

The effectiveness of the interest rate channel in the conduct of monetary policy, and the relationship between long-term and short-term interest rates in the Canadian context

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Abstract

The aim of this paper is to investigate whether the Bank of Canada has been successful in conducting monetary policy through one of the most important channels of transmission mechanism -- the interest rate transmission channel -- specially after the mid-1990s, when the overnight rate became the main concern of Canadian monetary policy, gravitating around the target overnight rate, set by the Bank of Canada. The analysis is based on theories of the monetary transmission mechanism and introduces market expectation as an important role in the response of long-term rates to the change of monetary policy. The econometric methodology is implemented through a cointegrated VAR model in which short-term interest rates and long-term interest rates are the outstanding variables of the model. Although casual observation suggests a much looser and more variable connection between the central bank actions and long-term interest rates, the empirical results reveal the existence of a relatively strong but sluggish relationship between them.

Keywords: term structure, monetary transmission, interest rate channel, cointegration, VAR, fractional cointegration.

... even though we may know our destination and the general route by which we must get there, conducting monetary policy . . . is akin to driving without full vision—perhaps like driving in a rainstorm with defective windshield wipers. It can be done, but only very carefully.

(Crow 1988)

I. Introduction

If you visit the website of the Bank of Canada, you will find its slogan, “The monetary policy formulated by the Bank of Canada contributes to solid economic performance and rising living standards for Canadians by keeping inflation low, stable, and predictable.” What does that mean in an economic sense? When you hear through the CBC finance news that the Bank of Canada is raising the bank rate by 50 basis points, you might realize that you will obtain more interest income from your cheque account’s balance; but what you really care is what effect this might have on the costs of your house mortgage or car loan. Will they both increase? By what magnitude? Before we answer these questions, let us look at another example regarding interest rates with real data from statistics of the Bank of Canada. In March of 2001, the average weighted yield on 10-year and over corporate bonds was 7.11%. From then on, the Bank of Canada started implementing the first of a rapid-fire string of ten reductions in the overnight rate target. One year later, the overnight rate target was a full 300 basis points lower! Very-short-term market rates also fell, but there was only a scant impact on long-term interest rates. In March of 2002, the yield on the 10-year and over corporate bonds was 7.15%, even slightly higher than its value one year before that.

How can this be? By conventional wisdom, reducing the overnight rate by the magnitude experienced from year 2001 to 2002 should have had some impact on longer-term interest rates. Why hasn't this happened? Does it mean that monetary policy has lost its effectiveness? Or on the contrary, it is, paradoxically, precisely because monetary policy has been so effective in recent years that long-term rates have failed to budge as short rates have plunged, since the effectiveness of monetary policy is ultimately measured by the central bank's ability to provide liquidity without raising the specter of inflation.

In theory, it is generally believed that monetary policy actions are transmitted to the economy through their effect on market interest rates. According to this standard view, a restrictive monetary policy by the central bank pushes up both short-term and long-term interest rates, leading to less spending by interest-sensitive sectors of the economy such as housing, consumer durable goods, and business fixed investment. Conversely, an easier policy results in lower interest rates that stimulate economic activity. Unfortunately, this description of the monetary policy process is difficult to reconcile with the actual behavior of interest rates. Although casual observation suggests a close connection between overnight rate actions and short-term interest rates, the relationship between policy and long-term interest rates appears much looser and more variable. In addition, some empirical studies that attempt to measure the impact of policy actions on long-term rates generally find only a weak relationship. Taken together, the empirical studies and the observed behavior of interest rates appear to challenge the standard view of the monetary transmission mechanism, especially that of the interest rate channel, and raise questions about the effectiveness of monetary policy.

The present paper attempts to reconcile theory and reality by reexamining the connection between monetary policy and long-term interest rates, mainly in the Canadian context, in the

following ways.

On the theoretical side, using a framework that emphasizes the importance of market expectations of future monetary policy actions, the paper argues that the relationship between policy actions and long-term rates is likely to vary over the business cycle as financial market participants alter their views on the persistence of policy actions. Accordingly, the standard view of the monetary transmission mechanism appears to provide an overly simplistic view of the policy process.

On the practical side, the paper underscores the importance of increasing transparency and communication in the conduct of monetary policy by the Bank of Canada since the mid-1990s, when the overnight rate target has been set officially. The central bank needs to ensure that its outlook for the future and its commitment to a particular course of action are clearly communicated to the public. The explanation can also provide a rationale for signaling, as the central bank does when it announces its views regarding future policy.

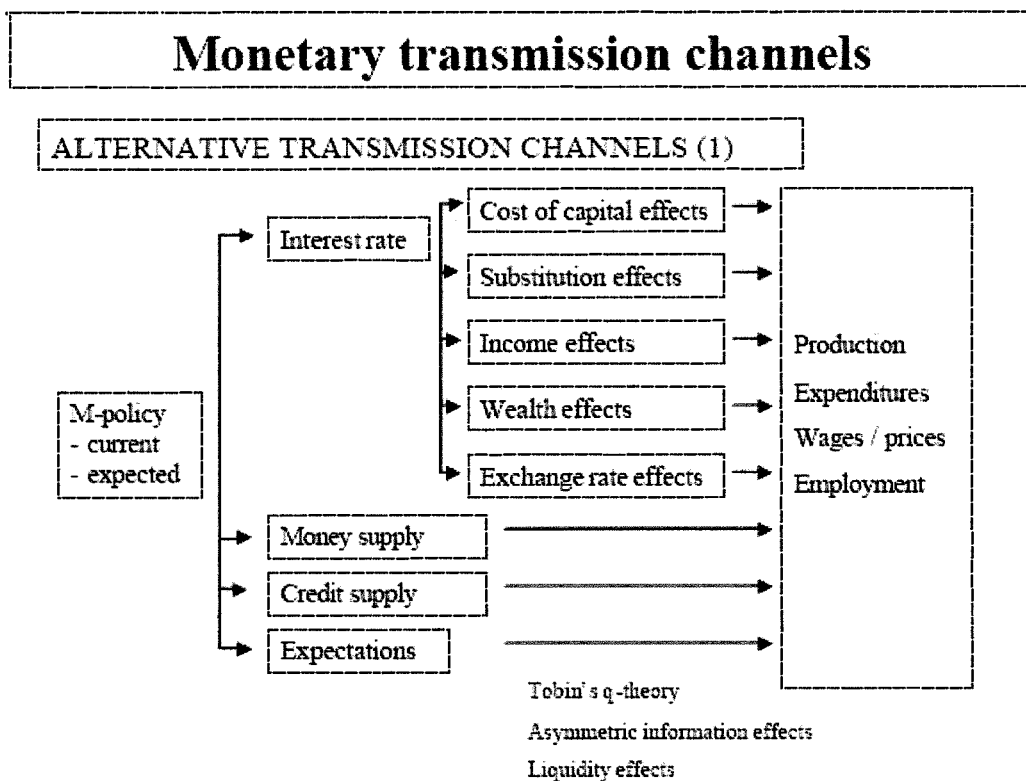
On the empirical side, the main objective then is to explore whether there exists an equilibrium long-term relationship between short-term and long-term interest rates with the aid of econometric tools. The results of my initial tests with standard cointegration techniques don't seem to support the existence of such long-term relationships. However, given that others have validated such a relationship, the contradiction may be due to the fact that the traditional concept of cointegration is too restrictive. I thus further propose here to refer to the results of a more rigorous test technique -- fractional cointegration -- and modify some of my original tests' parameters. The new results of the modified tests with Canadian data sources show that such an equilibrium long-term relationship does exist while it is not the case according to the usual cointegration tests.

The rest of this paper is organized as follows: The second section reviews alternative theoretical views of the monetary transmission mechanism in the literatures, focusing on the interest rate channel, and examines their consistency with actual interest rate behavior. The third section describes the monetary operations of the Bank of Canada, especially after the mid-1990s when the overnight rate became the main concern of Canadian monetary policy. The fourth section outlines the econometric methodology and the strategy used to search for connections in the Canadian data, and presents the results of the associated tests. The paper concludes with a summary and issues to be taken up in future research.

II. An overview of theories of the monetary transmission mechanism, focusing on the interest rate channel

1. The graphical description of the traditional monetary transmission channels (As depicted by Figure 1)

Figure 1: Alternative transmission channels



Source: Mishkin, F. (1996)

2. The important implications of the interest rate channel in the conduct of monetary policy.

An important part of monetary policy is the monetary transmission mechanism, the process by

which monetary policy actions influence the economy. While the transmission mechanism involves a number of channels, including exchange rates, bank credit, and asset prices, most economists consider interest rates to be the principal avenue by which monetary policy affects economic activity. In a simple, stylized view of the interest rate channel, monetary policy first influences bank lending rates and short-term market interest rates. Changes in short-term rates are then transmitted to long-term rates. Finally, economic activity responds as businesses and consumers react to these changes in interest rates.

The following theories elaborate the mechanism of the interest rate channel in the conduct of monetary policy from different perspectives.

(1) Keynes' theory (Liquidity preference and relation to short-term and long-term interest rates), evaluated from a Post-Keynesian perspective (Lavoie and Seccareccia, 2004, pp.164-165)

As articulated by Lavoie and Seccareccia (2004, p.165) "In his famous chapter 15 of *the General Theory*, Keynes had elaborated a theory of liquidity preference based on the crucial link between short-term and long-term interest rates. Although his assumption of money exogeneity has been questioned by Post-Keynesian economists, his views on the link between short-term and long-term interest rates show a profound understanding of the institutional structure of his time. Based on the experience of the United States during the early 1930s, he contended that central bank policy was confined to effectuating changes in the short-term interest rates and because of the existence of speculation in the financial markets and arbitrage between the financial and non-financial sectors, such interaction may frustrate the central bank's desire to effectuate changes also at the long end of the yield curve."

In this view, Keynes' position was that nothing prevented both rates from being under the effective control of the central bank while recognizing the existence of an appropriate spread between the two rates due to factors pertaining to risk. It was merely the particular institutional structure where the central bank is empowered to intervene at the short end only, with long-term interest rates being left to market forces, which gives the peculiarities of the yield curve.

(2)Recent contributions to the explanation of the classical interest rate channel (Taylor, 1995)

These authors infer that, at the very least, the influence of interest rates on economic activity affects the components of domestic demand. These contributions suggest that monetary authorities use their leverage over short-term interest rates to influence a set of prices, primarily the prices (cost) of capital and future consumption in comparison with current consumption. This also influences the relative price of domestic goods in comparison with foreign goods, particularly in terms of long-term interest rates and the exchange rate. Therefore, changes in short-term interest rates are transmitted to the real cost of capital, changing the optimal capital-output ratio and the required return from investment projects, as well as the rate of business investment.

The monetary transaction mechanism under this view works through the liability side of bank balance sheets. There are two necessary conditions for the money channel to work. First, banks cannot perfectly shield transaction balances from changes in reserves. Second, there is no close substitute for money in the conduct of transactions in the economy.

This conventional story, however, is not quite successful in explaining U.S. data. Bernanke and

Gertler (1995, pp.27-48) provide two explanations that make the conventional story incomplete.

First, empirical studies find spending fairly insensitive to interest rates. Second, monetary policy should have its strongest influence on short-term interest rates like the Federal funds rate and its weakest effect on long-term rates. It is, therefore, puzzling that monetary policy apparently has large effects on purchases of long-lived assets which respond to real long-term rates.

However, researchers have more recently recognized the importance of the monetary transmission mechanism through interest rates and make many crucial arguments. Taylor (1995, pp.13-18) argues that financial market prices are key components of how monetary policy affects real activities. In his model, a tightening monetary policy raises short-term interest rates. Since prices and wages are assumed to be rigid, real long-term interest rates increase as well. These higher real long-term rates lead to a decline in real investment, real consumption, and thereby on real GDP. In the long run, after wages and prices of goods begin to adjust, real GDP returns to normal.

In summary, the traditional view emphasizes the role of interest rates in responding to monetary policy and affecting economic activity. Monetary tightening transmitted to the real economy can be characterized by:

Tight monetary policy --> interest rate (up) --> investment (down) --> output (down).

(3)The *standard* view of the monetary transmission mechanism (John Hicks's, 1939) and the *augmented* expectations theory of the term structure (Campbell, 1995, pp.129-152)

The standard view of the monetary transmission mechanism relies on a **simple** version of the expectations theory of the term structure of interest rates. In this theory, long-term interest rates

are an average of current short-term rates and expected future short-term rates. Monetary policy affects long-term rates to the extent that it influences current and expected short-term rates.

In the standard view of the transmission mechanism, the relationship between policy actions and long-term rates is assumed to be straightforward. An increase in the desired level of the federal funds rate causes current short-term rates and expected future short-term rates to rise, which pushes up interest rates across all maturities. Similarly, a decrease in the desired funds rate causes current and expected future short-term rates to fall and leads to lower short-term and long-term rates.

In the standard view of the monetary transmission mechanism, monetary policy actions are expected to have a strong, positive effect on long-term rates. In contrast to this theory, the actual relationship between policy actions and long-term rates appears weaker and more variable.

To reconcile the actual behavior of long-term interest rates with the standard view of the monetary transmission mechanism requires a framework for understanding how policy actions affect the term structure of interest rates. The **augmented** expectations theory of the term structure was offered to suggest there is **no simple** relationship between policy actions and long-term rates. Rather, the reaction of long-term rates to policy actions can be highly variable depending on changing views of market participants as to the future direction of monetary policy.

In this framework of this complementary expectations theory, monetary policy can affect long-term rates partly by changing forward rates. Depending on how market participants interpret policy changes, the reaction of forward rates to policy changes may differ over time,

resulting in a variable response of long-term rates to policy actions.

According to this revised expectations theory, both the direction and magnitude of the response of long-term rates to monetary policy depend on market perceptions of future policy actions. In this framework, a strong, positive connection between long-term rates and policy actions is certainly possible. However, other patterns may also occur depending on investors' views as to the persistence of policy actions.

To a considerable degree, long-term rates appear to anticipate policy changes, moving well in advance of policy actions. Previous studies, which focus on the behavior of long-term rates only around the day of the policy action, do not fully capture these anticipation effects and so understate the relationship between policy actions and long-term rates.

In a nutshell, because market expectations play such an important role in the response of long-term rates to monetary policy, however, the connection between policy actions and long-term rates is likely to be more variable than suggested by the standard view of the monetary transmission mechanism. Monetary policy actions are likely to be most effective in changing long-term rates when these actions are seen as persistent. Consequently, to the extent that investors' views about the persistence of monetary policy actions change over the business cycle, the ability of monetary policy to influence long-term rates may vary over time.

III. The recent practice and conduct of monetary policy through the interest rate channel in Canada -- from the Post-Keynesian view

In the early 1990's the Canadian economy experienced the stagnation and a prolonged recovery while the United States economy enjoyed a continuation of the "Long Boom". When explaining the Canadian economic performance during that period, there exists perhaps a unique consensus among policy analysts that the major recession had essentially been brought by the overzealous near-zero inflation policy of Bank of Canada. This situation is exactly described by Lavoie(Dec.,2003,p.4): "Prior to 1991, Canada had a textbook monetary system: Commercial banks faced reserve ratios on their deposits, advances to banks at the discount window were strongly discouraged, and open market operations by the Bank of Canada were frequent." The discount rate (the Bank rate) was set as a mark-up over the Treasury bill rate, giving the illusion that financial markets, not the central bank, were responsible for the high interest rates that were then prevailing. The only peculiar characteristic was the use of transfers of government deposits, from the accounts of the central bank to those of commercial banks (or vice-versa) to increase (or decrease) the amount of high-powered money. From the mid-1990s, with impetus for change from various sources, the central bank made significant changes to the way they operate from then on, and has acquired greater operational independence to pursue its policy objectives up until now. It has also become a more open institution. Increased emphasis on communication and transparency is seen as important not only in terms of accountability to

the public, but for increasing the effectiveness of policy actions and for reducing economic uncertainty.

Today, the Bank of Canada announces that it carries out monetary policy with the aim of protecting the value of Canadian money by keeping inflation low and stable. And monetary policy is implemented mainly through changes in the target for the overnight rate which influence other interest rate and affect the level of spending and economic activity in the country. Since changes to the Bank Rate do not immediately affect the economy in a manner that is readily predictable, the transmission mechanism of monetary policy has long and variable lags because the economy takes time to adjust to changes in monetary conditions.

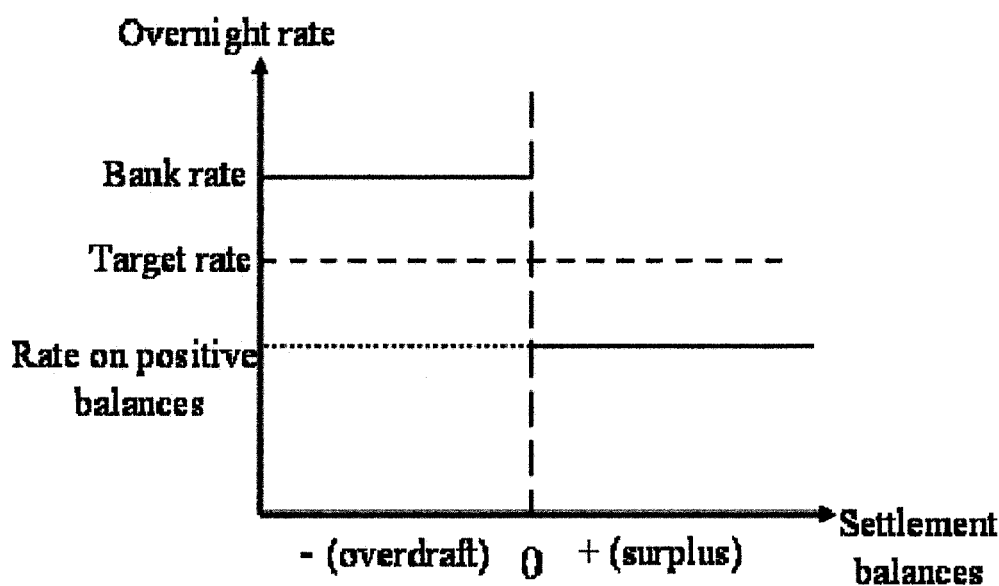
When it comes to how to conduct new policy actions, Lavoie (Oct., 2003, p.1) points out that:

“There are no reserve requirements any more in Canada, and the Bank of Canada does not enter into outright open market operations. This makes the monetary operations particularly transparent. The overnight rate, which is now the main concern of Canadian monetary policy, gravitates around the target overnight rate, set by the Bank of Canada. The discrepancy between the two rates is seldom more than one basis point. This is explained by the fact that the Bank of Canada knows with perfect certainty both its supply of settlement balances and the demand for settlement balances. In addition, the Bank has a symmetric system, whereby excess balances are remunerated at 25 basis points below the overnight rate target, while deficit balances are costed at 25 basis points above the target rate. The institutional and technical analysis shows that central banks engage essentially into ‘defensive’ operations.”

Put in another way, short-term interest rates are the exogenous variable under the control of central banks. The central banks do not, nor can they, control any monetary aggregate.

How does the new procedure determine the actual overnight rate after an official target overnight rate was put in place in 1995? The answer is illustrated in Figure 2, adapted from Clinton (1997): The target rate is in the middle of the operating band. Its upper limit is the Bank rate (the discount rate), at which commercial banks can borrow settlement balances (reserves); its lower limit is the rate on positive settlement balances – the rate paid on bank deposits at the central bank.

Figure 2: The operation of the settlements system



Source: Clinton (1997), Bank of Canada.

Clinton (1997, p.11) argues that in normal times both the supply and the demand for settlement balances are given by the vertical line arising from the zero level of settlement balances. “Since equality of demand and supply is represented by the intersection of two vertical lines (at zero quantity), on any given day the precise overnight rate at which the market settles is indeterminate within the 50-basis-point operating band. The actual rate will be influenced by a

variety of technical factors, such as the size and distribution of clearing imbalances among the banks”.

With the new procedures, tied to zero-reserve requirements, near-perfect certainty on the demand for settlement balances and absolute control over the supply of settlement balances, the Bank is able to control the overnight rate to the tune of one basis point. When target rates are changed, overnight rates move instantaneously to their new position.

Another feature that is worth noting is that overnight rates change in response to target rates without central banks having to add or subtract any amount of settlement balances. The Bank of Canada keeps targeting zero settlement balances, even when a new rate is announced. The target rate set by the central bank, with its operating band, provides an anchor to the financial system. The anchor is credible because the Bank of Canada has the capacity to enforce it. If the overnight rate were to wander away from the target, the Bank could get it back on track.

As Wray (1998,p.107) correctly concludes, “the Canadian system makes central bank operations more transparent – reserves are not a lever to be used to control the money supply. The Bank of Canada intervenes to keep net settlement balances at zero, an operation that by its very nature must be defensive”.

IV. Econometric methodology and test results

A. The econometric methodology

Before we start to explore empirical results, it is necessary to offer a brief introduction to econometric methodology. Since the data used in all the following tests are time series, in modern time-series econometrics it has become standard practice first to use unit root tests to verify the order of integration of each variable entering a model. If variables are found to be integrated of order one, denoted $I(1)$, then the focus shifts towards locating cointegrating relationships between these variables in order to exploit any long-run equilibrium properties of the data. Johansen cointegration tests can be performed to examine whether a group of non-stationary series is cointegrated. If there exists such a cointegration relationship, a Vector Error Correction Model (VECM) might then be estimated. Finally given the special case we are studying, the paper also addresses the need to use fractional cointegration as a complementary analysis technique to modify test parameters used in the standard cointegration tests.

1. The Unit Root tests

EViews performs two widely used unit root tests: the augmented Dickey-Fuller (ADF) tests and the Phillips-Perron (PP) test.

1-1. The Augmented Dickey-Fuller (ADF) test

It has the following form to control for the higher-order correlation:

$$\Delta y_t = \alpha y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \dots + \delta_p \Delta y_{t-p} + \varepsilon_t,$$

and the hypotheses are: $H_0: \alpha = 0$; $H_1: \alpha < 0$.

In this regression an important result obtained by Fuller is that the asymptotic distribution of the t-statistic on α is independent of the number of lagged first differences included in the ADF regression. Moreover, while the parametric assumption that y follows an autoregressive (AR) process may seem restrictive, Said and Dickey (1984, pp.599-607) demonstrate that the ADF test remains valid even when the series has a moving average (MA) component, provided that enough lagged difference terms are added to the regression.

1-2. The Phillips-Perron (PP) Test

It is more robust in the case of heterogeneously distributed errors.

2. Vector Auto regressions (VAR)

2-1 Specifications of VAR

The vector autoregression is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system.

The mathematical representation of a VAR is

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + B x_t + \varepsilon_t$$

where y_t is a k vector of endogenous variables, x_t is a d vector of exogenous

variables, A_1, \dots, A_p and B are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

2-2. Diagnostic Views

Once a VAR has been estimated, EViews 4.0 provides various views to work with the estimated VAR. In this section, we discuss VAR specific issues.

2-2-1. Lag Structure

Various criteria are computed to select the lag order of an unrestricted VAR. All the criteria are discussed in Lütkepohl (1991). The sequential modified likelihood ratio (LR) test is carried out as follows. Starting from the maximum lag, test the hypothesis that the coefficients on lag are jointly zero using the statistics.

2-2-2. Residual Tests

(1) Autocorrelation LM Test

The test reports the multivariate LM test statistics for residual serial correlation up to the specified order. The test statistic for lag order h is computed by running an auxiliary regression of the residuals u_t on the original right-hand regressors and the lagged residual u_{t-h} , where the missing first h values of u_{t-h} are filled with zeros. Under the null hypothesis of no serial correlation of order h , the LM statistic is asymptotically distributed χ^2 with k^2 degrees of freedom.

3. Johansen's Cointegration test

The Johansen's cointegration test is based on a VAR estimated of order p :

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + Bx_t + \varepsilon_t$$

where y_t is a n -vector of non-stationary $I(1)$ variables, x_t is a d -vector of deterministic variables, and ε_t is a vector of innovations, and rewrite the VAR as a VECM:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t$$

where

$$\Pi = \sum_{i=1}^p A_i - I$$

$$\Gamma_i = - \sum_{j=i+1}^p A_j$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there are $k \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta$, and βy_t is $I(0)$, r is the number of cointegrating relations (the rank), and each column of β is a cointegrating vector. The elements of α are known as the adjusted parameters in the VEC model. Johansen's method estimates the Π matrix from the VECM, and tests whether we can reject the restrictions implied by the reduced rank of Π .

To determine the number of the cointegrating relations, Johansen test proposes to use the following two statistics:

$$Q_r = -T \sum_{i=r-1}^k \ln(1 - \hat{\lambda}_i)$$

$$Q_{\max} = -T \ln(1 - \hat{\lambda}_{r+1})$$

where $\hat{\lambda}_i$ = the estimated values of the characteristic roots (also called eigenvalues), and T = the number of observations.

The first statistic tests the null hypothesis that the number of distinct cointegrating vectors is less than or equal to r against a general alternative. The second statistic tests the null hypothesis that the number of cointegrating vectors is r against the alternative of $r+1$ cointegrating vectors.

4. Vector Error Correction (VEC) models

A vector error correction (VEC) model is a restricted VAR designed for use with non-stationary series that are known to be cointegrated. The VEC model has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relation while allowing for short-run adjustment dynamics. The cointegration term is known as the correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

To take the simplest possible example, consider a two variable system with one cointegrating equation and no lagged difference terms. The cointegrating equation is $y_{2,t} = \beta y_{1,t}$, and the VEC model is

$$\Delta y_{1,t} = \alpha_1 (y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t}$$

$$\Delta y_{2,t} = \alpha_2 (y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{2,t}$$

In this simple model, the only right-hand side variable is the error correction term. In long run equilibrium, this term is zero. However, if y_1 and y_2 deviate from the long run equilibrium, the error correction term will be nonzero and each variable adjusts to partially restore the equilibrium relation. The coefficient α_i measures the speed of adjustment of the i -th endogenous variable towards the equilibrium.

B. The empirical test results

1. Data Description

In this study I use monthly data for a sample period 1985-2003, and all the data are retrieved from the Bank of Canada (*Selected Canadian and International Interest Rates including Bond Yields and Interest Arbitrage*) as follows:

1. Short-term interest rates:

1-1. Base rate – the overnight rate.

I take the overnight money market rate as the base series in all the tests, because since the late 1980s or early 1990s, the overnight rate was already considered as the key rate under the control of the central bank. It became officially so with the new "corridor" procedures in mid-1994, and the target rate started to be officially announced in February 1996.

I want to mention that since I start my study with data from the mid-1980s, it might be more appropriate to use the 3-month Treasury bill yield (*data source*: Bank of Canada, Treasury Bill Auction - Average Yields, 3month-B14007 (VI22541)) up until May 1994 to proxy the base rate, and the overnight rate (*data source*: Bank of Canada, Overnight money market financing (7-day average), B14044(VI22514)) from June 1994 until the end of 2003, for the reason just explained.

1-2. The prime rate (*data source*: Bank of Canada, Chartered Bank Administered Interest

Rates, Prime Business Loan, B14020(V122495))

The prime rate is the rate that banks give to their best and most credit-worthy customers. The rate fluctuates with the Bank of Canada decision to raise or lower short-term lending rates. The prime rate is a most important market short-term rate for the average consumer because loans such as home equity, mortgages, credit card, and automobile, rise and fall with this rate.

2. Long-term interest rates:

2-1. Average Yield of Government of Canada Marketable Bonds (over 10 years).

Data source: Bank of Canada, Government of Canada Marketable Bonds---Average Yield (over 10 years), B14013 (V122487)).

2-2. Average Weighted Yield (Scotia Capital)*of all corporates, long-term (over 10 years).

Data source: Bank of Canada, Other Bonds---Average Weighted Yield (Scotia Capital), B14048(V122518)).

Note:All tests are carried out with the Eviews 4.0 software.

2. A look at the sample Canadian interest rate time series

To set the stage, let us examine the selected time series data. The series are the overnight rate (*ON*), the prime rate (*PR*), the long-term corporate bond yield (*CB*), and the long-term government bond yield (*GB*). The tests include three separate groups :(1) *PR* vs. *ON*; (2) *CB* vs. *ON*; (3) *GB* vs. *ON*.

Figures 3, 4 and 5 are the plots of the data for the three groups just mentioned, respectively.

The overnight rate is nearly always below the other rates.

Figure3: Overnight rate and Prime rate

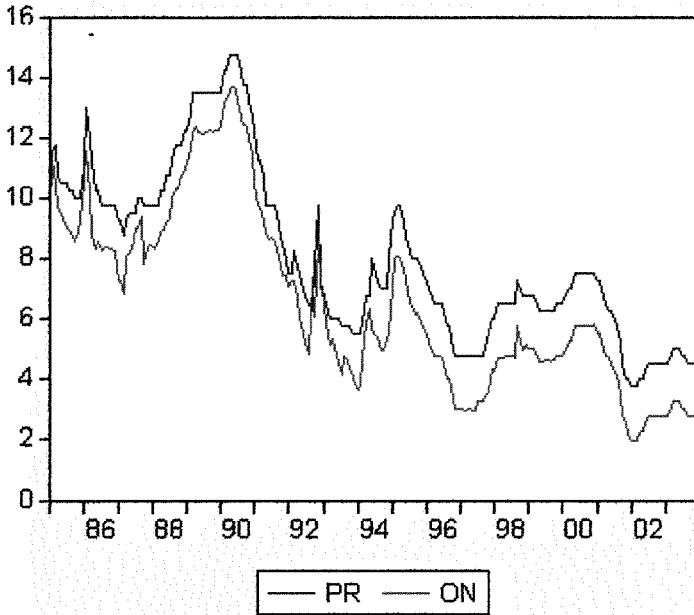


Figure 4: Overnight rate and long-term corporate bond yield

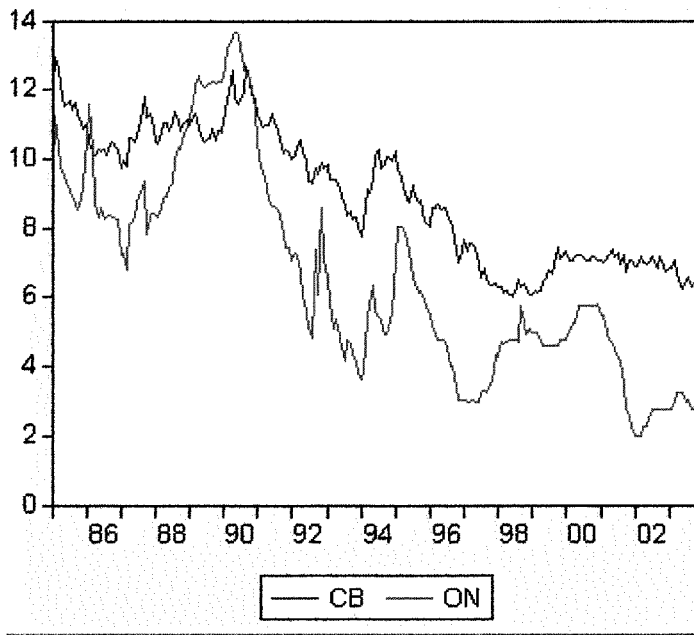
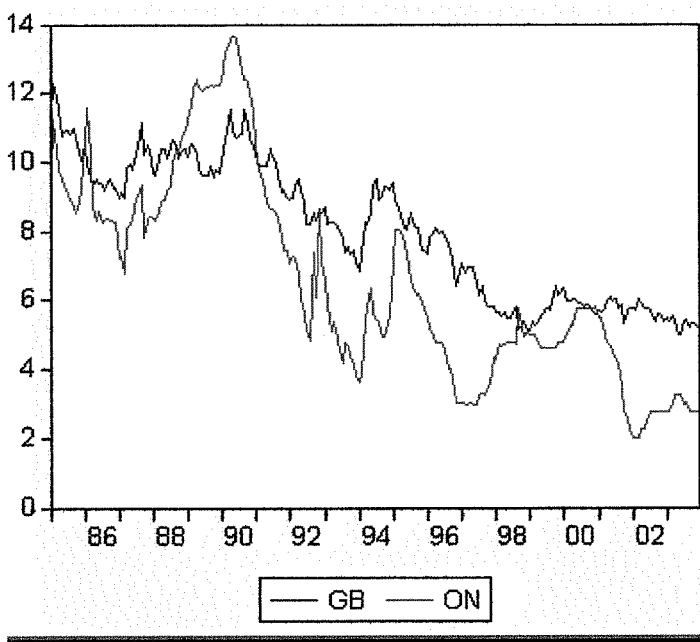


Figure 5: Overnight rate and long-term government bond yield



3. Unit root test results

I use both the Augmented Dickey-Fuller (ADF) test, which detects serial autocorrelation, and the Phillips-Perron test because of its robustness in the case of heterogeneously distributed errors.

About lag-length, it is suggested that the lag-length should normally be chosen on the basis of the formula reported in Schwert (1989, pp. 148-149), i.e., $l = \text{int} [12 * (T/100)^{1/4}]$ in ADF test; and truncation lag $q = \text{int} [4 * (T/100)^{2/9}]$ in Phillips-Perron test, where T is the sample size (in our case, $T = 228$).

The results of the two tests are very similar. As seen in Table 1, the t statistics are all less than the critical value (in absolute value) even at the 1% level, and we cannot reject the null hypothesis that each variable has a unit root in levels. Table 2 shows that the t statistics of all the interest rates in first difference are larger (in absolute value) than the critical value at least

at the 5% level, so we can reject the null hypothesis to conclude that variables in first differences are stationary.

Table1. Unit root test for variables in levels

Variables	lag length		truncation-lag	
	$=\text{int} [12*(T/100)^{1/4}]$	ADF test	$=\text{int}[4*(T/100)^{2/9}]$	Phillips-Perron test
ON	14	-2.55	4	-2.37
PR	14	-3.11	4	-2.18
CB	14	-2.33	4	-2.63
GB	14	-2.56	4	-3.00

Table2. Unit root test for variables in first difference

Variables	lag length		truncation-lag	
	$=\text{int} [12*(T/100)^{1/4}]$	ADF test	$=\text{int}[4*(T/100)^{2/9}]$	Phillips-Perron test
D(ON)	14	-3.60**	4	-15.35***
D(PR)	14	-3.69**	4	-12.48***
D(CB)	14	-4.52***	4	-15.14***
D(GB)	14	-4.61***	4	-15.53***

Note:

1. *Regarding the problem of whether to include a constant, a constant and a linear trend, or neither in the test regression. The approach selected here is the tests with both a constant and a linear trend since the other two cases are just special cases of this more general specification.*

2. *D(.) stands for the first difference of the variable.*

3. ****indicates statistically significant at the 1 percent level, ** indicates statistically significant at the 5 percent level and * indicates statistically significant at the 10 percent level.*

3. VAR and cointegration test (Johansen test) results

The estimating process of VAR(p) model for the three different pairs of variables has been carried out, The process has been the following:

- Select the VAR type: Unrestricted VAR here;
- Set the estimation sample.
- Enter the lag specification
- Run a VAR, and for a chosen lag;
 - (1) Check the AIC, to find the smallest value;
 - (2) Check the residuals, to make sure they are not correlated.
- Conduct Johansen cointegration tests

3-1. Prime rate and overnight rate

The path of overnight rate and the prime rate is depicted in Figure 3 above. It is seen that these variables are, by and large, moving together during the 1985:02–2003:12 period. This observation suggests that the overnight rate and the prime rate may be cointegrated; there may be an empirical equilibrium relation between these variables. Furthermore, analysis with error-correction modeling techniques of the dynamically stable adjustment process, implied by the cointegration relation, can reveal the direction of causality between these variables.(See Enders,1995, chapter 6).

Empirical results obtained by employing Johansen cointegration and vector error-correction

modeling techniques are presented in Table 3 below. This table also contains ordinary least squares (OLSQ) estimates for comparison. In the 1985:01–2003:12 sample period there is a positive and a significant cointegration relation between the overnight rate and the prime rate. The cointegration coefficient is about 0.95, indicating an almost complete pass-through from the overnight rate to the prime rate. The error-correction term, the lagged residual of the estimated cointegration equation, is a significant determinant of both the change in the overnight rate, $D(ON)$, and the change in prime rate, $D(PR)$. Also, note that the error-correction term is a significant determinant of the change in prime rate, but not of the change in the overnight rate. These results indicate that while the PR adjusts in maintaining the cointegration relation, the ON does not. These findings imply a unidirectional causality that runs from the overnight rate to the prime rate during the sample period. And the prime rate adjusts rapidly, since the estimated error-correction term for $D(PR)$ indicates that about 26 percent of the adjustment in prime rate is completed within one month after the change in the overnight rate.

Table 3. Overnight rate and prime rate, OLSQ and Johansen estimates

Sample period	Intercept	ON	R²	Error-correction term
OLSQ	1.8942	0.9395	0.9823	
Johansen	1.8301	0.9498(56.8743)		
D(ON)				0.1693(1.7454)
D(PR)				-0.2610(-3.0598)

Notes: 1. ON is the overnight rate (right-hand side variable) and PR is the prime rate (left-hand side variable). Values in parentheses are t-statistics. The Johansen cointegration tests assume no linear deterministic trend, lag interval (in first differences): 1 to 1. For sample period, both

the trace tests and the Max-eigenvalue test indicates 1 cointegrating equation at both 5% and 1% levels

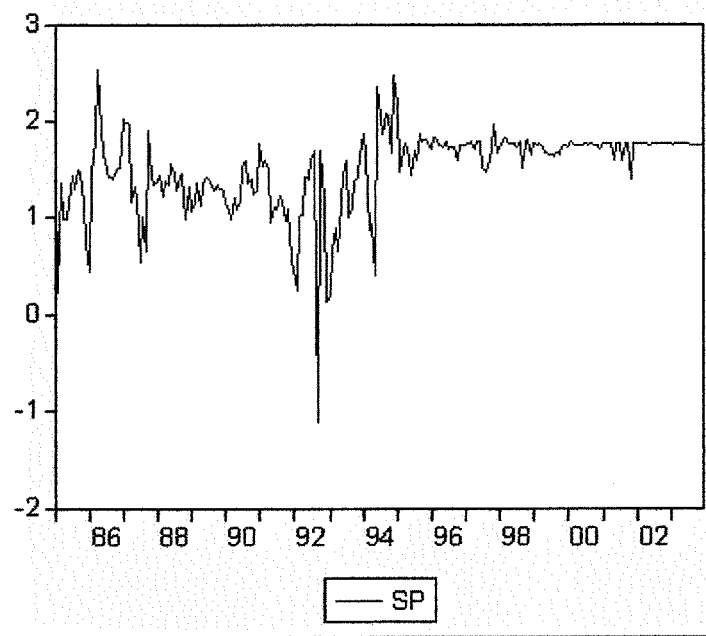
2. $D(ON)$ stands for the first difference of the overnight rate, and $D(PR)$ for the first difference of the prime rate.

3. t -values in parentheses.

A close examination of Figure 6 plotting of the spread, SP , reveals that the vertical distance between the overnight rate and the prime rate is more variable during the 1985–1995 period compared to the latter period from 1995 on, when an official target overnight rate was put in place. After 1995, the distance between these two variables barely appears to be varying. Note that the average spread in the after-1995 period is also higher than that of the previous period.

This shift in the markup would indicate that the banks have increased the interest rate spread to improve their profitability in the second period. By increasing the markup during the latter period, 1995–2003, banks might be trying to strengthen their balance sheets and increase their capital. Another possible explanation is that the institutional break taken place in 1994 makes the adjustment of short-term market interest rates to the change of the benchmark interest rate(ON) easier, faster and more stable.

Figure 6. Spread between prime rate and the overnight rate (percent)



3-2. Overnight rate and long-term Interest Rates

3-2-1. Overnight rate (*ON*) and Long-Term corporate bond yields (*CB*)

Paths of the long-term corporate bond yield (*CB*) and the overnight rate (*ON*) are presented in Figures 4. The figure shows that the spread (the vertical distance between the lines in each figure) between *CB* and *ON* is quite volatile from one period to the next. In the long run, however, *CB* and *ON* seem to move together.

After running VAR for *ON* and *CB*, the lag order selection criteria test indicates that the optimal lag length is 3 in the unrestricted VAR (and 2 in first differences) based on the Akaike Information Criterion (AIC). The multivariate LM test statistics for residual serial correlation up to the specified order 3 also shows no serial correlation at selected lag order 3.

The output of Johansen test listed in table 4 below tells that both Trace test and

Max-eigenvalue test indicate no cointegration at both 5% and 1% levels, i.e., there is no long-term equilibrium relationship between the two series in question, contrary to our original prediction.

Table 4: The results of Johansen cointegration test of long-term corporate bond yields and the overnight rate

Trend assumption: No deterministic trend (restricted constant)				
Series: CB ON				
Lags interval (in first differences): 1 to 2				
Unrestricted Cointegration Rank Test				
Hypothesized		Trace	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None	0.052241	15.54339	19.96	24.60
At most 1	0.015308	3.471041	9.24	12.97
<i>*(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Trace test indicates no cointegration at both 5% and 1% levels</i>				
Hypothesized		Max-Eigen	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None	0.052241	12.07235	15.67	20.20
At most 1	0.015308	3.471041	9.24	12.97
<i>*(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Max-eigenvalue test indicates no cointegration at both 5% and 1% levels</i>				

3-2-2. Overnight rate and Long-Term government bond yields

We continue the tests for exploring the relationship between long-term and short-term interest rates further using another group series: long-term government bond yields and the overnight rate.

Paths of the long-term government bond yield (*GB*) and the overnight rate (*ON*) were presented in Figure 5 above. Likewise, the figure shows that the spread (the vertical distance between the lines in each figure) between *GB* and *ON* is quite volatile from one period to the next. In the long run, however, *GB* and *ON* seem to move together.

After running VAR for *ON* and *GB*, lag order selection criteria test indicates once again that the optimal lag length is 3 in the unrestricted VAR (and 2 in first differences) based on the Akaike Information Criterion (AIC). And the multivariate LM test statistics for residual serial correlation up to the specified order 3 also shows no serial correlation at selected lag order 3.

The output of the Johansen test(see Table 5)tells that both Trace test and Max-eigenvalue test also indicates no cointegration at both 5% and 1% levels, i.e., there is no long-term equilibrium relationship between the two series in question, contrary to our original prediction

Table 5: The results of Johansen cointegration test of long-term government bond yields and the overnight rate

Trend assumption: No deterministic trend (restricted constant)				
Series: GB ON				
Lags interval (in first differences): 1 to 2				
Unrestricted Cointegration Rank Test				
Hypothesized		Trace	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None	0.046236	14.57075	19.96	24.60
At most 1	0.017269	3.919480	9.24	12.97
<i>(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Trace test indicates no cointegration at both 5% and 1% levels</i>				
Hypothesized		Max-Eigen	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None	0.046236	10.65127	15.67	20.20
At most 1	0.017269	3.919480	9.24	12.97
<i>(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Max-eigenvalue test indicates no cointegration at both 5% and 1% levels</i>				

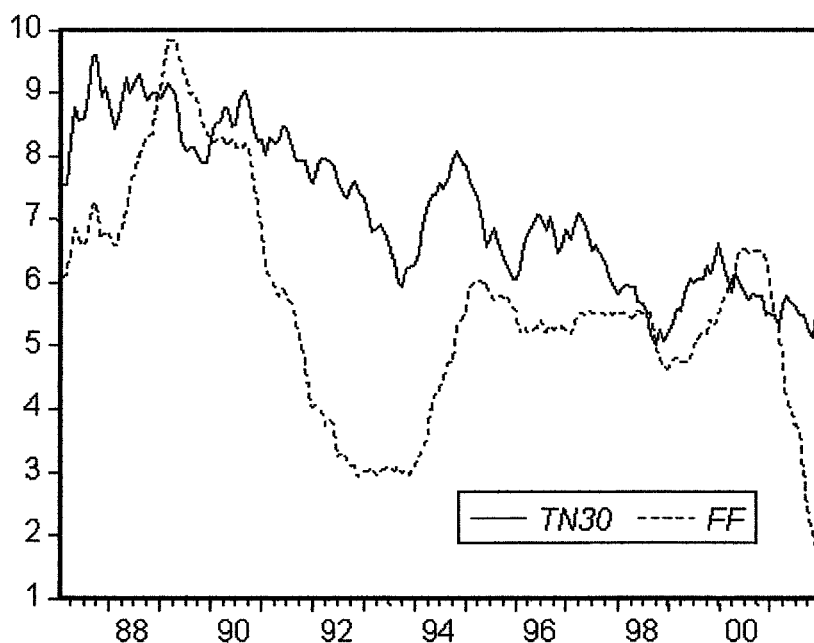
If we base our conclusion on the results of these two tests examining the relationship between long-term and short-term interest rates, we should stop here, and infer that there are no long-run equilibrium relationships between them. This would imply the ineffectiveness of the

interest rate channel in Canada.

However, to avoid too hasty a conclusion, we need more evidence to verify or refute this.

(1) In his "Monetary Policy and Long-Term Interest Rates", H. Atesoglu (2004,pp1-10) has proven there is an empirically stable long-run relation and uni-directional causality from the federal funds rate to the long-term interest rates in the U.S.. Intuitively, considering the close economic connection between Canada and U.S., our empirical test result should report results that are not widely different from the conclusions reached with American data. Comparing the graph showing U.S. federal funds rate (*FF*) vs. the 30-year Treasury note rate (*TN30*) (see figure 7) and that showing Canadian overnight rate and the long-term government bond yields (see figure 5), we can see some similarity between the two relationships to some extent. So I tried to replicate Atesoglu's test(2004) to find the reason, knowing that the lag-length chosen for the Johansen test for U.S. federal funds rate vs. the 30-year Treasury note rate was 43 months, which is actually much larger than the optimal selection according to the AIC criterion after running VAR. I guess that Atesoglu(2004) selected this lag length allowing for the response of TN30 to FF(See Figure7), while not relying on the AIC criterion alone, but rather relying on his estimate of the length of time required for short-term rates to impact long-term rates(suggested by the response pattern of TN30 to FF).

Figure 7. U.S. federal funds rate and 30-year Treasury note



Source: H. Sonmez Atesoglu, *Monetary Policy and Long-Term Interest Rates*, 2004.

(2) Many other papers in recent years have also verified the existence of a long-run equilibrium relationship between long-term and short-term interest rates with Canadian data, by using a more rigorous cointegration test technique -- *fractional cointegration*. It is said that the usual concept of cointegration is too restrictive, and thus we need to refer here to the concept of fractional cointegration introduced by Granger (1986, pp. 213-228). This notion is linked to fractional integration, which is itself linked to the long-term memory property of time series. In these conditions, the integration order of the error correction term is not necessarily 0 or 1, but it can be a real: the error correction term may be fractionally integrated. This allows for more various mean reverting behaviors. More specifically, a fractionally integrated error correction term implies the existence of an equilibrium long-term relationship between short-term and long-term interest rates. Thus, the error correction term needs not to be $I(0)$. Consequently, if

the error correction term is fractionally integrated, then there exists a fractional cointegration relationship (that is an equilibrium relationship) between interest rates, which is consistent with the expectations hypothesis. For instance, in "Estimating the Fractional Order of Integration of Interest Rates Using a Wavelet OLS Estimator" by Greg Tkacz (2000), to resolve the debate on the order of integration of interest rates long focused on the $I(1)$ versus $I(0)$ distinction, the author uses instead the wavelet OLS estimator of Jensen (1999, pp. 17-32) to estimate the fractional integration parameters of several interest rates for the United States and Canada from 1948 to 1999. His estimates of **fractional integration parameters (d)** of Canadian long-term and short-term interest rates 1978:3 to 1999:6 are shown as Table 6 below: the orders of all interest rate series with $0 < d < 1$. He finds that most rates are mean-reverting in the very long run, with the fractional order of integration increasing with the term to maturity. His findings differ somewhat over U.S. and Canadian rates. For the United States from 1948 to 1991, all short-term interest rates are long-run mean-reverting, while longer-term rates are most likely to follow unit root processes, as the estimated fractional integration parameters increase with the term to maturity. Non-constant term premia may be the cause of this last result. When restricting the attention to the latter half of the sample, he finds that the evidence in favor of non-stationarity is diminished. This leaves open the possibility that some rates, especially at the shorter horizons, may be following stationary long-memory processes. Overall, he concludes that the unit root hypothesis is unduly harsh for the United States except for the longer-term interest rates. Furthermore, the assumption of short-run mean-reversion is also strongly rejected by the data. The hypothesis that nominal interest rates follow long-memory processes seems the most plausible. Canadian rates also exhibit strong persistence over the full sample. Unlike the U.S. rates, however, this persistence remains even over the second half of

the sample. This indicates that shocks to interest rates take longer to dissipate in Canada than the United States. As noted, long-term bonds may be more non-stationary than short-term bonds due to the additional risk captured in the term premia. Canadian bonds are usually riskier than their American counterparts due to, for example, political uncertainty and exchange rate movements. This additional element of risk may be reflected in the larger order of integration of Canadian bonds in the last 20 years. For the applied researchers, the following conclusions emerge from the findings. First, the rate of mean-reversion decreases with the term to maturity, with longer-term rates reverting more slowly, if at all, to their means than short-term rates. Second, if these interest rates are used in cointegration analysis, then the underlying vectors may not be strict $I(0)$ processes. In other words, if the cointegrating relationship is fractionally integrated, then adjustments to shocks may take a longer time to be finalized.

Table 6: Estimated fractional integration parameters (d), Canada 1978:3 to 1999:6 (256 observations)

Rate	Wavelet			
	Haar	Daubechies-4	Daubechies-12	Daubechies-20
1-month	0.8598 (0.0272)	0.9123* (0.0444)	0.9412* (0.0385)	0.9326 (0.0243)
3-month	0.8752 (0.0285)	0.9202* (0.0454)	0.9529* (0.0362)	0.9520* (0.0266)
1- to 3- years	0.8751 (0.0267)	0.8983 (0.0426)	0.9378 (0.0259)	0.9299 (0.0116)
3- to 5- years	0.8841 (0.0307)	0.8997* (0.0515)	0.9438* (0.0310)	0.9303 (0.0147)
5- to 10- years	0.9008 (0.0359)	0.9059* (0.0644)	0.9511* (0.0337)	0.9438 (0.0170)
10-years and over	0.9226 (0.0384)	0.9184* (0.0705)	0.9603* (0.0332)	0.9572 (0.0209)

Note: Standard errors in parentheses. A (*) indicates that the unit root is within two standard errors of the estimated d .

Source: Greg Tkacz, "Estimating the Fractional Order of Integration of Interest Rates Using a Wavelet OLS Estimator", Working Paper 2000-5, Bank of Canada.

(3) *Cointegration, error-correction, and the econometric analysis of non-stationary data* (Granger, 1993, p.286) says "Both Gonzalo's (1994, pp.203-233) and Reimers's (1992, pp.335-359) studies consider the effects on the MLE (Johansen maximum likelihood estimator) of using incorrect lag lengths for the short-run dynamics. Gonzalo finds that the loss of efficiency from choosing too long a lag is small. However, if too short a lag length is used then the MLE is no longer the best method."

For these reasons, we can consider modifying the original standard cointegration tests in 3-2-1, 3-2-2 with larger lag lengths to approximate the truth. Since shocks to interest rates take longer

to dissipate in Canada than in the United States as noted by Tkacz(2000), it is reasonable to assume that we should use longer lag-lengths with Canadian data than their counterpart of the U.S. In Atesoglu's (2004) Johansen tests, the lag-length chosen for U.S. federal funds rate vs. the 30-year Treasury note rate was 43 months and for U.S. federal funds rate vs. the AAA bond yields was 35 months.

3-3. Cointegration analysis

Empirical results obtained for the relations between *CB* and *ON*, and *GB* and *ON* employing the Johansen cointegration and vector error-correction modeling technique with modified lag-lengths are presented in Tables 7 to 10 below. For comparison with these results, OLS (ordinary least squares) estimates are also presented.

3-3-1. Overnight rate (*ON*) and Long-Term corporate bond yields (*CB*)

Johansen results indicate that there is a positive and empirically stable long-run relation, a cointegration relationship between *CB* and *ON*. OLS results also indicate a comparable positive relation between *CB* and *ON*.

Note that the cointegration coefficient is about 0.66 for the cointegration equation, indicating there is a less than complete pass-through from the overnight rate to the long-term interest rates in the long-run. Vector error-correction models were estimated for the cointegration relations between *CB* and *ON*. The error-correction terms from the vector error-correction models (the lagged residual of the estimated cointegration equations) presented in Table 7 are significant determinants of the change in long-term corporate bond yield, $D(CB)$. But, the error-correction terms for the change in the federal funds rate, $D(ON)$, are not significant. These results indicate

that while the *CB* adjusts in maintaining the cointegration relations, the *ON* does not. These findings imply a uni-directional causality that runs from the overnight rate to the long-term corporate bond yield.

The estimated error-correction terms for $D(CB)$ indicates that only about 13 percent of the adjustment in *CB* is completed within one month after the change in the overnight rate. This finding about the relation between the overnight rate and the long-term corporate bond rate contrast with the larger adjustments in the prime rate that we presented earlier.

Table 7. The results of Johansen cointegration test of long-term corporate bond yields and the overnight rate with modified lag-length

Trend assumption: No deterministic trend (restricted constant)				
Series: CB ON				
Lags interval (in first differences): 1 to 43				
Unrestricted Cointegration Rank Test				
Hypothesized		Trace	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.095871	23.39884	19.96	24.60
At most 1	0.026040	4.854765	9.24	12.97
<i>*(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Trace test indicates 1 cointegrating equation(s) at the 5% level</i>				
<i>Trace test indicates no cointegration at the 1% level</i>				
Hypothesized		Max-Eigen	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.095871	18.54408	15.67	20.20
At most 1	0.026040	4.854765	9.24	12.97
<i>*(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Max-eigenvalue test indicates 1 cointegrating equation(s) at the 5% level</i>				
<i>Max-eigenvalue test indicates no cointegration at the 1% level</i>				

Table 8. Overnight rate and long-term corporate bond yield, OLSQ and Johansen estimates with modified lag-length

Sample period	Intercept	ON	R ²	Error-correction term
OLSQ	5.3981	0.5537(25.6911)	0.7449	
Johansen	4.1510	0.6639(10.67)		
D(ON)				-0.0079(-0.1287)
D(CB)				-0.1342(-3.1698)

Note: 1. CB is the long-term corporate bond yield, ON is the overnight rate. Values in parentheses are t-statistics. The Johansen cointegration test assumes no linear deterministic trend, and a lag interval (in first differences) of 1 to 43 months.

3. t-values in parentheses.

3-3-2. Overnight rate and Long-Term government bond yields

The Johansen test also indicates that there is a positive and empirically stable long-run relation, a cointegration relationship, between *GB* and *ON*. OLS results also indicate a comparable positive relation between *GB* and *ON*.

Note that the cointegration coefficient is about 0.69 for the cointegration equation, indicating there is again a less than complete pass-through from the overnight rate to the long-term interest rates in the long-run. Vector error-correction models were estimated for the cointegration relations between *GB* and *ON*. The error-correction terms from the vector error-correction models (the lagged residual of the estimated cointegration equations) presented in Table 9 are significant determinants of the change in long-term corporate bond

yield, $D(GB)$. But, the error-correction terms for the change in the federal funds rate, $D(ON)$, are not significant. These results indicate that while the GB adjusts in maintaining the cointegration relations, the ON does not. These findings imply a uni-directional causality that runs from the overnight rate to the long-term corporate bond yield.

The estimated error-correction terms for $D(GB)$ indicates that only about 11 percent of the adjustment in GB is completed within one month after the change in the overnight rate.

Table 9. The results of Johansen cointegration test of long-term government bond yields and the overnight rate with modified lag-length

Trend assumption: No deterministic trend (restricted constant)				
Series: GB ON				
Lags interval (in first differences): 1 to 44				
Unrestricted Cointegration Rank Test				
Hypothesized		Trace	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.103006	24.24306	19.96	24.60
At most 1	0.023489	4.349743	9.24	12.97
<i>*(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Trace test indicates 1 cointegrating equation(s) at the 5% level</i>				
<i>Trace test indicates no cointegration at the 1% level</i>				
Hypothesized		Max-Eigen	5 Percent	1 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Critical Value
None *	0.103006	19.89332	15.67	20.20
At most 1	0.023489	4.349743	9.24	12.97
<i>*(**) denotes rejection of the hypothesis at the 5%(1%) level</i>				
<i>Max-eigenvalue test indicates 1 cointegrating equation(s) at the 5% level</i>				
<i>Max-eigenvalue test indicates no cointegration at the 1% level</i>				

Table 10. Overnight rate and long-term government bond yield, OLSQ and Johansen estimates with modified lag-length

Sample period	Intercept	ON	R ²	Error-correction term
OLSQ	4.2695	0.5693(24.7095)	0.7298	
Johansen	2.8004	0.6913(89.1417)		
D(ON)				0.0001(0.0022)
D(GB)				-0.1111(-3.2525)

Note: 1. GB is the government bond yield, ON is the overnight rate. Values in parentheses are t-statistics. The Johansen cointegration test assumes no linear deterministic trend, and a lag interval (in first differences) of 1 to 43 months.

3. *t-values in parentheses.*

In Figures 8 and 9, the impact of *ON* changes on *GB* and *CB* are also presented.

These results are obtained from the vector error-correction models mentioned above that are estimated for the cointegration relation between *CB* and *ON*, and *GB* and *ON*. Figure 8 shows that, in response to an appreciable increase in *ON*, *GB* rises relative little in the first 8 months and reaches its peak response, around 24 percent, after about 30 months. As seen in Figure 9, the response of *CB* is also weak. These results as a whole suggest that Bank of Canada's actions, in the form of changes in the overnight target rate, do have an appreciable effect on long-term interest rates in the long-run. But, such actions do not have obvious effects on long-term interest rates in the short-run.

Figure 8.

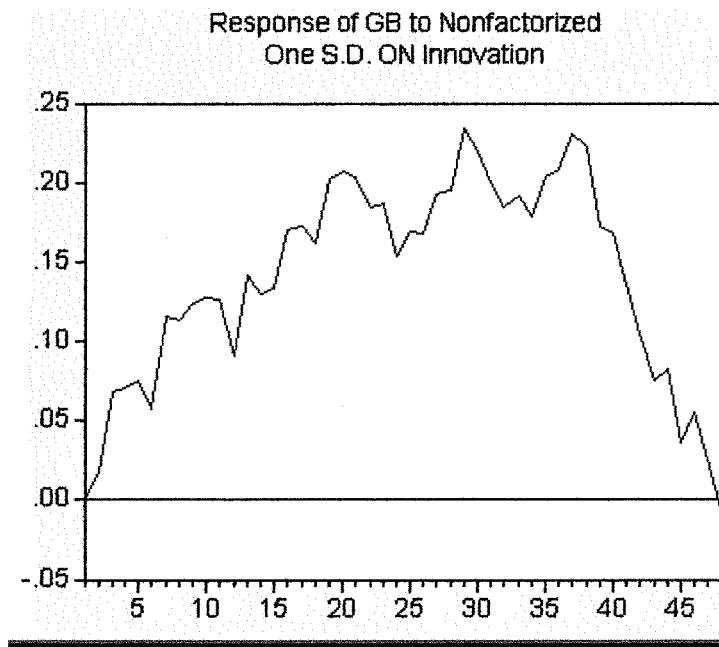
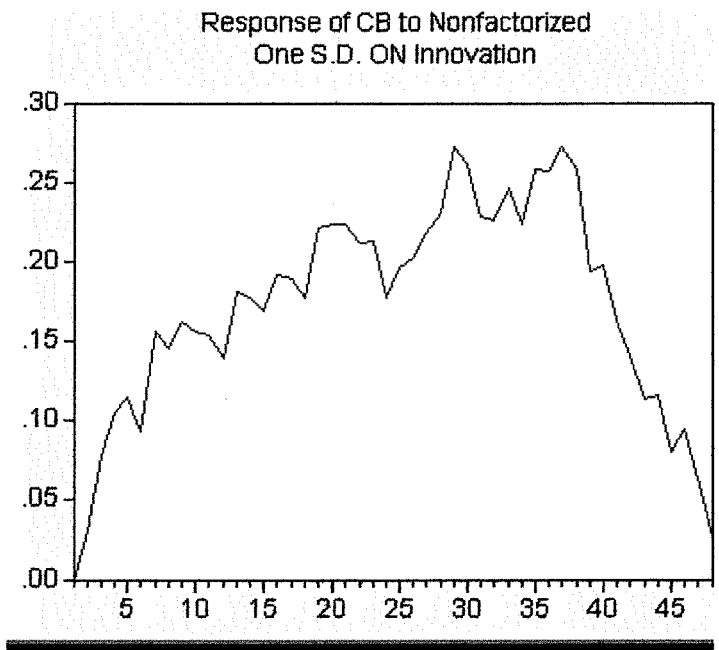


Figure 9.



V. Conclusion

In replying to the question of whether there are constraints on the ability of the central bank in controlling long-term rates of interest via its control of short-term rates, our first empirical findings with standard cointegration test tools are obviously contrary to the standard views of the term structure and monetary transmission mechanism. This contradiction may be due to the fact that the usual concept of cointegration is too restrictive. Thus after considering other important factors likely to influence the actual underlying relationship between the long-term and short-term interest rates in the long-run, combined with the more recent econometric techniques -- fractional cointegration, the lag-length parameters are modified to re-examine the long-run relationship. The results imply that such a fractional cointegration relationship exists.

In sum, the findings discussed above are qualified, but basically consistent with a monetary transmission mechanism where changes in the overnight rate, brought about by the decisions of the Bank of Canada, lead to changes in long-term interest rates. These findings are supportive of the interest rate channel of monetary transmission through financial markets and through the banking system. The findings, by revealing that there is an empirically stable long-run relation and uni-directional causality from the overnight rate to the long-term interest rates, are also supportive of the horizontalist rather than the structuralist view of the money supply endogeneity.

The findings, while indicating an empirically stable long-run relation between the overnight rate and long-term interest rates, also reveal that changes in the overnight rate do not have much of an impact on the long-term interest rates in the short-run. This can be contrasted to the

large and quick effects of the overnight rate changes on the prime rate, as discussed in the early part of the present paper. These results raise doubts concerning the effectiveness of monetary policy in the short-run and suggest that in the short-run the Bank of Canada can not rely on the long-term interest rate transmission channel of monetary policy. In the short-run, the Bank of Canada manipulation of the overnight rate appears to have a strong leverage on short-term interest rates, but not on the long-term rates.

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