.03** (0.01)	–0.02* (0.06)	–0.02** (0.03)
	Model Information					
Obs.	300	299	300	299	300	299
Adj R^2	0.99	0.99	0.99	0.99	0.99	0.99
AIC	–1.43	–1.43	–0.92	–0.93	–0.88	–0.88
	Diagnostic Tests					
Joint significance F-test	5181.46 (0.00)	4088.61 (0.00)	3506.71 (0.00)	2909.96 (0.00)	3551.17 (0.00)	2602.51 (0.00)
Serial correlation Durbin-Watson stat	1.96	2.00	1.94	2.06	1.94	1.99
Serial correlation Breusch-Godfrey LM test	0.61 (0.54)	1.09 (0.33)	1.73 (0.18)	1.70 (0.19)	1.98 (0.14)	2.98 (0.05)
Heteroskedasticity Breusch-Pagan-Godfrey test	4.40 (0.00)	3.96 (0.00)	3.28 (0.00)	3.25 (0.00)	4.20 (0.00)	3.25 (0.00)
Normality test J-B stat	67.11 (0.00)	67.42 (0.00)	36.08 (0.00)	35.24 (0.00)	19.88 (0.00)	24.63 (0.00)
Stability diagnostic Ramsey RESET test	0.22 (0.80)	o.58 (0.56)	0.11 (0.90)	0.17 (0.85)	0.26 (0.77)	0.27 (0.76)

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.

SECTION V: CONCLUSIONS

The findings from the estimated models of CAD swap yields have clear implications for macroeconomics, monetary policy, financial markets, and asset allocation. Both models of swap yields of different maturity tenors show that the current short-term interest rate has an important economic and statistically significant effect on swap yields of different maturity tenors. The results hold even when alternative independent variables are used, which augments the findings. Furthermore, the behavior of CAD swaps is in concordance with the patterns observed in the behavior of swaps denominated in other currencies. This lends credence to the plausibility of the Keynesian hypothesis of a strong connection between the short-term interest rate and the long-term market interest rate on various financial instruments.

These findings also suggest that the BOC has a noteworthy influence on swap yields of different maturity tenors. These findings vindicate the notion that the BOC has substantial sway over the country's financial system, as its monetary policy actions influence not just long-term Canadian government bond yields, as Das and Akram (2020) had already documented in earlier research, but also the yields of CAD-denominated interest rate swaps denominated. The results can be useful for portfolio managers, corporate leaders, and policymakers.

This paper has econometrically modeled the dynamics of CAD swap yields using monthly data. The results obtained evince that long-term CAD swap yields can be modeled using the current short-term interest rate on Treasury bills, core inflation, the growth of industrial production, and the percentage changes in the equity index, exchange rate, and the central bank's total assets. The estimated models affirm that the Keynesian perspective holds for market rates, such as CAD swap yields.

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