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Article

A Keynesian analysis of Canadian government securities yields

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Abstract:

Keynes argued that the short-term interest rate is the main driver of the long-term interest rate on government bonds. This paper empirically models the relationship between the short-term interest rate and long-term government securities yields in Canada, after controlling for other important financial variables. The statistical analysis uses high-frequency daily data from 1990 to 2018 to examine the behavioral dynamics of the long-term interest rate. The empirical results show that the actions of the Bank of Canada are key drivers of Canadian government securities yields in the long run, which supports the Keynesian perspective. There is a positive association between long-term bond yields and the Canadian federal government's net debt to GDP ratio, but the effect is fairly modest. An important implication of these findings is that the Bank of Canada's actions can have a decisive effect on the long-term interest rate over the long horizon.

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The long-term interest rate on Canadian government securities is an important theoretical and empirical topic for academics and policymakers. Understanding the empirics of Canadian government securities yields can also be useful for investors and portfolio managers in making strategic and tactical asset allocations, and investment decisions concerning duration, convexity, speculation and delta hedging. It is germane for macroeconomic theory and public policy, particularly as it concerns the following issues: the monetary transmission mechanism, monetary policy, market volatility, inflationary pressures, financial conditions, government debt

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management and operations, and the effects of higher government debt and deficit ratios on the government securities yields.

John Maynard Keynes (1930) argued that the central bank's actions have a decisive influence on the long-term interest rate. He claimed that the central bank's policy rate sets the short-term interest rate, which has a crucial influence on the long-term interest rate for government securities. Keynes wrote (1930): "[T]he influence of the short-term rate of interest on the long-term rate is much greater than anyone [...] would have expected" (p. 353). He attributed this correlation to fundamental macroeconomic factors, technical characteristics of financial markets, and investors' behavior, including herding and the formation of expectations. Further, he noted 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" (p. 363).

This paper contributes to the ongoing debate on the dynamics of government bond yields. The literature on government bond yields contains many substantial but unresolved debates. The two main schools of thought regarding the dynamics of government bond yields represent the neoclassical and the Keynesian views. The neoclassical view holds that government bond yields are the outcome of the demand and supply of loanable funds. Other exogenous factors, such as government debt and deficit ratios, also influence government bond yields. In the past two decades, scholars have presented their arguments in various studies on the dynamics of government bond yields and various macroeconomic and financial variables, including government debt and deficit ratios.

Neoclassical scholars have emphasized that higher debt and deficit ratios lead to higher government bond yields. Ardagna et al. (2007) claim that, for selected Organization for Economic Co-operation and Development (OECD) countries, a one-percentage-point increase in the primary deficit relative to GDP increases contemporaneous long-term interest rates by about 10 basis points. Furthermore, they claim that the same shock leads to a cumulative increase of almost 150 basis points after 10 years. Baldacci and Kumar (2010) argue that higher deficits and public debt cause a marked increase in long-term government bond yield interest rates. Based on their analysis of a panel of 31 advanced and emerging countries from 1980 through 2008, they warn that large fiscal deficit and debt ratios are likely to exert substantial upward pressures on government bond yields over the medium term. Likewise, Gruber and Kamin (2012) investigated the effect of fiscal positions on long-term government bond yields in the OECD. They argued that the marginal effect of the projected deterioration of fiscal positions would add about 60 basis points to US bond yields by 2015, with effects on other G-7 bond yields generally being smaller. Their prognosis was erroneous, as bond yields declined while government debt ratios rose in most OECD countries during the same period. Similarly, a number of scholars, such as Doi et al. (2011), Hansen and İmrohoroğlu (2013), Horioka et al. (2014), Hoshi and Ito (2013, 2014), Lam and Tokuoka (2013), and Tokuoka (2012), have analyzed the effects of higher deficits and debts in Japan. These scholars have fairly consistently opined that higher debt and deficit ratios in Japan would lead to higher bond yields and increase the probability of debt default. Such forecasts have proven to be inconsistent with the realized history, as Japanese government bond yields have declined over the years, thanks to the Bank of Japan's accommodative monetary policy, low inflation/deflation, and other factors. Nevertheless, the view that increased government deficit and debt ratios would lead to an inexorable rise in government bond yields in advanced countries is still quite common in neoclassical scholarship (Paccagnini, 2016; Poghosyan, 2014; Tkačevs and Vilerts, 2019). The neoclassical view is best represented in wellcited research, such as Elmendorf and Mankiw (1998) and Reinhart and Rogoff (2009), both of which warn against the dire consequences of increased government debt ratios.

Ontological uncertainty and liquidity preference are central to Keynes's view of the determinants of the long-term interest rate. Since investors have very little information about the long-term future, it is impossible for investors to have well-formulated mathematical expectations about the future. Investors cannot rely on well-defined expectations of future short-term interest rates because they do not have a reasonable basis to assign probability weights to them and they do not have any reliable forecast of them. Investors do not actually have a valid statistical basis for formulating their future outlook. Hence, Keynes maintained that investors are subject to "the prey of hopes and fears" arising from current conditions, transient events, herding, and social and behavioral factors.

The Keynesian school follows Keynes's ([1936] 2007) argument that interest rates have a psychological and sociological foundation in a world characterized by ontological uncertainty (Davidson, 2015). Keynesians maintain the liquidity preference view of interest rates and argue that the long-term interest rate is primarily determined by the central bank's actions, such as the setting of benchmark policy rates, repurchase and reverse repurchase agreements, forward guidance about policy rates, and decisions concerning the central bank's monetary base and balance sheets. Riefler's (1930) analysis of the dynamics of the short-term interest rate and the long-term interest rate in the US in the 1920s and 1930s provided the empirical basis for Keynes to formulate this hypothesis. The Keynesian perspective on interest rates and monetary operations and their relation to fiscal policy was later developed by Lerner (1947). Several Keynesian and post-Keynesian economists have advanced the Keynesian view of interest rates. They have argued that an increase (decrease) in government debt and deficit ratios does *not* necessarily lead to higher (lower) government bond yields (Kregel, 2011; Lavoie, 2014), particularly in countries with monetary sovereignty (Wray, 2012).

In recent years, Keynes's conjecture on the relationship between long-term bond yields and short-term interest rates has been empirically examined for several developed and developing countries. This paper contributes to the existing literature by examining whether Keynes' claim is warranted in Canada. Specifically, it analyzes the effects of the short-term interest rate on Canadian government securities yields, after controlling for several important factors, including domestic equity market, oil prices and the exchange rate of the Canadian dollar. A novelty of this statistical exercise is the use of daily data to identify the dynamics of these variables. There are two main benefits of using daily financial data. First, daily data over a long period provide many observations, which ensure a robust degree of freedom. Second, analyzing high-frequency data provides a near real-time fundamental assessment of long-term government securities yields and thus provides important information to investors, financial analysts and policymakers. There are only a few papers, such as Bollerslev et al. (2000) and Gürkaynak et al. (2007), that use such high-frequency daily data to study government security yields. Hence, examining the empirics of Canadian government bond yields from a Keynesian perspective is a useful extension of the literature because it furthers the ongoing debate.

The dataset used in the paper covers the period from 1 January 1990 to 31 December 2018. The relationship between Canadian government securities yields and short-term interest rates is examined using a set of time-series methods, including the Johansen cointegration technique, the autoregressive distributed lags (ARDL) approach, and Granger causality within a vector error correction modelling (VECM) framework. To preview, the results suggest that, in the long run, the short-term interest rate is a key long-run determinant of the long-term interest rate on

Canadian government securities. The paper identifies some open questions for further examination. This is the first paper to use daily data in analyzing Canadian government securities yields from a Keynesian perspective. However, the use of daily data usually prevents the deployment of fiscal variables, such as ratios of fiscal deficit or government debt to GDP, which are not available as daily time series. Hence, quarterly data is harnessed to assess the effect of the net government debt ratio on Canadian bond yields, in addition to the analysis based on daily data. The analysis of quarterly data serves to check the soundness of the findings. The results suggest that estimates do not suffer too much from an omitted variable bias. There is a positive association between long-term bond yields and the government debt ratio, though the economic effect of the higher net debt ratio on government bond yields is quite modest.

The rest of the paper proceeds as follows. Section 1 provides a literature review on the neoclassical-Keynesian debate on the determinants of long-term bond yields. Section 2 discusses some stylized facts. It also presents a brief institutional overview of Canada's federal debt management and government securities. Section 3 presents the data, undertakes unit root tests, and describes the econometric methodology used in the paper. Section 4 reports the empirical findings. Section 5 concludes with a summary of the findings, discusses their relevance to debates in economic theory and policy, and identifies some issues for future research. The appendices extend the findings of the paper. Appendix A contains tables showing the results for 30-year Canadian bond yields. Appendix B shows additional results using quarterly data incorporating the net government debt ratio to ascertain the effects of fiscal variables on Canadian bond yields.

1. Determinants of long-term bond yields: the neoclassical-Keynesian debate

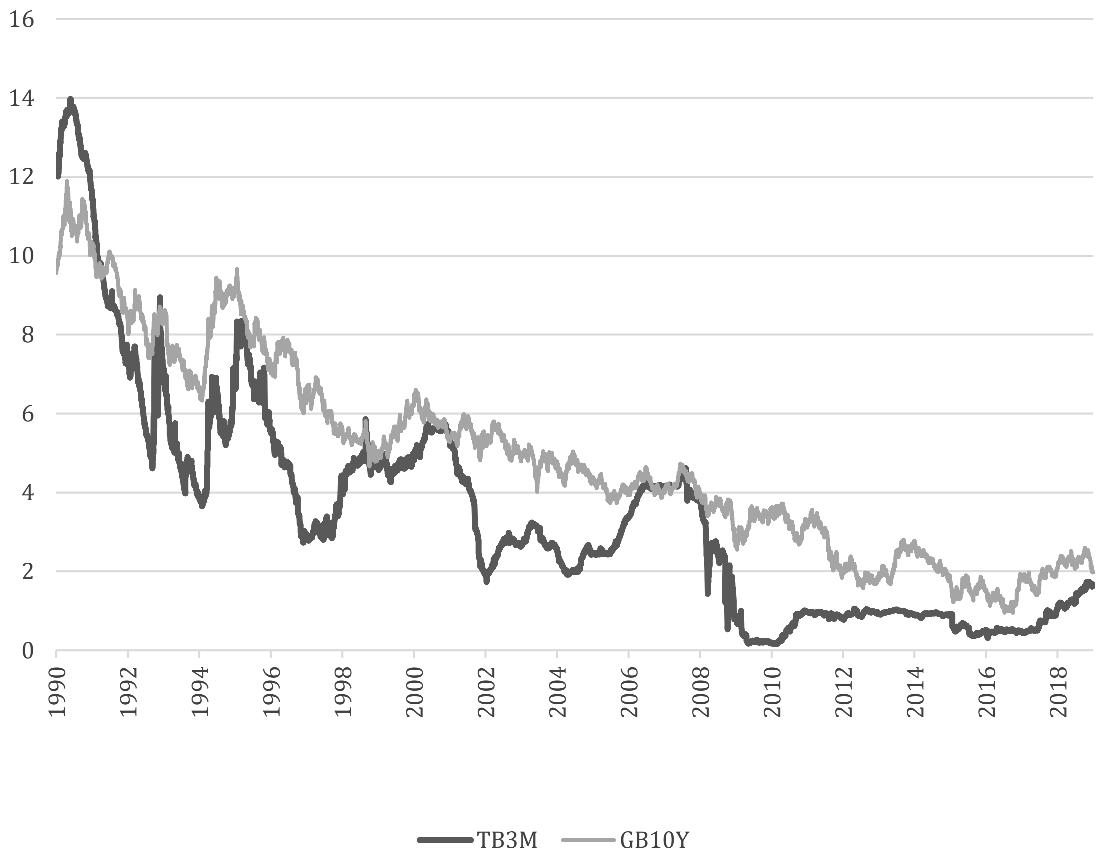
Keynes's (1930) views on ontological uncertainty suggest that the investor makes decisions based on past experience, present conditions, and near-future expectations. Therefore, the investor, instead of assigning probabilities to mathematically unknown outcomes, will rely on information on current conditions, including the current short-term interest rate, to assess and value long-term securities.

Mainstream economists, however, do not share the Keynesian view. As discussed in the previous section, neoclassical economists have maintained that an increase in debt or deficit increases the demand for financial capital and generates expectations about inflation. This pressure causes fears about the possibility of government default, which may warrant an increase in the interest rates of long-term government bonds. Contrary to the neoclassical view, several papers in recent years empirically show the importance of the short-term interest rate as a determinant of long-term government securities yield and thereby support the Keynesian hypothesis. Using monthly data from June 1994 to December 2014, Akram and Das (2014) showed that the short-term interest rate has the strongest influence on government bond nominal yields in Japan. Similar results for Japan were also found by Akram and Li (2019). Akram and Das (2017) examined the determinants of long-term bond yields for a panel of eurozone countries. The short-term interest rate was found to be the most important determinant of the long-term government bond yields for most eurozone countries, despite elevated government debt and deficit ratios in several eurozone countries, such as Spain, Italy, Portugal, Greece, and Ireland. Other researchers have found a strong relationship between the short-term interest rate and the long-term interest rate on government bonds for other advanced countries, such as Akram and Das (2019b), Akram and Li (2017, 2020), and Levrero and Deleidi (2019) for the

United States; and Akram and Das (2020) for Australia. Keynes's observations on the relationship between short-term and long-term interest rates appear to hold in several developing countries. Akram and Das (2015, 2019a) empirically established this relationship for India. Simoski (2019) finds the same patterns hold for major Latin American countries, including Brazil and Mexico.

A quick visual examination of figure 1 reveals that the Bank of Canada's short-term interest rate, as measured by the yield of 3-month Treasury bills, generally moves in tandem with the long-term government bond yields, as measured by the yield of 10-year government securities. Therefore, there may well be a relationship between short-term and long-term interest rates in Canada. However, Keynes's view that the investor's long-run expectations are driven by short-term realizations has not been tested for Canada from a Keynesian perspective. To fill this crucial lacuna in the literature, this paper examines the role of the short-term interest rate in determining Canadian government bond nominal yields, after controlling for a number of factors, including the influence of US interest rates on Canadian bond markets.

Figure 1 – *The evolution of yields of selected long-term Canadian government securities, 1990-2018*



2. The stylized facts and institutional overview of Canada's debt management

To understand the underlying dynamics between these variables, it is useful to examine the evolution of Canadian government securities yields and key macroeconomic variables. Such an examination provides a useful perspective about the drivers of the long-term interest rate and the fundamental relationships of these macroeconomic and financial variables. Figure 1 shows the evolution of long-term Canadian government securities yields and the short-term interest rate. It shows that government bond yields have progressively declined over time. There appears to be an underlying trend. The decline in government securities yields is partly due to a decline in observed inflation and inflation expectations. Government securities yields were elevated in the early 1990s and, since peaking around 12% in the early 1990s, they steadily declined until the mid-1990s. While there was a sharp increase in the mid-1990s, government securities yields have been following a declining trend since then. Government securities yields fell, notably, prior to the global financial crisis. It is evident that the short-term interest rate followed a path similar to that of Canadian government securities yields.

The Department of Finance (2019) and the Bank of Canada (2020) provide a detailed discussion on the stylized facts and the institutional arrangements of Canada's debt management. Following is an overview. The Government of Canada's marketable debt amounted to Canadian $721 billion at the end of the fiscal year 2018-19. Of the outstanding marketable debt, $705 billion (98%) was denominated in Canadian dollars, while only $16 billion (2%) was denominated in foreign currency. Of the outstanding market debt denominated in Canadian dollars, nearly 80% was in the form of marketable long-term debt, amounting to $570 billion, whereas 19% was in the form of marketable short-term Treasury bills and cash management debt, amounting to $134 billion. The total liabilities of the Government of Canada amounted to $1,185 billion at the end of the fiscal year 2018-19. The total outstanding debt amounted to $686 billion, after deducting the government's financial and non-financial assets.

The Government of Canada maintains a fairly conservative approach to the management of the government debt. The federal government of Canada's gross debt and net debt to GDP ratios were 43% and 26%, respectively, as of 2019 (Statistics Canada, 2020). These ratios are one of the lowest among the major advanced countries. The weighted average interest on market debt was less than 2.2% in the fiscal year 2018-19. The Government of Canada's long-term debt denominated in Canadian dollars enjoys the highest rating from credit rating agencies, such as S&P Global, Moody's Investor Services, and Fitch Ratings. The marketable securities are predominantly sold through auctions by the Bank of Canada, which acts as the fiscal agent of the Government of Canada. Government bond auctions are well covered. The Bank of Canada provides designated lists of government security dealers and primary dealers for Treasury bills and bonds. There are well-defined legal terms and conditions for Canada government securities.

The Government of Canada's marketable securities are issued in the forms of treasury and cash management bills, nominal long-term bonds, and long-term inflation indexed bonds. Long-term debt securities are generally issued in 2-year, 3-year, 5-year, 10-year, and 30-year securities. Domestic investors hold 70% of the country's outstanding debt, while non-resident investors hold the remaining 30%. Amongst the domestic investors, insurance companies and pension funds are the most important, holding around 25% of the outstanding marketable debt, followed by financial institutions, which hold 21%, and the Bank of Canada, which holds slightly above 13%. The domestically held share of outstanding debt has hovered around 70-80% of the total outstanding debt in the past decade. The secondary market for Canadian marketable debt is liquid. The average daily trading volume in the secondary market for Government of Canada bonds during 2018-19 was nearly $37 billion, while the annual debt stock turnover ratio in the Government of Canada secondary bond market was slightly higher than 18 in 2018-19.

Long-term interest rates, as reflected in the yields of Canadian government securities, have declined. There was a modest rise in the country's net debt ratio from around 40-45% of nominal GDP in the years immediately before the global financial crisis to around 50-55% of nominal GDP. However, government bond yields have generally declined, contrary to conventional views. While this paper does not examine the role of debt ratios in driving government yields, it offers an alternative but entirely plausible explanation of the declining trend in government bond yields in Canada using daily data.

3. Data and methods

Table 1 summarizes the data used in this paper. The daily data begin on 4 January 1990 and end on 31 December 2018. The use of daily data in the econometric analysis benefits from a large number of observations which enhance the degrees of freedom in econometric modeling of the behavioral dynamics. There are over 7,500 observations in the regression models estimated.

The following general equation is estimated to examine the relationship between the short-term interest rate and the long-term interest rate on Canadian government securities of various maturity tenors.

GB = F1(STIR, LN[FX], LN[EQUITY], LN[OIL], USGB, USSTIR) (1)

where GB is the yield on Canadian government securities, STIR is the Canadian short-term interest rate, FX is the foreign exchange rate, EQUITY is the equity price, OIL is the price of crude oil, USGB is the yield on US government long-term treasury securities, and USSTIR is the short-term interest rate of the US LN[.] is the natural log of the concerned variable. The yield on Canadian government securities is represented by 10-year government bond yields (GB10Y). The yield on Canadian 3-month Treasury bills (TB3M) is used for STIR. The potential impact of FX is represented by the spot rate between the Canadian dollar and the US dollar (CAD), measured as Canadian dollar per US dollar. An increase (decrease) in CAD means that the Canadian dollar has depreciated (appreciated) with respect to the US dollar. Brent Europe spot price (BRENT) is used for OIL. Standard and Poor's (S&P) and Toronto Stock Exchange (TSX) 60 equity index, which is an index of selected key stock prices listed on Canada's main stock exchange, is used for EQUITY. CAD, TSX and BRENT are then transformed to their respective natural logarithmic forms, i.e., LN[CAD], LN[TSX], and LN[BRENT], respectively. Since North American bond markets are quite integrated, and given the size of the US economy, it is fair to assume that Canadian bond yields are influenced by interest rates in the US. To control for the influence of short-term and long-term US interest rates on Canadian long-term interest rates, the yields on US 3-month Treasury bills (USTB3M) and 10-year US treasury securities yields (UST10Y) are included in the estimated equation as control variables. Therefore, the behavioral equation estimated in this paper takes the following form:

GB10Y = F2(TB3M, LN[CAD], LN[TSX], LN[BRENT], USTB3M, UST10Y) (2)

As a robustness check, the following equation is also estimated:

GB30Y = F3(TB3M, LN[CAD], LN[TSX], LN[BRENT], USTB3M, UST30Y) (3)

where GB30Y is the 30-year Canadian government bond yield and UST30Y is the 30-year US treasury securities yield. The results are provided in tables displayed in Appendix A.

Fiscal variables, such as the federal government's net debt ratio, may have an influence on long-term bond yields. Daily time series observations of this variable are not available. However, this variable is available in the quarterly format. As a further robustness check, the following additional behavioral equation is estimated:

GB30Yq = F4(TB3Mq, LN[CADq], LN[TSXq], LN[BRENTq], USTB3Mq, UST30Yq, NDEBTq) (4)

where daily data of GB30Y, TB3M, CAD, BRENT, USTB3M, and UST30Y were converted to their quarterly form by taking the quarterly average and were denoted as GB30Yq, TB3Mq, CADq, BRENTq, USTB3Mq, and UST30Yq, respectively. NDEBTq is the Canadian federal government's net debt to GDP ratio and is available in quarterly format. The results are provided in tables displayed in Appendix B.

Table 1 – *Definition and sources of the variables*

Variable	**Data description**	**Frequency**	**Sources**
Short-term interest rate			
TB3M	Canadian treasury bills, 3-month, yield, %; 1/4/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Bank of Canada; Macrobond (2019)
Canadian government securities yields			
GB10Y	Canadian government securities, 10-year, yield, %; 1/1/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Bank of Canada; Macrobond (2019)
Equity			
TSX	S&P/TSX 60 equity index, price return, Canadian dollar; 1/1/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Toronto Stock Exchange; Macrobond (2019)
Energy prices			
BRENT	Crude oil, Brent Europe spot price FOB, US$; 1/1/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Intercontinental Exchange; Macrobond (2019)
Currency			
CAD	FX spot rate, C$/US$€; 1/1/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Macrobond (2019)
US interest rate variables			
USTB3M	US treasury bills, 3-month, yield, %; 1/4/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Macrobond (2019)
UST10Y	US treasury securities, 10-year, yield, %; 1/4/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Macrobond (2019)
UST30Y	US treasury securities, 30-year, yield, %; 1/4/1990–12/31/2018 & 1990Q1-2018Q4	Daily/Quarterly	Macrobond (2019)
Fiscal debt			
NDEBT	Federal general government net debt to GDP ratio, %; 1990Q1-2018Q4	Quarterly	Statistics Canada (2020)

3.1 Method

Since the variables are defined over a long period of time, it is important to identify whether these variables are stationary. If they are found to be nonstationary, applying the standard least squares technique would be an inappropriate approach. The order of variable integration is tested using both augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) techniques. The standard Johansen cointegration technique can be applied if all the variables are integrated of order 1. This method serves as a basis for implementing a vector error correction model (VECM). In the Johansen methodology, both the trace and the maximum eigenvalue sequential testing approaches are used. The null hypothesis of the trace test is that there are r cointegrating equations. The alternative hypothesis is that there are k cointegrating equations, where k is the number of endogenous variables and $r \leq k$. According to the maximum eigenvalue test, the null hypothesis is that there are r cointegrating equations, and the alternative hypothesis is that there are $r+1$ cointegrating equations. In both tests, the decision rule is that the first null hypothesis that is not rejected should be accepted. A conclusive decision on the existence of cointegrating relationships can be made when both tests produce the same results. In the next step, an ARDL model is estimated to verify the findings from the Johansen test. This test is used to identify the error correction terms and the long-run and short-run dynamics between government bond yields, the short-term interest rate, and other relevant variables.

In the ARDL model, the existence of a long-run relationship is determined by the F-test and the t-test (Pesaran et al., 2001). The calculated F-test statistic is compared with upper, I(1), and lower, I(0), bound critical values. If the F-test statistic is greater than the upper bound critical value, there is evidence of a long-run level relationship. If the F-test statistic is between the lower and upper bound critical values, any decision about a long-run level relationship is inconclusive. When the F-test statistic is below the lower critical value, the null hypothesis of no long-run level relationship is not rejected. The t-test is used as a cross-check of the F-test. The null hypothesis of no cointegration is rejected if the absolute value of the t-test statistic is higher than the absolute upper bound critical values. Both the F-test and the t-test have to reject their respective null hypotheses to conclude that there is an overall long-run level relationship running from the independent variables to the dependent variable.

If evidence of cointegration is present in both techniques, then a well-specified VECM can be estimated to identify Granger causality among variables. However, before conducting Johansen, ARDL, and causality tests, it is important to identify the optimal lag length. In accordance with conventional practice, the Schwarz's Bayesian information criterion (SBIC) is used in this regard.

4. Results

To examine the unit root properties of the variables, both ADF and PP unit root test results with a constant and trend term are reported in table 2. From this table, irrespective of the test used, the results show that the variables are nonstationary at levels but stationary at first differences. Thus, using the Johansen cointegration technique is the appropriate approach to estimate the relationship among government bond yields, short-term interest rates, and other control variables.

Table 2 – *Unit root tests*

Variable	ADF	PP
GB10Y	–3.140 (0.100)	–3.003 (0.131)
ΔGB10Y	–84.059*** (0.000)	–84.019*** (0.000)
TB3M	–2.808 (0.194)	–2.787 (0.202)
ΔTB3M	–25.530*** (0.000)	–83.569*** (0.000)
LN[CAD]	–1.646 (0.775)	–1.500 (0.83)
ΔLN[CAD]	–87.683*** (0.000)	–88.071*** (0.000)
LN[TSX]	–2.213 (0.482)	–2.062 (0.566)
ΔLN[TSX]	–41.190*** (0.000)	–87.319*** (0.000)
LN[BRENT]	–2.198 (0.490)	–2.145 (0.52)
ΔLN[BRENT]	–53.128*** (0.000)	–88.114*** (0.000)
USTB3M	–1.275 (0.894)	–1.015 (0.941)
ΔUSTB3M	–17.265*** (0.000)	–77.669*** (0.000)
UST10Y	–1.698 (0.433)	–1.693 (0.435)
ΔUST10Y	–85.716*** (0.001)	–85.716*** (0.000)
UST30Y	–1.551 (0.508)	–1.498 (0.535)
ΔUST30Y	–86.929*** (0.000)	–87.039*** (0.000)

Notes: 1) *** and ** indicate statistical significance at the 1% and 5% levels, respectively. 2) The null hypothesis of both the ADF and the PP tests is that the series contains unit roots. 3) *p*-value is in parenthesis.

The optimal lag length according to SBIC is two. Using this lag length, the next stage of the empirical approach involves the implementation of the Johansen test. Table 3 presents results from the Johansen cointegration tests. The null hypothesis of no cointegration and the null hypothesis of at most one cointegrating relationship among variables in the model are rejected by both trace and maximum eigenvalue statistics. The null hypothesis of at most two cointegrating relationships is rejected by the trace test (only at the 10% level of statistical significance) but not rejected by the maximum eigenvalue test. Therefore, both statistics lead to the conclusion that there are two long-run relationships among government bond yields, short-term interest rates, and other relevant variables.

Table 3 – *Johansen cointegration test*

Hypothesized number of cointegrating equations	Eigenvalue	Trace statistic	Maximum eigenvalue statistics
None	0.008	168.753*** (0.000)	58.616*** (0.002)
At most 1	0.006	110.138*** (0.004)	42.920** (0.023)
At most 2	0.004	67.217* (0.079)	30.395 (0.123)
At most 3	0.003	36.822 (0.356)	23.890 (0.139)
At most 4	0.001	12.933 (0.895)	6.823 (0.961)

Notes: 1) The cointegrating relationship is between GB10Y, TB3M, LN[CAD], LN[TSX] LN[BRENT], USTB3M and UST10Y. 2) ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. 3) *p*-value is in parenthesis. 4) Determination: 2 cointegrating relationships at least at the 5% level.

Table 4 reports findings from *F*-test and *t*-test statistics. Both tests suggest that there is strong statistical evidence of a long-run level relationship running from the control variables to GB10Y. The *F*-test statistic has a value of 4.882, which is higher than the 1% level of statistical significance upper bound *F*-test critical value of 4.43. Further, the *t*-statistic has a value of -5.711. In the absolute term, this value is higher than the *t*-test critical value at the 1% level of statistical significance.

Table 4 – *F and T tests*

Equation	*F*-statistic		*t*-statistic	
GB10Y=F²(TB3M, LN[CAD], LN[TSX], LN[BRENT], USTB3M, UST10Y)	4.882**		−5.711***	
	I(0)	I(1)	I(0)	I(1)
10%	2.13	3.23	−2.57	−4.04
5%	2.45	3.61	−2.86	−4.38
1%	3.15	4.43	−3.43	−4.99

Note: *** and ** indicate statistical significance at the 1% and 5% levels, respectively.

Table 5 presents long-run results from the ARDL test of estimating Equation (2).[1] As expected, the error correction term, obtained from the short-run equation, is negative and statistically significant at the 1% level. The size of the coefficient variable is -0.010. Since the empirical analysis uses daily data, this result means that 1% of the deviation is corrected on one day. In other words, it takes almost three and one-half months for the long-run equilibrium to be achieved. Therefore, this result reinforces the earlier findings from the Johansen test. In the long run, TB3M seems to be one of the most important determinants of GB10Y. The coefficient magnitude is 0.22 and the variable is significant at the 1% level. This implies that a higher (lower) short-term interest rate tends to lead to a higher (lower) long-term interest rate. This finding is coherent with Keynes's conjecture mentioned earlier, holding other things the same. Among other variables, the coefficient of LN[TSX] is negative and statistically significant at the 1% level. This suggests that a lower (higher) long-term interest rate is associated with higher (lower) equity prices, all else constant. Both LN[CAD] and LN[BRENT] are positive and statistically significant at the 5% level. Thus, an appreciation of the Canadian dollar is positively associated with long-term bond yields. Similarly, as the price of oil rises, yields on Canadian long-term securities also go up.

Among the US variables, UST10Y is positively and USTB3M is negatively related to Canadian bond yields. The links between US interest rates and Canadian government bond yields exists because of the deep and entrenched economic and financial relationship between the two countries. The US economy, by virtue of its size, exerts substantial influence on the Canadian economy and financial markets. The econometric findings on the signs of the US interest rates suggest several things. First, when long-term interest rates rise (decline) in the

[1] Several diagnostic tests were undertaken. The Ramsey Regression Equation Specification Error Test (RESET) shows that the non-linear combinations of the fitted values explain the response variable. This means the estimated model does not suffer from misspecification. Unfortunately, the null hypotheses of the Breusch-Pagan-Godfrey heteroskedasticity test and the Breusch-Godfrey serial correlation Lagrange multiplier (LM) test were rejected.

US due to fundamental macroeconomic factors or technical conditions in the US Treasury securities markets, the yields of Canadian government bonds also rise (decline) in tandem. Second, the effect of the US short-term interest rate on Canadian bond yields, while negative and significant, is fairly small, and notably less so than that of the Canadian short-term interest rate. This result suggests that the fluctuations in Canadian short-term interest rates provide more relevant signals for the Canadian government bond market than the fluctuations in the US short-term interest rate. Third, the direct effect of a higher (lower) US short-term interest rate is a slight decrease (increase) in Canadian government bonds yields, other things held constant.

Table 5 – *Long-run ARDL results* (*dependent variable: GB10Y*)

Variable	**Coefficient**
TB3M	0.223*** (0.000)
LN[CAD]	1.428** (0.038)
LN[TSX]	–1.394*** (0.000)
LN[BRENT]	0.476** (0.032)
USTB3M	–0.162*** (0.006)
UST10Y	0.917*** (0.000)
Error correction term (from the short-run equation)	–0.010*** (0.000)
Selected model	ARDL (2, 1, 0, 0, 1, 2, 0)
Sample	1 January 1990-31 December 2018
Observations	7564

Notes: 1) *** and ** indicate statistical significance at the 1% and 5% levels, respectively. 2) *p*-value is in parenthesis.

The next step involves establishing the causal ordering by applying the Granger causality test within the VECM framework. Results are displayed in table 6. As mentioned earlier, the SBIC was used to select the optimal lag length of two for carrying out these tests. Results indicate that, in the short run, ΔTB3M does not Granger cause ΔGB10Y. However, ΔGB10Y Granger causes ΔTB3M when the latter is included in the equation as the dependent variable. Therefore, it can be argued that there is unidirectional causality from long-term bond yields to the short-term interest rate in the short run. Among other variables, there is evidence of a bidirectional causal relationship between ΔGB10Y and ΔLN[TSX] and unidirectional causal relationships running from ΔGB10Y to ΔLN[CAD], ΔLN[TSX] and ΔUST10Y. ΔGB10Y Granger causes ΔLN[BRENT] and ΔUSTB3M only at the 10% level. ΔLN[CAD] and ΔLN[TSX] also Granger cause ΔTB3M and ΔLN[BRENT]. ΔTB3M Granger causes ΔLN[TSX].

The above findings would suggest that, in the short run, the Keynesian conjecture does *not* hold for Canada. That is, the daily changes in the short-term interest rate do not appear to precede the daily changes in the long-term interest rate in the Canadian government bond market. Suffice to say, the words of Keynes are not quite divine, even though the Keynesian perspective is useful over a long horizon. Day-to-day fluctuations of long-term government bond yields may well be driven by a host of incoming information as well as noise. These are not fully encapsulated in the daily changes in the short-term interest rate. In contradistinction, in the long run, long-term government bond yields appear to be more influenced by monetary policy, the short-term interest rate, and various macroeconomic fundamentals.

Table 6 – *Granger causality within VECM framework*

Causal direction	**χ2**
ΔTB3M → ΔGB10Y	3.890 (0.143)
ΔLN[CAD] → ΔGB10Y	0.484 (0.785)
ΔLN[TSX] → ΔGB10Y	12.277*** (0.002)
ΔLN[BRENT] → ΔGB10Y	0.627 (0.731)
ΔUSTB3M → ΔGB10Y	2.248 (0.325)
ΔUST10Y → ΔGB10Y	3.737 (0.154)
All	20.740* (0.054)
ΔGB10Y → ΔTB3M	241.177*** (0.000)
ΔLN[CAD] → ΔTB3M	6.705** (0.035)
ΔLN[TSX] → ΔTB3M	5.857* (0.054)
ΔLN[BRENT] → ΔTB3M	1.485 (0.476)
ΔUSTB3M → ΔTB3M	137.415*** (0.000)
ΔUST10Y → ΔTB3M	77.729*** (0.000)
All	445.566*** (0.000)
ΔGB10Y → ΔLN[CAD]	12.260*** (0.002)
ΔTB3M → ΔLN[CAD]	0.953 (0.621)
ΔLN[TSX] → ΔLN[CAD]	176.114*** (0.000)
ΔLN[BRENT] → ΔLN[CAD]	7.984** (0.019)
ΔUSTB3M → ΔLN[CAD]	13.458*** (0.001)
ΔUST10Y → ΔLN[CAD]	1.291(0.525)
All	231.621*** (0.000)
ΔGB10Y → ΔLN[TSX]	20.987*** (0.000)
ΔTB3M → ΔLN[TSX]	8.380** (0.015)
ΔLN[CAD] → ΔLN[TSX]	19.600*** (0.000)
ΔLN[BRENT] → ΔLN[TSX]	0.727 (0.695)
ΔUSTB3M → ΔLN[TSX]	7.604** (0.022)
ΔUST10Y → ΔLN[TSX]	3.307 (0.191)
All	73.569*** (0.000)
ΔGB10Y → ΔLN[BRENT]	4.715* (0.095)
ΔTB3M → ΔLN[BRENT]	3.785 (0.151)
ΔLN[CAD] → ΔLN[BRENT]	114.808*** (0.000)
ΔLN[TSX] → ΔLN[BRENT]	54.722*** (0.000)
ΔUSTB3M → ΔLN[BRENT]	1.685 (0.431)
ΔUST10Y → ΔLN[BRENT]	2.140 (0.343)
All	249.298*** (0.000)
ΔGB10Y → ΔUSTB3M	4.871* (0.088)
ΔTB3M → ΔUSTB3M	3.947 (0.139)
ΔLN[CAD] → ΔUSTB3M	2.131 (0.345)
ΔLN[TSX] → ΔUSTB3M	4.224 (0.121)
ΔLN[BRENT] → ΔUSTB3M	5.163* (0.076)
ΔUST10Y → ΔUSTB3M	7.579** (0.023)
All	34.596*** (0.005)
ΔGB10Y → ΔUST10Y	25.411*** (0.000)
ΔTB3M → ΔUST10Y	0.544 (0.762)
ΔLN[CAD] → ΔUST10Y	1.740 (0.419)
ΔLN[TSX] → ΔUST10Y	6.706** (0.035)
ΔLN[BRENT] → ΔUST10Y	0.089 (0.956)
ΔUSTB3M → ΔUST10Y	6.529** (0.038)
All	42.061*** (0.000)

Notes: 1) ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. 2) *p*-value is in parenthesis.

As part of a robustness check, a similar set of regressions was run where the dependent variable GB10Y was replaced with GB30Y and one of the control variables UST10Y was replaced with UST30Y. The results from these regressions are similar to what have been discussed here. These results are presented in tables A1, A2, A3 and A4 in Appendix A.

Further, to examine the inclusion of NDEBTq on the dynamics between GB10Yq and other variables, and to understand the impact of NDEBTq on Canadian long-term securities yields, Equation (4) has been estimated. The results are shown in tables B1 and B2 in Appendix B. Results from both the *F*-test and *t*-test statistics suggest evidence of long-run level relationships. Comparing the new long-run results (table B2) with the original results (table 5), it is evident that the signs of the coefficients remain unchanged. But several control variables, including LN[CAD], LN[TSX] and LN[BRENT], are not statistically significant in the new regression. Nonetheless, the coefficient of TB3Mq, the key variable of interest, is still statistically significant at the 1% level and is strongly associated with GB10Yq in the long run.

Interestingly, the coefficient of NDEBTq is positive and statistically significant at the 5% level. This means that an increase in the government's debt to GDP ratio tends to increase long-term bond yields in Canada. This supports the earlier findings of Paccagnini (2016), Poghosyan (2014) and Tkačevs and Vilerts (2019) that an increase in debt/deficit ratios can increase government bond yields. Although the finding is statistically significant, the economic and financial effect of a higher net debt ratio on Canadian government bond yields is fairly modest. A one-percent point increase in the net debt ratio leads to less than a 3-bps increase in 10-year bond yields, which can be characterized as quite muted and modest. A higher fiscal net debt ratio should not be a cause for alarm in Canada.

5. Policy issues, open questions and future research

This paper examines the Keynesian perspective on the relationship between Canadian government securities yields and the short-term interest rate by examining their long-run and short-run dynamics. A set of macroeconomic and financial variables is included in the regressions to control for the variables' potential impacts on government securities yields. The short-term and long-term interest rates, along with other control variables, are found to be cointegrated. It is also established that the long-term interest rate can be plausibly modelled as a function of the short-term interest rate and other macroeconomic factors for a long-run horizon. However, in the short-run horizon, which is the daily change in bond yields, the Keynesian conjecture does *not* hold for Canada. Although not the primary focus of the paper, inclusion of the Canadian federal government debt ratio did not change the dynamics between the short-term interest rate and long-term government bond yields in Canada. Nonetheless, there is evidence of a positive long-run relationship between debt net ratio and long-term government bond yields.

The empirical findings reported in the paper have implications for both economic theory and public policy. The findings have implications for the ongoing debate in macroeconomics as reflected in the literature pertaining to the implementation of monetary policy and central bank operations (Bindseil, 2004; Fullwiler, [2008] 2017; Kregel, 2011; Lavoie, 2014), fiscal theory of price (Sims, 2013) and other issues on monetary policy (Wray, 2012). From the results, one can argue that the Bank of Canada's actions affect Canadian government bond yields primarily through the short-term interest rate on Treasury bills in the long run. This supports Keynes's view that the central bank's actions influence the long-term interest rate on government bonds mainly through the effects of its actions on the short-term interest rate, at least in the long run. The findings also show that, while the short-term interest rate is an important driver of the long-term interest rate on Canadian government securities yields, other factors, such as the equity index, also matter. It would be plausible to conjecture based on the results obtained so far that, if the Bank of Canada is willing to keep the short-term interest low, then it can prevent a spike in government bond yields over the long-run horizon. In particular, if the Bank of Canada keeps the short-term interest rate low in combination with other instruments of monetary policy actions, such as large-scale asset purchases, forward guidance and so forth, there is no reason to doubt the Bank of Canada's ability to keep the long-term interest rate low over the long-run horizon. Likewise, the Bank of Canada can exert upward pressure on the long-term interest rate over the long-run horizon by raising the policy rate in conjunction with other measures.

These findings are relevant for policy issues in Canada and elsewhere. The findings can inform the Bank of Canada in formulating its monetary policy in both a long-term and a short-term horizon. It can provide useful information to the monetary authorities in assessing and evaluating the monetary transmission. Further, these results can help policymakers in making decisions concerning fiscal policy and in assessing the impact of fiscal stimulus and contraction on long-term interest rates on Canadian government bonds.

Results from this paper have implications for investors. It is evident from the paper that the Bank of Canada's monetary policy decisions and changes in the short-term interest rate can have crucial effects on the value of long-term government bonds and spread products in investors' portfolios. Investors concerned about asset allocation in Canadian government securities and various spread products, such as mortgage-backed securities, need to be mindful of the central bank's decisions. In particular, investors need to pay heed to the effect of changes of the *current* short-term interest rate on asset values of long-term securities.

To draw a more complete picture on the determinants of long-term government securities yields, findings from this paper should be supplemented with additional results obtained from macroeconomic models that incorporate quarterly macroeconomic data, not just those concerning ratios of government debt and fiscal deficits to GDP. Indeed, it would be useful to analyze the effects of additional variables, such as credit flows, global financial flows, volatility, liquidity, and risk aversion in Canadian financial markets. Given Canada's deep, complex, and multidimensional ties to the US, it would be very sensible to examine the effects of US financial and macroeconomic variables on the long-term interest rate in Canada. Future research should examine these matters.

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Appendix A

Table A1 – *Johansen cointegration test*

Hypothesized number of cointegrating equations	Eigenvalue	Trace statistic	Maximum eigenvalue statistics
None	0.008	161.990*** (0.000)	58.023*** (0.002)
At most 1	0.006	103.967** (0.012)	41.501** (0.034)
At most 2	0.004	62.466 (0.168)	31.344* (0.097)
At most 3	0.002	31.123 (0.660)	18.109 (0.486)
At most 4	0.001	13.031 (0.891)	8.345 (0.881)

Notes: 1) The cointegrating relationship is between GB30Y, TB3M, LN[CAD], LN[TSX] LN[BRENT], USTB3M and UST30Y. 2) ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. 3) *p*-value is in parenthesis. 4) Determination: 2 cointegrating relationships at least at the 5% level.

Table A2 – *F and T tests*

Equation	*F*-statistic		*t*-statistic	
GB30Y=F³(TB3M, LN[CAD], LN[TSX], LN[BRENT], USTB3M, UST30Y)	3.531*		−4.659**	
	I(0)	I(1)	I(0)	I(1)
10%	2.12	3.23	−2.57	−4.04
5%	2.45	3.61	−2.86	−4.38
1%	3.15	4.43	−3.43	−4.99

Note: ** and * indicate statistical significance at the 5% and 10% levels, respectively.

Table A3 – *Long-run ARDL results (dependent variable: GB30Y)*

Variable	Coefficient
TB3M	0.154** (0.026)
LN[CAD]	1.435 (0.112)
LN[TSX]	−1.614*** (0.000)
LN[BRENT]	0.442 (0.132)
USTB3M	−0.055 (0.416)
UST30Y	0.852*** (0.000)
Error correction term (from the short-run equation)	−0.006*** (0.000)
Selected model	ARDL (1, 1, 0, 0, 1, 2, 0)
Sample	1 January 1990-31 December 2018
Observations	7304

Notes: 1) *** and ** indicate statistical significance at the 1% and 5% levels, respectively. 2) *p*-value is in parenthesis.

Table A4 – *Granger causality within VECM framework*

Causal direction	**χ2**
ΔTB3M → ΔGB30Y	2.784 (0.249)
ΔLN[CAD] → ΔGB30Y	0.279 (0.870)
ΔLN[TSX] → ΔGB30Y	5.679* (0.059)
ΔLN[BRENT] → ΔGB30Y	2.047 (0.359)
ΔUSTB3M → ΔGB30Y	1.484 (0.476)
ΔUST30Y → ΔGB30Y	4.572 (0.102)
All	14.920 (0.246)
ΔGB30Y → ΔTB3M	225.518*** (0.000)
ΔLN[CAD] → ΔTB3M	4.145 (0.126)
ΔLN[TSX] → ΔTB3M	3.569 (0.170)
ΔLN[BRENT] → ΔTB3M	2.255 (0.324)
ΔUSTB3M → ΔTB3M	135.664*** (0.000)
ΔUST30Y → ΔTB3M	82.444*** (0.000)
All	416.622*** (0.000)
ΔGB30Y → ΔLN[CAD]	7.456** (0.024)
ΔTB3M → ΔLN[CAD]	1.430 (0.489)
ΔLN[TSX] → ΔLN[CAD]	165.441*** (0.000)
ΔLN[BRENT] → ΔLN[CAD]	9.871*** (0.007)
ΔUSTB3M → ΔLN[CAD]	14.721*** (0.001)
ΔUST30Y → ΔLN[CAD]	13.312*** (0.001)
All	230.970*** (0.000)
ΔGB30Y → ΔLN[TSX]	21.980*** (0.000)
ΔTB3M → ΔLN[TSX]	11.113*** (0.004)
ΔLN[CAD] → ΔLN[TSX]	18.956*** (0.001)
ΔLN[BRENT] → ΔLN[TSX]	1.505 (0.471)
ΔUSTB3M → ΔLN[TSX]	6.758** (0.034)
ΔUST30Y → ΔLN[TSX]	5.878* (0.053)
All	68.943*** (0.000)
ΔGB30Y → ΔLN[BRENT]	1.399 (0.497)
ΔTB3M → ΔLN[BRENT]	4.695* (0.096)
ΔLN[CAD] → ΔLN[BRENT]	121.422*** (0.000)
ΔLN[TSX] → ΔLN[BRENT]	61.814*** (0.000)
ΔUSTB3M → ΔLN[BRENT]	1.173 (0.556)
ΔUST30Y → ΔLN[BRENT]	2.829 (0.243)
All	272.455*** (0.000)
ΔGB30Y → ΔUSTB3M	0.921 (0.631)
ΔTB3M → ΔUSTB3M	1.669 (0.434)
ΔLN[CAD] → ΔUSTB3M	2.027 (0.363)
ΔLN[TSX] → ΔUSTB3M	3.870 (0.144)
ΔLN[BRENT] → ΔUSTB3M	5.470* (0.065)
ΔUST30Y → ΔUSTB3M	6.483** (0.039)
All	31.832*** (0.002)
ΔGB30Y → ΔUST30Y	10.450*** (0.005)
ΔTB3M → ΔUST30Y	2.562 (0.278)
ΔLN[CAD] → ΔUST30Y	0.093 (0.955)
ΔLN[TSX] → ΔUST30Y	6.043** (0.049)
ΔLN[BRENT] → ΔUST30Y	1.395 (0.498)
ΔUSTB3M → ΔUST30Y	2.473 (0.290)
All	23.416** (0.024)

Notes: 1) ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. 2) *p*-value is in parenthesis.

Appendix B

Table B1 – *F and T tests (quarterly variables)*

Equation	***F*-statistic**		***t*-statistic**	
GB10Yq=F^4(TB3Mq, LN[CADq], LN[TSXq], LN[BRENTq], USTB3Mq, UST10Yq, NDEBTq)	3.257*		–5.277***	
	I(0)	I(1)	I(0)	I(1)
10%	2.03	3.13	–2.57	–4.23
5%	2.32	3.50	–2.86	–4.57
1%	2.96	4.26	–3.43	–5.19

Note: *** and * indicate statistical significance at the 1% and 10% levels, respectively.

Table B2 – *Long-run ARDL results (quarterly variables; dependent variable: GB10Yq)*

Variable	**Coefficient**
TB3Mq	0.354*** (0.000)
LN[CADq]	1.247 (0.161)
LN[TSXq]	–0.426 (0.389)
LN[BRENTq]	0.389 (0.209)
USTB3Mq	–0.350*** (0.000)
UST10Yq	1.012*** (0.000)
NDEBTq	0.027** (0.040)
Error correction term (from the short-run equation)	–0.274*** (0.000)
Selected model	ARDL (1, 1, 1, 1, 0, 1, 0, 0)
Sample	Quarter 1, 1990-Quarter 4, 2018
Observations	115

Notes: 1) *** and ** indicate statistical significance at the 1% and 5% levels, respectively. 2) *p*-value is in parenthesis.